Blood Rubber*

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Abstract: We examine the legacy of one of the most extreme examples of colonial extraction, the rubber concessions granted to private companies under King Leopold II in the Congo Free State, the present-day Democratic Republic of Congo. The companies used violent tactics to force villagers to collect rubber. Village chiefs were co-opted into supporting the rubber regime, and villagers were severely punished if they did not meet the rubber quotas. We use a regression discontinuity design along the well-defined boundaries of the ABIR and Anversoise concessions to show that historical exposure to the rubber concessions causes significantly worse education, wealth, and health outcomes. We then use survey and experimental data collected along a former concession boundary to examine effects on local institutions and culture. We find a negative effect on local institutional quality and a positive effect on culture. Consistent with the historical co-option of chiefs by the concession companies, village chiefs within the former concessions are more likely to be hereditary, rather than elected, and they provide fewer public goods. However, individuals within the concessions are more trusting, more cohesive, and more supportive of sharing income. The results suggest that colonial extraction may have different effects on institutions and culture.

Keywords: Africa, development, culture, institutions, colonialism.

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

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1. Introduction

A large literature examines the origins of sub-Saharan Africa's comparative development. Of particular interest has been the role of pre-colonial and colonial institutions. Pre-colonial ethnic-group level characteristics such as political centralization and exposure to the slave trade are important for understanding present day development (Gennaioli and Rainer, 2007, Michalopoulous and Papaioannou, 2013, 2014, Alsan, 2015, Nunn, 2008). Similarly, a large body of literature suggests that colonial institutions, and in particular colonial identity, have influenced African development (La Porta, López de Silanes, Shleifer and Vishny, 1998, Acemoglu, Johnson and Robinson, 2001).

Colonial rule was a bundle of goods comprised of investments and extraction. Investments in education, health, and infrastructure, either by the colonial state or missionaries, have been shown to have persistent, often positive, effects on development outcomes. However, colonial institutions also comprised elements of extraction (Heldring and Robinson, 2012). For example, the use of labor coercion was nearly universal (van Waijenburg, 2015). A common strategy was to use indirect rule – the co-option of local institutions – to achieve a colonial goal (Mamdani, 1996, Acemoglu, Reed and Robinson, 2014). While the effects of investments made by colonial governments have been studied (Huillery, 2009, Cage and Rueda, 2016, 2017, Osafo-Kwaako, 2012, Wantchekon, Klasnja and Novta, 2015, Lowes and Montero, 2017, Glaeser, La Porta, Lopez-De-Silanes and Shleifer, 2004), there is much less evidence on the effects of colonial extraction in Africa.

We examine one of the most extreme cases of colonial extraction, the Congo Free State (CFS). The CFS, what is today the Democratic Republic of Congo (DRC), was the personal colony of King Leopold II of Belgium between 1885 and 1908. Leopold designated large parts of the CFS as concessions to private companies. The companies used extremely violent tactics to force villagers to collect rubber. Historians have noted that the rubber concessions granted under Leopold II had disastrous consequences for local populations. As Hochschild describes, "the world has managed to forget one of the great mass killings of recent history...it was unmistakably clear that the Congo of a century ago had indeed seen a death toll of Holocaust dimensions" (Hochschild, 1998, pp. 3-4). In fact, an estimated 10 million people, approximately half of the population of Congo, died between 1880 and 1920 (Vansina, 2010, Hochschild, 1998). Despite the magnitude of the event, scholars have yet to empirically examine its implications for present-day development.

Exposure to the rubber concessions was characterized by the extraction of rubber, violence, and the use of local institutions, namely village chiefs, to enforce rubber quotas. The concession companies were given monopoly rights over natural resource extraction within the concession boundaries. European agents had monetary incentives tied to rubber production and were encouraged to use whatever means necessary to collect rubber. In fact, they were given state resources, primarily soldiers from the CFS armed forces (the *Force Publique*) and a state mandate to use coercive means, to reach their rubber extraction goals. The other critical component of exposure to the concession companies was the use of indirect rule. Historical accounts of the rubber concession period highlight how the rubber companies forced village chiefs 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).

The historical episode is particularly well-suited to examining the effects of exposure to colonial extraction because, unlike in other contexts where colonial governments or associated businesses also made investments for production (e.g. see Juif and Frankema (2017) for an example from southwestern DRC or Dell and Olken (2017) for an example from Indonesia), these companies did not make productive investments in these areas. Rubber is a unique commodity in that it requires little capital investment to be collected and does it not require training of the labor force. The primary input is labor, and the concession areas are connected to river networks so that there was no need to invest in road infrastructure. Thus, the key focus was extraction.

We use the well-defined boundaries of the two largest rubber concessions, ABIR and Anversoise, to examine the long-run effects of colonial extraction on economic development. The boundaries of ABIR and Anversoise 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, which are defined as a river and its tributaries, and a 25 kilometer buffer around the river basins to define the boundaries of the concessions (Harms, 1975). 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 extraction on present-day education, wealth, and health outcomes. Using a geographic regression discontinuity design, we find that individuals from the former concessions areas have significantly worse education, wealth, and health outcomes than individuals from just outside the former concessions. We analyze the DHS data by age cohort and find that there is little evidence of convergence in years of education, wealth, or height-for-age over time. We also use archival data to digitize the locations of posts where European agents were located within the rubber concessions. We create proxies for intensity of exposure to the rubber concessions at the post level: the length of time a post was in existence and estimates of the quantity of rubber collected by villages around the posts. We find that greater intensity of exposure to rubber extraction is correlated with lower wealth today for villages near posts.

We address several possible concerns with examining the effects of the historical rubber concessions: the use of river basins (plus the 25 km buffer) to define boundaries, selective migration, and subsequent colonial or missionary investment. First, we test whether the results reflect some inherent characteristic of residing within major river basins, rather than the effects of the rubber regime, by estimating our main specification across all major river basins in the DRC. Our estimates for the two rubber concessions are larger and more negative than the estimated effects on years of education for all other major river basins in DRC, suggesting that our results are not a consequence of using river basins to delineate the borders, but rather that the concessions were present in these river basins. Second, we test whether the observed results are driven by selective migration. We conduct several analyses to test what the extent of selective migration would have to be to fully explain our results and whether we observe differences in effect sizes between places where it is easier to migrate across the border relative to places where it is harder to migrate across the border. Finally, we digitize historical data to test for differential subsequent Belgian colonial investment and missionary presence. We find no evidence that selective migration, Belgian investments, or missionary presence explain our observed results.

When examining the effects of colonial extraction, there is naturally an interest in understanding the channels through which these effects persist. Various theories have been proposed for the origins of economic prosperity, and thus as potential fundamental channels, including institutions, culture, and geography (e.g. Acemoglu and Robinson, 2012). We examine the effect of exposure to the rubber regime on local institutions and on culture. Institutions are defined as external "rules" that shape individuals' expected payoffs from different actions, and culture is defined as the collection of beliefs and values of individuals.[1] We look at the effects of colonial extraction on both institutions and on culture because it is not clear that the effects should move in the same direction, i.e. undermine both local institutions and undermine culture.

To examine how exposure to colonial extraction has affected local institutions and culture, we collected survey and experimental data in Gemena, DRC, a town on the border of the former Anversoise concession. Gemena was created after the end of the concession era; therefore, those who live there are migrants themselves or decedents of migrants. Our analysis compares individuals in Gemena with ancestors from inside the former concessions to individuals with ancestors from outside the former concessions. Thus, everyone in the sample has a "village of origin" – the place where they and their family are from, even if they were not born there and do not currently reside there – along the concession boundary. By considering a population that currently lives in the same institutional environment, we are better able to isolate the impact of the rubber concession period on culture. To address concerns about using a sample of migrants, we present robustness to looking at only first generation migrants and only second generation and higher migrants, in addition to showing balance on reasons for migration.

Using our original survey data, we first examine how colonial extraction has affected local institutions. We test whether villages of origin within the former concessions have lower quality village institutions as measured by: (i) the selection mechanism for the chief (elections versus hereditary) and (ii) the extent to which the chief provides various public goods for the village. We find that village chiefs within the former concessions are 17 percentage points less likely to be elected to their position and are more likely to be hereditary. Given that we generally believe elected leaders (rather than hereditary leaders) are more accountable to their constituents, this suggests that leaders in villages in former concession areas are less accountable. Consistent with this, the village chiefs inside the former concessions are also less likely to provide critical public goods, such as road maintenance and conflict arbitration. Across these various measures, villages in the former rubber concessions have worse local institutions and lower provision of public goods.

We then examine how exposure to the rubber concessions has affected culture, which we define as the beliefs and values held by individuals. We measure several different cultural

[1] For evidence on the importance of institutions for development, see North (1990), Acemoglu et al. (2001), Acemoglu and Robinson (2012), Johnson and Koyama (2017). For evidence on the importance of culture for development, see Greif (1994a), Nunn and Wantchekon (2011).

traits, including trust, social cohesion, altruism, and support for sharing income, using both survey and experimental measures. First, we examine how trust was affected as result of the rubber period. This is particularly important because previous work has highlighted a positive correlation between trust and growth (Algan and Cahuc, 2010). If those areas exposed to colonial extraction are now less trusting, then this may explain their relative underdevelopment. Using survey questions on trust in a variety of other individuals or groups, we find that individuals from areas exposed to the rubber concessions are *more* trusting of others than those just outside the former concessions. We are unable to distinguish a differential effect for "in-group" versus "out-group" trust.

Because the historical narrative describes how communities responded to the concessions by increasing reliance on social ties and informal insurance, we then examine measures of social cohesion and support for sharing income. We provide evidence that individuals from the former concession areas report feeling closer to a variety of others and are 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 designed to test support for sharing income, individuals from concession areas are more likely to redistribute money from another player's earned endowment. Consistent with stronger beliefs in the importance of sharing, we find lower levels of income inequality (as measured by the standard deviation of and the inter-quartile range of the DHS wealth factor score) within DHS clusters inside the former concessions. These results of greater trust and cohesion and greater support for sharing income are surprising given that a large literature, primarily on Europe, shows that good institutions and "good" culture are positively correlated in the cross-section (see e.g. Guiso, Sapienza and Zingales, 2004, 2016, Tabellini, 2010, Valencia Caicedo, 2015, Gächter and Schulz, 2016). However, a growing literature on sub-Saharan Africa suggests that this need not be the case: bad institutions may actually be correlated with "good" culture (Acemoglu et al., 2014, Lowes, Nunn, Robinson and Weigel, 2017).

Finally, we examine the broader implications of the Leopold II concession system for the development of DRC as a whole, which is one of the least developed countries in the world.[2] Large parts of the CFS were granted as concessions during the CFS era. While the boundaries of the other concessions are less plausibly exogenous because they existed for longer periods of time under different political regimes, focused on the extraction of resources other than rubber,

[2] DRC is ranked 176 of 188 in the UN's 2016 Human Development Index.

and coincide with present day political boundaries, we can implement a similar RD design for all concession boundaries in the Congo. We find that being inside any former concession in DRC is correlated with worse development outcomes. For the 60% of the country that was part of a former concession, wealth would be 15% higher had these areas not been part of a concession. This is equivalent to increasing GDP per capita inside all former concessions areas from around $750 to $900. Understanding the effects of exposure to colonial extraction is relevant more generally because various forms of labor coercion and indirect rule were practiced in most African colonies.

We contribute to several literatures. Most broadly, we provide evidence on the effects of an historical event of significant magnitude that has yet to be examined quantitatively. This, in its own right, is of importance. After the slave trade, the Leopold II concession system is arguably one of the most important events in modern African history. Joseph Conrad, author of *Heart of Darkness*, describes this era as "the vilest scramble for loot that ever disfigured the history of human conscience and geographical exploration". We show that the rubber concessions granted by Leopold II have large and significant negative effects on economic development. This finding is related to a literature on the economic effects of mass exterminations, such as the Holocaust, the Rwandan genocide, and the expulsion of the Moriscos (Acemoglu, Hassan and Robinson, 2011, Rogall and Yanagizawa-Drott, 2014, Chaney and Hornbeck, 2016).

We contribute to the literature on comparative African development by demonstrating the negative effect of exposure to colonial extraction. An important set of studies using cross-country evidence found a large negative effect of colonialism on modern outcomes (La Porta et al., 1998, Acemoglu et al., 2001). However, other work suggests that the investments made by colonial regimes in public goods such as education and health continue to have important positive benefits (Huillery, 2009, Cage and Rueda, 2016, 2017, Wantchekon et al., 2015). In this paper, we are able to isolate the long-run effects of colonial extraction, rather than other possible confounding factors, by comparing areas that are geographically and culturally similar, had no differential colonial or missionary investment, and are presently under the same national institutions, but that had differential exposure to colonial extraction. Cross-country evidence is ill-suited to studying this particular question, while the sub-national variation in our setting lends itself to isolating the role of colonial extraction relative to other factors.

Relatedly, we also contribute to the literature on how indirect rule undermines accountability of local leaders (Mamdani, 1996). For example, Acemoglu et al. (2014) show that indirect rule has led to worse development outcomes but higher levels of social capital in Sierra Leone. We are able to leverage the exposure to the rubber regime, and the resulting variation in exposure to indirect rule, to provide evidence that indirect rule has been particularly detrimental to the quality and accountability of local leaders.

We also provide evidence on the relationship between institutions, culture, and development. We do this in two ways. First, we highlight how exposure to colonial extraction may have had unexpected effects on culture. Previous work has found that exposure to the slave trade may have undermined trust (e.g. Nunn and Wantchekon, 2011). However, a literature from political science, psychology, and evolutionary anthropology suggests that negative shocks, particularly from external threats, may actually increase social cohesion (Henrich, 2004, 2016, Boyd and Richerson, 1985, Bauer, Cassar, Chytilová and Henrich, 2014).[3] We demonstrate a persistent positive effect on culture as a result of the rubber period. While our results are different from Nunn and Wantchekon (2011), this highlights how the relative position of the perpetrator, e.g. a neighbor or family member versus a representative of the colonial regime, matters for subsequent trust outcomes.

We also demonstrate that, contrary to cross-sectional evidence primarily from Europe (Guiso et al., 2004, 2016, Tabellini, 2010, Gächter and Schulz, 2016), "good" institutions are not necessarily positively correlated with "good" culture. In fact, we find that worse local institutions are correlated with more pro-social values and beliefs in this context. This speaks to a growing theoretical literature that adopts an evolutionary perspective on the development of institutions and culture and under what conditions they may act as substitutes or complements (Greif, 1994b, 2006, Alesina and Giuliano, 2015, Besley and Persson, 2016, Greif and Tabellini, 2017, Bisin and Verdier, 2017). The long-run effect of exposure to extractive institutions, or other such critical junctures, likely depends on these cultural and institutional dynamics. While we cannot speak directly to the interaction between institutions and culture – as we can only identify the effects of colonial extraction on our outcomes – the results suggest that institutions and culture need not

[3] For example, Bauer, Blattman, Chytilová, Henrich, Miguel and Mitts (2016) provide an analysis of nearly 16 studies that examine the relationship between violence and social norms. The evidence they review suggests that violence can increase norms of local cooperation but, this increase does not necessarily improve subsequent development. This is consistent with an evolutionary perspective that emphasize the importance of local cooperation in the face of an external threat.

move in the same direction.[4]

Finally, we contribute to the literature on the long-run effects of labor coercion, a common element of colonial extraction in Africa and a common feature of labor relations for much of human history. Our paper is related to Dell (2010), who examines the long-run impacts of the mining *mita* in Peru, Nunn (2008), who documents the long-run effects of the slave trade, Dippel, Greif and Trefler (2017), who provide evidence on how labor coercion was effective in the British West Indies, and Acemoglu and Wolitzky (2011), who model how labor coercion affects effort in a principal-agent framework. Interestingly, we find negative estimates of a similar magnitude to Dell (2010). However, the colonial experience of Africa was vastly different from that of Latin America, and the "treatments" differ greatly across contexts – in particular with regard to the use of indirect rule. Additionally, by collecting survey and experimental data in the field, our paper is able to provide evidence on both institutional and cultural changes internal to those areas exposed to colonial extraction.

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 describes the data collection along a former concession boundary and presents results on the effects of the rubber concessions on local institutional quality and culture. Section 5 evaluates the broader implications of the concessions granted under Leopold for the whole of DRC. Finally, 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

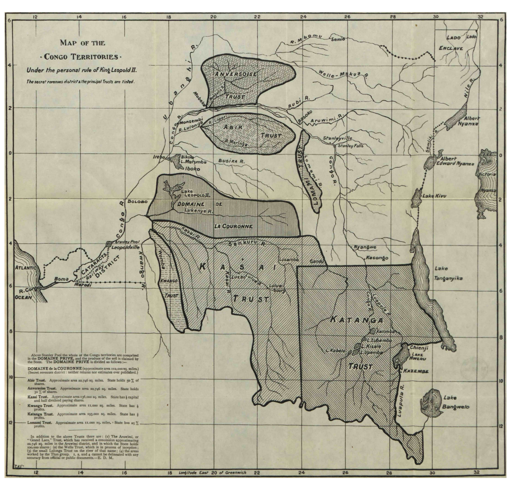
[4] Theoretically, the work by Bisin and Verdier (2017) is most closely related to how we approach understanding the legacy of the rubber concession system. The authors model the joint evolution of culture and institutions and highlight under what conditions cultural and institutional dynamics act as complements or substitutes. The authors write that in a society where culture and institutions are substitutes, good civic culture, for example, dampens the incentive to build better institutions.

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.

2.1. Concessions in the Congo Free State

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 1891 and 1892, in an attempt to increase revenues and contrary to the spirit of the Berlin agreement, he declared all lands and any raw materials found on these lands to be the property of the CFS. This decree divided Congo into three areas. The first area was the *domaine privé*, which was property of the state. Areas of the *domaine privé* were divided into concessions given to private companies. The two largest concessions granted in the *domaine privé* were Anglo-Belgian India Rubber Company (ABIR) and Anversoise (Waltz, 1918, pp. 34-36). An additional part of the *domaine privé* was allocated as private land for the king himself, called the *domaine de la couronne*. A second area, called the "closed area," was to be settled as circumstances allowed. Most of this area was eventually allocated to the Katanga Company in the southwest. The rest of the country was primarily a "free trade zone" where individuals of any nationality could engage in trade. The Kasai region in the South and Southeast remained open to free trade until 1902, when the Kasai trust was established. See Figure 1 for a map of the concessions as of 1904.

Figure 1: 1904 Map of Concessions Granted By Leopold II



Note: The two most northern concessions are Anversoise and ABIR.

The administration of the various areas of the CFS varied depending on whether they were part of a concession, the concession's timing and duration, and the natural resources present in the area. The ABIR and Anveroise concessions were the largest focusing on the collection of rubber and existed for 14 years, from 1892 to 1906. The Kasai area was partially under the free trade regime, then part of a concession company from 1902 to the mid-1950s. The Katanga area was part of a concession, though the extraction focused primarily on copper, rather than rubber. The ABIR and Anversoise concessions differed from these other concessions in that their borders were defined by the extent of river basins, their borders do not coincide with present day political boundaries, they existed for a short period of time, and the concessions focused almost exclusively on the collection of rubber. While most of the paper focuses on the ABIR and Anversoise concessions, we return to an examination of all of the concessions granted during the CFS in Section 5.

2.2. *Creation of ABIR and Anversoise*

ABIR and Anversoise were created in the Upper Congo Basin shortly after the invention of the pneumatic tire in 1890, which lead to a dramatic increase in the demand for natural rubber. The Upper Congo Basin had immense natural rubber resources, and Leopold finally saw an opportunity for profits. The state had limited manpower and capacity, so Leopold established concessions to be given to private companies for the exploitation of rubber.

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). 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 area around them.[5] In the same year Anversoise was created and given extraction rights in

[5] 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.

the Mongala river basin, defined by the Mongala river and its tributaries.[6] Figure 2 presents the boundaries of the ABIR and Anversoise concessions.

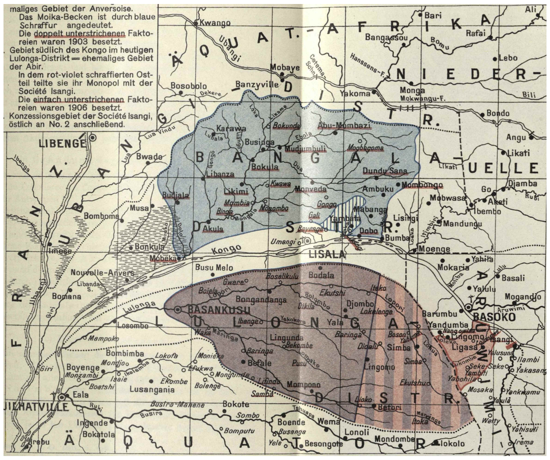
To see that the boundaries of the concessions do in fact conform to the definitions as stated in the founding contracts, Figure 3 illustrates the concession boundaries and the associated river basins. The concession borders appear to align almost exactly with the extent of the river basins. Additionally, Figure 3 shows the locations of the posts established by the concession companies. The posts all fall within the boundaries of the concessions. In Appendix B, we digitize all rivers in the area from a 1906 map to demonstrate that there are many rivers outside of the concession boundaries that are not part of the relevant river basins. In return for the land granted to the concession companies, the state would collect 2% of the 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.

2.3. *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, nor did it require the training of the labor force. The intensity of rubber extraction in concession areas was thus linked to the supply and productivity 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 collection of rubber based on these population censes (which, unfortunately, we have been unable to locate and were reportedly destroyed). Male villagers were required to deliver a quota of about 4 kilos of dried rubber every 2 weeks. In

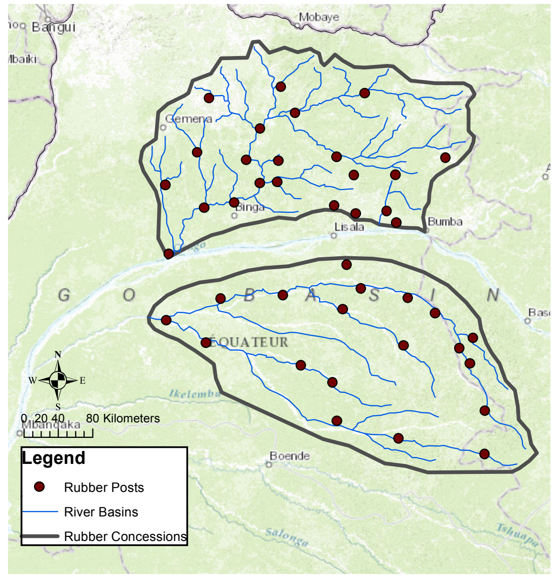
[6] This concession was defined as the area north of part of the Congo River up to the former international border between the CFS and French Equatorial Africa. The initial contract between the Secretary of the Interior of CFS, Mr. Eetvelde, and Mr. Alexander de Browne de Tiège, representative of Anversoise 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).

Figure 2: ABIR and Anversoise Rubber Concessions



Notes: The Anversoise rubber concession is the northern concession and the ABIR concession is the southern concession Waltz (1918).

Figure 3: Concessions, Posts, and River Basins



Notes: The Mongala river basin is the northern basin and the Maringa-Lopori river basin is the southern basin.

addition, villages were required to provide food and supplies to maintain nearby posts (Harms, 1983, 1975).

Most rubber collected during the CFS era was from the vine *landolphia*, which is delicate and easily damaged, rather than from the more hearty rubber trees, *funtumia elastica*, which were more prevalent in the French Congo and West Africa (Harms, 1975). Rubber collection was both time intensive and physically demanding. Individuals would travel deep into the jungle, find a rubber vine, make incisions in the vine to let the sap trickle out, and then allow the sap to dry. This process could take days, particularly as rubber supplies dwindled and untapped rubber vines became more difficult to find. 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.

2.4. Violence

The concession companies maintained militias comprised of sentries who were responsible for ensuring compliance with the rubber quotas. Generally, the sentries were outsiders recruited from other areas of Congo; this strategy was purposefully selected to ensure that sentries were willing to use violence against villagers. 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 the villages surrounding the posts. 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. The human hands were then smoked for preservation and collected by the European agents.

Individuals were severely punished if they failed to meet their rubber quota. The sentries from the concession companies' private militias were primarily responsible for carrying out these violent tactics. However, the European agents also engaged in the imprisonment, torture, and killing of villagers. 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).

Testimony collected by Robert Casement, a British consul sent to Congo to investigate accusations of atrocities, documents the intensity of the violence. First hand African accounts illustrate the extent of the violence:

> *"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 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.

2.5. *Political Capture and Indirect Rule*

A tactic employed by sentries to ensure rubber production was to undermine and co-opt local authority. One of the sentries in each village was assigned the position of *kapita*, or head sentry for that village. In fact, *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 and village chiefs. The village headmen were "shamelessly degraded in the eyes of their people, made to fetch and 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).

2.6. 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. As villages lacked the manpower to maintain and cultivate fields, agricultural production decreased. Historians have highlighted how the rubber period "demanded social adaptation and new forms of cooperation and mutual aid" (Nelson, 1994, p.102). Villagers had to develop alternative coping mechanisms as they faced a brutal rubber regime and local leaders who were unable to protect them.

According to oral histories of the Mongo people, who resided in the ABIR concession (see Figure A2b in Appendix B), the rubber period was associated with an increased reliance on horizontal ties and cooperation among villagers of the same age grade. These horizontal ties served several purposes. First, these "pacts of friendship and mutual aid between age-mates facilitated the social mobility required in the search for rubber" (Nelson, 1994, p.110), as people were often forced to collect rubber in groups far away from their village. These forms of cooperation would guarantee access to shelter and protection when young men were out searching for rubber. Second, the increased reliance on forms of mutual insurance were critical as they allowed individuals to "by-pass the corrupt or ineffective rule of their elders," who had been targeted by the rubber agents and the *kapitas* (Nelson, 1994, p.111). Elders could no longer be relied upon to protect the community or fulfill important leadership functions. In essence, as formal institutions were no longer reliable, mutual insurance systems strengthened in response. Finally, the increased reliance on mutual insurance sought to provide stability at a time of great uncertainty. Individuals were expected to help each other meet the demands of day-to-day subsistence, such as clearing and harvesting fields and constructing houses, and age-mates would share food, shelter, and land. The oral histories of the Mongo people highlight how social institutions adapted to the demands of the rubber regime.

2.7. *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, led to a large decrease in rubber prices (Harms, 1975).

The regime of rubber extraction 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 policies the nickname "*Red Rubber*" (Vangroenweghe, 1985).

3. The Effects of the Rubber Concessions on Development

3.1. *Data*

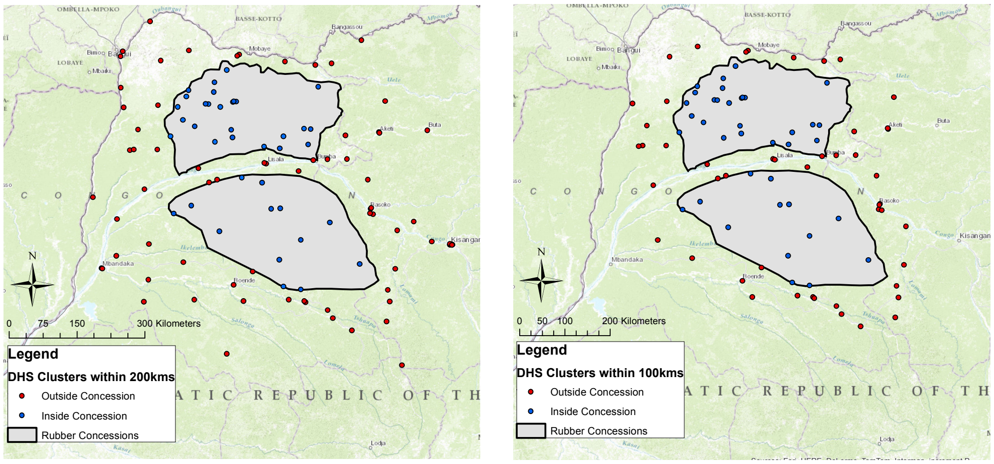
To examine the long run impact of the rubber concessions we first combine Demographic and Health Survey (DHS) data from 2007 and 2014 with detailed maps of the boundaries of ABIR and Anversoise. The DHS surveys from the DRC provide detailed information on education, assets, and health outcomes for individuals in many villages. These data sources and the variables used in our analysis are described in detail in Appendix A. We also attempted to use nightlight data as a measure of development. However, as shown in Figure A3b in Appendix B, the area of interest in DRC has little nightlight.

The maps of the rubber concessions are from Waltz (1918). This resource describes all of the concessions given by King Leopold II. This includes details on the physical boundaries of the concessions and the year when each concession was granted. Figure 2 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 focused exclusively on rubber (Vangroenweghe, 1985). Figure 4 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 the 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. 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.

Figure 4: Maps of Clusters from the DHS 2007 and 2014 for DRC - Within 200 km and 100 km



(a) Within 200km

(b) Within 100km

We have also examined these differences in means between areas inside the former concessions and areas outside the concessions for bandwidths of 100 kms and 50 kms and for all DHS clusters in the DRC. The summary statistics are generally consistent with Table 1.

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 cultures. 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 rubber concessions on the outcomes of interest by estimating the following regression discontinuity (RD) specification:

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

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 10000. 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 10000. 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 such as gender, age, and age squared; $\phi_{j(v)}$ represent district fixed effects;[7] $f(location_v)$ is the RD polynomial, which controls for smooth functions of geographic location for village v. For our baseline results we use a linear polynomial in latitude and longitude as suggested in recent work by Gelman and Imbens (2016). We also present results using cubic polynomials in distance to the concession borders and cubic polynomial in latitude and longitude. We check robustness to using various other forms of the RD polynomial.

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. We calculated the Imbens-Kalyanaraman optimal bandwidth for several of our outcomes of interest with dis-

[7] 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 political units from before decentralization.

tance to the border as the running variable. The optimal bandwidth was generally between 75 and 125 kilometers depending on the outcome.

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 part of 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. This RD approach has been used in multiple settings to examine the effects of historical events, such as in Dell (2010), Miguel and Roland (2011), Grosfeld, Rodnyansky and Zhuravskaya (2013), Michalopoulous and Papaioannou (2014), Becker, Boeckh, Hainz and Woessmann (2015), Fontana, Nannicini and Tabellini (2016).

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 on the interior of Congo in 1892. This is consistent with the evidence presented by Michalopoulous and Papaioannou (2014, 2016), who point out that colonizers drew African borders in an arbitrary manner.

To assess the plausibility of this first assumption, Panel A of Table 2 estimates specification (1) for important geographic characteristics such as altitude, precipitation, and soil suitability and finds balance on these geographic characteristics. This analysis is at the 20km by 20km grid cell level. These results are presented both with standard errors clustered at the territory level and Conley standard errors with a cut-off window of 50 kms to account for spatial auto-correlation (Conley, 1999). The results are robust to the use of different cut-offs for the Conley standard errors. For the clustered standard errors, we cluster at the territory level, the lowest administrative level for which there is spatial data. For some bandwidths, the number of clusters is slightly below thirty, potentially leading to overly optimistic standard errors (Cameron, Gelbach and Miller, 2008). However, the clustered standard errors tend to be quite consistent with the Conley standard errors. In addition to showing balance at the grid cell level, we also show balance on geographic characteristics at the DHS cluster level in Appendix H.2.

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. Reassuringly, the concession borders do not align with Murdock ethnic group borders (see Appendix Figure A2b) nor do they align with present day political borders.

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. Appendix Figure A1 visually presents the extent of river networks. 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.

The second important assumption for this regression discontinuity approach is that there was no selective sorting across the RD threshold when the concession borders were established. Selective sorting would require certain villages be able to select out of being allocated to a concession. This is unlikely to have happened given that villages were unable to negotiate the boundaries of the concessions.

An important related concern is selective migration either during the rubber era or subsequently, which would be considered an outcome of the rubber concessions. It is likely that some migration took place during the rubber era, as individuals tried to avoid the rubber demands and the associated violence. Unfortunately, there is no data available to quantify the magnitude of migration during the rubber era. We can only highlight the difficulties associated with migration. Anecdotal evidence from Harms (1975) suggests that the rubber companies greatly controlled migration (using the village censes they collected themselves) and forced people to remain in their villages. Harms (1975) notes that local chiefs were held accountable when individuals that migrated did not meet their quotas, incentivizing chiefs to prevent migration. Finally, since the concessions were defined by the extent of river basins, and rivers were used for transport, migration outside of the concessions would likely have been difficult.

Table 2: Balance on Geographic and River Characteristics

	Panel A: Geographic Characteristics								
	Elevation			*Precipitation*			*Soil Suitability*		
Sample Within:	200 kms (1)	100 kms (2)	50 kms (3)	200 kms (4)	100 kms (5)	50 kms (6)	200 kms (7)	100 kms (8)	50 kms (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 (1)	100 kms (2)	50 kms (3)	200 kms (4)	100 kms (5)	50 kms (6)	200 kms (7)	100 kms (8)	50 kms (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, Cameron, Parra, Jones and Jarvis (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, Foley, Norman and McSweeney (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). * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

While we are unable to analyze migration during the rubber era, we are able to use present-day DHS data to examine what the extent of current selective migration would have to be to explain our results. In Appendix F, we examine the sensitivity of the results to selective migration and to heterogeneity by ease of migrating from inside the concession to outside the concession boundaries. Rates of selective migration would have to be quite high to fully explain our results and there is no evidence of differential effects based on ease of migration.

3.4. *First Stage*

While it is not required to show a first stage for an RD analysis, we can examine whether the probability of having a "commercial post" is higher within the concession boundaries. A commercial post corresponds to places where rubber is collected and traded. In Appendix H.1 we present digitized maps of commercial posts and show that the former concession areas are much more likely to have had commercial posts. If there were no "first-stage" in the sense that the concession areas were not more likely to be exposed to the rubber extraction, then it is unlikely we would find effects of being inside a former concession. Additionally, if the RD were "fuzzy" such that the concession boundaries were not perfectly respected, this would bias our coefficients toward zero. Ideally, we would have detailed granular data of exposure to violence or rubber production. We have been unable to find such data, though in Section 3.8 we examine the correlation between post level rubber production for a six month period of 1904 for which we were able to find data and wealth today.

3.5. *Regression Discontinuity Results*

To examine the long-run effects of exposure to the rubber concessions, we analyze 2007 and 2014 DHS data on education, wealth, and health. All variables are defined in the table notes. We first focus on education and present results for observations within 200 kms, 100 kms, and 50 kms of the concession borders. Table 3 reports estimates for specification (1) for different education outcomes. We display results using a linear polynomial in latitude and longitude in Panel A, third-order polynomials in distance to the concession border in Panel B, and third-order polynomials in latitude and longitude in Panel C. Section 3.6 discusses additional RD polynomials and other robustness checks, including doing the analysis separately for each concession. The results in Table 3 are consistent with the summary statistics from Table 1: areas inside the concession have significantly lower levels of education across all specifications and bandwidths. Individuals just inside the former rubber concessions are estimated to have approximately 1.5 fewer years of education than individuals just outside the concessions.

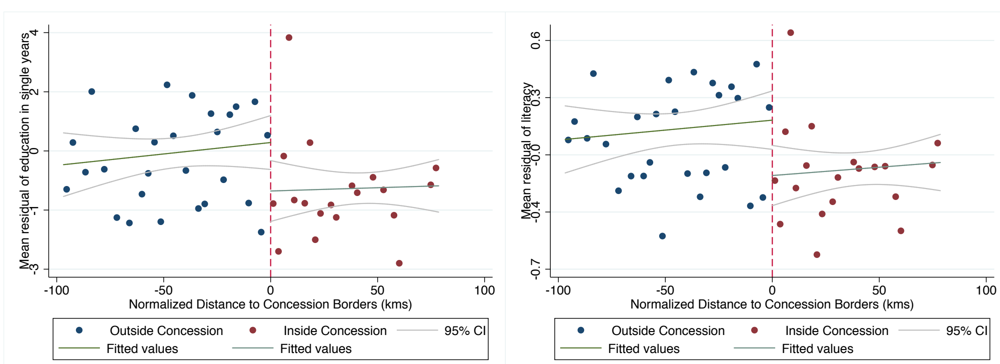
The results for years of education can be seen graphically in Figures 5 and 6. Figure 5 presents a standard RD plot, with distance to the border as the running variable and a local linear trend to each side of the discontinuity. For both years of education and literacy there is a clear discontinuity at the concession border. Figure 6 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. The spatial 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 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 5: Standard RD Plots for Education Outcomes



(a) Years of Education - 100 kms

(b) Literacy - 100 kms

Figure 6: Spatial RD Plot for Years of Education

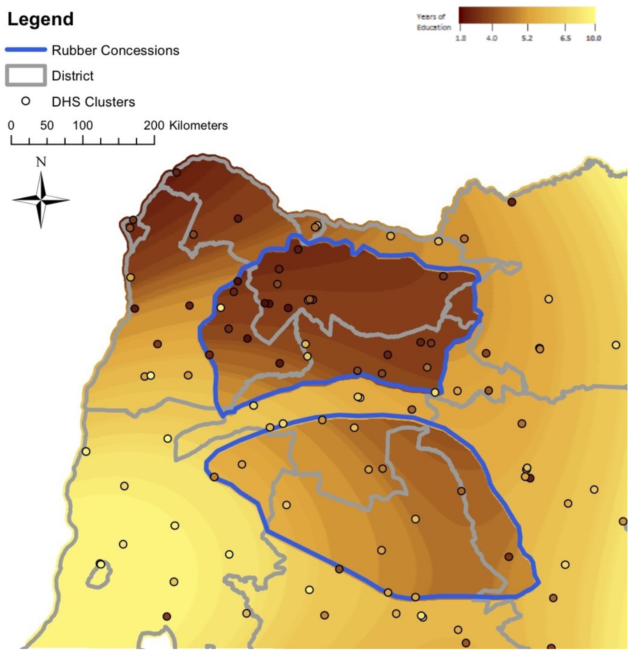


Table 4 reports estimates for specification (1) for the wealth measures available in the DHS survey. For the wealth and health outcomes, the standard and the spatial RD plots are presented in Appendix B. Individuals in villages inside the former rubber concessions are approximately 15% less wealthy than 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. 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.

3.6. 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

Table 4: Rubber Concessions and Wealth RD Analysis

	Wealth Index			*Wealth Factor*		
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	-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. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

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 begin to lose significance with higher-order polynomials (fourth order polynomials and above). The results for these specifications are in Appendix C.1. 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 less robust to higher-order RD polynomials compared to the education and wealth results; however, 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.

We also test robustness to alternative euclidian distance specifications, where we modify $f(.)$ in equation (1) to be a function of distance to the former concession border, rather than a function of latitude and longitude. Once again, 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). These results are presented in Appendix C.1. By "interacted" polynomial we

Table 5: Rubber Concessions and Health RD Analysis

	Child Ever Vaccinated			*Child Ht/Age Percentile*			*Respondent Ht/Age Percentile*		
Sample Within:	200 kms (1)	100 kms (2)	50 kms (3)	200 kms (4)	100 kms (5)	50 kms (6)	200 kms (7)	100 kms (8)	50 kms (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. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

mean that we interact the "Inside Concession" indicator with all terms in the polynomial. Again, 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 along 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 C.2 and find that the results are robust to excluding observations very close to the border. The results hold with alternative donut holes, for example, with a 10 km exclusion criterion. This provides evidence that the results are not being driven by these potentially mis-classified clusters.

In Appendix C we show our results are robust to the following additional robustness tests. We analyze the results looking at each concession individually to ensure that the results are not being driven by one particular concession. We analyze results dropping observations along the Congo river to address concerns that villages along the Congo river are different than those farther away from the river. We present the results at the DHS cluster level, rather than the individual level since assignment to treatment occurs at the village level (however, note that including individual level controls increases precision). We present results without district fixed effects and results with Conley standard errors to address spatial auto-correlation. Finally, in Appendix E we find no evidence of differential missionary presence or subsequent colonial investment, and in Appendix H, we examine whether road network density, population density, or conflict explain our observed results.

3.7. Falsification Exercise: Major River Basins in DRC

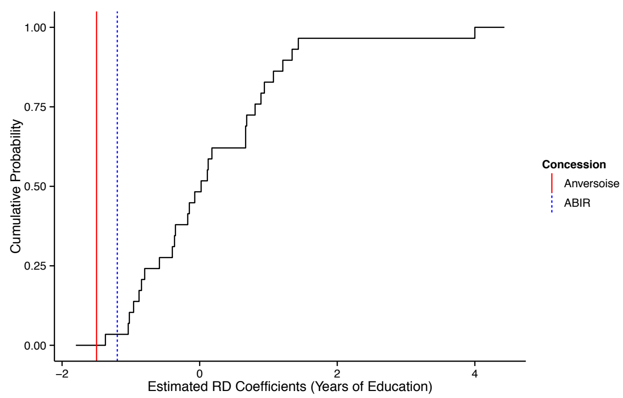
A possible concern with the results presented in Section 3.5 is that because the concession borders were drawn using major river basins as the salient geographic feature for the borders, the results reflect some inherent characteristic of river basins, rather than exposure to colonial extraction. To 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. See Appendix D for a detailed explanation of the HydroBASINS data, the algorithm used in the construction of the river basin layers, and the implementation of the falsification exercise.

Figure 7 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. We do this falsification exercise with years of education as the outcome variable because it is likely most comparable across DRC. On average, being inside a river basin is associated with more years of education. 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.

Appendix D presents results using alternative RD specifications as well as 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. This falsification exercise presents important evidence that the results presented in Section 3.5 are not a consequence of the concessions being drawn using river basins, but instead suggests that our estimates represent the impacts of exposure to colonial extraction during the rubber period.

Figure 7: 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 D for details on the implementation of this falsification exercise.

3.8. Analysis Using Historical Post Level Data

As a complement to the RD analysis, we analyze post-level rubber production data from 1904 for ABIR. We combined data on rubber production from the Belgian Foreign Public Service Foreign Affairs archives with data from the De Ryck Collection, a collection of Congo colonial manuscripts at the University of Wisconsin library. We were able to compile data on rubber production for 19 posts within the ABIR concession between July and December 1904 (see Figure 3 for map of post locations) (de Ryck, 1885-1954). 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. 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, as seen in Figure 8. Note that once controls are added in Figure 8, there is more variation within a bin, which is why there appear to be more observations in the binscatters. To the extent that rubber production captures the intensive margin of exposure to colonial extraction, these results suggest that greater exposure indeed leads to worse development outcomes. While the results are not statistically significant when we include individual and geographic controls as demonstrated in Column (2) of Table 6, the magnitude of the effect remains remarkably consistent with this inclusion, suggesting that the results lose statistical significance due to the small sample size.

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

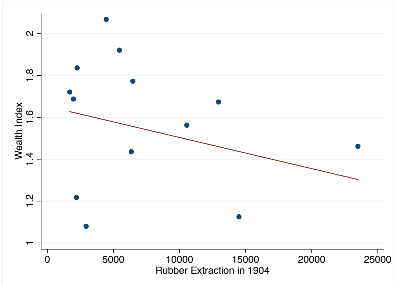
Notes: *Rubber Production in 1904* measures production in tons for the last six months of 1904 for ABIR posts. We match DHS clusters to the closest ABIR post and limit the sample to clusters within 50 kms of the former ABIR posts. We cluster standard errors at the DHS cluster level. In columns (2) and (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. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

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 in Figure 8, 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.

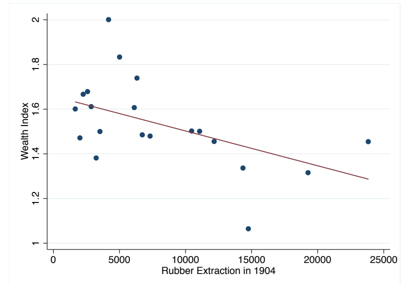
3.9. *On a Convergence Path?*

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

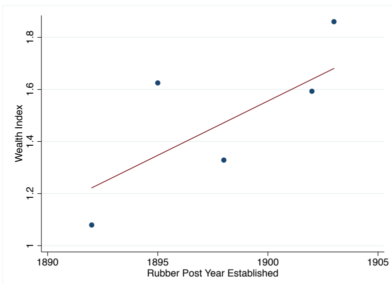
Figure 8: Analysis Using Historical Post Level Data



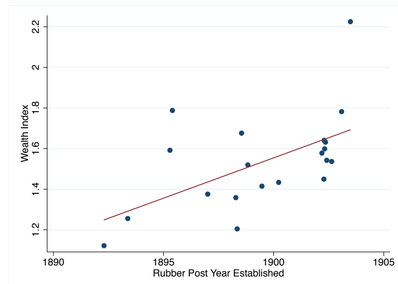
(a) Wealth and rubber production in 1904



(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.

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. Effectively, we are examining how the effect of being inside a concession varies over time.

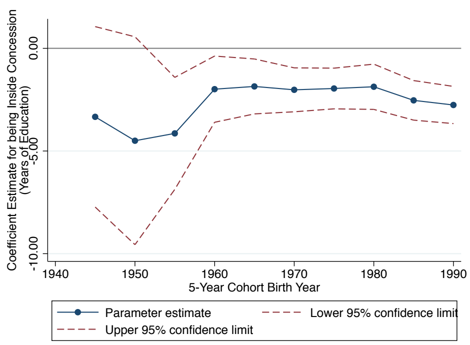
To do this, we compare cohorts inside and outside the concessions born within five years of each other by estimating a regression that includes fixed effects for each 5-year cohort along with the interactions between the $InsideConcession$ indicator and cohort fixed effects. Formally, we estimate the following specification for DHS clusters within 200 kms of the concession borders:

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

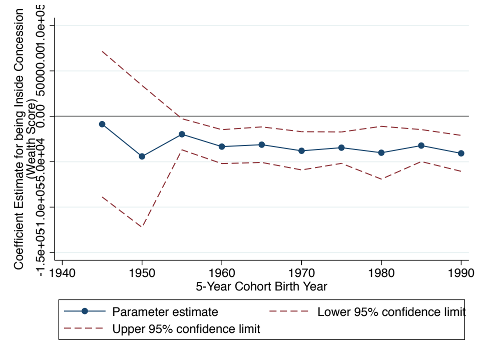
where C_y are 5-year cohort fixed effects and the other variables are defined as in equation (1). Note that we are not estimating a distinct RD polynomial for each cohort as that would be too demanding of the data given our sample size.

Figure 9 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 – e.g. for the older individuals we only observe those healthy enough to survive inside the former concessions.

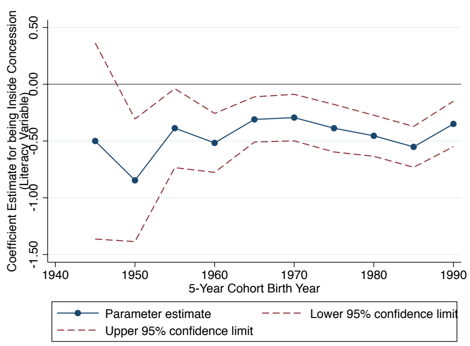
Figure 9: Estimated Cohort Coefficients for Individuals within 200 kms of the Rubber Concessions



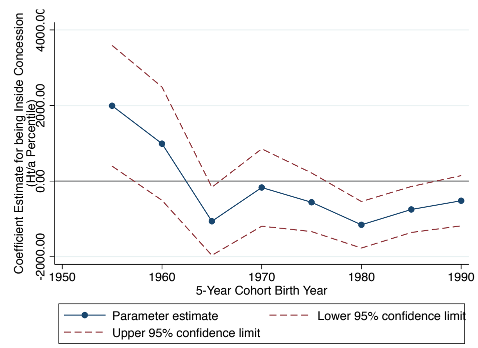
(a) Years of Education



(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.

4. The Effects of the Rubber Concessions on Local Institutions and Culture

The historical accounts presented in Section 2 suggest that exposure to the rubber regime affected a series of important outcomes related to local institutions by creating less accountable chiefs and outcomes related to beliefs about the importance of cooperation and sharing by increasing the importance of and reliance on mutual insurance. Thus, we examine how chiefs are selected, whether they provide public goods, and if villagers respect authority. We also test for differences in culture. We focus on trust, feeling of closeness with others, and survey and experimental measures of support for sharing. The data collection and hypotheses are described in detail below.

4.1. Data Collection

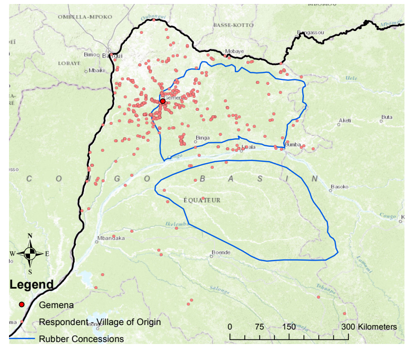
Existing data from DRC does not allow us to measure differences in chief accountability and quality or beliefs on the importance of cooperation and sharing. To better examine these channels, we conducted surveys and collected experimental data in Gemena, DRC. Gemena is the capital of Sud-Ubangi province and is situated near the border of the former Anversoise concession. Gemena is inside the former concession boundary, but less than 10 km away from the border. In the previous analyses, Gemena is consistently an outlier, representing one of the more developed places within the former concessions.

Gemena 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. A "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. A village of origin is not necessarily synonymous with where an individual is born.

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 10). We selected polygons to visit using two-stage clustered 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 randomly selected 40 polygons and randomly sampled households within each polygon, for a total sample size of 520 individuals for the first visit and 484 for the second visit. 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 11 presents a map of the locations of villages of origin for our sample, the location of Gemena, and the borders of the former rubber concessions. For more details on sampling and survey methods, see Appendix G.1.

Figure 10: Gemena Polygons for Sampling

Figure 11: Gemena, the Rubber Concessions, and Location of Origin Villages within the Sample



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 or responses to survey questions are capturing differences in internalized cultural norms. This follows the approach in Lowes et al. (2017) and is similar to the strategy employed in Alesina, Giuliano and Nunn (2013) where they compare migrants in Europe to try to understand cultural differences arising from differences in historical plough use in origin countries. However, given that migrants may be different from those who do not migrate, we explore differences in effects across first and second generation migrants. We also compare reasons for migration for individuals from in and outside the former concession boundaries.

Individuals 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 either side of the concession border, these questions allow us to understand whether villages inside the former concession have worse local institutional quality. Finally, individuals completed two behavioral experiments and an Implicit Association Test (IAT), which will be described in detail below.

4.2. *Summary Statistics*

Summary statistics are presented in Appendix G.5 for the survey data by whether or not an individual originates from inside the former concession. On average, individuals from inside the concession have fewer years of education and lower income than those from outside the concession, but these differences are not statistically significant. These differences are quite stark if we look only at first generation migrants (see Appendix G.6). Interestingly, the differences are of very similar magnitude to the DHS results presented in Section 3.5. However, if we examine second generation or higher migrants separately, we find convergence in outcomes. In terms of education and wealth, individuals from inside the concession no longer look different from individuals outside. This has interesting implications for understanding if our observed effects are "place" or "person" specific. It suggests that removing individuals from the former concession areas actually leads to relatively quick convergence in education and wealth outcomes.

A possible concern with data collected in Gemena is differential selective migration based on whether an individual is from the former concession area. To address this concern, Appendix Table A33 presents mean differences on key migration characteristics for individuals from inside and outside the former concessions. Importantly, we find very little evidence of differences in reasons for migration for individuals from inside and outside the concession. Additionally, 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.

4.3. *Empirical Approach*

To formally test for differences in chief accountability and quality and for differences in beliefs on the importance of cooperation and sharing, 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. We follow Kling, Liebman, Katz and Sanbonmatsu (2004) and Clingingsmith, Khwaja and Kremer (2009) and compute the average effect size (AES) across outcomes within an index.[8] 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). For all AES coefficients reported, in Appendix G.8 we include coefficient plots of each of the individual components of the index alongside the estimated AES coefficient.

4.4. Economic Development in Villages of Origin

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 available in their villages of origin and their perception of the relative wealth of their village of origin. Panel A of Table 7 presents the AES coefficients 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. Please note that for all results using AES indexes, we present coefficient plots of the coefficient for the AES estimate and the estimated coefficients individual components in Appendix G.8.

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 7 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 3.5 that show that places inside the former concessions are less developed today.

[8] 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.

Table 7: Village 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*** (0.056)	-0.174*** (0.058)	-0.197*** (0.066)	-0.110 (0.114)	-0.122 (0.118)	-0.198 (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*** (0.095)	-0.256*** (0.097)	-0.310*** (0.107)	-0.147* (0.078)	-0.168** (0.079)	-0.194** (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** (0.091)	0.201** (0.094)	0.182* (0.100)	0.020 (0.059)	0.016 (0.060)	0.043 (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. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

4.5. Differences in Village Institutions

The first hypothesis we test is whether the rubber concession period caused a long-term deterioration in the quality and accountability of village 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, and by Acemoglu et al. (2014) who find that places with fewer ruling families in Sierra Leone, and therefore less political competition, have chiefs that provide fewer public goods.

The historical accounts of the rubber period and the oral histories from individuals in Gemena suggest that the position of chief may have been affected by the rubber period (Young, 1965). Individuals from interviews conducted in January 2015 described how the rubber regime co-opted village 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, village chiefs are tasked with organizing public good maintenance and construction, resolving conflict, and welcoming outsiders. If the rubber regime altered the accountability and quality of village chiefs, this could explain the worse development outcomes we observe inside the former concessions. We first examine whether there are differences in whether a chief is elected. We interpret elected chiefs as more accountable relative to hereditary chiefs. We then examine differences in the quality of chiefs as measured by provision of public goods. Finally, we examine whether individuals inside the concessions have different respect for authority, as measured by survey questions and an IAT.

Accountability and Quality of Village Chiefs

Panel B of Table 7 presents the results on chief selection mechanism. Chiefs in villages inside the former rubber concessions are 15 percentage points less likely to be chosen by election. Instead, they are more likely to be hereditary, i.e. chosen from a particular lineage or clan within the community. This lineage is known as the "ruling" lineage, and chiefs then tend to come exclusively from this lineage.

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. We find that chiefs inside the former concessions are responsible for providing fewer public goods.

Respect for Chief Authority

An important consideration when examining differences in village 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. Conversely, if individuals report greater respect for authority, this may indicative of social capture, as in 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.

To examine respect for village chief authority, we first construct an index of subjective survey questions on confidence and trust in chiefs. We scale all variables so that more positive values indicate greater respect for local chiefs. 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 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. [9] In our case, the target group is chiefs. ST-IATs have been used recently in similar settings in the DRC by Lowes et al. (2017), Lowes (2017), and Lowes, Nunn, Robinson and Weigel (2015). See Appendix G.4 for more information on IATs, screenshots of the IAT, the details of the words

[9] 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.

we selected, and the protocols for implementation.[10]

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 7 reports the estimates from these two different measures of respect for authority. 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. 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. 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 Acemoglu et al. (2014), where they argue that lower quality chiefs may be better able to "capture" social society, despite their worse performance as well as recent evidence from India (Anderson, Francois and Kotwal, 2015). 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 inside the former concessions are not driven by lack of respect for authority.

4.6. Differences in Trust, Social Cohesion, Altruism, and Support for Sharing

We test for differences in culture, specifically: trust, social cohesion, altruism, and support for sharing income. The rubber period may have eroded norms of trust in others. Lower trust in others could potentially explain lower development today, as trust is particularly important for trade in the region.Individuals coped with the violence of the rubber regime and political capture by relying on mutual insurance and horizontal ties. As chiefs were unable to safeguard citizens from exploitation, individuals may have had to increase reliance on forms of informal insurance. Sharing norms are prevalent in Africa and have been argued to be an important aspect of African comparative development (Platteau, 2000). We examine both self-reported beliefs in the importance of sharing and experimental measures of sharing (Jakiela, 2011, Jakiela, Miguel and the Velde, 2014).

[10] Formally, we follow Lowes et al. (2015) 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.

Trust in Others

We examine whether trust is different across the former concession borders in Panel A of Table 8 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). The coefficients on trust inside the former concessions are positive and marginally statistically significant, suggesting that individuals from the former concessions are in fact 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 out-group trust, though the effect is slightly larger for in-group trust but not statistically distinguishable from the effect on out-group trust. The coefficient plots for each question individually is located in Appendix G.8.

We also ask respondents how close they feel to people to various groups of people. We present the results on differences in closeness in Panel A of Table 8. We find that individuals from the former concessions report feeling closer to others, both in their village of origin and in Gemena.

These results are potentially surprising given past work that shows a positive correlation between good institutions and good culture. It is also different from Nunn and Wantchekon (2011), who find that areas more exposed to the slave trade exhibit less trust today. This highlights the importance of the perpetrator of the violence. In Nunn and Wantchekon (2011) family and community members turned against each other, while during the rubber era communities faced a threat from outsiders: European agents or sentries from other parts of Congo.

Strength of Beliefs in Importance of Sharing

To test whether there are differences in beliefs in the importance of sharing, we first construct an index of survey questions asking individuals whether they think it is appropriate to share income in a variety of different situations. The index includes questions on whether you should share your own income when it is earned by luck and when it is earned by work, and whether others

Table 8: Survey and Experimental Measures of Trust and Sharing Beliefs

	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 Shared			*Effort Task: Share Redistributed*		
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: Amount Shared* measures the amount sent to an anonymous player 2 in the standard Dictator Game. *Effort Task: Share Redistributed* 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. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

should share their income with you when it is earned by luck and when it is earned by work. We also ask the respondent how they think people in their village of origin would respond to the same series of questions to understand their expectations regarding the beliefs of others.

Panel B of Table 8 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. Across all of these survey measures, individuals inside the concessions are more likely to believe it is important to share income.

We also collected experimental measures of support for sharing. Individuals in our sample participated in a dictator game (DG) to measure altruism and in a reverse dictator game, to measure support for redistribution. 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 DG 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. The amount player 2 decides to take from Player 1's earned income therefore represents a measure of willingness to redistribute.[11]

In the reverse-DG experiment, each respondent is matched to an anonymous, randomly selected individual from Gemena. 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. 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 would take for themselves. The share of earned income that player 2 decides to

[11] Variation (i) of the DG has been used before by Hoffman, McCabe, Shachat and Smith (1994) and Cherry, Frykblom and Shogren (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.

take from Player 1's earned income is our measure of support for redistribution.

For the earnings 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. Respondent were very engaged in the task and earned on average 700 CF in this task. See Appendix G.2 for more details on the reverse DG with earned income, the protocols used, and the earnings task.

Panel C of Table 8 presents the estimates for the experimental measures of altruism and willingness to redistribute. 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 player's earned endowment to themselves. We interpret this as having greater support for redistribution, consistent with the survey measures on sharing that suggest individuals think income should be shared.

One implication of greater support for sharing income is that we would expect villages inside the former concessions to have less income inequality. Consistent with greater support for sharing income, in Appendix H.3, we find lower levels of income inequality within DHS clusters inside the former concessions. We examine both the standard deviation of the wealth score and the inter-quartile range of the wealth score. The benefit of examining the inter-quartile range of the wealth score is that this dispersion measure is invariant to mean shifts in incomes. This means our inequality results are not driven by the fact that individuals inside the concession are on average less wealthy.

The results in Table 8 provide evidence that 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. The results all point to more pro-social beliefs and values within the former concessions. This may seem counter-intuitive, given the violence and brutality these communities experienced during the rubber era. However, recent work by Bauer et al. (2016), who review findings from 16 post-conflict settings, have found that individuals exposed to conflict are more pro-social. For example, they are more active in their communities and exhibit more pro-social behavior in experimental measures. The authors highlight that greater cooperation "may arise from the greater value of social insurance. War frequently destroys household assets, and may make victims of violence more dependent on local informal systems of risk-sharing and insurance, especially among kin and neighbors, thus increasing the return to investments in social capital" (Bauer et al., 2016, p.266). Our setting provides evidence that these effects can persist over time, even many generations after the exposure to violence.

4.7. *Discussion of Results*

The results above indicate that individuals from former rubber concessions (i) originate from villages with less accountable chiefs who provide fewer public goods (ii) are more trusting of others and (iii) are more supportive of sharing earnings. 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 culture suggest that individuals from within the former concessions are more trusting, cohesive, and more supportive of sharing as a result of the violence associated with the rubber era.

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 also highlighted that these changes in institutions and culture 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, p.97)

Based on oral histories of the rubber era, Nelson (1994) argues 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 a culture of increased reliance on informal redistribution acted as substitutes.

This is in line with theoretical work by Bisin and Verdier (2017), who highlight the importance of studying both institutions and culture, and who call into question how reasonable it is to focus on one channel or origin for economic prosperity. In fact, Bisin and Verdier (2017, p.38) write that their theoretical work "underlines the fact that the search for a...unique origin for long-term development can be quite an arduous and even sterile undertaking. Focusing more systematically on the positive or negative interactions between culture and institutions along the development process might be more fruitful in terms of historical understanding". Additionally, these results are 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. More recently, work from Lowes et al. (2017) find that historical state capacity is associated with weaker norms of rule following in the DRC.

An important question is: why did these changes persist? Of course, this cannot be directly tested in our data, but a compelling explanation is that these changes in institutional quality and culture 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 rely on informal norms for support. Importantly, this is a setting with extremely low central state-capacity, where the central state has made little effort to change development outcomes. Today, we see that both the institutional and cultural channels matter for economic development: worse institutions and stronger beliefs in the importance of sharing income would imply less engagement in risky activities such as trade, entrepreneurship, and cash crop farming. Appendix Table A36 presents survey evidence that suggests that this is in fact the case.

5. External Validity

We have presented evidence that those individuals from the former ABIR and Anversoise concession areas have lower levels of education, wealth, and health today. We argue that this is likely due to the how the rubber era undermined local chiefs and that the increase in trust, cohesion, and sharing has not been sufficient to offset these negative effects. Given that other concessions were granted during the CFS era, it is natural to examine the broader implications of the Leopold II concession system for the development of DRC. Could the concessions granted under Leopold II help explain why the DRC is one of the least developed countries in the world?

In Appendix I, we present RD results for education, wealth, and health examining all concessions granted in DRC as of 1904 (see Figure 1 for a map of all of the concession boundaries). We present results pooling all of the concessions as well as results excluding ABIR and Anversoise. We find that across all concessions in DRC, individuals experience worse education, wealth, and health outcomes. The coefficients are always negative, though sometimes not significant when ABIR and Anversoise are excluded. The OLS estimates (not presented) are similar to the RD estimates in magnitude and direction. For the 60% of DRC's landmass that was formally part of a concession, wealth would be about 15% higher had they not been part of a concession. While these estimates are unlikely to be causal, given that these other concession boundaries correspond with present day political boundaries and have different histories than ABIR and Anversoise, they are suggestive of the detrimental long run legacy of colonial extraction. Given the almost universal application of colonial extraction in African colonies, these results are important for understanding the comparative development of Africa.

6. Conclusion

We examine the long run effects of one of the most extreme examples of colonial extraction, the rubber concessions granted under Leopold II. This era has been described as an event of holocaust proportions, resulting in the deaths of millions (Hochschild, 1998). We exploit the well-defined boundaries of the ABIR and Anversoise concessions and 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*," and the use of local institutions to achieve rubber production quotas. Village chiefs were co-opted into enforcing the rubber quotas or were replaced by those who would. Armed sentries and European agents brutally punished individuals who did not meet the designated quotas. Using a geographic regression discontinuity design, we find that the former rubber concession areas have lower levels of education, wealth, and health than areas outside of the concessions. Examining effects by age cohorts, 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 local institutions and culture were affected by exposure to colonial extraction. Using original survey and experimental 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 are less likely to be elected (and are more likely to be hereditary) and provide fewer public goods. We argue that the rubber concessions affected institutional quality, and that this helps explain why these areas are more poor today.

We also examine how the rubber period affected culture. During the rubber era, villagers were forced rely on each other and provide mutual aid and insurance. We present evidence that individuals inside the former concessions today are more trusting, report feeling closer to others, are more likely to state it is important to share with others, and in a reverse dictator game they are more likely to redistribute. In the DHS data, the levels of inequality within villages are lower inside the concessions.

The combined results of lower institutional quality but more "good" cultural traits may be surprising, particularly given evidence from Europe. However, work from evolutionary anthropology and recent theoretical work within economics helps clarify that the effect on institutions and culture need not move in the same direction. One speculative interpretation of these results is that in this setting institutional quality and culture may be acting as substitutes. While "better" culture may partially off-set the negative effects of lower quality institutions, they does not seem to fully off-set them.

We present the first quantitative evidence on the effects of the Congo Free State rubber concessions in the Upper Congo Basin. Although the event was of short duration, it has significantly affected the development of the DRC. We present evidence that the changes to institutional quality and culture likely explain the persistence of the effects. These results have important implications for the development of the DRC as a whole, much of which was granted as a concession during the CFS era. The results also have implications for understanding the relationship between institutional quality and culture. This paper demonstrates how Africa's colonial history and exposure to colonial extraction continue to matter for comparative economic development today.

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Web Appendix for

Blood Rubber

Sara Lowes

Bocconi University, IGIER, and CIFAR

Eduardo Montero

Harvard University

27 November 2017

Contents

Appendix A. Data Sources and Variable Definitions

A.1. Geographic Data and Variables

- **Elevation:** The elevation data is provided by the Global Climate Database created by Hijmans et al. (2005) and available at http://www.worldclim.org/. This data provides elevation information in meters at the 30 arc-second resolution (approximately at the 1 km^2 level near the equator). The elevation measure is constructed using NASAs SRTM satellite images (http://www2.jpl.nasa.gov/srtm/). Our paper's elevation variable calculates the mean elevation for each 20 km by 20 km grid cell in meters.[12]

- **Precipitation:** Precipitation data is provided by the Global Climate Database created by Hijmans et al. (2005) and available at http://www.worldclim.org/. This data provides monthly average rainfall in millimeters. We calculate the average rainfall for each month for each 20 km by 20 km grid cell and average this over the twelve months to obtain our yearly precipitation measure in millimeters of rainfall per year.

- **Soil Suitability:** Soil suitability is the soil component of the land quality index created by the Atlas of the Biosphere available at http://www.sage.wisc.edu/iamdata/ used in Michalopoulos (2012) and Ramankutty et al. (2002). This data uses soil characteristics (namely soil carbon density and the acidity or alkalinity of soil) and combines them using the best functional form to match known actual cropland area and interpolates this measure to be available for most of the world at the 0.5 degree in latitude by longitude level. (The online appendix in Michalopoulos (2012) provides a detailed description of the functional forms used to create this dataset.) This measure is normalized to be between 0 and 1, where higher values indicate higher soil suitability for agriculture. Our Soil Suitability variable measures the average soil suitability in each 20km by 20km grid cel to provide a measure of soil suitability that also ranges between 0 and 1, with higher values indicate higher soil suitability for agriculture.

- **Rivers and Navigable Rivers:** The *Referentiel Geographique Commun*, an online repository for GIS maps for DRC, provides shape files for the DRC on all rivers and navigable rivers in DRC as of 2010. Our variables *Access to Navigable Rivers* and *Access to any River* are indicator variables equal to one if the 20 km by 20 km grid cell contains a navigable river or any river, respectively *Navigable River Density* is defined as total length in meters of navigable rivers in each grid divided by the grid's surface area in kilometers squared.

A.2. DHS Survey Data and Variables

Survey data on development outcomes for individuals is provided by the 2007 DHS survey on the DRC implemented by The DHS Program with the help of the DRC Ministry of Planning. The fieldwork was carried out from January 2007-August 2007 and sampled 9995 women between the ages of 15-49 and 4757 men between the ages of 15-59. The survey provides detailed information on education, assets, and health outcomes for individuals in multiple villages.As well, the DHS 2007 DRC survey provides GPS coordinates for each village (i.e. *clusters* in the survey); these coordinates are displaced by up to 5km 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. The survey data and detailed information on the sampling procedure and variable definitions is available at http://dhsprogram.com/data/

[12] See Figure A4b for a Map of the Grid Cells.

Data-Variables-and-Definitions.cfm. Below we explain the variable definitions for the variables used in this paper from the DHS 2007 DRC survey:

- **Years of Education:** For each individual surveyed, the DHS survey asks the individual the total number of years of education in single years.
- **Educational Attainment:** Educational Attainment is a 0 to 3 categorical variable that measures the highest education level attained, where 0 is no education, 1 is primary education, 2 is secondary and 3 is higher education.
- **Literacy:** Literacy is a 0 to 2 categorical variable for each individual where 0 is "cannot read at all", 1 is "able to read only parts of a sentence" and 2 is "able to read a whole sentence".
- **Wealth Factor:** Wealth Factor is an index generated by the DHS using principle component analysis on asset ownership for each individual.
- **Wealth Index:** Wealth Index is a is a 1 to 5 categorical variable where 1 is poorest quintile and 5 is richest quintile (in the entire DRC 2007 sample) from the Wealth Factor Score.

The DHS survey runs a survey instrument on health behavior to a subsample of the sampled female population (about a third of the entire sample). The following variables are only defined for this subsample:

- **Ever Vaccinated:** The DHS female-subsample includes question whether or not an individual has ever had a vaccination in her life. Thus, *Ever Vaccinated* is an indicator variable equal to 1 if the respondent has ever received a vaccination in their lifetime.
- **Respondent Ht/Age Percentile:** The aforementioned subsample of the female population measures respondent's height (cms) and weight (kgs). Respondent Ht/Age Percentile divides each respondent's height by their age and determines the percentile for this measure relative to the entire subsample. This index is then normalized by the DHS to be within 0 and 10000.

A.3. Colonial Data and Variables

- **Missionary Stations in 1897**: Missionary post locations in 1897 is from a map in Goffart (1908). This map contains missionary post locations for 1897 and was digitized in ArcGIS. Our variable *Number of Missionary Stations in 1897* is defined as the total number of missionary stations in 1897 located in each 20 km by 20 km grid cell.
- **Missionary Stations in 1924**: Missionary post location in 1924 is from Nunn (2010) and is available at http://scholar.harvard.edu/nunn/pages/data-0 in the form of a GIS shapefile. This shapefile was created by Nathan Nunn by digitizing maps from *"Ethnographic Survey of Africa: Showing the Tribes and Languages; also the Stations of Missionary Societies"* published by Roome (1924). Our variable *Number of Missionary Stations in 1924* is defined as the total number of missionary stations in 1924 located in each 20 km by 20 km grid cell.
- **Missionary Stations in 1953**: Missionary post location in 1953 is from a map in the Académie Royale des Sciences d'Outre-Mer (1954). This map contains missionary post locations for 1953 and was digitized in ArcGIS. Our variable *Number of Missionary Stations in 1953* is defined as the total number of missionary stations in 1953 located in each 20 km by 20 km grid cell.

- **Telecommunication Stations in 1953**: Telecommunication Station locations in 1953 are from a map in the Académie Royale des Sciences d'Outre-Mer (1954). This map contains telecommunication post locations for 1953 and was digitized in ArcGIS. Our variable *Number of Telecommunication Stations in 1953* is defined as the total number of Telecommunication stations in 1953 located in each 20 km by 20 km grid cell.

- **Health Centers in 1953**: Health center location in 1953 for the DRC is from the Académie Royale des Sciences d'Outre-Mer (1954). The Académie Royale des Sciences d'Outre-Mer (1954) includes a map with missionary post locations for 1953 that was digitized in ArcGIS. Our variable *Number of Health Centers in 1953* is defined as the total number of health centers in 1953 located in each 20 km by 20 km grid cell.

- **Road Network Density in 1968**: Maps outlining the road network in 1968 for the DRC are available at the UT Map Library (Perry-Castaneda Map Collection), specifically the Africa Map Series made by the Army Map Service, Corps of Engineers, U.S. Army. This series was made in 1968 using the best available sources at the time, and is available at http://www.lib.utexas.edu/maps/ams/africa/africa_index.html. The DRC maps and roads were digitized in ArcGIS. Our *Road Network Density in 1968* variable is defined as total length in meters of roads in 1968 in each 20 km by 20 km grid divided by the grid's total surface area in kilometers squared.

A.4. Road Network Data and Variables

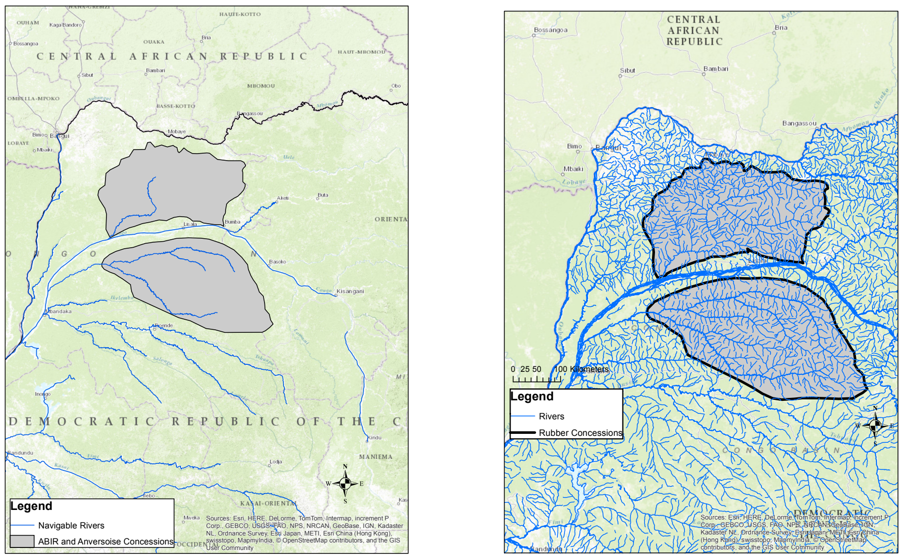
- **Road Density** The *Referentiel Geographique Commun* also provides a GIS shapefile on the road network in the DRC as of 2010. Our *Road Density* variable is defined as total length in meters of roads in each 20 km by 20 km grid divided by the grid's total surface area in kilometers squared.

- **Bridges** The *Referentiel Geographique Commun* provides a GIS shapefile on the location of all bridges in the DRC as of 2010. Our *Number of Bridges* variable is defined as the total number of bridges located in each 20 km by 20 km grid cell.

Appendix B. Additional Maps and Figures

B.1. Additional Maps

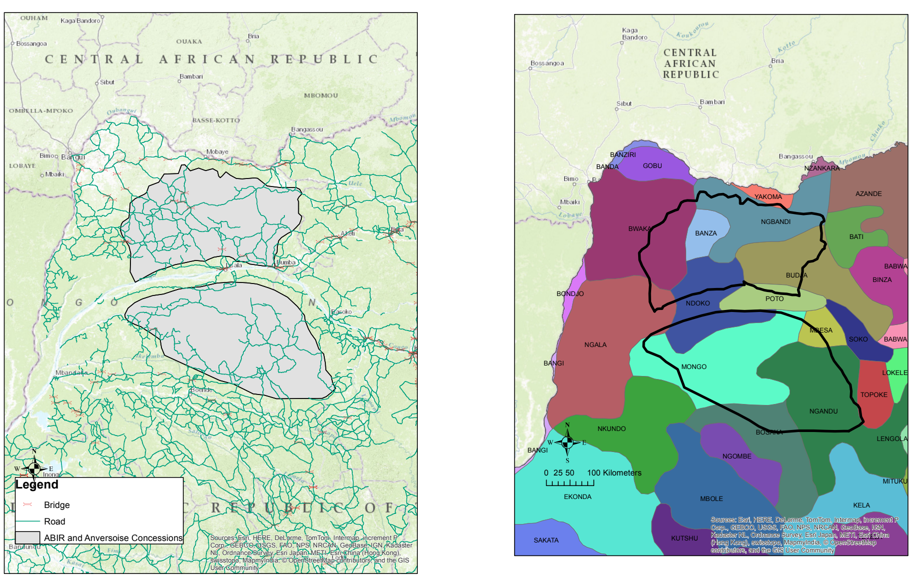
Figure A1: Rivers, Bridges and Rubber Concessions



(a) Navigable Rivers

(b) All Rivers

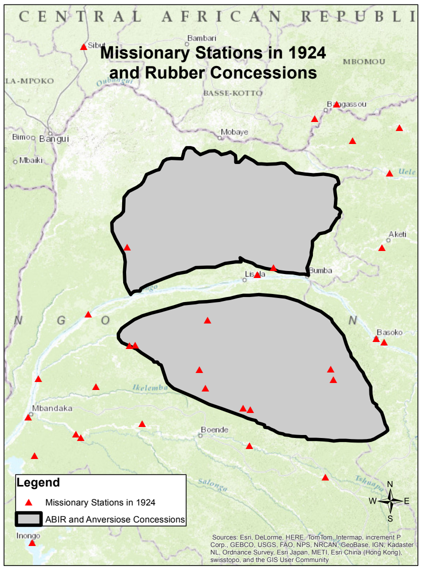
Figure A2: Road Networks, Murdock Ethnic Group Boundaries and Rubber Concessions



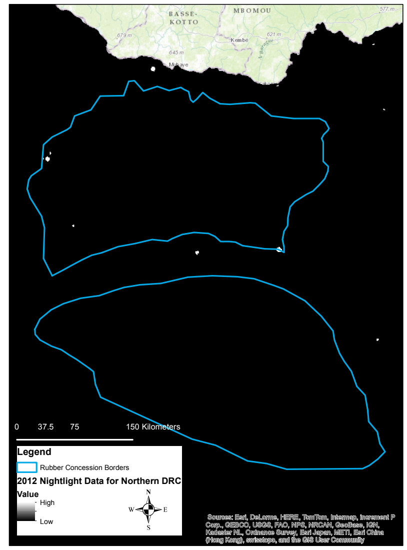
(a) Road Network

(b) Murdock Ethnic Group Borders and Rubber Concessions

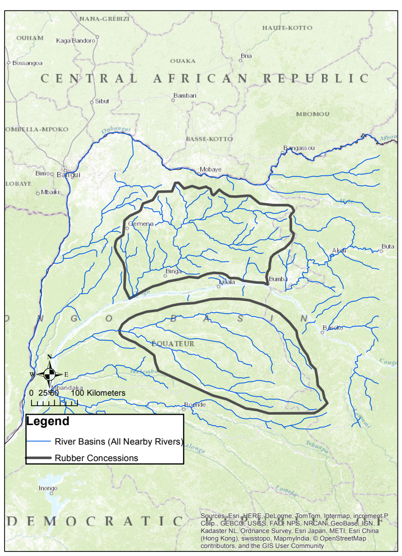
Figure A3: Missions in 1924, Nightlights today and Rubber Concessions



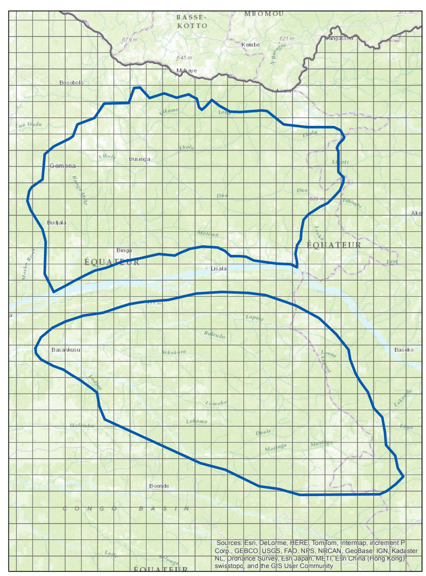
(a) Missionary Stations in 1924 and Rubber Concessions



(b) Nightlights in Northern DRC



(a) Rivers in 1908 and Rubber Concessions

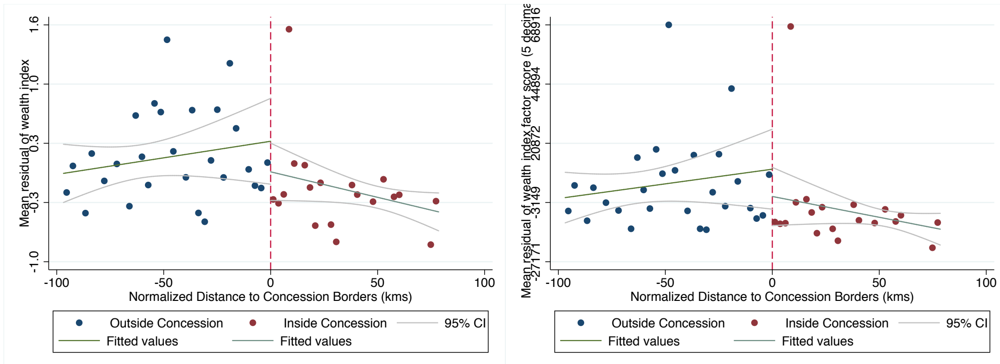


(b) 20 km by 20 km Grid Cell Example

B.2. 2D RD Plots

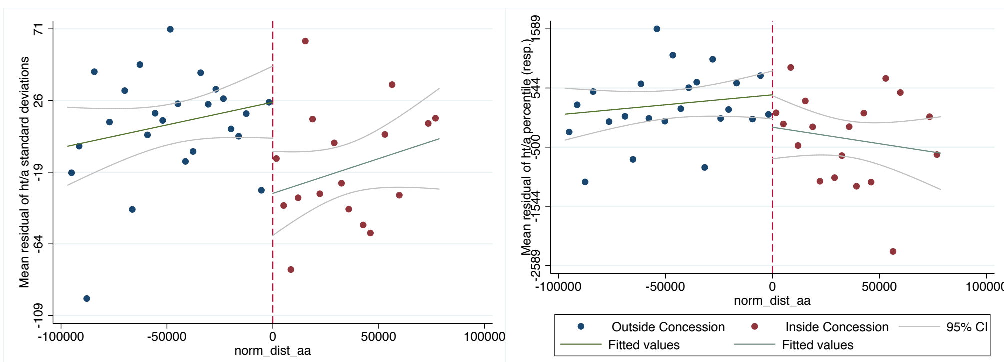
Note: The following figures follow standard 2D RD plots and present the mean value of the outcome variable at each 2.5 km bin along the running variable as well as with a local linear trend to each side of the discontinuity. The figures limit the bandwidth to 100 kms from the border and include the 95% confidence intervals on each side of the discontinuity, with standard errors clustered at the village level.[13]

Figure A5: Wealth RD Plots



(a) Wealth Score - 100 kms (b) Wealth Index - 100 kms

Figure A6: Health RD Plots



(a) Children's Height to Age Percentile - 100 kms (b) Female Height to Age Percentile - 100 kms

B.3. 3D RD Plots

Note: The figures below are spatial RD plots. Each figure plots the geographic scatterplot of the DHS clusters, each shaded with the mean value in each cluster of the outcome variable of interest. 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 $InsideConcession$ indicator variable. Darker values represent worse development outcomes and vice-versa.

[13] As noted by Dell (2010), to confidently estimate such a specification would require precise georeferencing and large sample size right near the border as it is very sensitive to observations right at the border; however, due to confidentiality restrictions, the DHS randomly displaces the coordinates of each of its villages (by up to 5km), and the sample size of villages right at the border is not very large. Thus, this local linear approach is not our preferred specification.

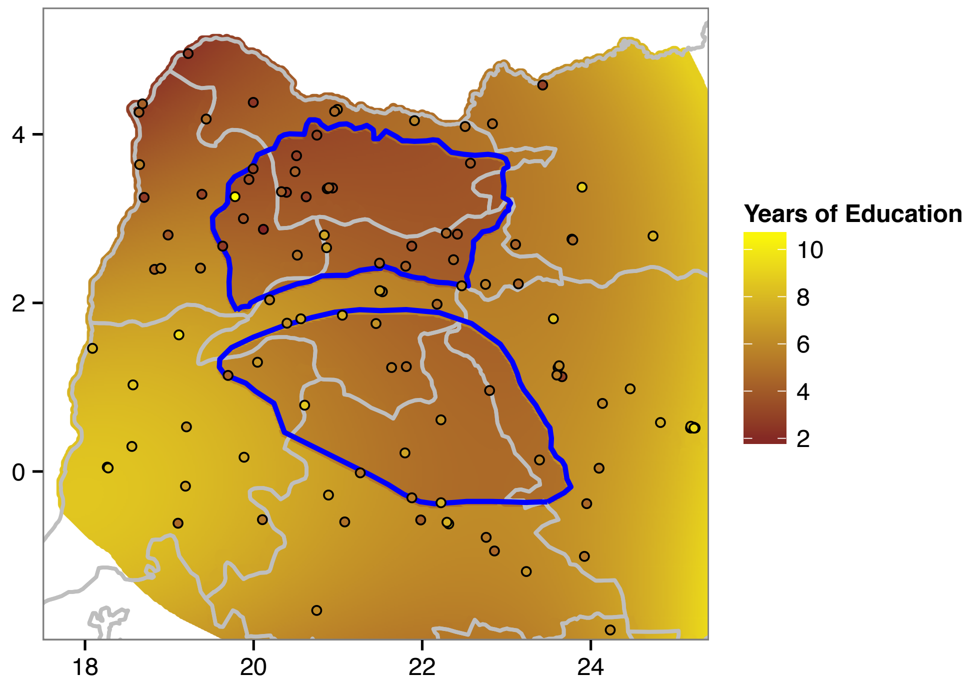


Figure A7: RD Plots - Years of Education

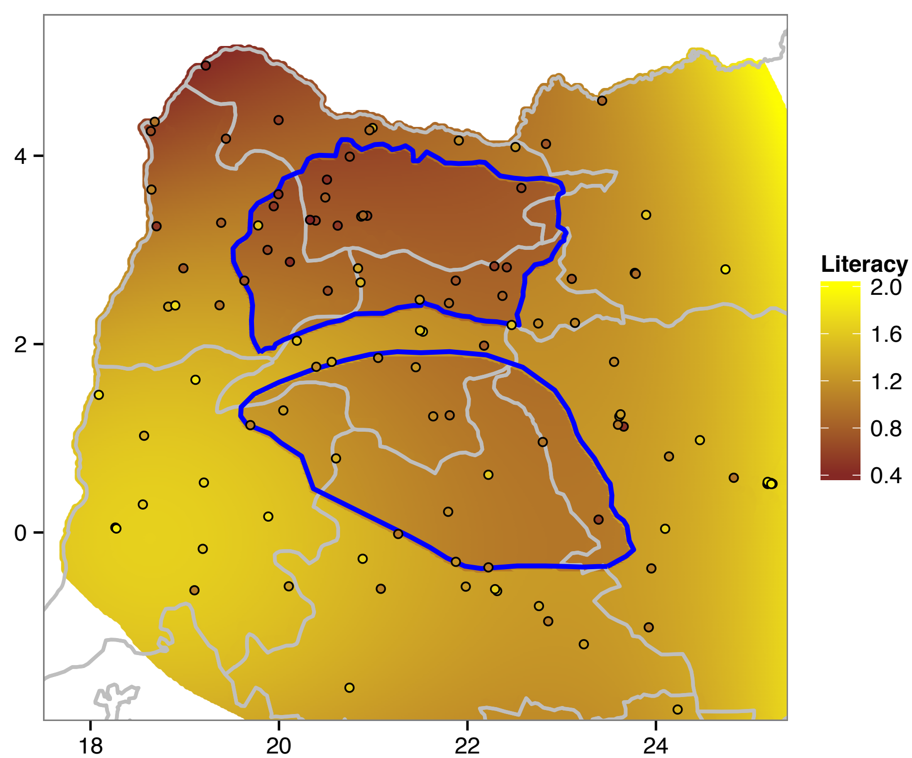


Figure A8: RD Plots - Literacy

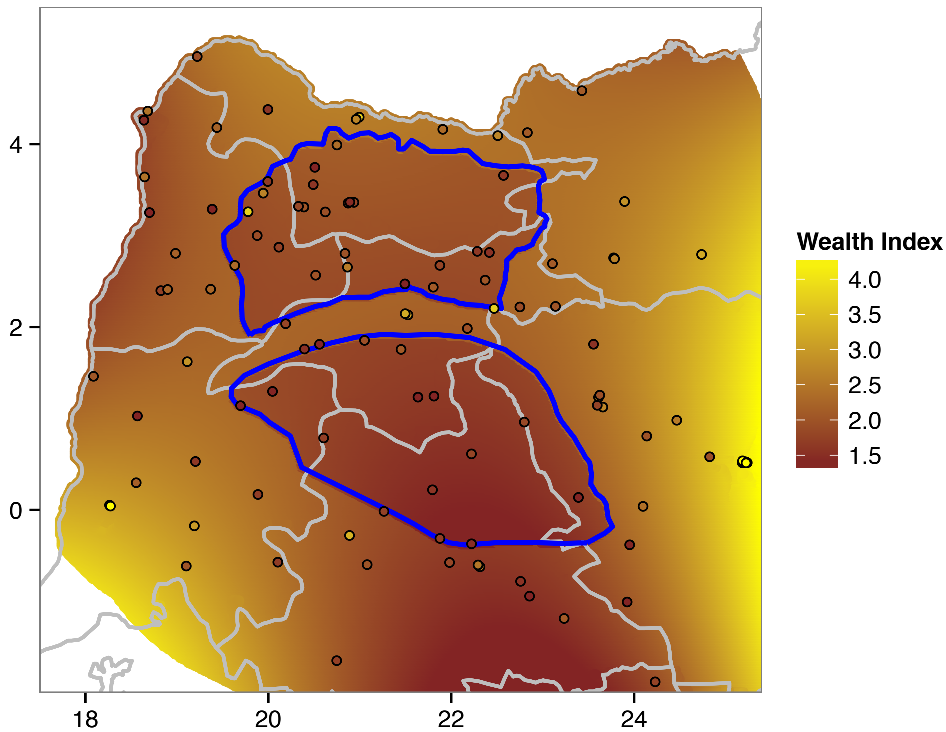


Figure A9: RD Plots - Wealth Index

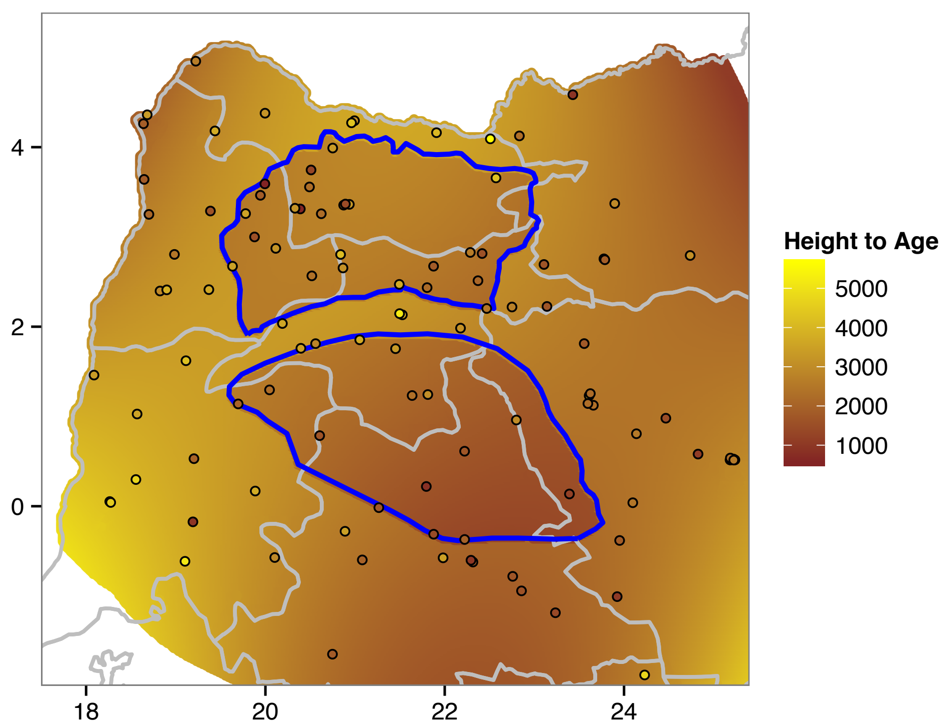


Figure A10: RD Plots - Height-to-Age

Appendix C. Robustness Tables

C.1. DHS Results - Varying the RD Polynomial

C.1.1. Alternative RD Polynomials: Distance to Concession Border Specifications

Table A1: Rubber Concessions and Education RD Analysis

Alternative RD Polynomials

	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 Distance to Concession Border					
Inside Concession	-1.173***	-1.440***	-1.706***	-0.230***	-0.293***	-0.363***
	(0.337)	(0.334)	(0.364)	(0.070)	(0.069)	(0.077)
	Panel B: Quadratic Polynomial in Distance to Concession Border					
Inside Concession	-1.174***	-1.428***	-1.724***	-0.230***	-0.288***	-0.367***
	(0.338)	(0.334)	(0.367)	(0.070)	(0.069)	(0.077)
	Panel C: Quartic Polynomial in Distance to Concession Border					
Inside Concession	-1.202***	-1.372***	-1.688***	-0.234***	-0.263***	-0.356***
	(0.344)	(0.337)	(0.371)	(0.073)	(0.071)	(0.079)
	Panel D: Interacted Linear Polynomial in Distance to Concession Border					
Inside Concession	-1.317***	-1.632***	-0.986	-0.253**	-0.300***	-0.210
	(0.491)	(0.521)	(0.731)	(0.103)	(0.108)	(0.142)
	Panel E: Interacted Quadratic Polynomial in Distance to Concession Border					
Inside Concession	-1.214*	-1.649**	-1.173	-0.219*	-0.308*	-0.144
	(0.664)	(0.816)	(0.935)	(0.131)	(0.156)	(0.174)
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: We cluster standard errors at the DHS cluster level. We include district fixed effects and control for age, age squared and gender. *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. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table A2: Rubber Concessions and Wealth RD Analysis

Alternative RD Polynomials

	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 Distance to Concession Border					
Inside Concession	-0.472***	-0.557***	-0.567***	-11,486**	-17,016***	-18,268***
	(0.149)	(0.150)	(0.195)	(5,706)	(5,296)	(6,802)
	Panel B: Quadratic Polynomial in Distance to Concession Border					
Inside Concession	-0.473***	-0.562***	-0.564***	-11,505**	-17,129***	-18,460**
	(0.147)	(0.148)	(0.199)	(5,655)	(5,276)	(7,093)
	Panel C: Quartic Polynomial in Distance to Concession Border					
Inside Concession	-0.459***	-0.540***	-0.526***	-11,155*	-16,427***	-15,893**
	(0.145)	(0.153)	(0.196)	(5,648)	(5,407)	(6,693)
	Panel D: Interacted Linear Polynomial in Distance to Concession Border					
Inside Concession	-0.358	-0.560**	-0.288	-5,517	-16,897*	-6,845
	(0.220)	(0.262)	(0.425)	(8,546)	(8,568)	(16,164)
	Panel E: Interacted Quadratic Polynomial in Distance to Concession Border					
Inside Concession	-0.546*	-0.543	-0.433	-11,454	-17,958	-17,647
	(0.311)	(0.449)	(0.608)	(11,636)	(15,638)	(20,328)
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	-46331	-43799

Notes: We cluster standard errors 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 on asset ownership. *Wealth Index* is a 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 A3: Rubber Concessions and Health RD Analysis

Alternative RD Polynomials

	Child Ever Vaccinated			*Child Ht/Age Percentile*			*Respondent Ht/Age Percentile*		
Sample Within:	200 kms (1)	100 kms (2)	50 kms (3)	200 kms (4)	100 kms (5)	50 kms (6)	200 kms (7)	100 kms (8)	50 kms (9)
	Panel A: Linear Polynomial in Distance to Concession Border								
Inside Concession	-0.083**	-0.084**	-0.088*	-473.8***	-480.1***	-680.6***	-715.6***	-777.2***	-835.1***
	(0.035)	(0.037)	(0.047)	(180.7)	(180.5)	(191.0)	(209.2)	(217.2)	(264.4)
	Panel B: Quadratic Polynomial in Distance to Concession Border								
Inside Concession	-0.083**	-0.081**	-0.089*	-474.0***	-477.0***	-678.5***	-711.6***	-780.7***	-860.2***
	(0.035)	(0.036)	(0.046)	(180.1)	(179.8)	(187.5)	(211.8)	(216.6)	(265.9)
	Panel C: Quartic Polynomial in Distance to Concession Border								
Inside Concession	-0.083**	-0.081**	-0.098*	-496.2***	-520.4***	-598.8***	-735.1***	-797.5***	-904.2***
	(0.035)	(0.036)	(0.049)	(179.2)	(170.7)	(174.6)	(209.8)	(215.9)	(257.4)
	Panel D: Interacted Linear Polynomial in Distance to Concession Border								
Inside Concession	-0.063	-0.051	-0.134	-710.1***	-892.6***	-271.7	-558.0*	-584.4*	108.2
	(0.063)	(0.077)	(0.092)	(229.8)	(246.6)	(367.6)	(295.5)	(333.2)	(382.2)
	Panel E: Interacted Quadratic Polynomial in Distance to Concession Border								
Inside Concession	-0.035	-0.102	-0.135	-590.3*	-419.1	-794.5*	-630.8	-27.73	246.7
	(0.090)	(0.101)	(0.101)	(337.7)	(354.0)	(415.4)	(404.8)	(446.3)	(478.9)
Observations	3,184	2,556	1,627	1,605	1,314	822	1,589	1,218	758
Clusters	110	85	52	109	85	52	110	85	52
Mean Dep. Var.	0.814	0.797	0.793	2523	2468	2472	2689	2602	2628

Notes: We cluster standard errors at the DHS cluster level. We include district fixed effects in all regressions. We control for age and age squared. The DHS health questions are only asked to a subset of female respondents. Respondent *Ht/Age Percentile* divides each respondent's height by their age and finds their 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 their age and finds their 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. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

C.1.2. Alternative RD Specifications: Latitude and Longitude Specifications

Table A4: Rubber Concessions and Education RD Analysis

Alternative RD Specification: Latitude and Longitude Polynomials

	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: Quadratic Polynomial in Latitude and Longitude					
Inside Concession	-1.426***	-1.407***	-1.570***	-0.271***	-0.279***	-0.349***
	(0.397)	(0.405)	(0.443)	(0.084)	(0.094)	(0.096)
	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: We cluster standard errors at the DHS cluster level. We include district fixed effects and control for age, age squared and gender. *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. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table A5: Rubber Concessions and Wealth RD Analysis

Alternative RD Specification: Latitude and Longitude Polynomials

	Wealth Index			*Wealth Factor*		
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	-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: Quadratic Polynomial in Latitude and Longitude					
Inside Concession	-0.592***	-0.717***	-0.724***	-15,129**	-20,698***	-22,714***
	(0.174)	(0.190)	(0.209)	(6,727)	(6,573)	(7,620)
	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	-46331	-43799

Notes: We cluster standard errors 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 on asset ownership. *Wealth Index* is a 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 A6: Rubber Concessions and Health RD Analysis

Alternative RD Specification: Latitude and Longitude Polynomials

	Child Ever Vaccinated			*Child Ht/Age Percentile*			*Respondent Ht/Age Percentile*		
Sample Within:	200 kms (1)	100 kms (2)	50 kms (3)	200 kms (4)	100 kms (5)	50 kms (6)	200 kms (7)	100 kms (8)	50 kms (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: Quadratic Polynomial in Latitude and Longitude								
Inside Concession	-0.050	-0.022	-0.043	-577.5***	-699.3***	-634.1**	-768.5***	-784.2***	-841.6***
	(0.046)	(0.055)	(0.057)	(186.9)	(204.0)	(248.1)	(238.8)	(262.0)	(296.0)
	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	1,627	1,605	1,314	822	1,589	1,218	758
Clusters	110	85	52	109	85	52	110	85	52
Mean Dep. Var.	0.814	0.797	0.793	2523	2468	2472	2689	2602	2628

Notes: We cluster standard errors at the DHS cluster level. We include district fixed effects in all regressions. We control for age and age squared. The DHS health questions are only asked to a subset of female respondents. Respondent *Ht/Age Percentile* divides each respondent's height by their age and finds their 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 their age and finds their 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. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

C.2. DHS Results - 5 km "Donut Hole" RD Specifications

Table A7: Rubber Concessions and Education 5km Donut Hole RD Analysis

	Years of Education			*Literacy*		
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 in Latitude and Longitude					
Inside Concession	-0.998**	-1.282***	-1.715***	-0.215***	-0.276***	-0.365***
	(0.393)	(0.389)	(0.444)	(0.081)	(0.081)	(0.094)
	Panel B: Cubic Polynomial in Distance to Concession Border					
Inside Concession	-1.033**	-1.222***	-1.751***	-0.217***	-0.259***	-0.394***
	(0.396)	(0.385)	(0.419)	(0.082)	(0.080)	(0.088)
	Panel C: Cubic Polynomial in Latitude and Longitude					
Inside Concession	-1.658***	-1.803***	-1.599***	-0.331***	-0.398***	-0.404***
	(0.428)	(0.392)	(0.480)	(0.089)	(0.087)	(0.096)
Observations	5,147	3,751	2,100	5,125	3,743	2,096
Clusters	99	74	41	99	74	41
Mean Dep. Var.	5.674	5.100	5.218	1.176	1.059	1.068

Notes: Regression exclude observations within 5kms of the former concession borders. We cluster standard errors at the DHS cluster level. We include district fixed effects and control for age, age squared and gender. *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. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table A8: Rubber Concessions and Wealth 5km Donut Hole RD Analysis

	Wealth Index			*Wealth Factor*		
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	-0.434***	-0.522***	-0.662***	-8,940	-15,014***	-21,261***
	(0.148)	(0.150)	(0.210)	(6,145)	(5,529)	(7,671)
	Panel B: Cubic Polynomial in Distance to Concession Border					
Inside Concession	-0.410***	-0.502***	-0.506**	-9,127	-14,278***	-15,226**
	(0.144)	(0.148)	(0.195)	(5,966)	(5,393)	(6,917)
	Panel C: Cubic Polynomial in Latitude and Longitude					
Inside Concession	-0.712***	-0.821***	-0.533**	-19,153***	-22,865***	-14,243
	(0.177)	(0.199)	(0.222)	(7,262)	(7,161)	(8,662)
Observations	5,155	3,757	2,103	5,155	3,757	2,103
Clusters	99	74	41	99	74	41
Mean Dep. Var.	2.329	2.057	2.160	-27905	-45681	-42008

Notes: Regression exclude observations within 5kms of the former concession borders. We cluster standard errors 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 on asset ownership. *Wealth Index* is a 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 A9: Rubber Concessions and Health 5km Donut Hole RD Analysis

	Child Ever Vaccinated			*Child Ht/Age Percentile*			*Respondent Ht/Age Percentile*		
Sample Within:	200 kms (1)	100 kms (2)	50 kms (3)	200 kms (4)	100 kms (5)	50 kms (6)	200 kms (7)	100 kms (8)	50 kms (9)
	Panel A: Linear Polynomial in Latitude and Longitude								
Inside Concession	-0.061	-0.060	-0.059	-325.3*	-358.4*	-565.8*	-761.3***	-876.2***	-1,066***
	(0.038)	(0.040)	(0.050)	(187.0)	(196.2)	(295.9)	(237.2)	(235.2)	(324.1)
	Panel B: Cubic Polynomial in Distance to Concession Border								
Inside Concession	-0.059	-0.058	-0.066	-505.626**	-657.172**	-555.360*	-791.6***	-867.1***	-1,068***
	(0.037)	(0.040)	(0.055)	(237.356)	(255.084)	(323.040)	(236.7)	(246.7)	(295.9)
	Panel C: Cubic Polynomial in Latitude and Longitude								
Inside Concession	-0.045	-0.037	-0.068	-434.014*	-559.885**	-298.259	-976.7***	-1,142***	-1,097***
	(0.049)	(0.061)	(0.057)	(242.264)	(240.775)	(244.653)	(266.9)	(286.0)	(389.8)
Observations	2,822	2,194	1,265	1,410	1,119	627	1,434	1,063	603
Clusters	99	74	41	99	74	41	99	74	41
Mean Dep. Var.	0.815	0.795	0.789	2485	2411	2371	2706	2612	2653

Notes: Regression exclude observations within 5kms of the former concession borders. We cluster standard errors at the DHS cluster level. We include district fixed effects in all regressions. We control for age and age squared. The DHS health questions are only asked to a subset of female respondents. Respondent *Ht/Age Percentile* divides each respondent's height by their age and finds their 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 their age and finds their 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. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

C.3. DHS Results - By Concession

C.3.1. ABIR

Table A10: ABIR: 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	-1.225***	-1.197***	-1.041*	-0.244***	-0.239***	-0.231**
	(0.425)	(0.384)	(0.531)	(0.087)	(0.081)	(0.109)
	Panel B: Cubic Polynomial in Distance to Concession Border					
Inside Concession	-1.066**	-1.054**	-0.992**	-0.207**	-0.209**	-0.232**
	(0.448)	(0.425)	(0.477)	(0.088)	(0.080)	(0.096)
	Panel C: Cubic Polynomial in Latitude and Longitude					
Inside Concession	-1.317**	-0.884	0.672	-0.198*	-0.171	0.123
	(0.593)	(0.832)	(0.992)	(0.117)	(0.151)	(0.154)
Observations	3,031	1,907	1,157	3,020	1,904	1,156
Clusters	59	39	24	59	39	24
Mean Dep. Var.	6.662	5.967	6.133	1.370	1.238	1.267

Notes: We cluster standard errors 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. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table A11: ABIR: Wealth RD Analysis

	Wealth Index			*Wealth Factor*		
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	-0.737*** (0.175)	-0.738*** (0.177)	-0.675** (0.245)	-20,698*** (7,293)	-20,725*** (5,898)	-23,257** (9,361)
	Panel B: Cubic Polynomial in Distance to Concession Border					
Inside Concession	-0.586*** (0.186)	-0.579*** (0.171)	-0.415** (0.191)	-19,032** (7,460)	-16,828** (6,226)	-14,817* (7,794)
	Panel C: Cubic Polynomial in Latitude and Longitude					
Inside Concession	-0.640*** (0.239)	-0.406 (0.242)	-0.041* (0.288)	-18,669 (11,525)	-11,573 (8,869)	4,137 (9,523)
Observations	3,034	1,908	1,158	3,034	1,908	1,158
Clusters	59	39	24	59	39	24
Mean Dep. Var.	2.405	1.921	1.978	-17389	-47834	-45184

Notes: We cluster standard errors 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 A12: ABIR: Health RD Analysis

	Child Ever Vaccinated			*Child Ht/Age Percentile*			*Respondent Ht/Age Percentile*		
Sample Within:	200 kms (1)	100 kms (2)	50 kms (3)	200 kms (4)	100 kms (5)	50 kms (6)	200 kms (7)	100 kms (8)	50 kms (9)
	Panel A: Linear Polynomial in Latitude and Longitude								
Inside Concession	-0.024 (0.054)	-0.020 (0.049)	-0.009 (0.049)	-498.6*** (155.6)	-533.0*** (140.1)	-530.9*** (167.2)	-754.0*** (225.9)	-805.4*** (234.8)	-726.7** (289.4)
	Panel B: Cubic Polynomial in Distance to Concession Border								
Inside Concession	-0.064 (0.047)	-0.058 (0.046)	-0.075* (0.043)	-578.4*** (179.5)	-570.1*** (161.9)	-542.9*** (186.8)	-596.2** (257.1)	-682.5** (254.1)	-514.2 (306.6)
	Panel C: Cubic Polynomial in Latitude and Longitude								
Inside Concession	0.014 (0.061)	0.036 (0.065)	0.006 (0.042)	-720.6*** (241.8)	-463.5* (235.6)	-56.53 (210.5)	-893.7*** (300.2)	-498.3 (309.4)	552.1** (246.3)
Observations	1,658	1,182	748	815	594	370	858	551	338
Clusters	59	39	24	59	39	24	59	39	24
Mean	0.823	0.797	0.828	2730	2626	2641	2679	2457	2494

Notes: We cluster standard errors at the DHS cluster level. We include district fixed effects in all regressions. We control for age and age squared. The DHS health questions are only 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. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

C.3.2. Anversoise

Table A13: Anversoise: Education RD Analysis

	Years of Education			*Literacy*		
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	-1.504***	-1.499***	-1.910***	-0.329***	-0.333***	-0.438***
	(0.518)	(0.513)	(0.564)	(0.106)	(0.105)	(0.119)
	Panel B: Cubic Polynomial in Distance to Concession Border					
Inside Concession	-1.346**	-1.316**	-2.007***	-0.277**	-0.283***	-0.437***
	(0.519)	(0.494)	(0.570)	(0.109)	(0.104)	(0.120)
	Panel C: Cubic Polynomial in Latitude and Longitude					
Inside Concession	-1.348	-1.576	-1.507*	-0.347*	-0.378*	-0.394**
	(0.887)	(0.993)	(0.798)	(0.178)	(0.203)	(0.157)
Observations	2,639	2,367	1,466	2,628	2,362	1,463
Clusters	51	46	28	51	46	28
Mean Dep. Var.	4.466	4.417	4.480	0.946	0.926	0.927

Notes: We cluster standard errors 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. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table A14: Anversoise: Wealth RD Analysis

	Wealth Index			*Wealth Factor*		
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	-0.461**	-0.462**	-0.722**	-15,814*	-15,975*	-24,540**
	(0.220)	(0.219)	(0.322)	(7,965)	(8,003)	(11,357)
	Panel B: Cubic Polynomial in Distance to Concession Border					
Inside Concession	-0.468**	-0.471**	-0.798**	-16,072**	-16,061**	-25,953**
	(0.195)	(0.204)	(0.327)	(7,284)	(7,328)	(11,247)
	Panel C: Cubic Polynomial in Latitude and Longitude					
Inside Concession	-0.673	-0.465	-0.000	-23,642*	-19,313	-2,927
	(0.421)	(0.474)	(0.339)	(12,775)	(15,132)	(11,833)
Observations	2,645	2,373	1,469	2,645	2,373	1,469
Clusters	51	46	28	51	46	28
Mean	2.153	2.124	2.199	-44185	-45122	-42707

Notes: We cluster standard errors 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 A15: Anversoise: Health RD Analysis

	Child Ever Vaccinated			*Child Ht/Age Percentile*			*Respondent Ht/Age Percentile*		
Sample Within:	200 kms (1)	100 kms (2)	50 kms (3)	200 kms (4)	100 kms (5)	50 kms (6)	200 kms (7)	100 kms (8)	50 kms (9)
	Panel A: Linear Polynomial in Latitude and Longitude								
Inside Concession	-0.139***	-0.136***	-0.142**	-151.7	-141.8	-262.5	-750.3**	-784.2**	-1,300***
	(0.046)	(0.044)	(0.063)	(240.1)	(257.9)	(379.2)	(361.3)	(344.4)	(402.9)
	Panel B: Cubic Polynomial in Distance to Concession Border								
Inside Concession	-0.120**	-0.121**	-0.176**	-136.9	-185.3	-129.8	-773.2**	-770.9**	-1,370***
	(0.047)	(0.049)	(0.073)	(265.4)	(261.3)	(345.2)	(356.8)	(368.0)	(446.5)
	Panel C: Cubic Polynomial in Latitude and Longitude								
Inside Concession	-0.139	-0.046	-0.167	44.67	112.5	694.8	-1,068*	-226.2	-361.8
	(0.102)	(0.150)	(0.205)	(486.3)	(592.5)	(521.3)	(629.9)	(572.8)	(472.3)
Observations	1,526	1,374	879	790	720	452	731	667	420
Clusters	51	46	28	51	46	28	51	46	28
Mean	0.804	0.796	0.763	2311	2338	2334	2702	2722	2736

Notes: We cluster standard errors at the DHS cluster level. We include district fixed effects in all regressions. We control for age and age squared. The DHS health questions are only 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. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

C.4. DHS Results - Without District Fixed Effects

Table A16: Rubber Concessions and Education RD Analysis - Without District Fixed Effects

	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	-1.368***	-1.194***	-1.453***	-0.263***	-0.235***	-0.289***
	(0.310)	(0.363)	(0.407)	(0.064)	(0.076)	(0.087)
	Panel B: Cubic Polynomial in Distance to Concession Border					
Inside Concession	-1.383***	-1.530***	-1.600***	-0.284***	-0.317***	-0.335***
	(0.361)	(0.372)	(0.459)	(0.076)	(0.079)	(0.098)
	Panel C: Cubic Polynomial in Latitude and Longitude					
Inside Concession	-1.153***	-1.611***	-1.698***	-0.240***	-0.340***	-0.356***
	(0.399)	(0.345)	(0.334)	(0.083)	(0.078)	(0.073)
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 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. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table A17: Rubber Concessions and Wealth RD Analysis - Without District Fixed Effects

	Wealth Index			*Wealth Factor*		
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	-0.707***	-0.521***	-0.608***	-28,343***	-15,102***	-19,265***
	(0.124)	(0.127)	(0.182)	(6,060)	(4,272)	(6,568)
	Panel B: Cubic Polynomial in Distance to Concession Border					
Inside Concession	-0.467***	-0.443***	-0.488**	-13,297***	-13,755***	-15,347**
	(0.130)	(0.135)	(0.189)	(4,873)	(4,572)	(6,491)
	Panel C: Cubic Polynomial in Latitude and Longitude					
Inside Concession	-0.454**	-0.672***	-0.674***	-7,892	-20,368***	-21,209***
	(0.181)	(0.187)	(0.185)	(7,742)	(6,466)	(6,391)
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 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 A18: Rubber Concessions and Health RD Analysis - Without District Fixed Effects

	Child Ever Vaccinated			*Child Ht/Age Percentile*			*Respondent Ht/Age Percentile*		
Sample Within:	200 kms (1)	100 kms (2)	50 kms (3)	200 kms (4)	100 kms (5)	50 kms (6)	200 kms (7)	100 kms (8)	50 kms (9)
	Panel A: Linear Polynomial in Latitude and Longitude								
Inside Concession	-0.069*	-0.055	-0.081	-337.6*	-336.8*	-686.8***	-680.6***	-633.5***	-836.6***
	(0.036)	(0.039)	(0.050)	(174.6)	(188.9)	(250.5)	(197.3)	(210.5)	(266.4)
	Panel B: Cubic Polynomial in Distance to Concession Border								
Inside Concession	-0.048	-0.048	-0.085	-421.3**	-446.1**	-719.5***	-467.1**	-457.1**	-682.4**
	(0.040)	(0.042)	(0.051)	(189.3)	(177.4)	(216.3)	(220.8)	(222.6)	(278.6)
	Panel C: Cubic Polynomial in Latitude and Longitude								
Inside Concession	-0.049	-0.063	-0.058	-634.1***	-804.4***	-915.4***	-822.7***	-994.6***	-984.9***
	(0.045)	(0.049)	(0.050)	(208.4)	(190.6)	(204.2)	(229.6)	(234.9)	(236.1)
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 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. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

C.5. DHS Results - Conley Standard Errors

Table A19: Rubber Concessions and Education RD Analysis - with Conley Standard Errors

	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)
	[0.355]	[0.348]	[0.370]	[0.073]	[0.071]	[0.074]
	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)
	[0.358]	[0.347]	[0.375]	[0.077]	[0.071]	[0.074]
	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)
	[0.389]	[0.390]	[0.444]	[0.081]	[0.086]	[0.087]
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: We present standard errors clustered at the territory level in ( ) and Conley standard errors in [ ] assuming a cut-off window of 50 kms. 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. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table A20: Rubber Concessions and Wealth RD Analysis - with Conley Standard Errors

	Wealth Index			*Wealth Factor*		
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	-0.503***	-0.582***	-0.682***	-11,235*	-17,540***	-22,610***
	(0.142)	(0.143)	(0.200)	(5,720)	(5,152)	(7,115)
	[0.156]	[0.149]	[0.203]	[6,854]	[5,132]	[6,777]
	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)
	[0.161]	[0.160]	[0.207]	[6,486]	[5,413]	[7,108]
	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)
	[0.183]	[0.204]	[0.222]	[7,534]	[6,621]	[7,417]
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: We present standard errors clustered at the territory level in ( ) and Conley standard errors in [ ] assuming a cut-off window of 50 kms. 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 A21: Rubber Concessions and Health RD Analysis - with Conley Standard Errors

	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)
	[0.034]	[0.035]	[0.042]	[134.0]	[130.3]	[168.0]	[213.9]	[208.0]	[286.1]
	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)
	[0.035]	[0.035]	[0.042]	[160.0]	[151.0]	[147.8]	[210.4]	[218.9]	[277.8]
	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)
	[0.041]	[0.047]	[0.050]	[137.6]	[141.3]	[168.5]	[232.7]	[252.7]	[296.4]
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: We present standard errors clustered at the territory level in ( ) and Conley standard errors in [ ] assuming a cut-off window of 50 kms. 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. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

C.6. DHS Results - Collapsing on Means at the DHS Cluster Level

Table A22: Rubber Concessions and Education RD Analysis - Collapsing at the DHS Cluster Level

	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	-1.197***	-1.449***	-1.624***	-0.250***	-0.310***	-0.373***
	(0.338)	(0.342)	(0.390)	(0.071)	(0.070)	(0.080)
	Panel B: Cubic Polynomial in Distance to Concession Border					
Inside Concession	-1.262***	-1.433***	-1.650***	-0.243***	-0.299***	-0.378***
	(0.343)	(0.340)	(0.404)	(0.074)	(0.070)	(0.082)
	Panel C: Cubic Polynomial in Latitude and Longitude					
Inside Concession	-1.561***	-1.510***	-1.481***	-0.310***	-0.336***	-0.376***
	(0.396)	(0.400)	(0.474)	(0.080)	(0.086)	(0.091)
Observations	110	85	52	110	85	52
Mean Dep. Var.	5.496	5.071	5.158	1.144	1.057	1.066

Note: We collapse the data at the DHS cluster level on means and present robust standard errors in parenthesis. We include district fixed effects and survey-year fixed effects. *Literacy* is a 0 to 2 categorical variable where 0 is cannot read at all and 2 is able to read a whole sentence. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table A23: Rubber Concessions and Wealth RD Analysis - Collapsing at the DHS Cluster Level

	Wealth Index			*Wealth Factor*		
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	-0.515***	-0.571***	-0.650***	-11,835**	-16,583***	-20,923***
	(0.136)	(0.138)	(0.204)	(5,237)	(4,827)	(7,113)
	Panel B: Cubic Polynomial in Distance to Concession Border					
Inside Concession	-0.482***	-0.538***	-0.531**	-12,034**	-15,663***	-16,604**
	(0.145)	(0.148)	(0.207)	(5,369)	(5,104)	(7,134)
	Panel C: Cubic Polynomial in Latitude and Longitude					
Inside Concession	-0.666***	-0.722***	-0.576**	-17,837***	-20,105***	-16,484**
	(0.174)	(0.201)	(0.224)	(6,557)	(6,722)	(7,785)
Observations	110	85	52	110	85	52
Mean Dep. Var.	2.199	2.004	2.044	-35301	-47409	-45669

Note: We collapse the data at the DHS cluster level on means and present robust standard errors in parenthesis. *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 A24: Rubber Concessions and Health RD Analysis - Collapsing at the DHS Cluster Level

	Child Ever Vaccinated			*Child Ht/Age Percentile*			*Respondent Ht/Age Percentile*		
Sample Within:	200 kms (1)	100 kms (2)	50 kms (3)	200 kms (4)	100 kms (5)	50 kms (6)	200 kms (7)	100 kms (8)	50 kms (9)
	Panel A: Linear Polynomial in Latitude and Longitude								
Inside Concession	-0.096***	-0.091**	-0.100**	-426.6*	-514.2**	-836.7**	-647.3***	-776.9***	-840.4***
	(0.036)	(0.036)	(0.043)	(255.3)	(249.6)	(369.9)	(227.6)	(226.3)	(306.7)
	Panel B: Cubic Polynomial in Distance to Concession Border								
Inside Concession	-0.096***	-0.092***	-0.111**	-669.3**	-698.4**	-1,088***	-713.0***	-787.0***	-841.5***
	(0.035)	(0.035)	(0.044)	(277.6)	(279.3)	(321.9)	(218.6)	(225.0)	(303.5)
	Panel C: Cubic Polynomial in Latitude and Longitude								
Inside Concession	-0.072*	-0.054	-0.092	-761.0**	-1,088***	-1,005**	-778.2***	-837.7***	-777.3**
	(0.042)	(0.051)	(0.059)	(317.1)	(350.9)	(450.0)	(250.5)	(271.4)	(349.1)
Observations	110	85	52	110	85	52	110	85	52
Mean Dep. Var.	0.813	0.790	0.788	2694	2631	2615	2667	2610	2626

Note: We collapse the data at the DHS cluster level on means and present robust standard errors in parenthesis. The DHS health questions are only 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. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

C.7. DHS Results - Excluding Observations Near the Congo River

Table A25: Rubber Concessions, Education and Wealth RD Analysis - Excluding Observations Near Congo River

	Years of Education			*Wealth Index*		
Sample Within:	200 kms (1)	100 kms (2)	50 kms (3)	200 kms (4)	100 kms (5)	50 kms (6)
	Panel A: Sample >5km from Congo River					
Inside Concession	-0.868**	-1.098***	-1.291***	-0.372***	-0.369***	-0.506**
	(0.341)	(0.354)	(0.429)	(0.128)	(0.132)	(0.213)
Observations	4,600	3,868	2,365	4,607	3,875	2,369
Clusters	91	77	47	91	77	47
Mean Dep. Var.	5.113	4.938	5.018	1.989	1.950	2.022
	Panel B: Sample >25km from Congo River					
Inside Concession	-0.845**	-1.094***	-1.412***	-0.412***	-0.424***	-0.665**
	(0.383)	(0.407)	(0.494)	(0.141)	(0.150)	(0.251)
Observations	4,214	3,524	2,121	4,220	3,530	2,124
Clusters	83	70	42	83	70	42
Mean Dep. Var.	5.031	4.844	4.929	2.000	1.967	2.057

Note: Standard errors are clustered at the DHS cluster level. We include district fixed effects and control for age, age squared and gender. Regressions use a linear polynomial in latitude and longitude. *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. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Appendix D. Basin Falsification Exercise

This section explains the falsification exercise discussed in Section 3.7. It first details the data used and the algorithm used in the construction of the river basin shapefiles, then explains how the falsification exercise was implemented, and finally presents multiple versions of the results to show that it is robust to alternative specifications and definitions.

D.1. River Basin Data

The data used in the falsification exercise is from Lehner and Grill (2013).[14] The data used is called the "HydroBASINS" data. This data provides a set of polygon shapefile layers that depict watershed boundaries and delineate sub-basins at a global scale.

The significant innovation in this data is the sub-basin delineation procedure. Two important feature required for a consistent mapping of river basins at a global scale are (1) a consistent method for sub-basin breakdown, i.e. the decision of when and how to subdivide a larger basin into multiple tributary basins, and (2) a method for grouping sub-basins together. For example, take the Mongala river basin in this paper, which defined the limits of the Anversoise river concession. The Mongala River basin is part of the larger Congo River basin, but also constitutes its own sub-basin, the Mongala River Basin.

The HydroBASINs data proceeds as follows for sub-basin breakdown. First, it breaks out sub-watersheds at any confluence where the inflowing branches (i.e., a tributary and its main stem) exceed a certain size threshold. In particular, hydroSHEDs divides a basin into two sub-basins at

[14] The data is available online at WWW.HYDROSHEDS.ORG.

every location where two river branches meet which each have an individual upstream area of at least 100 km^2(Lehner and Grill, 2013).

The second critical feature of the HydroSHEDs data is the way the sub-basins are grouped or coded to allow for the breakout of nested sub-basins at different scales. The "Pfafstetter" coding system is used due to its relative simplicity and ease of application. Pfafstetter coding in this case means that a larger basin is sequentially subdivided into 9 smaller units (the 4 largest tributaries, coded with even numbers, and the 5 inter-basins, coded with odd numbers). Thus, the next finer resolution of a sub-basin delineation is achieved at the next Pfafstetter level by adding one digit to the code of the previous level as depicted in the Figure A11 from Lehner and Grill (2013). The HydroBASINS data uses the Pfafstetter coding system for 12 levels globally.

D.2. Implementation

With the data detailed above from Lehner and Grill (2013), we re-run our main analysis using all other river basin limits from HydroBASINS that are of similar size and importance as our two main river basins. Specifically, the river basins corresponding to Anversoise and ABIR concession boundaries are level 5 and 6 river basins in the HydroBASINS data, respectively. Thus, the falsification exercise uses all level 5 and level 6 HydroBASINS layers to only consider river basins of similar size and importance to the main basins of interest.

We take all of these river basins – excluding the basins corresponding to Anversoise and ABIR concession boundaries – and use the DRC DHS 2007 and 2014 to calculate distance to each basin and whether or not a DHS observation falls within the river basin polygon. We exclude all DHS observations in Kinshasa and Lubumbashi since Kinshasa and Lubumbashi – the two largest cities in DRC – are major outliers in the DHS data. We then estimate our two specifications. (1) A parsimonious linear latitude-longitude RD specification using a 100 km bandwidth from the river basin border, and (2) our baseline RD specification – linear latitude-longitude – within a bandwidth of 100 km from the river basin border that includes controls for age, age-squared, gender, survey-year fixed effects and district fixed effects. The district fixed effects serve as border-segment fixed effects. The advantage of using districts fixed effects as border-segment fixed effects is that we can construct border-segment fixed effects for all of DRC in a non-arbitrary manner. Specification (2) is our preferred specification as detailed in Section 3.3. As the dependent variable, we use years of education, as years of education is a well-measured indicator of development and is potentially more comparable across large geographic spaces relative to other measures of development.[15] We limit our analysis to river basins that have at least ten DHS clusters within the basin so that the RD estimate is well-estimated, leaving us with 29 river basins in total. We record the RD estimates for each of these river basins and present them visually in the next section below. Figure A14a presents a map of all level 5 river basins in DRC and Figure A14b presents a map of all level 6 river basins in DRC from the HydroBASINS data.

D.3. Results

Figure A12 presents the empirical cumulative distribution of the RD estimates for all the major river basins in DRC, excluding the basins corresponding to Anversoise and ABIR concession boundaries. Figure A12a presents the cumulative distribution for the specification without controls. Figure A12b presents the cumulative distribution for our preferred specification with controls.

[15] The results are very similar when we use the measure of income from the DHS surveys, but are more prone to being influenced by large outliers and major cities.

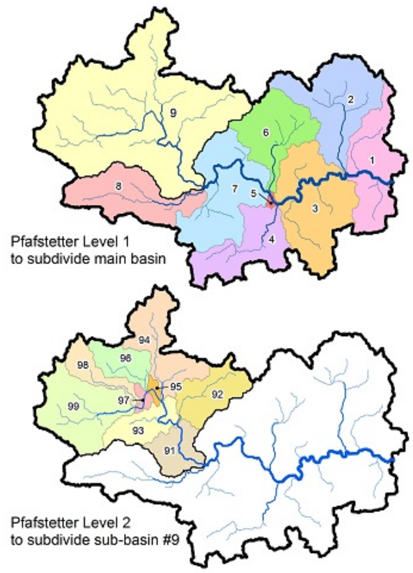
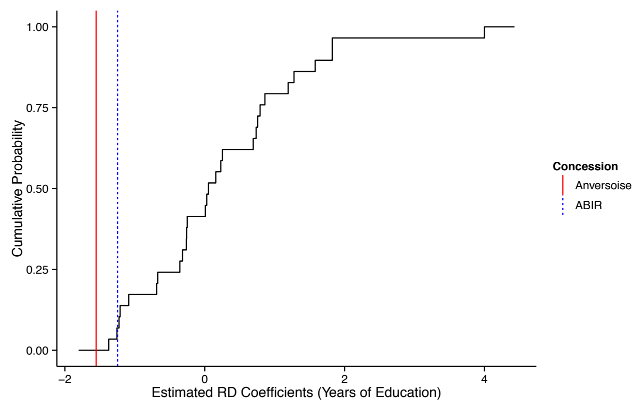


Figure A11: Example of the Pfafstetter Coding used in HyrdroBASINS

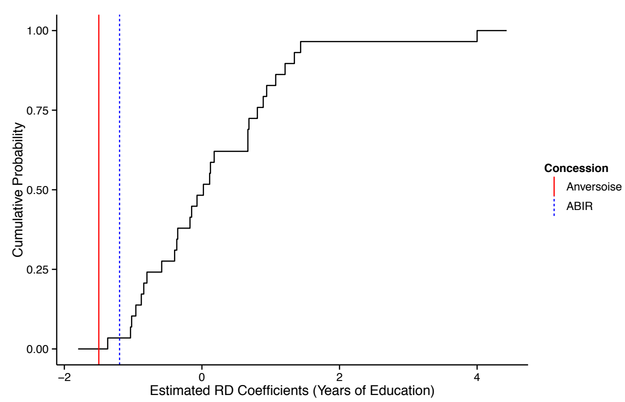
To highlight where the corresponding RD estimates for ABIR and Anversoise would fall relative to these estimated basin effects, we include in solid-red the RD estimate corresponding to the Anversoise concession border and in dashed-blue the RD estimate corresponding to the ABIR concession border. Figure A13 also presents the empirical cumulative distribution of the RD estimates for all the major river basins in DRC, but includes the RD estimates for the river basins corresponding to ABIR and Anversoise instead of the concession borders.[16] The results are very similar in both cases: the Anversoise estimate falls on the far-left of the distribution and there is no river basin that has as negative an estimate. The ABIR estimate is also on the far-left of the distribution and only one river basin estimate is more negative than almost all other river basin RD estimates. In particular, 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 using our baseline specification. ABIR falls in the bottom 6.89% of the distribution when we don't include our baseline controls, but this is driven by very large river basins, where the district fixed effects are important in improving precision of the RD estimates. These results offer evidence that the results presented in Section 3.5 are not an artifact of the concessions being drawn on river basins, but instead represent the impacts of the labor coercion during the rubber period.

[16] Figure A15 presents a map of the HydroBASINS river basins corresponding to the ABIR and Anversoise concessions along with the actual concession borders. It shows that both boundaries are roughly similar, consistent with Section 2 on how these concession boundaries were drawn. It is important to note that we wouldn't expect the borders to match the modern river basins as rivers can move across decades, and the concession borders were drawn with imperfect maps at a time when the interior of DRC was not mapped in great detail.

Figure A12: Empirical Cumulative Distribution of RD Estimates for Major River Basins in DRC - Relative to Concession Boundary Effects

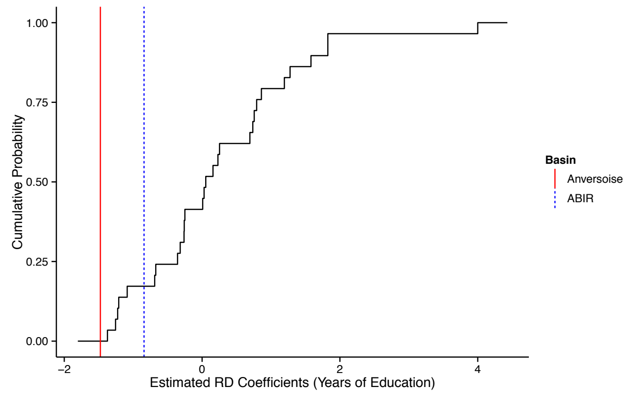


(a) Cumulative Distribution and Concession Estimates (No Controls)

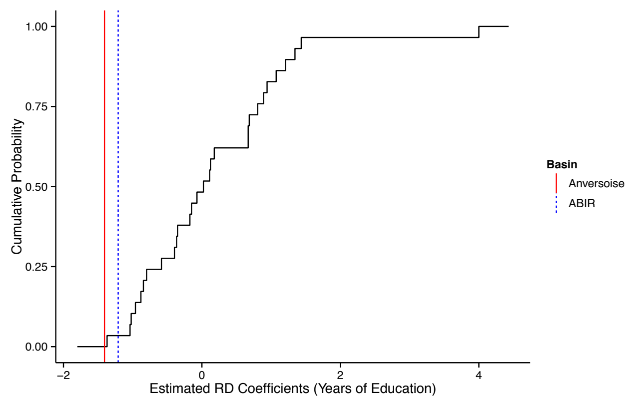


(b) Cumulative Distribution and Concession Estimates (w/ Controls)

Figure A13: Empirical Cumulative Distribution of RD Estimates for Major River Basins in DRC - Relative to Basin Boundary Effects

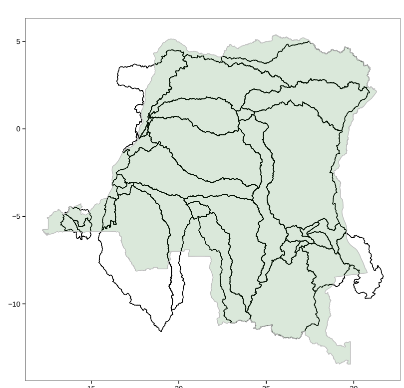


(a) Cumulative Distribution and Concession-Basin Estimates

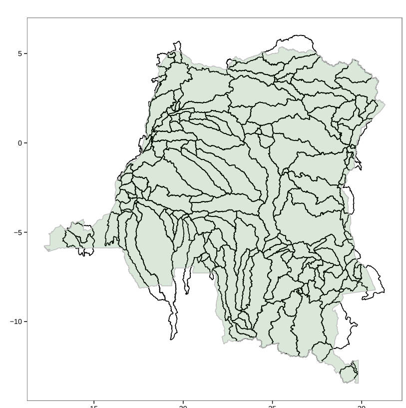


(b) Cumulative Distribution and Concession-Basin Estimates (w/ Controls)

Figure A14: Major River Basins in DRC from HydroBASINS

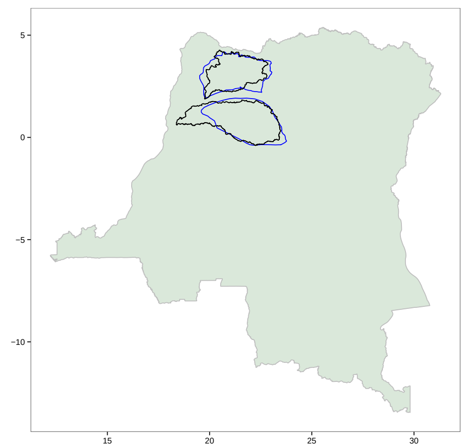


(a) Level 5 River Basins



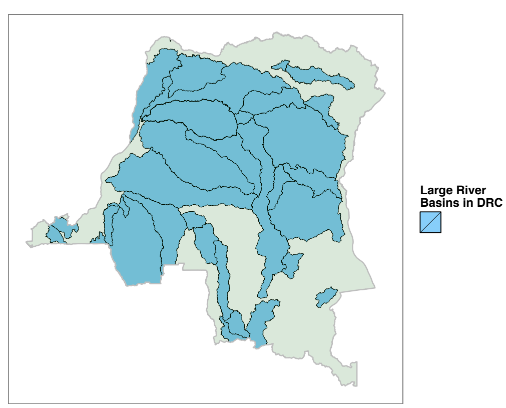
(b) Level 6 River Basins

Figure A15: Concession Borders and Concession River Basins from HydroBASINS



Notes: Concession Borders are outlined in blue and River Basins from HydroBASINS corresponding to the river basins used to define the concessions are outlined black.

Figure A16: River Basins from HydroBASINS - Sample in Falsification Exercise



Notes: The map shows the river basins outlines from HydroBASINS corresponding to the river basins used the falsification exercise. These correspond to all level 5 and level 6 river basins for DRC with at least ten clusters in the DHS data for DRC.

Appendix E. Differences in Subsequent Colonial Policies

In this section, we explore several alternative mechanisms that may explain our observed results. In particular, we explore whether the rubber extraction period (i) affected subsequent Belgian colonial infrastructure investments and missionary presence (ii) altered migration patterns and induced selective migration. In Appendix H.4 we examine differences in market access today using modern road network data, and in Appendix H.5 we analyze differences in population density.

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 Goffart (1908) 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.

E.1. Missionary Presence

During the colonial period, Catholic and Protestant missions were the primary providers of education (Hochschild, 1998). The differences in education found in Table 3, could be explained by differences in missionary presence 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 (from Goffart (1908)) and 1953 (from Académie Royale des Sciences d'Outre-Mer (1954)) to test whether areas inside the concessions had fewer missionary posts.

Panel A of Table A26 presents results from estimating equation (1) on missionary presence in 1897, 1924, and 1953 (see Appendix Figure A3a for a map of mission stations in 1924). 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 differences in type of mission station (e.g. with health center, school or neither).[17] 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.

E.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 using maps from the Army Map Services, Corps of Engineers, U.S. Army (1968). 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. The estimates are presented in Panel B of Table A26. We find little evidence that

[17] These results are not presented but are available upon request.

Table A26: Rubber Concessions, Missionary Stations, and Colonial Investment

	Panel A: Number of Missionary Stations in:								
	1897			*1924*			*1953*		
Sample Within:	200 kms (1)	100 kms (2)	50 kms (3)	200 kms (4)	100 kms (5)	50 kms (6)	200 kms (7)	100 kms (8)	50 kms (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 (1)	100 kms (2)	50 kms (3)	200 kms (4)	100 kms (5)	50 kms (6)	200 kms (7)	100 kms (8)	50 kms (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 (1)	100 kms (2)	50 kms (3)	200 kms (4)	100 kms (5)	50 kms (6)	200 kms (7)	100 kms (8)	50 kms (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 Goffart (1908) 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 A42. We present standard errors clustered at the territory level in ( ) and Conley standard errors in [ ] (assuming a cut-off window of 50 kms). * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

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.

Appendix F. Migration

F.1. 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. 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. 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 what the magnitude of present day selective migration would have to be to explain our observed results and to test for heterogeneity in effect sizes by ease of migration.

First, we conduct a trimming exercise with the DHS data to examine whether selective migration might be responsible for the differences in development outcomes between former concessions and areas just outside the former concessions. The intuition is that all of the "good" people inside the concession areas leave and locate just outside the concession areas. Thus, the areas outside the concession appear more developed. We consider how much of the sample we would have to trim in order for our results to lose significance. Specifically, we ask what percentage of the most well-off individuals who reside outside of the concessions would we need to omit so that we no longer observe statistically significant differences between former concession and non-concession areas, under the strong assumption that the x% of the most well-off from outside the concession are actually from inside the concession and that the "good" individuals from outside are not migrating to even better locations. 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. This would imply that for selective migration to fully explain the results, only the "best" people from inside are leaving and that the top one-fifth of the individuals we observe outside the concession are all came from inside the concession.

We present the results if we trim the top 15% of the most well-off individuals. 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.2.1 and demonstrate that even under a strong assumption of high levels of selective migration our results remain consistent. As a point of reference, Dell (2010) omits the top 4.8% using information on migration rates in Peru. A 15% migration rate is a much higher estimate of migration 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 compared to modern Landscan data. In both cases, population growth differences between inside and outside the concessions are a maximum of 4%.

Finally, we 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. If selective migration is easy such that more of the "good" people are leaving, we would expect that the RD estimates for villages where it is easier to migrate to be larger and more negative than the estimate for villages for which migration is more difficult. As proxies for ease of migration, we use (i) the colonial road network and (ii) ethnic group boundaries. For (i), we calculate the shortest distance along a road to leave the concession for each village. We then compare villages that have a below median road distance to leave the former concessions to those villages that have an above median road distance to leave the former concessions. Almost all villages happen to be next to a road segment, so this exercise is not comparing villages with roads to those without roads. The intuition is that for villages with a shorter road segment out of the concession, it is easier to migrate. For (ii), we use maps of ethnic groups boundaries from Murdock (1959) and compare villages inside ethnic homelands with an above median share of their ethnic homeland outside of the concession to those villages within ethnic homelands with a below median share of their ethnic homeland outside the concession. The intuition is that leaving the concession is easier for individuals with an above median share of their ethnic homeland outside of the concession. The results for exercise (i) are described and presented in Appendix F.3. The results for exercise (ii) are detailed and presented in Appendix F.4. In both cases, we find that villages where it is easier to migrate are not significantly worse off than villages where it is less easy to migrate, offering additional suggestive evidence that selective migration is not enough to explain the differences in development presented in Section 3.5 In fact, in general, those areas where it is harder to migrate have larger and more negative effect sizes.

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, Gaduh, Rothenberg and Wong (2016) examine the Transmigration Program in Indonesia that relocated two million migrants from rural Java and Bali to new rural settlements in the Outer Islands. They find that there has been little selective migration away from the settlements. The results are also consistent with qualitative evidence from our visits to the area: migration to other rural areas is challenging due to poor infrastructure and difficulties in gaining access to land and resources in a different village if one does not originate from that community.

F.2. Trimming for Selective Migration

F.2.1. Trimming with a 15% Migration Rate

Table A27: Rubber Concessions, Migration 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	-0.631**	-0.878***	-1.130***	-0.121*	-0.189***	-0.251***
	(0.313)	(0.316)	(0.350)	(0.071)	(0.070)	(0.083)
	Panel B: Cubic Polynomial in Distance to Concession Border					
Inside Concession	-0.683**	-0.867***	-1.172***	-0.130*	-0.181**	-0.274***
	(0.310)	(0.308)	(0.342)	(0.071)	(0.070)	(0.079)
	Panel C: Cubic Polynomial in Latitude and Longitude					
Inside Concession	-1.016***	-1.073***	-1.067***	-0.206**	-0.238***	-0.281***
	(0.339)	(0.345)	(0.375)	(0.080)	(0.086)	(0.087)
Observations	5,235	4,069	2,505	5,092	3,946	2,447
Clusters	110	85	52	110	85	52
Mean Dep. Var.	5.034	4.742	4.869	1.067	0.983	1.008

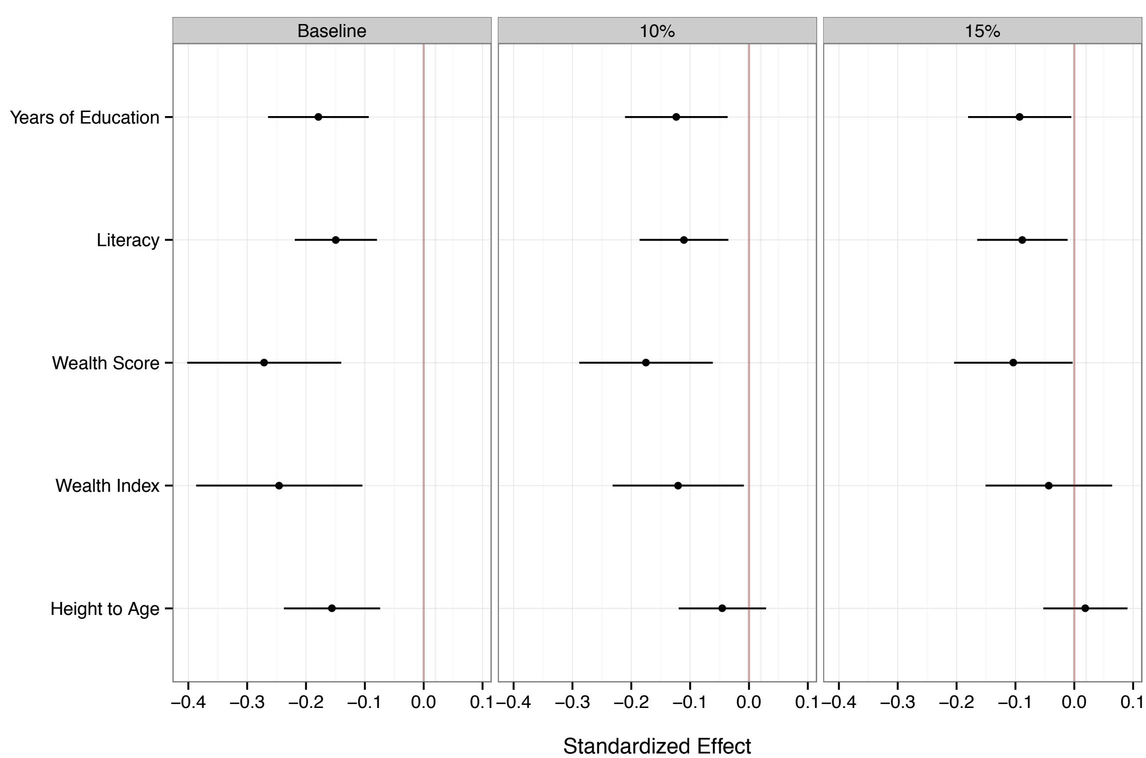
Notes: We trim our sample by dropping the top 15% of observations outside of the former concessions for each dependent variable. We cluster standard errors at the DHS cluster level. We include district fixed effects and control for age, age squared and gender. *Literacy* is a 0 to 2 categorical variable where 0 is cannot read at all and 2 is able to read a whole sentence. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table A28: Rubber Concessions, Migration and Wealth RD Analysis

	Wealth Index			*Wealth Factor*		
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	-0.482***	-0.518***	-0.594***	-8,894***	-9,922***	-11,489***
	(0.130)	(0.132)	(0.182)	(3,264)	(3,183)	(3,981)
	Panel B: Cubic Polynomial in Distance to Concession Border					
Inside Concession	-0.441***	-0.479***	-0.453**	-8,062**	-8,980**	-7,384
	(0.134)	(0.141)	(0.185)	(3,281)	(3,443)	(4,429)
	Panel C: Cubic Polynomial in Latitude and Longitude					
Inside Concession	-0.658***	-0.714***	-0.552***	-13,653***	-14,113***	-11,539**
	(0.156)	(0.182)	(0.184)	(3,620)	(4,210)	(4,416)
Observations	5,300	4,232	2,586	5,103	4,156	2,529
Clusters	110	85	52	110	85	52
Mean Dep. Var.	2.092	1.999	2.055	-49144	-50532	-49350

Notes: We trim our sample by dropping the top 15% of observations outside of the former concessions for each dependent variable. We cluster standard errors 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. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

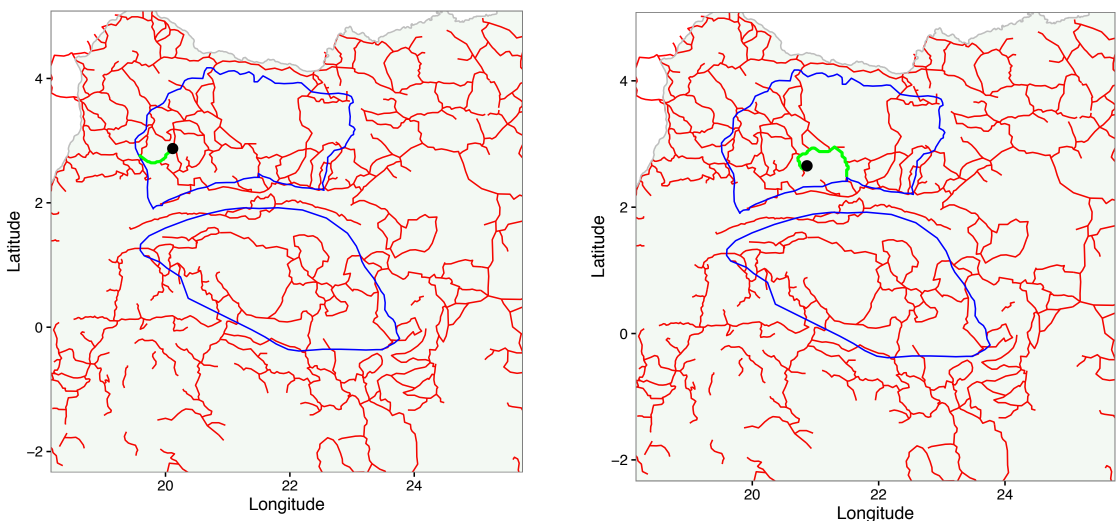
Figure A17: DHS Results - Trimming for Selective Migration - 100 kms



F.3. Heterogeneity by Ease of Migration Based on the Colonial Road Network

In this section, we examine how our results differ depending on the ease of migration to outside the former concession. In particular, we examine villages that happen to be on a road segment that has a easy access (i.e. shorter distance) to the concession border relative to those villages who happen to be on roads with harder access to the border. For intuition, consider Figure A18. Here we are considering two villages in the former Anversoise concession with similar euclidean distances to the border but differing road route distances to the border: one village is located on a road that makes it easier to leave along the road network (Figure A18a, optimal path highlighted in green) while the other village is on a road that makes it harder to leave the former concession (Figure A18b). By comparing these two villages, we can examine whether people in the villages where it's easier to get out have worse development outcomes than those from villages where it's harder to get out.

Figure A18: Road Networks and Road Distance to Concession Borders: Examples

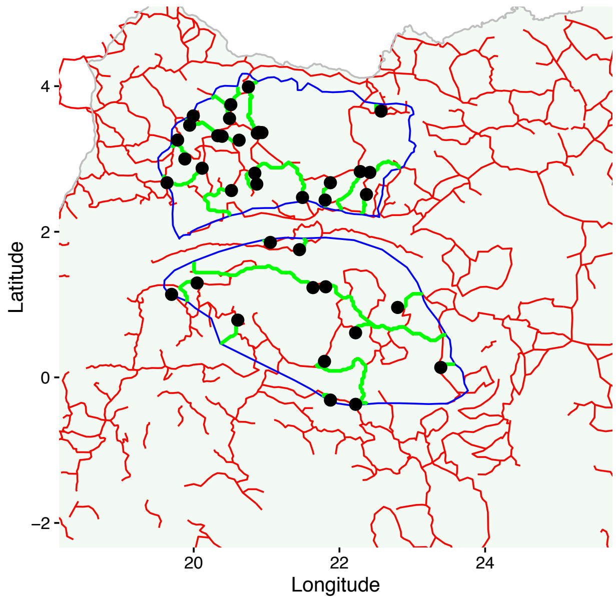


(a) Short Road Distance

(b) Long Road Distance

We proceed in the following way. First, for each village inside the former concessions, we calculate the shortest cost road route from its location to the border. These optimal shortest cost road segments for each cluster in the DHS data are highlighted in the map in Figure A18a in green. Second, for each sub-sample of villages within an Euclidean distance bandwidth away from the concession borders, we split the sample into villages above and below median road distance to the concession borders and estimate our baseline specification. Note that almost all villages happen to fall right next to some road, so this exercise is not simply comparing villages with roads to those without roads. Instead, it is comparing villages with easier access to out-migrate to outside the concessions relative to villages where it is harder to out-migrate due to differences in the road network structure.

Figure A19: Road Networks and Road Distance to Concession Borders: All Clusters



If selective migration is very large, we would expect that the RD estimates for villages with shorter road distance to the former borders (i.e. where it is easier to out-migrate) to be larger than the estimates for villages longer road distances to the former borders (i.e. where it is harder to out-migrate). Table A29 presents the estimates from splitting the sample within each bandwidth as described above. The results suggest that the estimates for the negative impacts of the rubber concession on education and wealth are very similar for both samples; in fact, the negative estimated effect of the rubber concession seems to be slightly larger in places where the road network makes it harder to out-migrate. Thus, areas with easier access to out-migrate are not significantly worse off than villages with less access to out-migrate, offering suggestive evidence against selective migration being a crucial explanation for the results in Section 3.5.

Table A29: Ease of Migration and Education and Wealth RD Analysis

	Years of Education			*Wealth Index*		
Sample Within:	200 kms (1)	100 kms (2)	50 kms (3)	200 kms (4)	100 kms (5)	50 kms (6)
	Panel A: > Median Road Distance to Border (Easier to Migrate)					
Inside Concession	-1.095***	-1.462***	-1.744***	-0.433**	-0.571***	-0.668***
	(0.413)	(0.400)	(0.413)	(0.174)	(0.168)	(0.206)
Observations	4,737	3,385	2,240	4,743	3,389	2,243
Clusters	91	67	44	91	67	44
	Panel B: < Median Road Distance to Border (Harder to Migrate)					
Inside Concession	-1.231***	-1.521***	-1.473***	-0.583***	-0.634***	-0.666**
	(0.374)	(0.377)	(0.482)	(0.185)	(0.188)	(0.231)
Observations	4,766	3,370	1,719	4,772	3,374	1,720
Clusters	91	66	33	91	66	33
Mean Dep. Var.	5.628	5.109	5.209	2.287	2.034	2.101

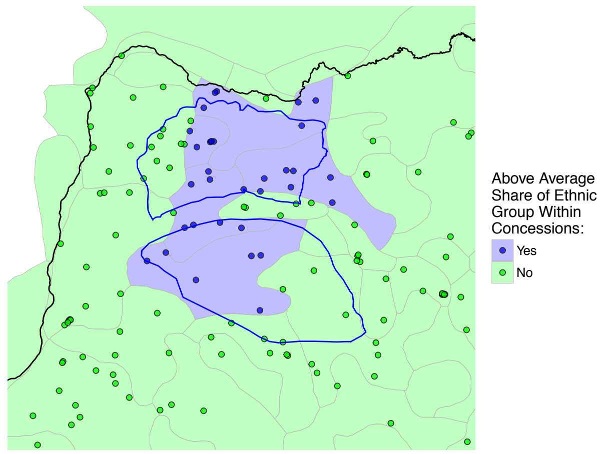
Notes: The estimated regressions use a linear polynomial in latitude and longitude as the RD polynomial. Standard errors are clustered at the DHS cluster level. We include district fixed effects and control for age, age squared and gender. *Wealth Factor* is an index generated by the DHS using principle 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. *Traversing Road* is an indicator variable equal to one if a DHS cluster is closest to a concession border segment within 10 km of a traversing road. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

F.4. Heterogeneity by Ease of Migration Based on Ethnic Group Boundaries

In this exercise, we use the intersection the rubber concession borders with ethnic group boundaries to examine heterogeneity of our estimated effects by the amount of ethnic group area is outside the concessions. The intuition is to analyze how our results differ depending on whether a village is part of an ethnic group with many possible villages for individuals to migrate outside the concessions, relative to villages part of an ethnic group that does not have many possible villages for individuals to migrate to outside the concession. The idea is that it may be difficult for individuals to migrate to villages where they are not the main ethnic group (due to cultural differences or language differences for instance).

We proceed in three steps. First, using the ethnic group boundaries map from Murdock (1959) and the rubber concession boundaries, for each ethnic group with at least one DHS village within the concessions, we calculate the share of its area that falls within the concessions. Second, we split our DHS sample within the former concessions into those part of an ethnic group with greater than average share of its ethnic group residing outside the concession and those with a lower than average share of its ethnic group residing outside the concession. The average village inside the former concessions is part of an ethnic group with approximately 50% of its area inside the former concessions. Third, we estimate our main specification for education and wealth for these two samples and compare the estimates. Figure A20 demonstrates which ethnic groups near the former concessions have an above and below average share of their area outside the former concessions, and which DHS villages belong to each group.

Figure A20: Ethnic Group Boundaries and Rubber Concessions



If selective migration is very large, we would expect that the RD estimates for villages with a higher share of their ethnic group residing outside former borders (i.e. where it is easier to out-migrate) to be larger than the estimates for villages with a lower share of their ethnic group residing outside the former borders (i.e. where it is harder to out-migrate). Table A30 presents the estimates from splitting the sample as described above. Interestingly, as in Section F.3 the estimates suggest that the (negative) impacts of the rubber concession on education and wealth are very similar for both samples and that the effect seems to be slightly more negative in places where the ethnic boundary locations make it harder to out-migrate. Thus, the results offer suggestive evidence once more that selective migration is unlikely to be a critical explanation for the DHS results from Section 3.5.

Table A30: Ease of Migration by Ethnic Group Boundaries

	Years of Education			*Wealth Index*		
Sample Within:	200 kms (1)	100 kms (2)	50 kms (3)	200 kms (4)	100 kms (5)	50 kms (6)
	Panel A: < Avg. Share of Ethnic Group Inside Concession (Easier to Migrate)					
Inside Concession	-1.021**	-1.386***	-1.569***	-0.348**	-0.470***	-0.632***
	(0.394)	(0.389)	(0.418)	(0.159)	(0.163)	(0.217)
Observations	4,898	3,502	2,159	4,905	3,507	2,161
Clusters	94	69	42	94	69	42
	Panel B: > Avg. Share of Ethnic Group Inside Concession (Harder to Migrate)					
Inside Concession	1.325***	-1.602***	-1.994***	-0.750***	-0.793***	-0.861***
	(0.372)	(0.393)	(0.436)	(0.159)	(0.164)	(0.236)
Observations	4,605	3,253	1,800	4,610	3,256	1,802
Clusters	88	64	35	88	64	35
Mean Dep. Var.	5.628	5.109	5.209	2.287	2.034	2.101

Notes: The estimated regressions use a linear polynomial in latitude and longitude as the RD polynomial. 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. *Avg. Share of Ethnic Group Inside Concession* is 0.49. *Share of Ethnic Group Inside Concession* is the share of the Murdock ethnic group polygon that falls inside either rubber concession. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Appendix G. Field Work

G.1. Sampling Procedure

The data were collected between July and August 2015 in Gemena, the capital of Sud-Ubangi province (formerly a part of Equateur province). We used Google satellite imagery from June 2015 to develop a sampling frame. We divided Gemena in to enumeration areas - "polygons" - whose shape was determined by natural boundaries, such as roads and rivers. We estimated the population size within each polygon by counting the number of houses. See Figures G.1, G.1 and G.1 for maps showing the satellite image of Gemena, Gemena divided into sampling polygons, and the sampled polygons and households that participated in the survey (indicated by navy blue dots).

Random sample

For the random sampling, 40 out of the 89 polygons were randomly selected to be visited by survey enumerators. The probability of a polygon being chosen was proportional to its estimated population size. Thus, more populated polygons had a higher probability of being selected. In other words, we used a probability-proportional-to-size (PPS) sampling method. The target number of observations for the study was 520. The number of households visited within each polygon is constant. Thus, 13 households were chosen to be visited in each randomly selected polygon.[18] To ensure geographic coverage of the polygon, enumerators followed a skip pattern within each polygon that depended on the number of houses within that polygon. Due to differences in the size of polygons, this generated a different skip pattern for each polygon. The polygons chosen, their approximate population size, and the skip pattern for each one is shown in Figure G.1 below. Using this sampling method, we visited 506 households within 40 randomly selected polygons during July and August of 2015.

G.2. Data Collection

For each household that was visited, survey team members asked to speak to the head of the household. If the head of the household was not available, the enumerator asked to interview an adult member of the household, with a preference for older household members. In order to avoid survey fatigue and improve engagement, we split up our survey into two parts, the first one conducted on the first visit and the second part in the second visit, along with some behavioral games. Below, we explain each visit in-depth.

First Visit - Main Survey

The first survey sections consisted of questions intended to identify the respondent's ethnic group and village and territories of origin and of birth. The survey collected information on basic demographics, migration, the institutions of the individual's village of origin, politics, values, and religion. In addition, for a final section of the survey, enumerators asked to speak to the oldest member of the household to collect data on her views of various historical events in the region. Respondents' were also asked to take a picture, if willing, in order to make relocating them for the second visit easier. The survey also contained detailed question on respondents' village of origin – on the status of the village, public goods available, trade and political institutions – but these were only asked to respondents who were at least somewhat familiar with their village of

[18] One polygon had to be dropped once enumeration began as most of it was a military complex and our enumerators were not granted access inside of it.

Figure A21: Satellite Image of Gemena

Figure A22: Satellite Image of Gemena with Sampling Polygons

Figure A23: Satellite Image of Gemena with Sampled Polygons and Households Visited

origin to improve the quality of the data. For this first visit, 506 households were visited and 503 households agreed to participate in the first survey.[19]

Second Visit - Survey and Behavioral Games

During the second visit, enumerators were asked to revisit the original households if the respondents' village of origin was within 200 kms of the former rubber concessions. The villages were located on maps by the respondent and enumerator during the first visit, and the distance to the former borders was done in R between the two visits. In total, there were 484 households out of 503 who fit this criteria and were therefore selected for the second visit. Enumerators were tasked with finding the same respondent as in the first visit to conduct a short survey, a variant of the Reverse Dictator Game (DG), a time and risk module, and an Implicit Association Test (IAT) on views of local chiefs. The Reverse DG and the IAT are explained in detail in Sections G.3 and G.4. The survey was always conducted first, and then the order of the three subsequent activities was randomized. When enumerators were unable to track down the original respondent due to travel or illness,they were asked to first attempt to locate another member of the same household and arrange two visits (to conduct the survey from the first part and the second visit); if they could not locate another household member, they were asked to use the same sampling method and skip pattern for that polygon to attempt to find a replacement household. This method of replacement resulted in 29 households being replaced in order to reach our target of 484 households for the second visit.

Third Visit - Payments from Behavioral Games

Finally, enumerators conducted a final visit that only consisted of payment for the outcomes of the Reverse DG. No survey was conducted in this visit; respondents only had to sign a receipt of payment and, if willing, take a photo with their sealed envelope containing the payment.[20]

[19] Three households refused to participate in the survey and were therefore not included in the survey.

[20] The pictures were taken to verify payment.

Figure A24: Sampling Frame

(1) Polygon ID	(2) Number of Households in Polygon	(3) Skip Pattern: Visit Every x Households
62	128	10
19	120	9
70	63	5
18	130	10
40	133	10
74	305	23
3	80	6
45	155	12
14	102	8
77	146	11
56	75	6
27	488	38
15	361	28
2	120	9
26	257	20
69	97	7
28	95	7
78	289	22
23	334	26
87	136	10
41	253	19
59	96	7
24	462	36
35	110	8
46	201	15
1	48	8
8	179	14
73	195	15
42	187	14
83	76	6
60	171	13
50	65	5
55	175	13
48	80	6
86	31	5
38	191	15
84	184	14
29	180	14
13	239	18
16	168	13

G.3. Reverse Dictator Game

Description of Game

During the second visit, we asked participants to play a variation of the Dictator Game (DG) proposed by (Jakiela, 2011) to experimentally measure an individual's *respect for earned property rights*. In this section we first explain the basic outline of the game and then provide the detailed experimental instructions we used.

In the standard DG, one player (*Player 1*) is allocated an amount of money (*budget*) and asked to allocate it between themselves (the"dictator") and another subject (*Player 2*). In the (Jakiela, 2011) variant, there are two differences from the standard DG: (i) instead of having an external *budget* endowed to *Player 1*, *Player 1* must perform a real effort task to earn the *budget*, and (ii) instead of *Player 1* being the "dictator", now *Player 2* is the "dictator" and gets to decide how to divide *Player 1*'s earned income between themselves and *Player 1*.

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 right*. 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, see). 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. 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, every respondent is matched to an anonymous, randomly selected individual from Gemena. This individual was chosen from within our sample and 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. Additionally, every respondent plays the game twice: once as *Player 2* and then as *Player 1*. 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. played as *Player 1*), subjects decide how they wanted to take from an anonymous *Player 1*'s income. We used the strategy method to elicit these divisions: for each of 20 possible earnings, respondents would enter the amount they wished to take for themselves. The share of earned income that *Player 2* decides to take from *Player 1*'s earned income is our measure for the *respect for earned property rights*.

For the earnings task, we selected a task that could be easily understood by all respondents and in 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 click on it before it disappears.Importantly, this effort task did not rely on physical strength or skill for effort but instead relied more on concentration and perseverance for effort. 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) for each 10 successful clicks. Respondent were very engaged in the task as participants earned on average 700 CF in this task, a significant amount for this region of DRC equal to about 1 days wage. Figure G.3 provides a picture of the basic layout of the game. The game was preformed on seven-inch Samsung Galaxy II tablets.

The game was conducted in private between the participant and the enumerator at the home of the respondent. Out of the 484 second visit participants, 482 total individuals participated in this reverse dictator game variation. Two individuals chose to skip participation, one due to poor eyesight and the other because her husband refused giving her and the enumerator permission to conduct the game in privacy. On average, participants chose to take close to 40% of the other

Figure A25: Clicking Task

individuals' earnings when playing this game. Below, we present the experimental instructions we used to conduct the game. These are presented in English; we translated these instructions to french and then Lingala using back translation to verify the accuracy of the translations.

Experimental Instructions - Reverse Dictator Game

[Find a private place to meet with the same respondent whom you interviewed for the survey. It is very important that the player will not be watched by members of his household or other people while he or she is playing the games.]

Now I will explain how to play this game. It is very important to pay attention because only those who understand the rules of the game well will be able to play. Let me remind you that this project is completely voluntary and you are free to leave at any time if you decide that you do not want to participate in this game.

This game is played in pairs: there is a player 1 and a player 2. Importantly, you will play both roles today.

You will play with someone chosen randomly from the population of Gemena. Neither you nor I will know exactly who you are playing with. Only one person in our research office will know who plays with who, and he will never tell anyone.

In this game, Player 1 earns money by performing some task and Player 2 will decide how they want to divide the money that Player 1 earns between them and the other player. Player 1 will earn money by performing a clicking task that will explain soon. The performance in this task will determine how much money is given to each pair of players. For example, if Player 1 earns 1000 FC, then Player 2 will decide how to divide the 1000 FC given to the players; if Player 1 earns 100 FC, then Player 2 will decide how to divide the 100 FC given.

Let me explain how the task is paid out. In this game, Player 1 will earn money by playing a clicking game on the tablet. In this game, a blue button will appear on the screen and the Player 1 must click the button to earn a point. The button will appear in different parts of the screen and it is Player 1's job to find it and click it before it disappears. Each time Player 1 presses the button the number of clicks on the screen increases by one. [Show player the image of the clicking game.]

Every time Player 1 clicks the blue button, the number goes up by one Ð it never decreases - and the button will change color. So, the number at the top of the tablet will show the number of times Player 1 has clicked. In this game, Player 1 will be paid money based on the number of times she clicks. WeÕll give Player 1 five minutes in which Player 1 can click as much as Player 1 can. Player 1 has to play the game with only one hand Ð Player 1 canÕt switch hands, or click with two hands. The more times Player 1 clicks the blue button during the five minutes, the more money Player 1 will be paid.

PAYOUTS

How much Player 1 is paid depends on how much Player 1 clicks. For each number of times she might click, she will earn 10 FC per click. We will then round this number to the closest hundred value. This sheet shows you how much she will be paid. So, Player 1 will be paid 100 FC if Player 1 clicks between 50 times and 149 times. If Player 1 clicks between 150 and 249 times, she will be paid 200 FC. The more times Player 1 clicks, the more money Player 1 earns.

- 0-4 Cliquers: 0 FC
- 5-14 Cliquers: 100 FC
- 15-24 Cliquers: 200 FC
- 25-34 Cliquers: 300 FC
- 35-44 Cliquers: 400 FC
- 45-54 Cliquers: 500 FC
- 55-64 Cliquers: 600 FC
- 65-74 Cliquers: 700 FC
- 75-84 Cliquers: 800 FC
- 85-94 Cliquers: 900 FC
- 95-104 Cliquers: 1000 FC
- 105-114 Cliquers: 1100 FC
- 115-124 Cliquers: 1200 FC
- 125-134 Cliquers: 1300 FC
- 135-144 Cliquers: 1400 FC
- 145-154 Cliquers: 1500 FC
- 155-164 Cliquers: 1600 FC
- 165-174 Cliquers: 1700 FC
- 175-184 Cliquers: 1800 FC
- 185-194 Cliquers: 1900 FC
- >195 Cliquers: 2000 FC

[Check that the player has understood how Player 1 will be paid depending on the number of clicks.]

Player 2 must then decide how to divide the money between himself and player 1. Player 2 must take between 0 and 1000 FC from player 1, but the total amount possible will depend on the effort made by Player 1. Player 2 takes home what he takes from player 1, and player 1 takes home the rest. Now, we are going to run through some examples to show how this game can be played.

[Take the money in your hands for these demonstrations and push the offer made to player 2 across a line on the floor.]

1. Here is the first example. Imagine that Player 1 earns 1000 FC. Player 2 then chooses to take 900 FC from Player 1. Then, Player 2 will go home with 900 FC. Player 1 will go home with 100 FC (1000 FC minus 900 FC equals 100 FC).
2. Here is another example. Imagine that Player 1 earns 600 FC. Player 2 then chooses to take 200 FC from Player 1. Then, Player 2 will go home with 200 FC. Player 1 will go home with 400 FC (600 FC minus 200 FC equals 400 FC).

3. Here is another example. Imagine that Player 1 earns 1000 FC. Player 2 then chooses to take 500 FC from Player 1. Then, Player 2 will go home with 500 FC. Player 1 will go home with 500 FC (1000 FC minus 500 FC equals 500 FC).
4. Here is another example. Imagine that Player 1 earns 700 FC. Player 2 then chooses to take 700 FC from Player 2. Then, Player 2 will go home with 700 FC. Player 1 will go home with 0 FC (700 FC minus 700 FC equals 0 FC).
5. Here is another example. Imagine that Player 1 earns 500 FC. Player 2 then chooses to take 0 FC from Player 1. Then, Player 2 will go home with 0 FC. Player 1 will go home with 500 FC (500 FC minus 0 FC equals 1000 FC).

Now please respond to the following test questions to be sure that you have understood. Then, I will tell you if you are a player 1 or a player 2 and you will begin to play. You will play as both Player 1 and Player 2 today, and we will return with your payouts in the next week.

[Use the following list as test questions. If it is necessary to ask more test questions, start again with the first example above and write "test questions repeated" in the notes section.]

For all the following questions, imagine Player 1 has earned 1000 FC:

Test Questions

1. Imagine that Player 2 chooses to take 1000 FC from Player 1. How much will Player 2 go home with? [1000] And how much will Player 1 go home with? [0]
2. Now imagine that Player 2 chooses to take 400 FC from Player 1. How much will Player 2 go home with? [400] How much will player 1 go home with? [600]
3. Now imagine that Player 2 chooses to take 600 FC from Player 1. How much will Player 2 go home with? [600] How much will player 1 go home with? [400]
4. Now imagine that Player 2 chooses to take 100 FC from Player 1. How much will Player 1 go home with? [900] How much will player 2 go home with? [100]
5. Now imagine that Player 2 chooses to take 800 FC from Player 1. How much will Player 1 go home with? [200] How much will player 2 go home with? [800]
6. Now imagine that Player 2 chooses to take 300 FC from Player 1. How much will Player 1 go home with? [700] How much will player 2 go home with? [300]

Now that you fully understand the game, do you still want to participate?

For this activity, first you are Player 2. The Player 1 you play with will be someone chosen randomly from the population of Gemena who has performed the clicking task. Remember that only one person in our research office will know who plays with who, and he will never tell anyone. Now I will ask you how much money you would take from Player 1 depending on how much they earned at the task:

1. If Player 1 earned 1000 FC, how much of this amount, if anything, would you take from Player 1?
2. If Player 1 earned 1000 FC, how much of this amount, if anything, would you take from Player 1?
3. If Player 1 earned 1000 FC, how much of this amount, if anything, would you take from Player 1?
4. If Player 1 earned 1000 FC, how much of this amount, if anything, would you take from Player 1?
5. If Player 1 earned 1000 FC, how much of this amount, if anything, would you take from Player 1?
6. If Player 1 earned 1000 FC, how much of this amount, if anything, would you take from Player 1?
7. If Player 1 earned 1000 FC, how much of this amount, if anything, would you take from Player 1?
8. If Player 1 earned 1000 FC, how much of this amount, if anything, would you take from Player 1?
9. If Player 1 earned 1000 FC, how much of this amount, if anything, would you take from Player 1?

10. If Player 1 earned 1000 FC, how much of this amount, if anything, would you take from Player 1?
11. If Player 1 earned 1000 FC, how much of this amount, if anything, would you take from Player 1?
12. If Player 1 earned 900 FC, how much of this amount, if anything, would you take from Player 1?
13. If Player 1 earned 800 FC, how much of this amount, if anything, would you take from Player 1?
14. If Player 1 earned 700 FC, how much of this amount, if anything, would you take from Player 1?
15. If Player 1 earned 600 FC, how much of this amount, if anything, would you take from Player 1?
16. If Player 1 earned 500 FC, how much of this amount, if anything, would you take from Player 1?
17. If Player 1 earned 400 FC, how much of this amount, if anything, would you take from Player 1?
18. If Player 1 earned 300 FC, how much of this amount, if anything, would you take from Player 1?
19. If Player 1 earned 200 FC, how much of this amount, if anything, would you take from Player 1?
20. If Player 1 earned 100 FC, how much of this amount, if anything, would you take from Player 1?

Now that you have told me what amounts you would take from Player 1, our research office will calculate your payoff after comparing your responses with the amount earned by Player 1. I will return in one or two weeks with your payment for these activities.

Now, you are a player 1. The player 2 you play with will be someone chosen randomly from the population of Gemena. You will never know with whom you are playing, and this player 2 will never know that he is playing with you.

You will earn money by clicking a game on the tablet like this Çdemonstrate imageÈ. We will then match you with a Player 2 who will decide how much to take from what you earn, and we will return with your payment in two or three weeks.

[Ask the player if he/she remembers how the clicking and payouts work. If he/she is uncertain, explain the following:]

Let me explain how the task is paid out. In this game, Player 1 will earn money by playing a clicking game on the tablet. In this game, a blue button will appear on the screen and the Player 1 must click the button to earn a point. The button will appear in different parts of the screen and it is Player 1's job to find it and click it before it disappears. Each time Player 1 presses the button the number of clicks on the screen increases by one. **[Show player the image of the clicking game.]**

Every time Player 1 clicks the blue button, the number goes up by one Ð it never decreases - and the button will change color. So, the number at the top of the tablet will show the number of times Player 1 has clicked. In this game, Player 1 will be paid money based on the number of times she clicks. WeÕll give Player 1 five minutes in which Player 1 can click as much as Player 1 can. Player 1 has to play the game with only one hand Ð Player 1 canÕt switch hands, or click with two hands. The more times Player 1 clicks the blue button during the five minutes, the more money Player 1 will be paid.

PAYOUTS

How much Player 1 is paid depends on how much Player 1 clicks. For each number of times she might click, she will earn 10 FC per click. We will then round this number to the closest hundred value. This sheet shows you how much she will be paid. So, Player 1 will be paid 100 FC if Player 1 clicks between 5 times and 15 times. If Player 1 clicks between 15 and 24 times, she will be paid 200 FC. The more times Player 1 clicks, the more money Player 1 earns.

- 0-4 Cliquers: 0 FC
- 5-14 Cliquers: 100 FC
- 15-24 Cliquers: 200 FC
- 25-34 Cliquers: 300 FC
- 35-44 Cliquers: 400 FC
- 45-54 Cliquers: 500 FC

- 55-64 Cliquers: 600 FC
- 65-74 Cliquers: 700 FC
- 75-84 Cliquers: 800 FC
- 85-94 Cliquers: 900 FC
- 95-104 Cliquers: 1000 FC
- 105-114 Cliquers: 1100 FC
- 115-124 Cliquers: 1200 FC
- 125-134 Cliquers: 1300 FC
- 135-144 Cliquers: 1400 FC
- 145-154 Cliquers: 1500 FC
- 155-164 Cliquers: 1600 FC
- 165-174 Cliquers: 1700 FC
- 175-184 Cliquers: 1800 FC
- 185-194 Cliquers: 1900 FC
- >195 Cliquers: 2000 FC

[Check that the player has understood how he/she will be paid depending on the number of clicks. Then, go to the "Effort Task" game on the home screen. Enter the respondent's information and give the Player the tablet. Have them play the game and, after the 5 minutes, then return to geoodk.]

[Read the conclusion only after having administered the activity.] Thank you for participating in this game. The player 2 you will be playing with will be drawn randomly from the population of Gemena and will decide how to divide the money you just earned. I will return in one or two weeks to give you this money.

G.4. Implicit Association Test (IAT)

During the second visit, we also conducted a Single-Target Implicit Association Test (ST-IAT) on local chief authority 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 of a single target – in our case, this is local chiefs. ST-IATs have been used very recently in similar settings in the DRC by Lowes et al. (2015) and Lowes et al. (2017).

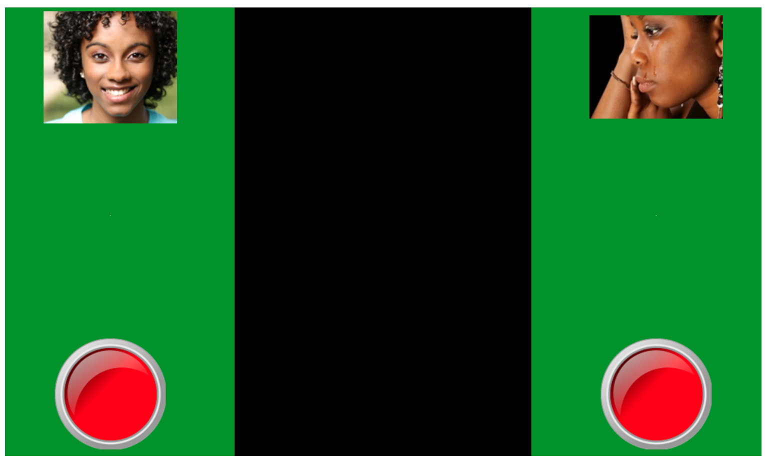
The ST-IAT (henceforth IAT) asks respondents to sort words into two groups, one group on the left side and the other on the right side of the screen. Three different sets of words are presented audibly: words related to happiness, words related to sadness, and words related to local chiefs. The IAT consists of two blocks: in one happy words and chiefs words are sorted left and sad words to the right, and the other happy words are sorted to the left and chief words and sad words are sorted to the right. The order of the blocks is randomized across individuals.

The intuition behind the IAT is that if a respondent has a positive view of chiefs, he/she will have an easier time sorting chief words to the left with happy words than to the right with sad words. The respondent would be using a subconscious heuristic that good things go left and bad things go right (Lowes et al., 2015) . If a respondent does not have a positive association with chiefs, then this heuristic will not apply and the opposite heuristic will be used; he/she will find it easier to sort chief words to the right instead. By examining the difference in the speed at which the respondent sorts the words across the two blocks we can infer their implicit view of chiefs.

Formally, we follow Lowes et al. (2015) 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.

The IATs were played on seven-inch Samsung Galaxy II tablets with Panasonic RP-HT21 Lightweight Headphones connected to them. The respondents always played a practice block first that asks them to sort only happy words and sad word; this allows them to get used to the interface, the headphones and the tablet. To sort a word to the left (right), the participant presses the red button on the left (right) side of the screen, presented in Figure ??. In every block of the IAT, participants had to obtain a 75% success rate in sorting words to the correct side in order to advance to the next block. If they did not meet this success rate, they had to repeat the block. Figure ?? presents a screenshot of the practice block set-up. There is an image of a happy person on the left and an image of a sad person on the right to help the participant with the sorting directions.

Figure A26: IAT Screenshot - Practice Block



After the practice block, the participant engages in two more blocks where three different sets of words are presented audibly: words related to happiness, words related to sadness, and words related to local chiefs. These serve as the main two block of the the IAT: in one happy words and chiefs words are sorted left and sad words to the right, and the other happy words are sorted to the left and chief words and sad words are sorted to the right. The order of the blocks is randomized across individuals. In all blocks, happy words are sorted left and sad words are sorted left. Each time a participant gets to sort a new word is called a trail, and each block consists of 24 trails: 8 trails with happy words, 8 trails with sad words, and 8 trails with chief words. The order of the trails was randomized within each block. The full list of words used is presented in Table A31. Figures G.4 and G.4 present screenshots of the two blocks: the first image of the block in which chiefs words are sorted with happy words, and the second one of the block in which chief words are sorted with sad words. The screen displays the word "kapita" – the word for local chief in Lingala – on the left or right side of the screen to help the participant with the sorting.

As stated earlier, examining the difference in the speed at which the respondent sorts the words across the two blocks allows us to infer their implicit view of chiefs using the standard *D-Score* as our inferred measure of the implicit view of chiefs for a given respondent. We follow Lowes et al. (2015) and ignore data from practice blocks and repeated blocks where the participant did not achieve a 75% success rate. We windsorize the response times (also known as latency) to 3,000

Figure A27: IAT Screenshot - Block B

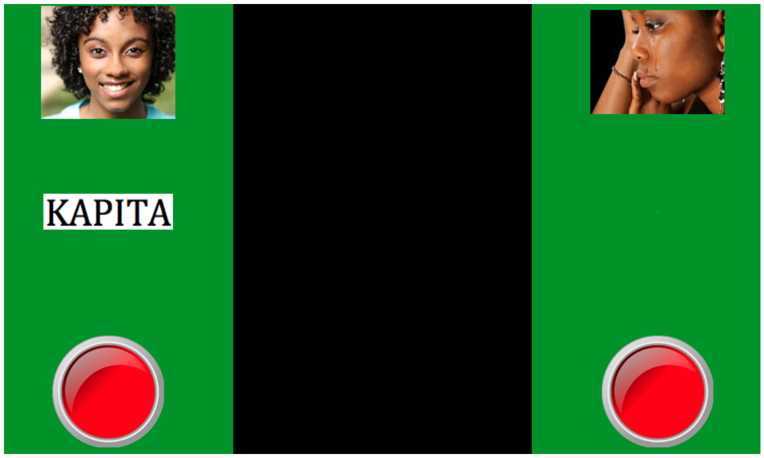
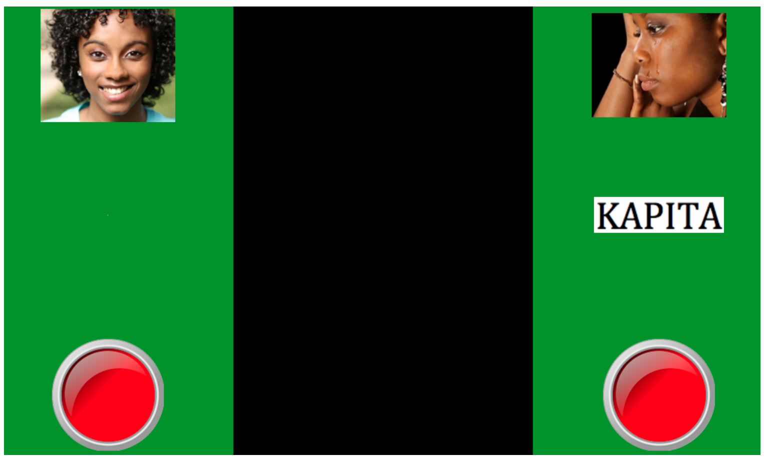


Figure A28: IAT Screenshot - Block C



milliseconds. We account for incorrect replacing their latency with the block mean plus the block standard deviation.

The IAT instructions we used borrow heavily from Lowes et al. (2015). Lowes et al. (2015) conducted ST-IATs in the DRC during 2014 and their findings confirm that the single-target IAT succeeds in capturing participants' implicit attitudes in a very similar setting. These instructions are presented below in English. We translated the instructions, the tablet audio, and the tablet-game prompts into Lingala using back translation methods to verify the accuracy and consistency of the translations.[21]

During the second visit, 459 participated completely in the activity. Many participants refused to participate, either due to poor eyesight, hearing problems, and/or sickness. Some participants refused to complete the activity due to failing to achieve a 75% success rate and grew fatigued of having to repeat blocks. Thus, we have 459 IAT observations from our second visits to test for implicit views of chiefs.

[21] We only performed the IAT in Lingala as everyone in our sample for the second visits spoke Lingala, the Lingala for the game is very basic, and the chief authority words have more meaning in Lingala than their equivalents in French for the local context.

Table A31: Words used in the IAT

Happy Words		*Sad Words*		*Chief Authority Words*	
English	Lingala	English	Lingala	English	Lingala
Love	Bolingo	Pain	Bolosi	Chief	Kapita
Generosity	Boboto	Failure	Kokueya	Chiefs	Bakapita
Laughter	Koseka	Suffering	Kpokoso	Village Chief	Mokonzi
Joy	Sai	Bad	Kitkote	Village Chiefs	Bakonzi
Glory	Kembo	Horrible	Somo	Sub-tribe Chief	Kumu
Happiness	Esengo	Wrong	Mabe	Sub-tribe Chiefs	Bakumu
Pleasure	Kosepela	Wicked	Motomboki	Local Leader	Mokambi
Sympathetic	Motema Kitoko	Terrible	Yakobangisa	Arbiter of Village Conflict	Mokubua

Notes: English and French words for the Happy Words and Sad Words come from Lowes, Nunn, Robinson and Weigel (2015).

Experimental Instructions - IAT

[Find a private place to meet with the same respondent whom you interviewed for the survey. It is very important that the player will not be watched by members of his household or other people while he or she is playing the games.]

Now I will explain how to play this game. It is very important to pay attention because only those who understand the rules of the game well will be able to play.

Let me remind you that this project is completely voluntary and you are free to leave at any time if you decide that you do not want to participate in this game.

First Block:

We are going to play a computer game. Before we play I would like to ask you to put on these headphones. If they are too loud or are uncomfortable, please let me know so I can adjust them.

[Ask participant if he/she will put on headphones]

[If participant doesn't want to put on headphones then wait until the start of the second block to ask if they changed their mind. If they still decline, unplug the headphones and use the computer's internal speakers. But make sure the volume isn't so loud that other people can hear.]

You are going to hear sounds when an dot appears in the middle of the screen one at a time. Some words will be good words and some words will be bad words. If you hear a good word like happy or nice I want you to press the left button as fast as you can. There is a smiley face on the left side to remind you to press the left button when you hear a good word. But if you hear a bad word like wicked or mad I want you to press the right button as fast as you can. There is a frowny face on the right side to remind you to press the right button when you hear a bad word.

Now, there are a few things to remember.

1. Please use one finger for each button. [Demonstrate by holding one finger by both buttons and pressing each one at a time.]

2. After you press the button be sure to take your finger off of it because if you hold it down [demonstrate holding it down], the button will stop working.
3. Please play the game as fast as you can. It is okay if you make mistakes, I just want to see how quickly you can play. But if you do press the wrong button, just press the correct one and keep playing.

Now that you fully understand the game, do you still want to participate?

[If the person indicates yes, administer the game.]

[Have participant put one finger by each button before beginning the first block.]

Are you ready to play the game?

[Make sure the participant has one finger by each button and is ready to begin before starting.]

Some sounds will be words related to happiness and words related to sadness. If you hear a sound related to happiness, I want you to press the red button on the left as quickly as you can; There is a picture of a smiling face on the left side to remind you to press the red when you hear words related to happiness. Finally, if you hear a sound related to sadness, I want you to press the right button as quickly as you can; There is a picture of a sad face on the right side to remind you to press the red button on the right when you hear words related to sadness.

Remember: please try to play the game as fast as you can. It is okay if you make mistakes.

Second Block:

This next activity will be a bit more complicated. You are going to hear words about chief authority and hear words about happiness or sadness one at a time. If you hear a word related to chief authority in the middle of the screen I want you to press the red button on the left side of the screen as quickly as you can like you were doing earlier. There is a picture of the word "chief" on the right side to remind you to press the red button on the right when you hear sounds about chief authority. If you hear a good word I also want you to press the left button as fast as you can like you were doing before. And if you hear a bad word I also want you to press the red button on the right side of the screen as fast as you can like you were doing before.

Remember: please try to play the game as fast as possible, and don't worry about making mistakes.

[When they get to the break in the middle, say:]

That was great.

Third Block:

Now they've changed sides on you. This time, if you hear a word related to chief authority please press the red button on the right side of the screen as quickly as you can.

[Point out that the category reminders – i.e. the word for chief - has switched sides when you are reciting the instructions].

But, as before if you hear a good word I also want you to press the left button as fast as you can like you were doing before. And if you hear a bad word I also want you to press the right button as fast as you can like you were doing before.

Are you ready to play?

G.5. Summary Statistics

Table A32: Fieldwork: Summary Statistics for the Full Sample

	Individuals Within 200 kms of Concession Borders			
	Mean Inside	Mean Outside	Clustered S.E.	(p-value)
Educational Attainment	2.594	2.626	0.085	0.708
Obs.	254	257		
Years of Education	7.165	7.798	0.351	0.072
Obs.	231	233		
Student	0.091	0.093	0.024	0.907
Obs.	254	257		
Income: Last Week	11,770	13,312	2,907	0.596
Obs.	254	257		
Primary Earner	0.626	0.607	0.047	0.687
Obs.	254	257		
Married	0.839	0.794	0.032	0.167
Obs.	254	257		
Female	0.374	0.424	0.046	0.273
Obs.	254	257		
Age	39.260	39.988	1.269	0.566
Obs.	254	257		

Notes: Data collected in Gemena, DRC during the summer of 2015. Standard errors are clustered at the village of origin level. Educational Attainment is a 0 to 4 categorical variable where 0 is no education and 4 is higher education. Student is an indicator variable equal to 1 if the respondent is currently a student. Income: Last Week is self-reported income level by respondents. Primary Earner is an indicator variable equal to 1 if the respondent is currently the primary earner for his/her household. Married is an indicator variable equal to 1 if the respondent is currently married. Female is an indicator variable equal to 1 if the respondent is a female.

G.6. Migrant Characteristics

Table A33: Differences in Migrant Characteristics and Reasons for Migration

	Individuals From Within 200 kms of Concession Borders			
	Mean Inside	Mean Outside	Clustered S.E.	(p-value)
First-Generation Migrant	0.142	0.171	0.032	0.353
Obs.	254	257		
Father Migrant	0.642	0.650	0.045	0.857
Obs.	254	257		
Mother Migrant	0.685	0.638	0.041	0.255
Obs.	254	257		
Father: Migrated to Find Better Economic Opportunities	0.393	0.425	0.060	0.587
Obs.	163	167		
Father: Migrated to Find Better Educational Opportunities	0.074	0.072	0.028	0.951
Obs.	163	167		
Mother: Migrated to Find Better Economic Opportunities	0.034	0.073	0.025	0.123
Obs.	174	164		
Mother: Migrated to Find Better Educational Opportunities	0.023	0.018	0.015	0.757
Obs.	174	164		
Migrant Father Educational Attainment	2.410	2.181	0.136	0.094
Obs.	139	144		
Migrant Mother Educational Attainment	0.962	1.185	0.145	0.125
Obs.	157	151		

Note: Data collected in Gemena, DRC during the summer of 2015. Standard errors are clustered at the village of origin level. First-Generation Migrant is an indicator variable equal to 1 if the respondent is a first generation migrant. Father Migrant is an indicator variable equal to 1 if the respondent's father is a migrant to Gemena. Mother Migrant is an indicator variable equal to 1 if the respondent's mother is a migrant to Gemena. Father: Migrated to Find Better Economic Opportunities is an indicator variable equal to 1 if the respondent's father migrated to Gemena in search of better economic opportunities. Father: Migrated to Find Better Educational Opportunities is an indicator variable equal to 1 if the respondent's father migrated to Gemena in search of better educational opportunities. Mother: Migrated to Find Better Economic Opportunities is an indicator variable equal to 1 if the respondent's mother migrated to Gemena in search of better economic opportunities. Mother: Migrated to Find Better Educational Opportunities is an indicator variable equal to 1 if the respondent's mother migrated to Gemena in search of better educational opportunities. Migrant Father Educational Attainment and Migrant Mother Educational Attainment are 0 to 4 categorical variables where 0 is no education and 4 is higher education for migrant parents.

Table A34: Fieldwork: Summary Statistics for First-Generation Migrants

	First-Generation Migrants From Within 200 kms of Concession Borders			
	Mean Inside	Mean Outside	Difference	(p-value)
Migrated to Find Better Economic Opportunities	0.222	0.205	0.018	0.849
Obs.	36	44		
Migrated to Find Better Educational Opportunities	0.167	0.205	-0.038	0.647
Obs.	36	44		
Migrated due to Disagreement with Family or Villagers	0.056	0.068	-0.013	0.816
Obs.	36	44		
Migrated with Parents (as a Child)	0.167	0.341	-0.174	0.090
Obs.	36	44		
Outcast from Village	0.028	0.023	0.005	0.889
Obs.	36	44		
Years of Education	7.562	9.353	-1.790	0.057
Obs.	32	34		
Student	0.111	0.227	-0.116	0.168
Obs.	36	44		
Income: Last Week	4,689	20,629	-15,940	0.010
Obs.	36	44		

Notes: Data collected in Gemena, DRC during the summer of 2015. Standard errors are clustered at the village of origin level. Student is an indicator variable equal to 1 if the respondent is currently a student. Income: Last Week is self-reported income level by respondents. Migrated to Find Better Economic Opportunities is an indicator variable equal to 1 if the respondent migrated to Gemena in search of better economic opportunities. Migrated to Find Better Educational Opportunities is an indicator variable equal to 1 if the respondent migrated to Gemena in search of better educational opportunities.

Table A35: Fieldwork: Summary Statistics for Second-Generation or Higher Migrants

	Second-Generation Migrants From Within 200 kms of Concession Borders			
	Mean Inside	Mean Outside	Difference	(p-value)
Educational Attainment	2.578	2.554	0.024	0.798
Obs.	218	213		
Years of Education	7.101	7.533	-0.432	0.255
Obs.	199	199		
Student	0.087	0.066	0.021	0.363
Obs.	218	213		
Income: Last Week	12,940	11,800	1,140	0.720
Obs.	218	213		
Primary Earner	0.651	0.620	0.032	0.540
Obs.	218	213		
Married	0.844	0.789	0.055	0.120
Obs.	218	213		
Female	0.374	0.424	0.046	0.273
Obs.	254	257		
Age	39.48	39.78	-0.298	0.826
Obs.	218	213		

Note: Data collected in Gemena, DRC during the summer of 2015. Standard errors are clustered at the village of origin level. Educational Attainment is a 0 to 4 categorical variable where 0 is no education and 4 is higher education. Student is an indicator variable equal to 1 if the respondent is currently a student. Income: Last Week and Income: Last Month are self-reported income levels by respondents. Primary Earner is an indicator variable equal to 1 if the respondent is currently the primary earner for his/her household. Married is an indicator variable equal to 1 if the respondent is currently married. Female is an indicator variable equal to 1 if the respondent is a female.

G.7. Additional Fieldwork Tables

Table A36: Trade, Entrepreneurship and Cash Crop Farming

	Village Trade Index (AES Coefficients)		
Sample Within:	200 kms (1)	100 kms (2)	50 kms (3)
Inside Concession	-0.166*** (0.063)	-0.153** (0.064)	-0.107 (0.070)
Observations	301	276	226
Clusters	221	201	161

Note: Standard errors clustered at the origin village level. Regressions include district fixed effects. *Village Trade Index* presents Average Effect Size estimates for the following questions (with response options in parentheses): (1) Is village trade mostly done by external traders or by the villagers themselves? (0 - External; 1 - Villagers), (2) How would you rate the level of entrepreneurship displayed in your village of origin? (0 - Very bad; 4 - Very good), (3) Is rice the main primary crop farmed in your village? (0 - No, 1 - Yes), (4) Is rice the second primary crop farmed in your village? (0 - No, 1 - Yes), and (5) Is rice the third primary crop farmed in your village? (0 - No, 1 - Yes). * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table A37: Survey and Experimental Measures of Pro-Social Norms
Second-Generation Migrants

	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	0.068	0.085	0.071	0.180**	0.178**	0.259***
	(0.074)	(0.075)	(0.080)	(0.079)	(0.082)	(0.090)
Observations	431	393	309	419	383	299
Clusters	298	272	213	290	265	206
	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	0.237**	0.219*	0.227*	0.129	0.127	0.083
	(0.118)	(0.118)	(0.133)	(0.092)	(0.091)	(0.103)
Observations	419	382	300	294	272	222
Clusters	289	263	205	217	201	160
	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	16.65	18.46	15.71	0.036**	0.037**	0.029*
	(13.02)	(13.28)	(14.41)	(0.015)	(0.015)	(0.017)
Mean Dep. Var.	444	444	447	0.399	0.399	0.399
Observations	410	374	293	409	373	292
Clusters	287	262	203	286	261	202

Notes: Standard errors clustered at the origin village level. Regressions estimated for the sample of second-generation or higher migrants to Gemena. Regressions include district fixed effects and a linear polynomial in latitude and longitude. The regressions are estimated for the sub-sample of individuals who are not first-generation migrants to Gemena (i.e. they are second-generation or higher). *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. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table A38: Survey and Experimental Measures of Pro-Social Norms
First-Generation Migrants

	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	0.482**	0.464**	0.408**	0.084	0.061	0.102
	(0.213)	(0.205)	(0.199)	(0.211)	(0.212)	(0.227)
Observations	80	72	56	78	70	55
Clusters	75	67	52	75	67	52
	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	0.866***	0.814***	0.823***	0.315	0.323	0.257
	(0.118)	(0.118)	(0.133)	(0.304)	(0.309)	(0.310)
Observations	79	71	55	54	48	37
Clusters	74	66	51	52	46	36
	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	-3.93	-1.70	-6.26	0.052	0.048	0.047
	(31.28)	(32.25)	(34.86)	(0.052)	(0.049)	(0.052)
Mean Dep. Var.	453	450	454	0.410	0.417	0.419
Observations	72	64	48	72	64	48
Clusters	70	62	47	70	62	47

Notes: Standard errors clustered at the origin village level. Regressions estimated for the sample of first-generation migrants to Gemena. Regressions include district fixed effects and a linear polynomial in latitude and longitude. The regressions are estimated for the sub-sample of individuals who are not first-generation migrants to Gemena (i.e. they are second-generation or higher). *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. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

G.8. AES Components Coefficient Plots

This section presents the coefficient plots for the AES indexes presented in the main text. For each index, we plot the estimated AES coefficient and then plot the standardized individual component coefficient for each component that is included in the index. The coefficient plots are presented for regression discontinuity estimates using a 100 km bandwidth. All estimates use linear polynomials in latitude and longitude and include district fixed effects. Standard errors are clustered at the village of origin level. The plots include 95% confidence intervals for each coefficient.

Figure A29: AES Components Coefficient Plots - Village Public Goods

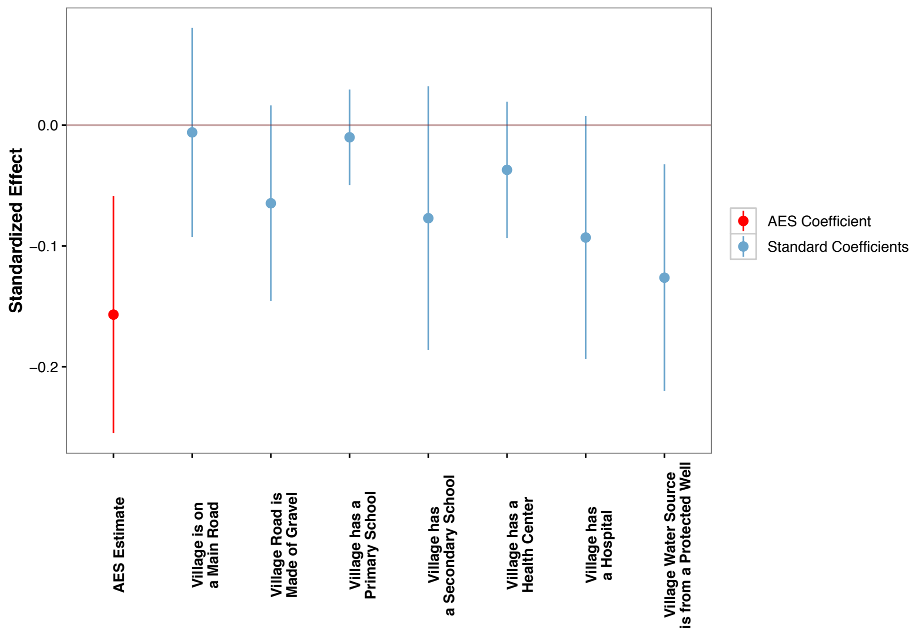


Figure A30: AES Components Coefficient Plots - Chief Public Good Provision

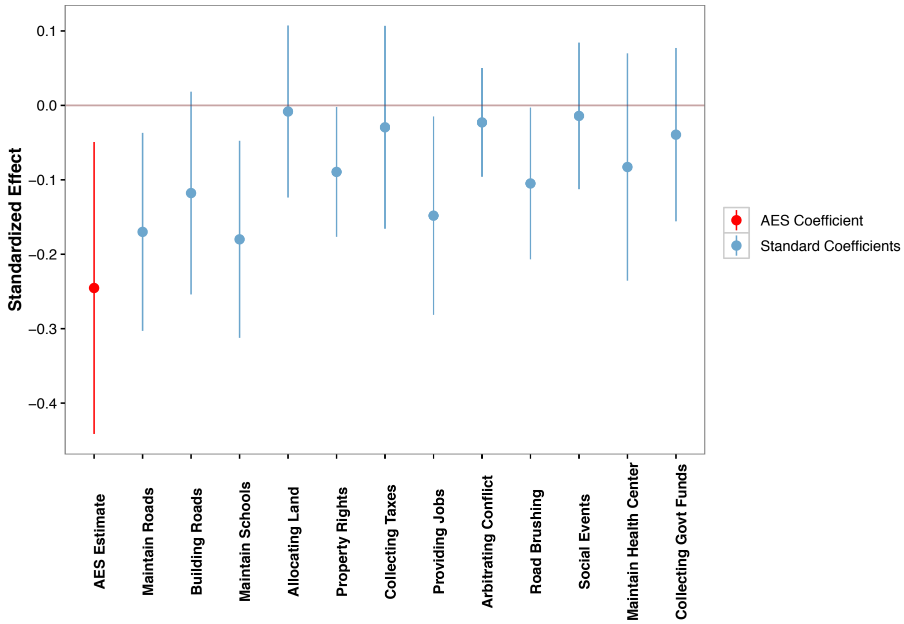


Figure A31: AES Components Coefficient Plots - Respect for Authority

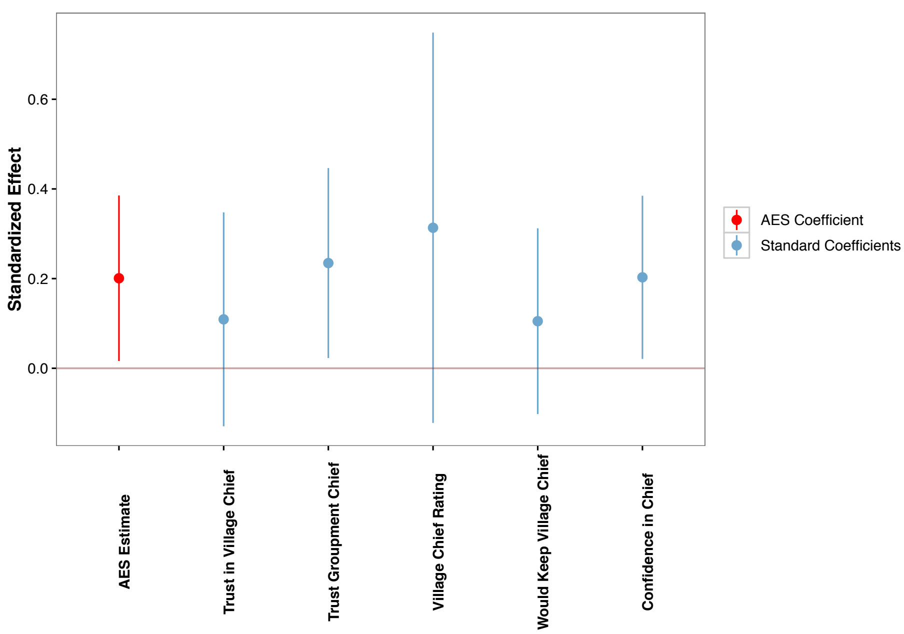


Figure A32: AES Components Coefficient Plots - Trust in Others

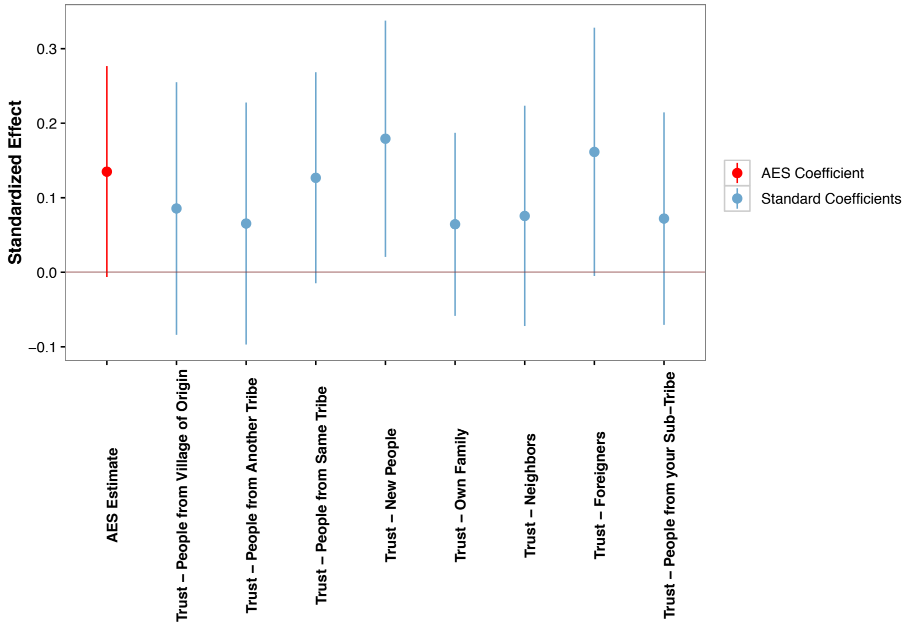


Figure A33: AES Components Coefficient Plots - Closeness

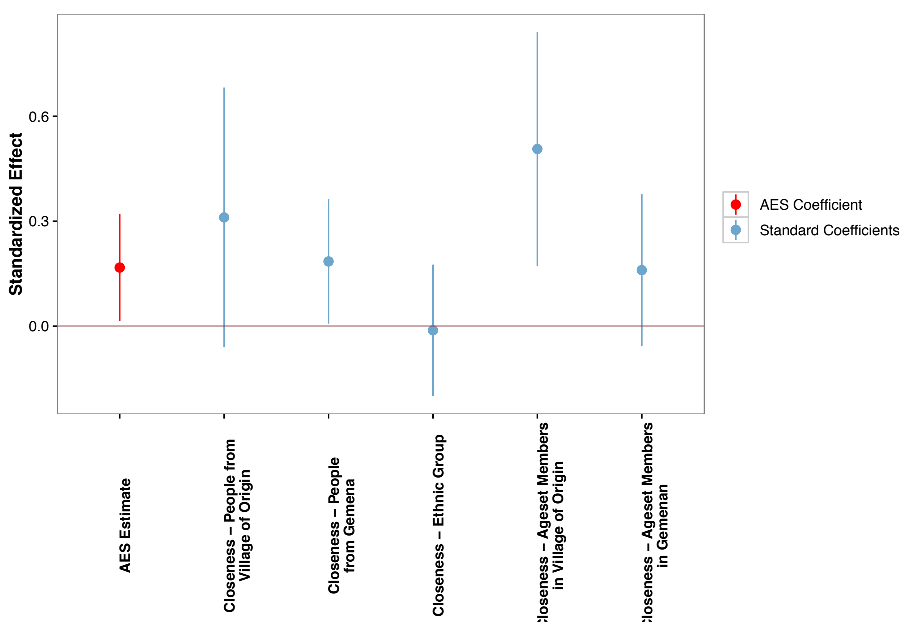


Figure A34: AES Components Coefficient Plots - Individual Sharing Norms

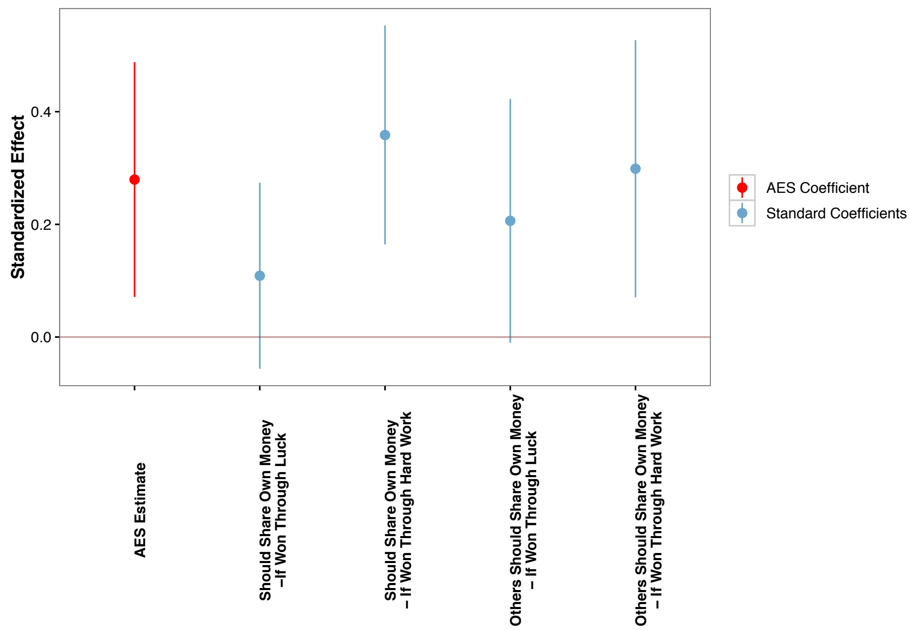
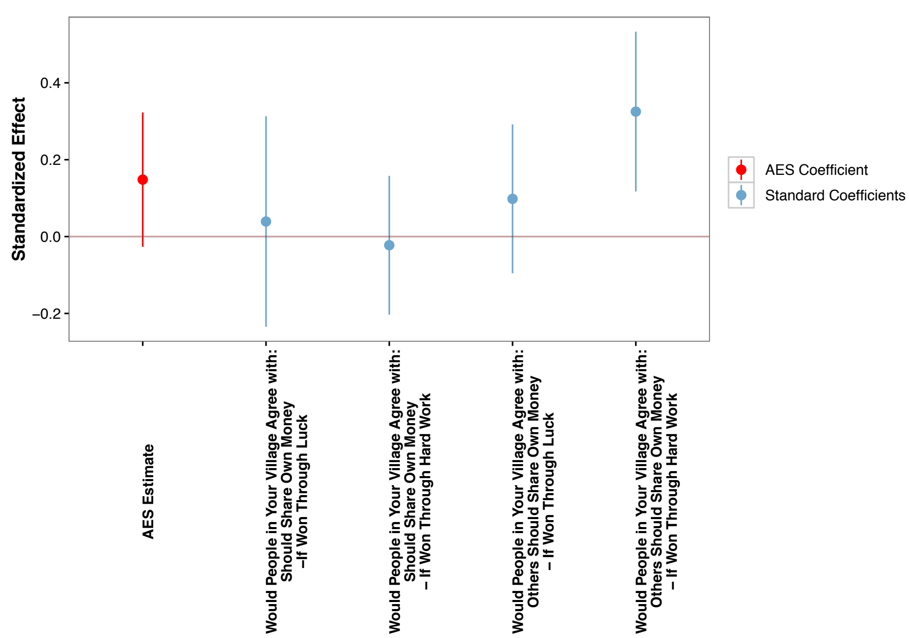


Figure A35: AES Components Coefficient Plots - Village Sharing Norms



Appendix H. Additional Results

H.1. Establishing a First-Stage Discontinuity - Commercial Posts in 1897 and 1905

Table A39 presents the regression discontinuity estimates for indicator variable for having a "commercial post" is higher within the concession boundaries. The indicator is constructed at the grid cell level as in Table 2. A commercial post corresponds to places where rubber is collected and traded. Columns (1)-(3) present results using Figure A36 on commercial post locations in 1897 from Goffart (1908), while Columns (4)-(6) present results using Figure A37 on commercial post locations in 1905 from Rouck (1945). The results demonstrate that the former concession areas are much more likely to have had commercial posts compared to areas just outside the former concession boundaries.

Table A39: Establishing a First-Stage Discontinuity - Differences in “Commercial” Post Presence

	Commercial Post in 1897			*Commercial Post in 1905*		
Sample Within:	200 kms (1)	100 kms (2)	50 kms (3)	200 kms (4)	100 kms (5)	50 kms (6)
Inside Concession	0.0274*	0.0259	0.0418**	0.0432***	0.0398***	0.0422**
	(0.016)	(0.017)	(0.019)	(0.009)	(0.010)	(0.016)
	[0.012]	[0.013]	[0.015]	[0.014]	[0.015]	[0.018]
Observations	1,350	850	501	1,350	850	501
Clusters	34	29	25	34	29	25
Mean Dep. Var. Outside	0.0090	0.0140	0.0074	0.0301	0.0359	0.0335

Notes: The estimated regressions use a linear polynomial in latitude and longitude as the RD polynomial. All regressions include district fixed effects. *Commercial Posts in 1897* is an indicator variable equal to one if a 20 by 20 km grid cell had at least one commercial posts in 1897 in Goffart (1908). *Commercial Posts in 1905* is an indicator variable equal to one if a 20 by 20 km grid cell had at least one commercial posts in 1905 in Rouck (1945). Standard errors clustered at the territory level in ( ) and Conley standard errors in [ ] (assuming a cut-off window of 40 kms). * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

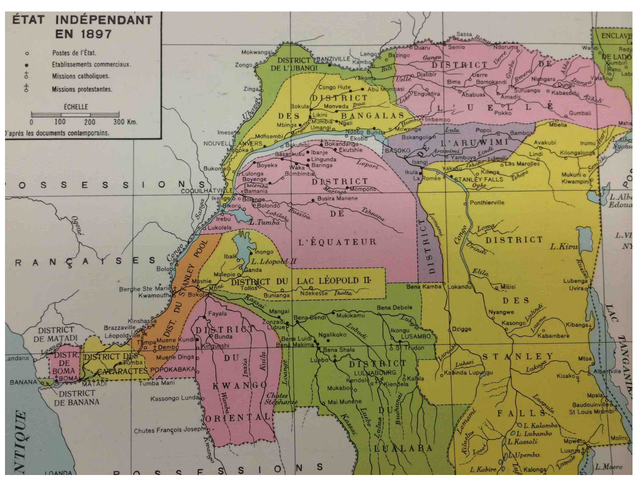


Figure A36: Map with 1897 Commercial Post Locations

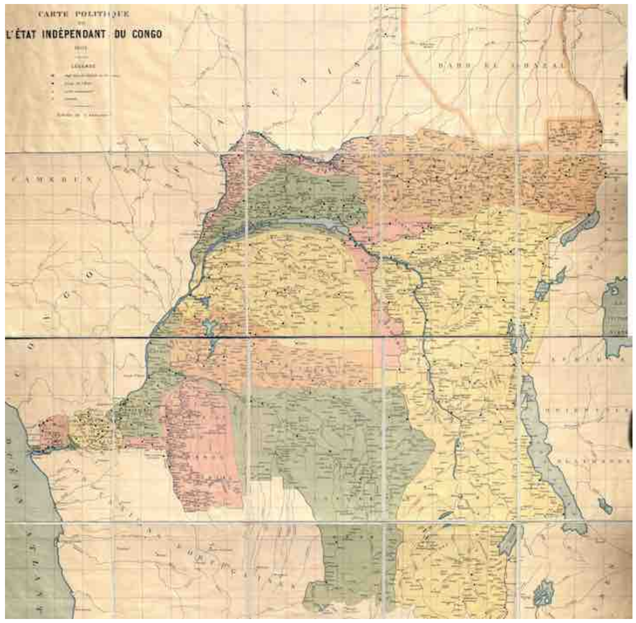


Figure A37: Map with 1905 Commercial Post Locations

H.2. Balance on Geographic Characteristics - DHS Cluster Level

Table A40 presents the estimates for differences in geographic characteristics for the DHS clusters in the sample instead of at the grid cell level as in Section 3.3. As in Table 2, there are no significant differences in the main geographic variables of interest for our baseline specification in Panel A.[22]

[22] There is some evidence of a discontinuity in elevation when using the demanding cubic polynomial in latitude and longitude as the RD ploynomial; however, this estimate is extremely noisy and driven by one observation. For this reason and the other reasons already detailed in Section 3.3, the baseline specification of a linear polynomial in latitude and longitude is preferable.

Table A40: Balance on Geographic Characteristics: DHS Cluster Level

	Elevation			*Precipitation*			*Soil Suitability*		
Sample Within:	200 kms (1)	100 kms (2)	50 kms (3)	200 kms (4)	100 kms (5)	50 kms (6)	200 kms (7)	100 kms (8)	50 kms (9)
	Panel A: Linear Polynomial in Latitude and Longitude								
Inside Concession	17.2	15.3	27.0	2.45*	1.39	-0.34	-0.016	-0.017	-0.013
	(14.462)	(14.874)	(21.010)	(1.376)	(1.345)	(1.231)	(0.010)	(0.011)	(0.014)
	[13.8]	[14.32]	[18.7]	[1.557]	[1.526]	[1.271]	[0.011]	[0.010]	[0.012]
	Panel B: Cubic Polynomial in Distance to Concession Border								
Inside Concession	19.6	19.2	35.3*	0.441	-0.186	-2.047	-0.017	-0.021*	-0.015
	(13.3)	(13.0)	(17.7)	(1.485)	(1.530)	(1.453)	(0.011)	(0.011)	(0.013)
	[13.4]	[12.7]	[16.5]	[1.676]	[1.702]	[1.476]	[0.011]	[0.011]	[0.012]
	Panel C: Cubic Polynomial in Latitude and Longitude								
Inside Concession	27.1	41.6**	50.5***	0.829	1.396	1.443	-0.002	-0.010	-0.003
	(17.3)	(18.2)	(17.3)	(1.025)	(0.952)	(1.099)	(0.016)	(0.014)	(0.019)
	[16.2]	[17.6]	[15.7]	[1.091]	[0.987]	[0.984]	[0.015]	[0.013]	[0.015]
Observations	110	85	52	110	85	52	110	85	52
Mean Dep. Var.	386.1	390.4	393.0	150.8	151.0	152.9	0.048	0.045	0.043

Notes: All regression include district fixed effects. *Elevation* is measured in meters and is reported directly in the DHS survey for each cluster. Precipitation measures are 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 DHS cluster. *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. We present robust standard errors in () and Conley standard errors in [ ] (assuming a cut-off window of 50 kms). * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

H.3. Wealth Inequality at the DHS Cluster Level

Table A41 presents the regression discontinuity estimates for wealth inequality for DHS clusters. Columns (1)-(3) present results using the standard deviation in the DHS wealth factor score for each DHS cluster as the dependent variable, while Columns (4)-(6) present results using the inter-quartile range in the DHS wealth factor score for each DHS cluster as the dependent variable. The results demonstrate that villages inside the former concessions have lower levels of wealth inequality compared to villages just outside the former concession boundaries.

Table A41: Wealth Inequality: DHS Cluster Level: DHS Cluster Level

	St. Dev. of Wealth Score			*IQR of Wealth Score*		
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	-10,495***	-10,834***	-16,195***	-13,648***	-15,530***	-19,048**
	(3,604)	(3,783)	(5,148)	(4,250)	(4,583)	(7,165)
	Panel B: Cubic Polynomial in Distance to Concession Border					
Inside Concession	-10,280***	-9,601**	-12,976**	-13,948***	-15,244***	-16,457**
	(3,736)	(3,850)	(5,282)	(4,766)	(4,788)	(6,633)
	Panel C: Cubic Polynomial in Latitude and Longitude					
Inside Concession	-14,282***	-14,776***	-12,796**	-18,428***	-19,029***	-12,914*
	(4,247)	(4,431)	(4,876)	(5,972)	(5,752)	(7,084)
Observations	110	85	52	110	85	52
Mean Dep. Var.	25813	22457	24017	31134	25574	26791

Notes: Robust standard errors are presented in parenthesis. All regressions include district fixed effects. *St. Dev. of Wealth Score* is the standard deviation of the DHS wealth factor score calculated for each DHS cluster. *IQR of Wealth Score* is the inter-quartile range of the DHS wealth factor score for each DHS cluster. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

H.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. 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.

Using data from the *Referentiel Geographique Commun* on current road networks and bridges in DRC today, Panel C of Table A26 examines whether areas inside the former concession have lower market access today (Appendix B presents maps of the road networks and bridges). 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 A26 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.

H.5. Population Density

This section examines differences in population density. The results below 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 (**?**) and the 1609 Spanish expulsion of the Moriscos (**?**) – suggest that the concessions would have converged to a similar level of development by now. This suggests that differences in population density directly to the violence are unlikely to explain the results.

We use data from Landscan 2007 to get a measure of population density as an additional indicator of development. Landscan 2007 data uses detailed satellite imagery to construct measures of population density at a resolution of approximately 1 km by 1 km for the entire world. Figure A38a is a map of population data around the rubber concession areas. Table A42 presents our results from estimating specification (1) on 20 km by 20 km grid cells constructed with GIS.[23] We find that areas inside the former rubber concessions are less populated today than areas outside. Areas inside the former concession borders have approximately three fewer people per 1 km by 1 km grid cell on average (this corresponds to about 25 % fewer people per square kilometer). Thus, even though the rubber extraction and violence occurred over 100 years before the population density measure, the areas inside the former rubber concessions continue to be less populated today than areas outside the former concessions.

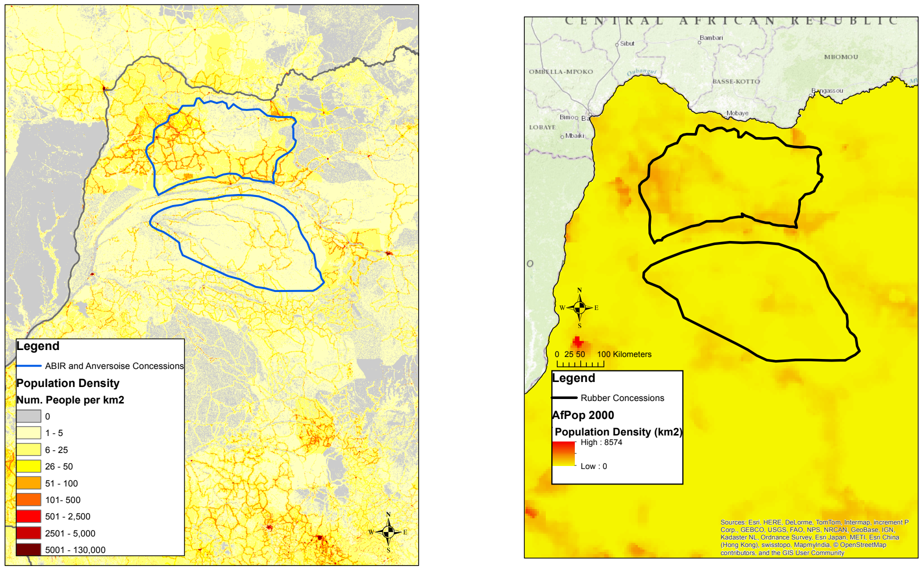
Table A42: Rubber Concession and Population Density RD Analysis

	Mean Population Density			*Mean Population Density (River Corrected)*		
Sample Within:	200 kms (1)	100 kms (2)	50 kms (3)	200 kms (4)	100 kms (5)	50 kms (6)
Inside Concession	-1.503	-3.594**	-3.970**	-1.732	-3.722**	-4.046**
	(1.787)	(1.687)	(1.694)	(1.825)	(1.712)	(1.711)
	[1.503]	[1.557]	[1.673]	[1.542]	[1.584]	[1.699]
Observations	1,339	845	496	1,339	845	496
Clusters	34	29	25	34	29	25
Mean Dep. Var.	12.755	15.609	16.471	13.100	15.979	16.836

Notes: The estimated regressions use a linear polynomial in latitude and longitude as the RD polynomial. The estimates include district fixed effects and control for elevation and presence of a river. River correction scales population density by percent of non-river land. Data is from Landscan 2007. We present standard errors clustered at the territory level in ( ) and Conley standard errors in [ ] (assuming a cut-off window of 50 kms). * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

[23] We use 20 km by 20 km grid cells to match the analysis by Dell (2010). To conserve space, we present results using only a cubic polynomial in distance to the concession border; the results are very similar for the cubic polynomial in latitude and longitude and are available upon request. For the Landscan analysis, we drop outlier grid cells before running our analysis; specifically, we drop any observation above the 99th percentile.

Figure A38: Population Density and Rubber Concessions



(a) Population Density Measure from Landscan 2007

(b) Population Density Measure from the African Population Database

Finally, we collected colonial data on population density from the Académie Royale des Sciences d'Outre-Mer (1954) in order to examine whether the population density differences are a common pattern throughout the history of this area or a more recent phenomenon. The Académie Royale des Sciences d'Outre-Mer (1954) contains extremely detailed population density maps for Equateur province for 1954. We use the 1954 population data because it has very granular measures of population density. We have not found similarly granular data for earlier years. Table A43 presents our results from estimating specification (1) on 20 km by 20 km grid cells constructed with GIS, where the dependent variable is the average number of individuals per square kilometer. We find that areas inside the former rubber concessions were also less populated in 1954 than areas outside. Areas inside the former concession borders have approximately 1 fewer person per 1 km by 1 km grid cell on average (this also corresponds to about 25% fewer people per square kilometer). Thus, we find evidence that areas inside the former rubber concessions have been significantly less populated since at least the colonial period.

Table A43: Rubber Concession and Population Density in Equateur (1954)

	Population Density in 1954		
Sample Within:	200 kms	100 kms	50 kms
	(1)	(2)	(3)
Inside Concession	-1.705***	-1.949***	-1.578**
	(0.461)	(0.483)	(0.588)
	[0.520]	[0.553]	[0.758]
Observations	933	652	396
Clusters	26	25	20
Mean Dep. Var.	3.296	3.805	4.071

Notes: The estimated regressions use a linear polynomial in latitude and longitude as the RD polynomial. The estimates include district fixed effects and control for elevation and presence of a river. Data is from 1954 and is from the *Atlas Général du Congo et du Ruanda-Urundi* (1954). *Population Density in 1954* measures the mean number of people per square km for Equateur province. We present standard errors clustered at the territory level in ( ) and Conley standard errors in [ ] (assuming a cut-off window of 50 kms). * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table A44: Rubber Concessions and Population Density - African Population Database

	Mean Population Density		
Sample Within:	200 kms	100 kms	50 kms
	(1)	(2)	(3)
Inside Concession	-3.090	-5.715**	-7.826***
	(2.233)	(2.253)	(2.499)
	[2.201]	[2.242]	[2.608]
Observations	1,334	844	495
Clusters	34	29	25
Mean	12.207	13.773	16.333

Notes: We use a linear polynomial in latitude and longitude, include district fixed effects and control for elevation and presence of a river. River correction scales population density by percent of non-river land. Data is from the African Population Database. (See Data Appendix for more details.) We present standard errors clustered at this territory level in ( ) and Conley standard errors in [ ] (assuming a cut-off window of 50 kms). * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

H.6. Violence and Conflict

The intense violence experienced during the rubber extraction period might have changed social norms for violence by making people more prone to resort to violence for conflict resolution. These differences could have led areas inside the former concessions to experience more violence and conflict, and this could have hindered economic development.

We test for differences in violence using data from PRIO that documents the location and intensity of major conflict events in the DRC since 1989. Table A45 presents estimates on differences in violent conflict. The dependent variable is total amount of conflict in 20 km by 20 km grid cells. We find little evidence that these areas experience more conflict. However, note that this is not the ideal test of differences in social norms for violence, since most of the PRIO data for Congo captures large-scale conflicts that were a consequence of the Congo Wars. Thus, we cannot conclude that differences in conflict and violence explains the persistence.

Table A45: Rubber Concession and Conflict RD Analysis

	Number of Conflict Events			*No. of Conflict Events (Controlling for Ethnic Boundary)*			*Number of Civilian Deaths*		
Sample Within:	200 kms (1)	100 kms (2)	50 kms (3)	200 kms (4)	100 kms (5)	50 kms (6)	200 kms (7)	100 kms (8)	50 kms (9)
Inside Concession	0.009	0.045**	0.038*	0.012	0.042*	0.036*	-1.609	-1.808	-1.792
	(0.027)	(0.022)	(0.019)	(0.026)	(0.021)	(0.019)	(0.999)	(1.390)	(2.028)
	[0.029]	[0.027]	[0.021]	[0.028]	[0.026]	[0.021]	[1.366]	[1.669]	[2.316]
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.	0.088	0.070	0.060	0.088	0.070	0.060	1.885	2.300	2.982

Notes: The estimated regressions use a linear polynomial in latitude and longitude as the RD polynomial. Conflict data is from the Uppsala Conflict Data Program, ethnicity boundary data comes from Murdock (1959) geo-referenced by Nathan Nunn, and population density data is from LandScan 2007. We include district fixed effects and control for percentage river and population density. The specification with ethnic boundaries includes an indicator for whether a cell is on the border of two ethnic groups. We present standard errors clustered at the territory level in ( ) and Conley standard errors in [ ] (assuming a cut-off window of 50 kms). * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Appendix I. All CFS Concession Results

This section presents the regression discontinuity results using all the CFS concession borders presented in Figure 1 as the discontinuity and the DHS data as the outcome data. Section I.1 presents the results pooling all the concessions together, and Section I.2 presents the results excluding ABIR and Anversoise.

I.1. All Concessions

Table A46: All 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	-0.935*** (0.247)	-1.056*** (0.253)	-1.359*** (0.265)	-0.182*** (0.050)	-0.207*** (0.051)	-0.263*** (0.054)
	Panel B: Cubic Polynomial in Distance to Concession Border					
Inside Concession	-0.913*** (0.249)	-1.042*** (0.260)	-1.367*** (0.277)	-0.175*** (0.051)	-0.202*** (0.053)	-0.267*** (0.056)
	Panel C: Cubic Polynomial in Latitude and Longitude					
Inside Concession	-1.641*** (0.260)	-1.621*** (0.267)	-1.868*** (0.286)	-0.315*** (0.053)	-0.319*** (0.055)	-0.368*** (0.057)
Observations	24,920	17,927	11,561	24,791	17,850	11,509
Clusters	500	366	234	500	366	234
Mean Dep. Var.	6.165	6.089	6.211	1.241	1.218	1.243

Note: 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. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table A47: All Concessions and Wealth RD Analysis

	Wealth Index			*Wealth Factor*		
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	-0.255** (0.103)	-0.261** (0.107)	-0.330*** (0.122)	-9,163 (6,245)	-9,134 (6,461)	-12,933** (5,970)
	Panel B: Cubic Polynomial in Distance to Concession Border					
Inside Concession	-0.286*** (0.104)	-0.290*** (0.109)	-0.347*** (0.124)	-10,789* (6,422)	-10,713 (6,699)	-15,036** (6,667)
	Panel C: Cubic Polynomial in Latitude and Longitude					
Inside Concession	-0.350*** (0.106)	-0.346*** (0.106)	-0.515*** (0.126)	-13,570** (5,771)	-13,642** (5,812)	-21,178*** (6,056)
Observations	24,953	17,953	11,574	24,953	17,953	11,574
Clusters	500	366	234	500	366	234
Mean Dep. Var.	2.650	2.598	2.731	-14425	-15645	-7248

Note: 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 A48: All Concessions and Health RD Analysis

	Child Ever Vaccinated			*Child Ht/Age Percentile*			*Respondent Ht/Age Percentile*		
Sample Within:	200 kms (1)	100 kms (2)	50 kms (3)	200 kms (4)	100 kms (5)	50 kms (6)	200 kms (7)	100 kms (8)	50 kms (9)
	Panel A: Linear Polynomial in Latitude and Longitude								
Inside Concession	-0.015	-0.010	-0.014	-208.6*	-215.4*	-336.2**	-412.0***	-415.0***	-476.5***
	(0.024)	(0.024)	(0.028)	(122.1)	(126.0)	(144.3)	(150.1)	(154.3)	(171.9)
	Panel B: Cubic Polynomial in Distance to Concession Border								
Inside Concession	-0.016	-0.015	-0.024	-192.3	-206.8	-301.8**	-433.6***	-451.0***	-543.4***
	(0.024)	(0.024)	(0.028)	(122.0)	(125.9)	(148.4)	(149.2)	(151.4)	(170.7)
	Panel C: Cubic Polynomial in Latitude and Longitude								
Inside Concession	-0.039	-0.033	-0.018	-460.2***	-443.7***	-521.3***	-610.9***	-640.5***	-695.8***
	(0.028)	(0.029)	(0.032)	(130.7)	(131.9)	(158.7)	(163.4)	(166.5)	(186.0)
Observations	13,439	9,852	6,271	7,228	5,230	3,294	7,210	5,164	3,360
Clusters	500	366	234	500	366	234	500	366	234
Mean Dep. Var.	0.835	0.838	0.821	2247	2251	2282	2357	2438	2547

Note: Standard errors clustered at the DHS cluster level. We include district fixed effects in all regressions. We control for age and age squared. The DHS health questions are only 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. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

I.2. Excluding ABIR and Anversoise

Table A49: All Other Concessions and Education RD Analysis

	Years of Education			*Literacy*		
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	-0.775**	-0.891**	-1.347***	-0.153**	-0.177**	-0.272***
	(0.342)	(0.348)	(0.366)	(0.068)	(0.069)	(0.073)
	Panel B: Cubic Polynomial in Distance to Concession Border					
Inside Concession	-0.783**	-0.903***	-1.314***	-0.151**	-0.175**	-0.258***
	(0.337)	(0.347)	(0.381)	(0.068)	(0.070)	(0.076)
	Panel C: Cubic Polynomial in Latitude and Longitude					
Inside Concession	-2.005***	-1.981***	-2.356***	-0.391***	-0.416***	-0.492***
	(0.384)	(0.413)	(0.448)	(0.077)	(0.083)	(0.087)
Observations	20,877	14,298	9,096	20,762	14,227	9,048
Clusters	420	294	185	420	294	185
Mean Dep. Var.	6.35	6.34	6.49	1.27	1.26	1.29

Note: 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. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table A50: All Other Concessions and Education RD Analysis

	Wealth Index			*Wealth Factor*		
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	-0.187	-0.170	-0.229	-9,311	-7,943	-13,795
	(0.133)	(0.137)	(0.153)	(9,588)	(9,899)	(8,894)
	Panel B: Cubic Polynomial in Distance to Concession Border					
Inside Concession	-0.210	-0.193	-0.229	-10,336	-8,774	-14,230
	(0.134)	(0.143)	(0.161)	(9,797)	(10,120)	(9,965)
	Panel C: Cubic Polynomial in Latitude and Longitude					
Inside Concession	-0.356**	-0.393***	-0.538***	-20,232**	-21,129*	-31,728***
	(0.142)	(0.144)	(0.164)	(9,786)	(10,805)	(10,172)
Observations	20,903	14,317	9,105	20,903	14,317	9,105
Clusters	420	294	185	420	294	185
Mean Dep. Var.	2.766	2.740	2.896	-8370	-7909	2588

Note: 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 A51: All Other Concessions and Education RD Analysis

	Child Ever Vaccinated			*Child Ht/Age Percentile*			*Respondent Ht/Age Percentile*		
Sample Within:	200 kms (1)	100 kms (2)	50 kms (3)	200 kms (4)	100 kms (5)	50 kms (6)	200 kms (7)	100 kms (8)	50 kms (9)
	Panel A: Linear Polynomial in Latitude and Longitude								
Inside Concession	0.038	0.044	0.010	-105.0	-105.0	-182.9	-220.7	-185.1	-277.6
	(0.030)	(0.030)	(0.034)	(160.7)	(162.2)	(172.3)	(198.1)	(200.9)	(215.0)
	Panel B: Cubic Polynomial in Distance to Concession Border								
Inside Concession	0.037	0.040	0.010	-83.43	-91.86	-88.52	-233.8	-237.8	-331.4
	(0.029)	(0.030)	(0.036)	(165.2)	(167.5)	(196.0)	(196.4)	(197.4)	(216.3)
	Panel C: Cubic Polynomial in Latitude and Longitude								
Inside Concession	-0.006	0.007	0.009	-442.1**	-421.1**	-405.2**	-527.4**	-466.7*	-593.4**
	(0.041)	(0.044)	(0.044)	(198.1)	(198.5)	(194.7)	(233.6)	(248.5)	(263.1)
Observations	11,020	7,663	4,738	5,998	4,105	2,520	6,073	4,130	2,647
Clusters	420	294	185	420	294	185	420	294	185
Mean Dep. Var.	0.840	0.846	0.830	2205	2190	2222	2301	2378	2517

Note: Standard errors clustered at the DHS cluster level. We include district fixed effects in all regressions. We control for age and age squared. The DHS health questions are only 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. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$