

Corporations as the State: Urbanisation, Women’s Empowerment, and Long-Run Development in the Copperbelt

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Abstract

Does corporate paternalism leave a persistent legacy after the firm disappears? I examine two concessions in the Copperbelt: the Union Minière du Haut-Katanga (UMHK) and the Rhokana Corporation (RC). While both extracted resources under comparable profit constraints, the UMHK minimised labour turnover by incentivising permanent family resettlement, whereas the RC maintained a transient workforce. Using a spatial regression discontinuity design, I show that UMHK’s policy generated urban agglomeration and persistent development gains: individuals inside the former concession exhibit 1.5 additional years of education, higher literacy rates, and greater household wealth. The RC border displays no discontinuity. By formally integrating the household into the labour contract, the UMHK also left a distinct gendered legacy: women inside the former concession today report greater reproductive autonomy, better remuneration outcomes, and increased authority over household finances.

Keywords: Colonial Institutions, Concessions, Corporate Governance, Urbanisation, Women’s Empowerment

JEL Classification: J16, N37, O43, R12

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1 Introduction

Extractive colonial institutions are widely understood to undermine long-run development (Acemoglu et al., 2001; Dell, 2010). Private concessionary companies, granted state-like powers to exploit vast territories, are typically characterised as the epitome of this predatory model (Lowes and Montero, 2021a). Yet, this paper documents a ‘paradox of paternalism’: a case where a private corporation, motivated primarily by profit maximisation, generated robust, positive, and persistent development outcomes. I argue that this divergence is driven by an often overlooked nuance in institutional design: the structure of the labour contract. While the standard extractive model treated labour as a transient, disposable input, I show how a corporate strategy incentivising permanent family resettlement effectively generated agglomeration, human capital accumulation, and women’s empowerment that have outlasted the firm itself.

I study the long-run effects of corporate labour strategies by exploiting a natural experiment in the Central African Copperbelt. This region, divided between the Belgian Congo (now DRC) and Northern Rhodesia (now Zambia), hosted two mining giants: the Union Minière du Haut-Katanga (UMHK) and the Rhokana Corporation (RC) (Ferguson, 1999; Van Reybrouck, 2010; Laporte, 2017; Munene, 2018). Operating in a contiguous geographic setting with large mineral deposits, both corporations faced identical profit constraints and sectoral shocks, most notably the Great Depression and local labour scarcity (Juif and Frankema, 2018). However, their institutional responses to these shared pressures diverged sharply. While the UMHK transitioned to a ‘Labour Stabilisation’ model that encouraged human capital while investing in healthcare and family housing to secure a permanent workforce, the RC entrenched the Southern African model of extractive, circular migration based on short-term seasonal contracts (Parpart, 2018). This variation in corporate governance within a homogeneous setting helps separate the role of labour institutions from the broader influence of colonial regimes, mineral wealth, and the concessionary model as such.

To estimate these legacies, I employ a comparative spatial regression discontinuity design.

First, this involves two separate RD estimations to measure local effects inside versus outside each concession. Second, I compare the discontinuities estimated separately at the UMHK and RC borders to assess whether the long-run effects observed in Katanga are specific to the UMHK’s labour-stabilisation model rather than a general feature of concessionary mining. The validity of this design rests on the exogeneity of the concession boundaries (Keele and Titiunik, 2015). I document that these borders, originally delineated as vast prospecting zones, do not systematically align with pre-colonial ethnic territories or the exact location of mineral deposits. Validating this, formal tests indicate balance at both concession boundaries, with continuity across a wide variety of geographic and pre-concession demographic covariates. Furthermore, the overarching colonial border separating the two regions was itself arbitrarily determined by European powers in 1894 (Gordon, 2001), preceding the discovery of the Copperbelt’s true mineral wealth. To address the related concern that current discontinuities might reflect contemporary mining, I also control for proximity to the nearest active mine and, more broadly, to the nearest documented mineral site.

Analysis of georeferenced data from the 2007 and 2014 Demographic and Health Surveys (DHS) reveals a significant divergence in long-run development. Inside the former UMHK concession, outcomes are robustly positive. Households are approximately one standard deviation wealthier, and human capital accumulation is markedly higher: individuals achieve, on average, roughly 1.5 to 1.7 additional years of schooling and are about 26 to 30 percentage points more likely to be literate. Health outcomes mirror this pattern, with women and children ranking about 14 to 17 percentiles higher in height-for-age. These anthropometric results indicate that the concession provided a superior biological standard of living during childhood (See Steckel, 1995; Fogel, 2004). Consistent with this hypothesis, alternative specifications that split the sample by current immigration status confirm that development gains are largest among the native population today. Even so, I cannot rule out intergenerational effects of endogenous sorting as a channel driving development.

In contrast, I find no comparable discontinuity in development outcomes at the former

RC boundary. This null result weakens the hypothesis that mineral endowments drive the observed prosperity. It suggests that the RC’s extractive model was institutionally closer to the surrounding colonial framework in Northern Rhodesia, so that corporate extraction there was less distinct from the baseline environment. This lack of a similar RC legacy reinforces the interpretation that it was the UMHK’s specific deviation into paternalism, rather than the general presence of a corporation, that generated long-run development. The appendix reports a pooled difference-in-discontinuities exercise that points in the same direction, approximating the specific impact of the labour stabilisation model.

I trace this divergence to the firms’ opposing institutional responses to the binding constraint of labour scarcity. After the Great Depression, the copper boom driven by WWII re-armament created intense pressure for both corporations to secure a stable labour supply, yet they adopted diametrically opposing strategies ([Juif and Frankema, 2018](#)). The UMHK pivoted from early coercive practices to a comprehensive Labour Stabilisation model, using long-term contracts and extensive non-wage benefits (e.g., company-provided housing, healthcare, and schooling) to incentivise the permanent resettlement of miners and their families ([Higginson, 1989](#)). Conversely, the RC adopted the South African model of circular migration, favouring short-term seasonal contracts and actively discouraging permanent African settlement to prevent ‘detrribalisation’ ([Wilson, 1942](#)). Furthermore, the RC enforced a rigid colour bar that explicitly reserved skilled positions for Europeans and locked African labourers into low-skill roles ([Berger, 1974](#); [Butler, 2007](#)), effectively blocking the local accumulation of human capital.

I propose that the primary channel of persistence is a shift in the region’s spatial equilibrium. Standard economic theory suggests that high labour mobility maximises allocative efficiency. However, my results point to a potential channel where the UMHK’s strategic introduction of labour rigidity, anchoring workers into specific locations via paternalism, may have helped overcome a coordination failure and spur urbanisation. By reducing turnover, the firm may have effectively subsidised the fixed costs of city formation. Its legacy remains

physically visible today: the former concession area exhibits significantly higher nightlight density ([Henderson et al., 2012](#); [Donaldson and Storeygard, 2016](#)) and built-up surface area, with households about 40 to 60 percentage points more likely to have access to electricity and piped water. This prosperity persists despite a comparative deterioration in the rail and road network relative to the control group, indicating that agglomeration economies, rather than transport infrastructure, drive the effect. In contrast, the RC’s reliance on circular migration hindered this process of urban formation, leaving behind a fragile spatial structure (called ‘villagisation’) that failed to sustain development after the mining industry declined ([Ferguson, 1999](#); [Mususa, 2012](#)). This divergence suggests that corporate-driven urbanisation transformed temporary corporate incentives into persistent spatial advantages.

The divergence in corporate strategy also created distinct social fabrics by shifting the balance of power within the household. Consistent with collective household models ([Chiap-pori, 1992](#); [Anderson and Eswaran, 2009](#)), the UMHK’s family-settlement model structurally enhanced female intra-household bargaining power: by making high-value non-wage benefits such as housing, marriage bonuses, and payments for newborns contingent on the presence of a spouse, the corporation effectively integrated women as stakeholders in the labour contract. In contrast, the RC’s circular migration model entrenched male-dominated transient communities, often characterised by precarious gender relations ([Chauncey, 1981](#); [Parpart, 1986](#)). I show that this historical shock to the household equilibrium persists: women inside the former UMHK concession exhibit significantly higher reproductive autonomy, with modern contraceptive use higher by about 9 to 11 percentage points, alongside better remuneration outcomes and stronger participation in household purchase decisions. These findings suggest that corporate paternalism, while designed to secure labour, inadvertently generated a durable institutional legacy of female empowerment.

This paper contributes to the political economy of colonial institutions by resolving an ambiguity in the legacy of private rule. While a seminal literature establishes the persistence of colonial institutions ([Acemoglu et al., 2001](#); [Huillery, 2009](#); [Dell, 2010](#); [Wantchekon et al.,](#)

2015), defunct administrative borders (Becker et al., 2016; Dell et al., 2018), and the role of pre-colonial characteristics (Nunn, 2008; Michalopoulos and Papaioannou, 2013; Lowes and Montero, 2021b), recent work has focused specifically on the distinct role of private colonialism, often finding negative aggregate effects driven by coercion (Guardado, 2018; Lowes and Montero, 2021a; Chiovelli et al., 2026). I advance this literature by isolating the heterogeneity of corporate governance. By exploiting a setting where two firms shared the same extractive mandate but diverged in their labour strategy, I distinguish the effects of corporate paternalism from the extractive penalty of mining itself. This offers a rare counter-example to the predatory logic of extraction (Olson, 1993; Acemoglu and Robinson, 2008; Sánchez De La Sierra, 2020; Henn et al., 2025), suggesting that under specific labour constraints, profit-maximising firms can generate public goods and institutional quality that rival the state (Dell and Olken, 2020; Méndez and Van Patten, 2022). These findings further provide micro-evidence for the view that the quality of institutions mediates the resource curse (Mehlum et al., 2006; Robinson et al., 2006; Andersen and Aslaksen, 2008; Ross, 2015).

Second, I provide a micro-founded mechanism for the persistence of spatial inequality: path-dependent urbanisation. While the existing literature often attributes local development to transportation infrastructure (Jedwab and Moradi, 2016; Storeygard, 2016; Donaldson and Hornbeck, 2016; Donaldson, 2018; Banerjee et al., 2020; Jedwab and Storeygard, 2022), I argue that infrastructure without settlement may be insufficient. Consistent with theories of path dependence (Krugman, 1991; Glaeser et al., 1992; Michaels, 2011; Bleakley and Lin, 2012), I propose that the UMHK’s labour policy generated a density of human capital that outlasted corporate incentives, contributing to long-run economic divergence (Becker and Woessmann, 2009; Bolt and Bezemer, 2009; Khanna et al., 2026). This contrasts with the fragility of the RC’s company camps (Mususa, 2012, 2014), supporting the view that agglomeration economies – not only mineral rents or railway lines – are a potential driver of persistent local development in resource-rich settings (Melo et al., 2009; Glaeser, 2011; Duranton and Puga, 2014; Gollin et al., 2016; Jedwab et al., 2017; Mamo et al., 2019;

Donovan et al., 2024).

Finally, I bridge the gap between resource economics and the literature on the cultural origins of gender norms. A prominent literature, exemplified by Ross (2008), argues for a gender resource curse, where extractive industries reduce female labour force participation and political power. While recent empirical work suggests mining and circular migration can shift local labour and marriage markets for women (Kotsadam and Benshaul-Tolonen, 2016; Denton-Schneider, 2024; Benshaul-Tolonen, 2024), I identify a distinct channel: corporate paternalism. My findings align with the logic of Qian (2008) and Alesina et al. (2013), who argue that shifting the relative economic value of women alters their social status. By explicitly monetising the family unit through housing and marriage bonuses, the UMHK model generated a positive shock to female bargaining power. This provides evidence that corporate institutional design can inadvertently engineer durable shifts in household bargaining and reproductive autonomy (Bailey, 2006; Bailey et al., 2012; Wilson, 2012; Kotsadam et al., 2017; Tur-Prats, 2019; Bau, 2021; Ojha and Babbar, 2024), challenging the deterministic view of the resource curse for women.

The remainder of the paper proceeds as follows: Section 2 details the historical context; Section 3 describes the data; Section 4 presents the identification strategy and main UMHK results; Section 5 develops the mechanisms of paternalism, gender, and urbanisation, and presents the RC counterfactual; and Section 6 concludes.

2 Historical Framework

2.1 Copperbelt Concessionary Companies

The 1884-1885 Berlin Conference established general areas of influence in Africa, while specific borders were later decided during bilateral negotiations. Figure 1 shows the colonial border of the Congo pedicle, resulting from the Anglo-Belgian agreement of 12 May 1894. This division between the BSAC and the CFS initiated changes in the region due to dif-

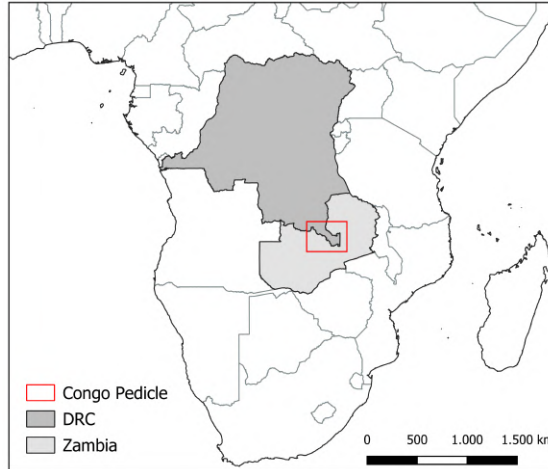


Figure 1: The Congo Pedicle in the Central African Copperbelt

ferences in official colonial policy: the British reliance on Indirect Rule and the Belgian paternalistic principle of *dominer pour servir*.¹ These heterogeneous colonial state-corporate relationships influenced the two corporations' institutional responses to shared pressures, including fluctuating copper prices and labour scarcity.

In 1891, the territory of Katanga was placed under a concession arrangement under the name *Compagnie du Katanga* to deter British interference in the region. By 1899, King Leopold II had entrusted its administration to the private *Comité Spécial du Katanga* (CSK). Operating largely independently and reporting directly to Brussels, the CSK later partnered with British Tanganyika Concessions Limited (TCL) in 1906 to establish the *Union Minière du Haut Katanga* (UMHK). The UMHK was granted an extensive private concession for copper exploitation in southern Katanga. The corporation retained this copper mining monopoly even after the Belgian state assumed formal control over the Congo in 1908.²

Katanga's rich surface copper oxide deposits (7 to 15 per cent copper) facilitated easy extraction in the form of low-tech open pit style mines (Coleman, 1971). Production began in 1912 and the UMHK became the third-largest copper producer in the world by the 1920s,

¹A phrase coined in 1948 by the Belgian Congo's Governor-General Pierre Ryckmans, justifying authoritarian colonial rule with rapid social and economic development (Ryckmans, 1948).

²The CFS of King Leopold II was taken over by the Belgian government in 1908 under international pressure, leading to the creation of the Belgian Congo.

accounting for 6% of world output ([Perrings, 1979](#)). It also became the number one global cobalt producer and an early uranium producer, holding a virtual world monopoly until WWII.³ Figure 2 illustrates the state of all mining concessions on the eve of Congolese independence. The UMHK concession area remained unchanged throughout its 60 years of operation (1906-1966).

In parallel, Northern Rhodesia’s early years were similarly shaped by private interests. Founded by the colonial entrepreneur Cecil John Rhodes, the BSAC governed the colony until 1924. Northern Rhodesian mineral deposits were first discovered in 1902 at Bwana Mkubwa (now Ndola). Although the BSAC created the Nkana concession in 1911, these were initially low-grade oxide ores unprofitable for large-scale mining ([Slinn, 1971](#)). The local copper mining industry took off in the mid-1920s, about 15 years after it first developed in Katanga. This was driven by advancements in froth flotation mineral processing that enabled the profitable extraction of abundant sulphide deposits in Nkana ([Burdette et al., 1990](#); [Mouat, 1996](#)). At this time, the Nkana concession was being extensively drilled and developed by the Bwana Mkubwa Company, the Rhodesia Congo Border Company (RCBC), and the Anglo-American Company (AAC) ([Munene, 2018](#)).

In 1931, these three Copperbelt mining companies consolidated into the Rhokana Corporation (RC), named after Rhodesia and Nkana. This historical merger was driven by several motives: to more easily raise fresh capital, secure a better bargaining position for output restriction discussions with other large copper producers, and negotiate more effectively with the BSAC and Northern Rhodesian administration ([Alford and Harvey, 1980](#); [Munene, 2018](#)). The RC’s attention centred on the Nkana concession, discontinuing the development of the Nchanga mines and any active prospecting in the RCBC. Figure 3 shows the Nkana concession located within the RCBC at RC’s inception ([Brooks, 1944](#)). The corporation became the largest Copperbelt mining company, responsible for over half of Northern Rhodesia’s copper output ([Munene, 2018](#)), remaining in continuous operation until 1969.

³The uranium for the Manhattan Project originated for over 90% from Katanga ([Laporte, 2017](#)).



Figure 3: Map of Northern Rhodesia's Mining Concessions

Notes. The Nkana concession is the small area in the centre north of Northern Rhodesia. The map was created by the Anglo American Company and presents the situation of mining concessions in 1929. This version comes from [Frederiksen \(2013\)](#), from a report by the AAC.

2.2 Colonial Labour Institutions

In October 1929, the New York Stock Exchange crashed, triggering a global economic downturn and financial turmoil. Between 1929 and 1931, global copper prices halved as world consumption declined ([Munene, 2021](#)). This fall in commodity prices, production, and consumption marked a moment of institutional transformation for the copper industry in both the Belgian Congo and Northern Rhodesia.

Falling profits – driven by rising labour and recruitment costs, coupled with declining metal prices – forced the UMHK to reassess its previously violent, short-term, and high-turnover labour policy.⁴ The labour commission of 1924-25 already recommended establish-

⁴Early UMHK operations relied on coerced labour recruited by Robert Williams and Company (a TCL subsidiary), which was later managed by the *Bourse du Travail du Katanga* (BTK), a state-corporate alliance that violently extracted labour from rural areas ([Gordon, 2001](#)).

ing a more stable, skilled African workforce. In the initial stages of the economic downturn, the mines were able to easily shed their precarious migrant and foreign labour. Further decreased profits during the Great Depression prompted the adoption of a new colonial vision. The UMHK fully embraced its ‘Labour Stabilisation Programmes’: policies aimed at stabilising its labour supply (Perrings, 1979; Ferguson, 1999). This paternalistic approach permeated nearly every aspect of life within the concession. Miners were expected to sign stable, restrictive, longer-term contracts, binding them to the mines for extended periods. As African workers often left families in their home villages, the UMHK encouraged permanent family resettlement (including wives and children). Family housing was offered as a part of the miners’ benefits. Moreover, women and children were not only accepted to secure necessary labour, but also as a source of both morale and future labour:

“Women and children at U.M. [UMHK] are treated as being the mine’s strength and under their discipline and control. Schools are provided and women participate e.g. in horticulture.”

(Juif and Frankema, 2018)

Investment into children’s education was viewed as both a charitable activity and an investment yielding future returns (the next generation of mine employees). Marriage and childbirth were incentivised: UMHK provided bride prices as signing bonuses for unmarried men and payments for newborns. Juif and Frankema (2018) quantifies labour stabilisation in Katanga: forced labour recruitment fell from 75% of total workers before the programmes to only 10% in the 1950s. Females as a percentage of the male population in UMHK compounds evolved from 28% in the early 1920s to over 80% near independence. The percentage of married indigenous labourers, the birth rate, and the number of children per 100 workers at the UMHK all doubled over the first decade of labour stabilisation.

Similarly, increased investment in African worker skills was an integral part of the labour stabilisation programmes. Such investment was only profitable with sufficiently long-term employment; a three-year threshold was deemed necessary for workers to integrate and justify skill investment. A key motivating factor was that medium skilled black employees were

substantially cheaper than their white counterparts. In 1938, 65% of the workforce was still on contracts shorter than three years. By 1950, this percentage fell to 23.9% (Juif and Frankema, 2018).

In contrast, though the beginnings of large-scale mining in Northern Rhodesia coincided with the Great Depression, threatening to stall the industry in its infancy, its impact was less disruptive for Northern Rhodesia compared to the Belgian Congo (Munene, 2021). Multiple scholars have identified labour as the crucial factor (Perrings, 1979; Butler, 2007; Larmer, 2017). The RC mines relied on a larger share of cheap, abundant, unskilled African labour. Colonial-era scholars contemporaneously highlighted this imbalance, noting its far-reaching effects on African miners' social and economic life (Wilson, 1942; Saffery, 1943).

As the Northern Rhodesian Copperbelt expanded in the late 1920s, the RC quickly adopted labour policies similar to those in South Africa. It featured predominantly seasonal contracts and circular migrant labour, eschewing permanent contracts and resettlement. Workers were encouraged to return to their home villages after their contracts were over. This system was motivated by the Northern Rhodesian government's fears of 'detribalisation.' Administrators expected that labour stabilisation would accelerate urbanisation, reducing tribal authority and strength. The authorities feared that widespread severance of tribal identity could lead to social unrest.

Beyond contractual organisation, the Copperbelt mines also introduced the South African dual (skilled and unskilled) labour structure, designed to maximise profits (Mhone, 1982). The mining sector required both skilled and unskilled labour in development, construction, and production. Most Africans lacked formal education and could not supply skilled labour, which was reserved for Europeans through a tight industrial 'colour bar' (i.e., strong segregation). Unlike their northern neighbours, African workers in Northern Rhodesia were explicitly barred from medium-skilled jobs. Additionally, investment in African labour skills was simply unprofitable due to the use of seasonal, short-duration contracts.

3 Data

To estimate the persistent impact of corporate governance on long-run welfare, I construct a micro-level dataset combining geocoded individual responses from the 2007 and 2014 Demographic and Health Surveys (DHS) for the DRC and Zambia (ICF, 2014). I study three groups of outcomes. First, I measure long-run development using household wealth, human capital, and health. Household wealth is captured by the standard DHS asset ownership index and the logarithm of its underlying wealth score. Human capital accumulation is measured through literacy and total years of schooling. Health is measured using women’s and children’s height-for-age percentiles, which proxy for nutritional status and disease exposure during early life.

Second, I examine women’s outcomes to study the household channel of persistence. Using the DHS women’s questionnaire, I measure reproductive autonomy through the use and knowledge of modern contraception. I capture intra-household bargaining through remuneration, a categorical scale ranging from in-kind payments to formal cash wages, and household purchases, an average of indicators for whether the respondent participates in decisions over major and daily household expenditures.

Third, I measure persistent urbanisation using both satellite and household-based indicators. I employ nightlight luminosity from the VIIRS sensor and built-up surface area from the Global Human Settlement Layer (GHSL) as proxies for economic density. I complement these measures with household-level indicators for access to electricity and piped water, including public taps, to capture the reach of public utility networks.

Table 1 reports summary statistics for all DHS clusters within 200 km of the former UMHK concession boundary and within 100 km of the former RC concession boundary. These wide bandwidths serve as a common robustness benchmark throughout the paper while preserving broadly balanced numbers of observations on either side of each concession boundary. The baseline estimates instead use MSE-optimal bandwidths.

I determine treatment assignment by reconstructing the historical geography of the Cop-

Table 1: UMHK and RC Concession Summary Statistics

Variable	Outside Concession			Inside Concession		
	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.
<i>Panel A: Development Outcomes</i>						
UMHK						
Wealth index	5,642	2.531	1.304	5,096	4.354	1.126
Log(wealth score)	5,642	-6.207	8.726	5,096	7.892	8.567
Years of education	5,624	3.031	3.641	5,080	4.878	4.874
Literacy	1,559	0.538	0.499	1,466	0.839	0.368
Woman ht./age pctl.	543	15.117	20.394	479	30.928	27.870
Child ht./age pctl.	523	16.950	27.738	448	25.882	30.133
RC						
Wealth index	7,347	3.062	1.341	6,970	4.238	0.921
Log(wealth score)	7,347	-2.593	10.790	6,970	7.605	8.463
Years of education	7,315	4.135	4.150	6,933	5.850	4.710
Literacy	1,367	0.677	0.468	1,514	0.854	0.353
Woman ht./age pctl.	1,396	27.037	24.955	1,556	29.813	25.793
Child ht./age pctl.	1,079	19.705	27.885	858	21.253	26.879
<i>Panel B: Women's Outcomes</i>						
UMHK						
Modern use (contra.)	1,057	0.017	0.129	982	0.093	0.290
Modern knowledge (contra.)	1,057	0.799	0.401	982	0.883	0.322
Remuneration	859	2.073	0.929	548	2.385	0.940
Household purchases	269	0.770	0.719	397	0.776	0.702
RC						
Modern use (contra.)	490	0.553	0.498	488	0.619	0.486
Modern knowledge (contra.)	1,385	0.981	0.138	1,530	0.989	0.105
Remuneration	679	2.194	1.265	724	2.448	1.135
Household purchases	855	1.175	0.525	781	1.284	0.480
<i>Panel C: Urbanisation Outcomes</i>						
UMHK						
Nightlights	5,642	0.036	0.128	5,096	8.214	7.711
Built-up surface	5,642	0.037	0.107	5,096	0.541	0.362
Electricity	5,642	0.041	0.198	5,096	0.595	0.491
Water	5,642	0.122	0.328	5,096	0.684	0.465
RC						
Nightlights	7,347	2.196	4.091	6,970	7.638	6.496
Built-up surface	7,347	0.173	0.298	6,970	0.401	0.280
Electricity	7,307	0.227	0.419	6,970	0.549	0.498
Water	1,383	0.274	0.446	1,530	0.622	0.485

Notes. The table reports summary statistics for the sample restricted to observations within 200km (100km) of the UMHK (RC) concession boundary. See results tables for detailed variable definitions.

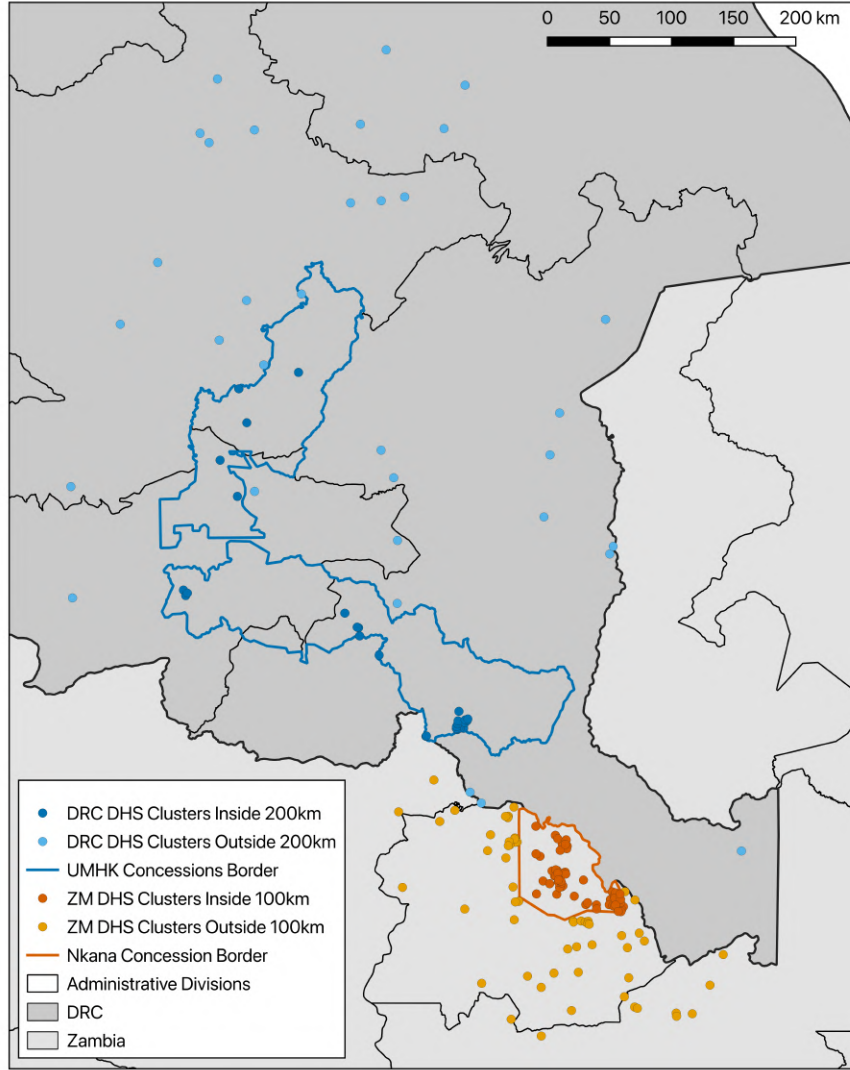


Figure 4: Historical Concession Boundaries and Contemporary DHS Clusters

Notes. The map displays the historical concession boundaries for the UMHK and the RC. Blue and orange markers represent contemporary DHS clusters located near the UMHK and RC concessions, respectively. Administrative divisions are outlined in black.

perbelt. I digitised the concession boundaries using original colonial maps: the *Atlas Général du Congo* (1954) for the UMHK ([Académie Royale des Sciences d’Outre-Mer, 1954](#)), and the Rhodesian Anglo American maps (1929) for the RC ([Frederiksen, 2013](#)). I spatially match each DHS cluster to these polygons to define the treatment indicator and the running variable (distance to the boundary). Figure 4 displays both former concession boundaries in the DRC and Zambia, including the treatment and control DHS clusters for each concession.

To ensure that the estimated discontinuities reflect institutional differences rather than environmental endowments, I construct a vector of geographic covariates. These include elevation, slope, and ruggedness from digital elevation models (Nunn and Puga, 2012); soil quality from the Atlas of the Biosphere, based on soil carbon and nitrogen following Michalopoulos (2012); and long-run rainfall volatility from the Global Climate Database.

To account for pre-colonial differences, I link observations to ethnic characteristics from Murdock’s Ethnographic Atlas (Murdock, 1967) and to ethnic-level slave trade exposure from Nunn and Wantchekon (2011).

To address concerns about contemporary mining activity and broader mineral geography, I construct distance-based controls from the U.S. Geological Survey’s Mineral Resources Data System (MRDS) (U.S. Geological Survey, 2005). The main control measures the distance from each DHS cluster to the nearest MRDS site coded as a ‘Producer’, that is, a site recorded in MRDS as actively producing at the time of observation. A broader alternative measures distance to the nearest documented MRDS site regardless of development status. This second measure pools all MRDS status categories present in the data: ‘Producer’, ‘Past Producer’, ‘Plant’, ‘Prospect’, ‘Occurrence’, and ‘Unknown’, and therefore captures both active extractive activity and the wider geography of documented mineral sites. The former captures contemporary mining exposure; the latter captures mineral-site geography more generally.

Finally, I reconstruct colonial-era investments in public goods and infrastructure. For the Belgian Congo, I digitise and georeference historical locations of healthcare facilities and missionary posts, again from the *Atlas du Congo* (Académie Royale des Sciences d’Outre-Mer, 1954). For Northern Rhodesia, I use the recent dataset by Chiseni (2024), which offers superior spatial precision relative to older missionary compendia (see Jedwab and Storeygard, 2022). I further digitise post-independence transport networks (circa 1968) from the *Perry-Castaneda Map Collection* and modern Congolese infrastructure (2010) from *Le Répertoire Géographique Commun* to track the evolution of transportation infrastructure.

4 Development Outcomes

4.1 Empirical Strategy

I estimate the impact of exposure to colonial concessions and their private corporations on development outcomes using a geographic regression discontinuity (RD) design.

The baseline specification is:

$$Y_{i,c} = \alpha + \beta \text{Concession}_{i,c} + f(\text{distance}_c) + \gamma \mathbf{X}_i + \epsilon_{i,c} \quad (1)$$

where $Y_{i,c}$ is the outcome variable for individual i from DHS cluster c . $\text{Concession}_{i,c}$ is an indicator equal to 1 if DHS cluster c is inside the concession area and 0 otherwise. distance_c is the signed distance (km) from cluster c to the concession boundary, positive inside the concession and negative outside, and $f(\cdot)$ is a smooth function of distance to the boundary fitted separately on each side. $\mathbf{X}_i$ is a vector of covariates including survey year and province fixed effects; individual-level outcomes additionally control for sex, age, and age squared, except women-only outcomes and woman height, which omit sex. Finally, $\epsilon_{i,c}$ is the error term, with standard errors clustered at the DHS cluster level.

The baseline specification uses a local linear polynomial in distance to the boundary, estimated separately on each side (Gelman and Imbens, 2019), following best practices for spatial regression discontinuities (Calonico et al., 2014a,b; Cattaneo et al., 2016, 2019). This involves calculating the optimal bandwidth through the Mean Squared Error (MSE)-minimising procedure. For robustness, I also present results using a wider, fixed bandwidth of 200 km, ensuring approximately balanced clusters on either side of the boundary.

The coefficient of interest, β , captures the effect of being located just inside a former colonial concession. Causal interpretation relies on the assumption that concession boundaries were drawn independently of pre-concession local geography and demographic conditions. This central continuity assumption matters for causal identification, as pre-existing differ-

ences in geography, culture, or political organisation could otherwise confound contemporary development outcomes (e.g., [Nunn, 2008](#); [Michalopoulos and Papaioannou, 2014](#); [Alsan, 2015](#); [Lowes et al., 2017](#)). Under this assumption, any local discontinuities in outcomes can be attributed to colonial corporate exposure.

To assess whether units on either side of the boundary are valid counterfactuals, I show that geographic and precolonial demographic variables vary smoothly around the concession borders. Panel A in Table 2 presents summary statistics and RD estimates for geographic variables near the UMHK concession boundaries. This balance test utilises a 20 km by 20 km cell grid, with variable values averaged for each cell. The RD estimates are derived from a version of specification (1), adapted to the grid-cell level by averaging outcomes within each cell. Standard errors are clustered at the territory level for geographic characteristics.

I find that geographic characteristics vary smoothly around the concession boundaries, supporting the validity of the identification assumption. Moreover, most of these geographic characteristics are also balanced over the entire bandwidths. These results suggest that the concession areas were not significantly different from the surrounding regions in terms of geography prior to the concessions.

For pre-colonial demographics, I use ethnic group data from the Ethnographic Atlas ([Murdock, 1967](#)). I also incorporate variables related to the Atlantic and Indian slave trade, created by [Nunn and Wantchekon \(2011\)](#), aggregated at the ethnic group level. Panel B in Table 2 shows no significant difference in the makeup of pre-colonial demography at or near the UMHK concession boundary. The concession boundary also does not align with any pre-colonial ethnic group boundaries, further supporting the identification strategy.

A potential concern in this empirical setting is that concession boundaries may correlate with mineral deposits rather than being randomly drawn. However, this consideration does not undermine identification. Concessions were initially granted as prospecting and exploration zones (e.g., *blocs à droits exclusifs de recherches* in the Belgian Congo; prospecting concessions in Northern Rhodesia), and only later expanded to include mine-specific exploita-

Table 2: UMHK Concession Balance Test

	Control Group	RD Specification			
	Mean (SD) (1)	Estimate (SE) (2)	Opt. BW (km) (3)	Effective Obs. (4)	Clusters (5)
<i>Panel A: Geography</i>					
Elevation	1,109.67 (253.66)	−2.13 (137.86)	129.18	591	25
Slope	2,245.94 (1,540.81)	−153.03 (702.79)	105.87	520	25
Ruggedness	84.84 (58.69)	−6.19 (26.71)	105.08	519	25
Soil suitability index	96.35 (1.03)	0.05 (0.77)	131.09	606	25
Rainfall (avg.)	1,190.33 (86.37)	−10.14 (30.11)	119.72	565	25
Rainfall (std. dev.)	11.80 (10.07)	−0.45 (3.05)	118.77	562	25
Malaria suitability	7.31 (3.50)	−0.03 (1.91)	136.11	619	25
Navigable river	0.02 (0.15)	0.06 (0.27)	91.10	479	22
<i>Panel B: Demography</i>					
Population density	−0.25 (0.65)	−0.04 (0.32)	108.45	137	5
Total enslaved	551.16 (913.49)	368.18 (880.60)	180.56	767	17
State centralization	0.85 (0.36)	−0.20 (0.25)	370.13	1,115	14
Polygyny	0.77 (0.42)	−0.09 (0.33)	177.98	717	15
Hereditary headman	0.99 (0.10)	−0.00 (0.02)	168.53	616	15

Notes. The table tests for balance in predetermined characteristics at the concession boundary. Panel A reports geographic variables; Panel B reports pre-colonial institutional and demographic characteristics from the *Ethnographic Atlas* (Murdock, 1967). The unit of observation is a 20 km × 20 km grid cell. Column (1) reports the mean (and standard deviation) of the control group within the optimal bandwidth. Column (2) reports the *Conventional* RD coefficient and the *Robust* standard error (in parentheses). Panel A clusters standard errors at the territory level; Panel B clusters at the ethnic group level. Estimates use a local linear regression with a triangular kernel; standard errors and significance levels are robust to the bias-correction procedure. Column (3) reports the optimal bandwidth selected by the MSE-minimising procedure (Cattaneo et al., 2019). Columns (4) and (5) report the effective number of observations and clusters within this bandwidth.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

tion rights. To address this concern directly, Section 4.3 reports robustness specifications that add distance to the nearest MRDS Producer as a control for contemporary mining activity. Appendix C.1 reports the corresponding broader specification using distance to the nearest MRDS site of any type, which captures mineral-site geography more generally.

4.2 Results

Long-Run Development. Exposure to the UMHK is associated with consistently positive long-term development outcomes across household wealth (Panel A), individual education (Panel B), and health indicators (Panel C), as reported in Table 3. Households within the former UMHK concession area are approximately one standard deviation wealthier, individuals attain roughly 1.5 to 1.7 additional years of schooling, and literacy rates are substantially higher, by roughly 26 to 30 percentage points. Women and children are also significantly taller for their age, by about 14 to 17 height-for-age percentiles, consistent with improved early-life health and nutritional conditions. These results indicate persistent effects of past colonial corporate policies on contemporary development outcomes.

This wide range of benefits challenges common narratives about the universally extractive nature of colonial concessions in Africa. The fact that these effects remain observable decades after the collapse of the UMHK underscores the durability of corporate institutional environments. The economic magnitude of these effects, particularly the large increase in education and literacy, suggests not only greater investment but also a shift in household-level human capital accumulation (Foster and Rosenzweig, 1995), tied to the UMHK’s efforts to stabilise and incentivise long-term family settlement.

Figure 5 presents RD plots illustrating discontinuities at the UMHK boundary for each outcome in Table 3. The running variable is the distance to the UMHK concession boundary. A linear fitted trend is estimated on both sides of the discontinuity at the border (0 km). Each plot shows a clear discontinuity at the boundary, visually supporting a causal interpretation of the main results.

Table 3: UMHK Concession Development Outcomes

	Optimal (1)	Wide (2)	Optimal (3)	Wide (4)
<i>Panel A: Asset Wealth</i>				
	Wealth index		Log(wealth score)	
UMHK	1.527*** (0.559)	1.625*** (0.522)	13.101*** (4.296)	13.676*** (4.112)
Observations	8,992	10,738	8,992	10,738
Clusters	51	61	51	61
Bandwidth (km)	122.84	200.00	122.42	200.00
Mean dep. var.	3.617	3.396	2.028	0.484
Std. dev. dep. var.	1.481	1.525	11.070	11.154
<i>Panel B: Education</i>				
	Years of education		Literacy	
UMHK	1.499** (0.668)	1.709*** (0.631)	0.258** (0.106)	0.298*** (0.099)
Observations	8,962	10,704	2,372	3,025
Clusters	51	61	48	61
Bandwidth (km)	119.23	200.00	111.17	200.00
Mean dep. var.	4.067	3.908	0.734	0.684
Std. dev. dep. var.	4.451	4.369	0.442	0.465
<i>Panel C: Health</i>				
	Woman ht./age pctl.		Child ht./age pctl.	
UMHK	13.810** (6.047)	14.135*** (5.403)	17.576*** (4.440)	16.995*** (4.173)
Observations	808	1,022	802	971
Clusters	48	61	52	61
Bandwidth (km)	107.80	200.00	130.34	200.00
Mean dep. var.	25.101	22.528	21.475	21.071
Std. dev. dep. var.	26.288	25.431	29.135	29.195

Notes. The table reports bias-corrected regression discontinuity point estimates using a local linear specification with a triangular kernel, estimated separately on each side of the concession boundary, with robust standard errors following [Calonico et al. \(2014b\)](#). Standard errors are clustered at the DHS cluster level and reported in parentheses. Optimal bandwidths (in km) are selected using the MSE-minimising procedure from [Cattaneo et al. \(2019\)](#). All regressions control for survey year and province fixed effects; individual-level outcomes also control for sex, age, and age squared, except woman height, which omits sex. *Wealth score* is the DHS principal component index of asset ownership. *Wealth index* is a categorical variable (1–5) representing quintiles of the wealth score. *Literacy* is a binary indicator for reading ability. *Woman* and *Child ht./age pctl.* represent the respondent's height-for-age percentile within the entire sample, calculated for the subsets of eligible women and children, respectively.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

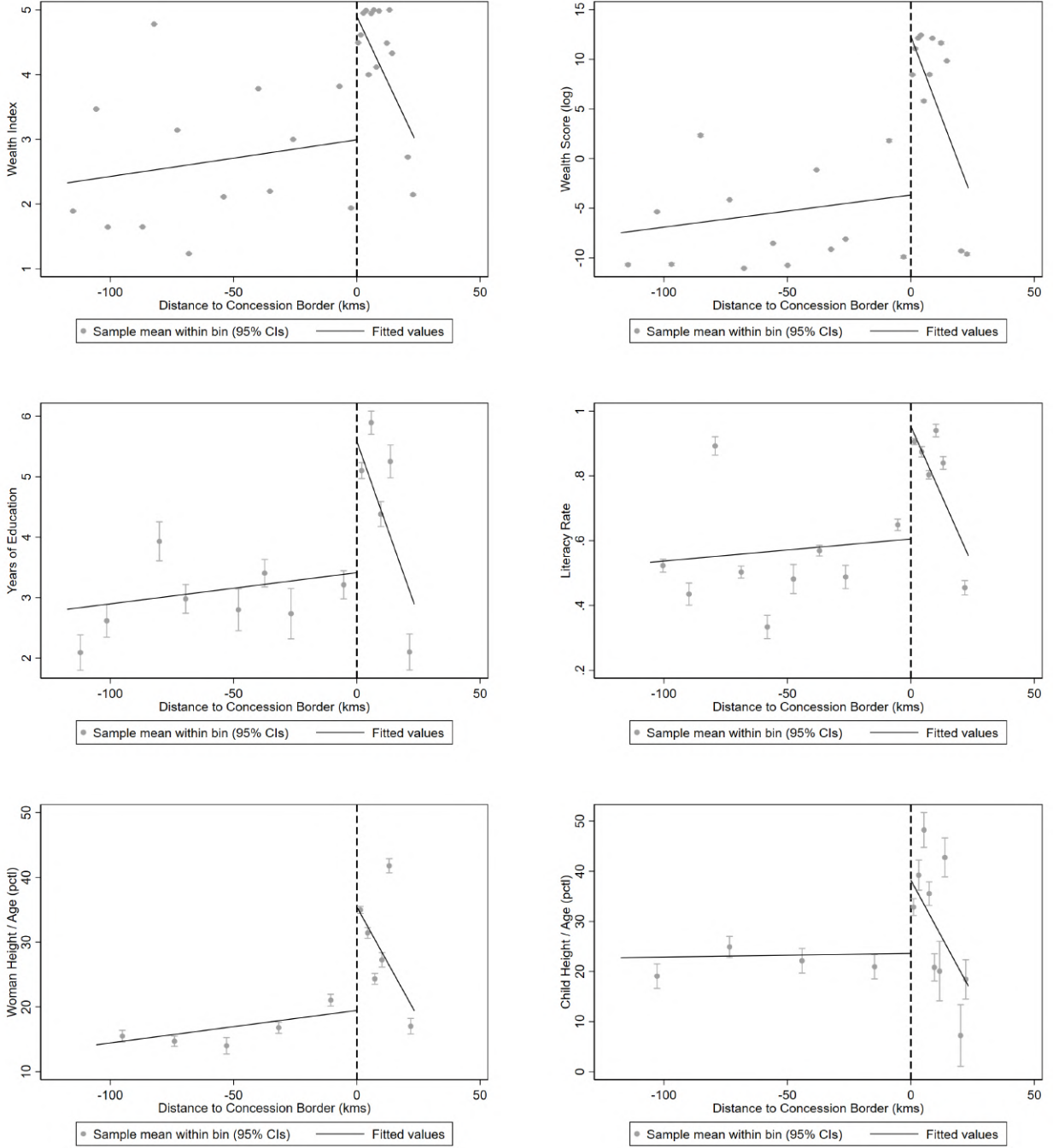


Figure 5: UMHK RD Plots for Development Outcomes

Notes. The figure displays the RD plots for development outcomes and the mean value of each outcome variable at the optimal number of bins as recommended by Cattaneo et al. (2019) along the running variable (distance to the UMHK concession boundary), including a local linear trend estimated separately on each side of the discontinuity.

Women’s Empowerment. The legacy of the UMHK’s paternalistic policies also extends to women’s contemporary outcomes, an uncommon feature in studies of historical institutional legacies. Gender-related outcomes are considerably better within the former UMHK concession. Women’s ability to access and use modern contraception is a key determinant of their broader life outcomes (Bailey, 2006; Bailey et al., 2012; Bailey and Lindo, 2017). Panel A of Table 4 shows higher rates of both modern contraceptive use and modern contraceptive knowledge in the former concession area.

Women’s economic outcomes reinforce this positive legacy. Panel B in Table 4 presents gender outcomes in terms of household income and expenses. The remuneration variable, serving as an indicator of women’s economic compensation and the formalisation of their work, represents an earnings scale ranging from no payment whatsoever, to payments in-kind, to mixed in-kind and cash payments, to full wages in cash. The household-purchases variable captures the respondent’s participation in decisions over major and daily household expenditures through the average of those two decision-making indicators. Women are more frequently compensated for their work, with a higher likelihood of receiving cash payments. They also report greater influence over household spending decisions.

Taken together, the evidence suggests that women in the former UMHK area enjoy greater reproductive autonomy, better earnings, and more household decision-making power than women in comparable nearby regions. These gendered effects provide suggestive evidence that paternalistic labour institutions, when tied to family settlement and social provisioning, may paradoxically have unintended but persistent effects on women’s empowerment.

4.3 Robustness and Sensitivity Checks

Contemporary Mining Activity. A concern is that the discontinuities attributed to the colonial concession legacy may instead reflect present-day mining activity. Contemporary mines may affect nearby outcomes through local labour demand, backward linkages to suppliers and services, infrastructure investments, or the fiscal spillovers associated with active

Table 4: UMHK Concession Women’s Outcomes

	Optimal (1)	Wide (2)	Optimal (3)	Wide (4)
<i>Panel A: Contraception</i>				
	Modern use		Modern knowledge	
UMHK	0.107*** (0.035)	0.094*** (0.034)	0.128 (0.078)	0.149** (0.073)
Observations	1,830	2,039	1,683	2,039
Clusters	54	61	51	61
Bandwidth (km)	155.72	200.00	117.53	200.00
Mean dep. var.	0.060	0.053	0.858	0.840
Std. dev. dep. var.	0.237	0.225	0.349	0.367
<i>Panel B: Income & Expenses</i>				
	Remuneration		Household purchases	
UMHK	0.836** (0.358)	0.913*** (0.330)	0.155** (0.064)	0.149** (0.064)
Observations	1,024	1,407	569	666
Clusters	48	61	18	21
Bandwidth (km)	115.11	200.00	105.96	200.00
Mean dep. var.	2.243	2.195	0.766	0.773
Std. dev. dep. var.	0.951	0.945	0.700	0.708

Notes. The table reports bias-corrected regression discontinuity point estimates using a local linear specification with a triangular kernel, estimated separately on each side of the concession boundary, with robust standard errors following [Calonico et al. \(2014b\)](#). Standard errors are clustered at the DHS cluster level and reported in parentheses. Optimal bandwidths (in km) are selected using the MSE-minimising procedure from [Cattaneo et al. \(2019\)](#). All regressions control for age, age squared, survey year, and province fixed effects. *Modern use* and *knowledge* are binary indicators for the usage and awareness of modern contraception methods. *Remuneration* is a categorical variable (1–4) ranging from unremunerated to fully cash-based work. *Household purchases* is the average of indicators for whether the woman participates in decisions on major and daily household purchases.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

extractive production (Benshaul-Tolonen and Musso, 2025). In that case, the RD estimates could capture the contemporary geography of mining rather than the persistent effects of colonial corporate institutions. To address this concern directly, Table 5 re-estimates the UMHK development and women’s outcome battery while additionally controlling for distance to the nearest MRDS Producer. A broader geology and extractive-site robustness check using distance to the nearest MRDS site of any type is reported in Appendix C.1.

The estimates attenuate relative to the baseline specification, but the main pattern remains intact. All six development outcomes remain positive and statistically significant under the contemporary-mining control, both at the optimal and wide bandwidths. Among the women’s outcomes, modern contraceptive use, remuneration, and household purchases also remain significant, while modern contraceptive knowledge becomes imprecisely estimated. This pattern points to, if anything, stronger reproductive autonomy, as contraceptive use remains higher even when differences in knowledge are less pronounced. The broader Appendix C.1 specification using distance to the nearest MRDS site of any type yields a similar pattern for the development outcomes, while some women’s outcomes attenuate further. These results indicate that the main UMHK discontinuities are not simply a reflection of contemporary mining activity or the broader geography of mineral sites.

Selective Migration. A primary concern with spatial persistence studies is selective migration: do superior outcomes reflect the institutional environment, or the sorting of high-human-capital individuals into the former concession area? Accurately determining the magnitude of historical endogenous sorting in the Katanga province and beyond is impossible.⁵ However, more recent selective migration is both a larger threat to identification and interpretation, as it does not constitute a long-run channel itself, and it is quantitatively identifiable. To address this, I estimate the RD specification separately for natives (individuals who report having always lived in their current location) and migrants.

⁵In particular, there is no reliable geocoded micro-level data covering internal migration and population location over the post-independence period, including the Mobutu era, roughly from the 1960s to the early 2000s, that would allow the paper to trace long-run sorting dynamics in former Zaire/DRC.

Table 5: UMHK Concession Development and Women’s Outcomes with Contemporary Mining Activity Controls

	Optimal (1)	Wide (2)	Optimal (3)	Wide (4)
<i>Panel A: Development Outcomes</i>				
	Wealth index		Log(wealth score)	
UMHK	1.223** (0.522)	1.434*** (0.493)	10.578** (4.386)	11.903*** (4.144)
Observations	8,992	10,738	9,174	10,738
	Years of education		Literacy	
UMHK	1.231* (0.649)	1.544** (0.619)	0.213** (0.102)	0.277*** (0.097)
Observations	8,962	10,704	2,372	3,025
	Woman ht./age pctl.		Child ht./age pctl.	
UMHK	9.661* (5.469)	11.946** (5.089)	17.193*** (4.384)	16.885*** (4.160)
Observations	835	1,022	802	971
<i>Panel B: Women’s Outcomes</i>				
	Modern use		Modern knowledge	
UMHK	0.082** (0.035)	0.073** (0.033)	0.060 (0.057)	0.085 (0.056)
Observations	1,830	2,039	1,592	2,039
	Remuneration		Household purchases	
UMHK	0.665* (0.387)	0.808** (0.351)	0.143** (0.063)	0.127** (0.063)
Observations	1,024	1,407	533	666

Notes. The table reports bias-corrected regression discontinuity point estimates using a local linear specification with a triangular kernel, estimated separately on each side of the concession boundary, with robust standard errors following [Calonico et al. \(2014b\)](#). Standard errors are clustered at the DHS cluster level and reported in parentheses. Optimal bandwidths (in km) are selected using the MSE-minimising procedure from [Cattaneo et al. \(2019\)](#). All regressions control for province fixed effects. Individual-level outcomes additionally control for sex, age, and age squared, except women’s outcomes and woman height, which omit sex. All regressions additionally control for distance to the nearest MRDS Producer of any commodity. *Household purchases* is the average of indicators for whether the woman participates in decisions on major and daily household purchases.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6 provides results that reduce concern about the contemporary endogenous sorting hypothesis. Across all specifications, the discontinuity remains large and statistically significant for the native population. The overall increased magnitude of the coefficients is driven by data availability, as the question was only answered by women in 2007 (hence the absence of a child height-for-age estimate). Even so, what matters for this robustness check is the relative effect size of these results: the treatment effects for natives are consistently larger than for migrants. For example, natives within the UMHK concession exhibit an education effect roughly 1.4 years larger than the corresponding effect for migrants, and a wealth effect nearly double that of the migrant population. This contrasts with the literature on forced migration, which typically finds that uprooted populations invest relatively more in human capital as a portable asset (Becker et al., 2020), reinforcing the view that the UMHK effects are driven by place-based institutional quality rather than migrant sorting.

The anthropometric results further suggest an environmental channel. Native women, whose height is determined by early-life conditions within the former concession, rank roughly 27 height-for-age percentiles higher than those just outside the border. This indicates that the concession provided a superior biological standard of living during childhood, rather than merely attracting taller adults.

Measurement Error. A different potential limitation of this analysis is that the DHS data clusters are randomly displaced to maintain the confidentiality of the respondents. This random displacement can be up to 2 km for all urban clusters, up to 5 km for 99% of the rural clusters, and up to 10 km for 1% of the rural clusters. This displacement introduces a specific form of non-classical measurement error in the forcing variable (distance to the boundary). While this complicates the standard interpretation, the resulting misclassification of units near the cut-off is, in this context, still most likely to attenuate the estimated discontinuity. Nonetheless, as noted by Lowes and Montero (2021a), the results of an RD approach may be driven by incorrectly assigned clusters right along the boundary.

Table 6: UMHK Concession Development Outcomes by Migration Status

	Native (Optimal BW) (1)	Immigrant (Optimal BW) (2)
<i>Panel A: Asset Wealth</i>		
Wealth index	3.745*** (0.199)	1.985*** (0.702)
Observations	464	317
Clusters	18	18
Bandwidth (km)	108.7	109.2
Log(wealth score)	22.577*** (0.858)	20.577*** (2.189)
Observations	464	317
Clusters	18	18
Bandwidth (km)	110.5	106.6
<i>Panel B: Education</i>		
Years of education	7.203*** (0.614)	5.820*** (0.947)
Observations	464	286
Clusters	18	17
Bandwidth (km)	106.8	105.0
Literacy	0.721*** (0.120)	0.633*** (0.105)
Observations	462	266
Clusters	18	16
Bandwidth (km)	113.1	96.9
<i>Panel C: Health</i>		
Woman ht./age pctl.	26.871*** (4.465)	22.256*** (8.004)
Observations	264	122
Clusters	18	17
Bandwidth (km)	116.1	118.9

Notes. The table reports bias-corrected regression discontinuity estimates using the optimal bandwidth selection procedure from [Cattaneo et al. \(2019\)](#), with robust standard errors following [Calonico et al. \(2014b\)](#). *Native* refers to respondents who reported having always lived in their current location; *Immigrant* refers to those who moved to their current location. All regressions control for sex, age, age squared, survey year, and province fixed effects. Standard errors are clustered at the DHS cluster level and reported in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Given the narrow shape of the UMHK concession area, “donuthole” estimations excluding clusters near the boundary are impractical. However, as the DHS GPS displacement algorithm does not allow clusters to cross internal administrative boundaries, major urban clusters like Lubumbashi, Likasi, and Kolwezi remain correctly assigned within the concession area. This is especially relevant in light of the urbanisation analysis in Section 5.4, which suggests that a substantial share of the estimated discontinuities is driven by these larger urban centres, reducing the risk that misclassification drives the observed discontinuities. Nevertheless, it could theoretically bias the results in either direction; however, in spatial settings, the estimated discontinuities then represent a lower bound on the true impact.

Finally, I verify that the results are robust to using a local quadratic polynomial and alternative bandwidth selection procedures. The main findings appear to be robust to a battery of alternative specifications, shown in Table C.4 in Appendix C.2.

In sum, these findings collectively provide robust evidence of the enduring positive impacts of the UMHK’s presence, not only on overall economic development and human capital but also on various dimensions of women’s empowerment, revealing a long-term legacy of colonial corporate governance.

5 Mechanisms of Divergence

This section traces the mechanisms behind the UMHK’s local legacy in four steps, relying on a comparison with the RC. I first discuss how wage coordination pushed the UMHK and RC toward different non-wage labour strategies, and how those strategies translated into different patterns of corporate investment. I then examine how those settlement regimes shaped household structure and female bargaining power. The third subsection investigates outcomes at the RC boundary as a local comparative benchmark, evaluating differences between the UMHK and RC concession boundaries. The final subsection proposes urbanisation as the main spatial channel through which these institutional differences persisted.

5.1 Corporate Paternalism and Investment

I argue that the institutional divergence between the UMHK and RC concessions lies in their distinct corporate responses to a shared constraint: the inability to use wages as a competitive instrument. These divergent strategies shaped not only immediate labour conditions but also produced lasting differences in urban formation and infrastructural development. While existing literature identifies labour policy as a key determinant of colonial institutions' developmental legacies ([Chiovelli et al., 2026](#)), the evidence here points to an additional, indirect channel: corporate labour strategies influenced the pace and permanence of urbanisation, thereby shaping the spatial distribution and durability of public infrastructure.

Wage Coordination. The most direct channel through which firms could have differentiated their labour policies was through wage setting. However, a system of wage coordination was implemented across the Central African Copperbelt in the early 1930s. Mining corporations in both the Belgian Congo and Northern Rhodesia agreed to harmonise pay scales to avoid competition for labour, rendering wages locally non-instrumental as a recruitment tool. Importantly, this coordination did not suppress overall compensation: Copperbelt miners remained among the best-paid manual labourers in Sub-Saharan Africa ([Juif and Frankema, 2018](#)).

The suppression of wage competition shifted competition toward non-wage margins. Restricted from offering higher pay, the UMHK instead competed on living conditions and labour stabilisation, assuming a broader role in the provision of local public goods to secure its workforce. In contrast, the RC remained more narrowly oriented toward extraction. As a result, non-wage benefits began to diverge from the late 1930s.

Healthcare. The UMHK invested heavily in healthcare provision. In Panel A of Table 7, the estimated increase in healthcare facilities (0.033) exceeds the control mean (0.030), while the apothecary coefficient (0.102) is more than twice its control mean (0.046). Interpreted

in levels, areas just inside the former UMHK concession had roughly double the density of facilities and more than triple the density of apothecaries relative to the surrounding region in 1953. By contrast, similar incentives were largely absent in the RC concession, where short-term labour contracts undermined the rationale for long-term welfare investment. Panel B reports a negative healthcare coefficient of the same magnitude as the control mean (-0.030 relative to 0.030), implying essentially no comparable healthcare concentration within the former RC concession.

Education. Documenting direct corporate investment in education is more challenging, as these services were primarily outsourced to missionaries ([Cagé and Rueda, 2016](#); [Chiseni, 2024](#)). Columns (3-4) of Table 7 offer only weak and statistically insignificant evidence of systematic differences in missionary presence. Within the UMHK concession, missionary presence in 1950 is modestly higher inside the boundary (0.074 relative to a control mean of 0.075), but the 1924 difference is imprecisely estimated. Within the RC concession, there is no detectable 1924 gap, yet missionary presence in 1950 is also higher inside the boundary (0.151 relative to a control mean of 0.074). Missionary expansion therefore does not map cleanly onto the long-run education results and is unlikely, by itself, to explain the strong educational gains at the UMHK boundary. A more plausible interpretation is that the UMHK’s Labour Stabilisation Programmes, by fostering permanent family resettlement, created a stable population with stronger incentives to invest in human capital.

5.2 Gender and Household Structure

The same labour strategies also shaped broader demographic patterns. Corporate labour policy influenced not only individual labour migration but also the migration of miners’ families into the UMHK concession. This early divergence in settlement policy generated a persistent shift in intra-household bargaining power.

Table 7: UMHK and RC Concession Labour Policy

	Healthcare		Missionary Posts	
	Facilities (1)	Apothecaries (2)	in 1924 (3)	in 1950 (4)
<i>Panel A: UMHK Concession</i>				
UMHK	0.033** (0.013)	0.102** (0.039)	0.053 (0.037)	0.074* (0.040)
Posts in 1924				0.513*** (0.138)
Observations	832	832	832	832
Clusters	18	18	18	18
Bandwidth (km)	200.00	200.00	200.00	200.00
Control mean	0.030	0.046	0.025	0.075
<i>Panel B: RC Concession</i>				
RC	-0.030* (0.016)		-0.007 (0.006)	0.151* (0.077)
Posts in 1924				1.940*** (0.023)
Observations	154		154	154
Clusters	18		18	18
Bandwidth (km)	100.00		100.00	100.00
Control mean	0.030		0.007	0.074

Notes. The table reports cross-sectional regression results for the number of facilities or missionary posts in each 20 km $\times$ 20 km grid cell. Panel A reports results for the UMHK concession (DRC) within a 200 km bandwidth. Panel B reports results for the RC concession (Zambia) within a 100 km bandwidth. Column (4) controls for the number of missionary posts in 1924. Standard errors are clustered at the territory level and reported in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Monetisation of the Family. Under the UMHK’s Labour Stabilisation Programmes, the family unit was explicitly monetised. The corporation provided bride prices, payments for newborns, and family-sized housing to secure a long-term workforce. This transformation was a documented reality: the female-to-male ratio in UMHK compounds rose from 28% to over 80% (Juif and Frankema, 2018). By making access to substantial non-wage benefits conditional on the presence of a spouse, the UMHK framework elevated the wife from a dependent to a structural ‘shareholder’ in the labour contract. In a collective household framework (Chiappori, 1992; Anderson and Eswaran, 2009), this integration likely operated as a one-time positive shock to female bargaining power and shifted the female threat point: the cost to the husband of household dissolution was no longer just the loss of a partner, but also the loss of the paternalistic premium itself. By explicitly financing the domestic unit, the UMHK lowered the economic threshold for female autonomy and created a structural precedent for female financial decision-making that proved durable.

Circular Migration. The UMHK’s corporate paternalism stands in sharp contrast to the Rhokana Corporation’s South African model. The RC’s circular migration strategy actively discouraged permanent settlement to prevent ‘detribalisation,’⁶ fostering a demographic imbalance heavily skewed toward male labourers. Historical and anthropological literature (e.g. Chauncey, 1981; Parpart, 1986; Ferguson, 1999) highlights how these temporary, male-dominated compounds created a high demand for commercial sex work and informal domestic services, leading to precarious gender relations. Consequently, the RC model lacked the institutional mechanisms that elevated female status in Katanga. The predictions for the RC women’s outcomes thus align more closely with the classic gender-resource-curse literature (Ross, 2008; Kotsadam et al., 2017; Benshaul-Tolonen, 2024), which generally documents net-negative effects of extractive industries on women.

⁶Detribalisation is the process where members of a tribe or indigenous group lose their characteristic customs, traditional social structures, and cultural identities, often adopting urban or Western ways of life (see Wilson, 1942).

5.3 Comparative Development Outcomes

The mechanisms in Sections 5.1 and 5.2 generate a clear prediction. If the UMHK’s long-run footprint reflects its labour-stabilisation regime (paternalistic investment, family settlement, and the formal incorporation of the household into the labour contract) rather than copper extraction per se, the RC border should not display comparable discontinuities. Both concessions sat on the same mineral belt, faced the same global price shocks, and operated under broadly similar profit constraints. The RC border is therefore the closest available counterfactual for what a Copperbelt corporate concession looks like absent the UMHK’s settlement regime.

Two caveats discipline the comparison. First, the Belgian Congo and Northern Rhodesia inherited distinct colonial administrations and post-colonial trajectories, and any cross-border comparison bundles those differences with the corporate variation of interest (Keele and Titiunik, 2015). The formal pooled difference-in-discontinuities exercise reported in Appendix D is therefore a descriptive complement. Second, an RD at the RC border identifies whether the RC’s labour regime produced a local, place-based legacy of the kind documented at the UMHK boundary. It is agnostic about whether the RC affected sending regions elsewhere in Northern Rhodesia: because circular migration recruited workers from outside the concession by design, any origin-side legacy of the RC system would have to be identified at workers’ home districts rather than at the mine (as in Denton-Schneider, 2024; Khanna et al., 2026).

Table 8 reports concession-level RD estimates at the RC boundary, using the same outcome battery, MSE-optimal bandwidth procedure, and covariate set as the UMHK results in Section 4. The contrast with the UMHK estimates is uniform. At the optimal bandwidth, years of schooling at the RC boundary is -0.22 , against 1.5 to 1.7 years at the UMHK boundary; literacy is -11.9 percentage points, against 26 to 30; women’s and child height-for-age percentiles are -0.34 and 7.10, against 14 to 17 percentiles at the UMHK boundary; the wealth index discontinuity is -0.22 , against one standard deviation in the UMHK.

The pattern extends to the women’s outcomes: at the RC boundary, the discontinuity in modern contraceptive use and knowledge is essentially zero, as are remuneration and participation in household purchase decisions. None of the RC point estimates is statistically distinguishable from zero at the optimal bandwidth, and the same pattern holds at the wider bandwidth reported in Columns (2) and (4). The contrast with the UMHK is therefore not a matter of degree: where the UMHK boundary marks a definitive positive discontinuity in development and women’s outcomes, the RC boundary marks no discontinuity at all.

Asymmetric Control Regions. A potential concern is that the RC null reflects properties of the Zambian control region rather than of the RC concession itself. The Copperbelt Province is among the most developed regions in Zambia, with high literacy and urbanisation levels driven in part by the partial nationalisation of the Copperbelt mines from 1969 (later consolidated as the Zambia Consolidated Copper Mines, ZCCM) and the intra-provincial fiscal redistribution that accompanied it ([Fraser and Larmer, 2010](#); [Larmer, 2017](#)). If these channels lifted both sides of the RC boundary symmetrically, an RD at the boundary could mechanically return a null even if the historical RC had produced a positive level effect inside its concession.

Two pieces of evidence discipline this reading. First, the local identifying variation picked up by the RD is anchored in comparable baselines: as documented in [Appendix B.2](#), the control sides of the two boundaries display similar near-cut-off baseline outcomes, with literacy rates differing by roughly 5 percentage points (69 vs. 74) and wealth indices that are nearly identical (2.88 vs. 2.91), even though absolute development levels diverge over wider geographies. Second, even granting some province-wide convergence in Zambia, the implication does not necessarily weaken the comparative claim made here: it implies that any local RC legacy was either small to begin with or has since been absorbed into a province-wide development gradient, in either case unlike the UMHK, whose concession boundary continues to mark a local discontinuity nearly a century after it was drawn.

Table 8: RC Concession Development and Women’s Outcomes

	Optimal (1)	Wide (2)	Optimal (3)	Wide (4)
<i>Panel A: Development Outcomes</i>				
	Wealth index		Log(wealth score)	
RC	−0.218 (0.417)	0.142 (0.369)	−1.136 (3.653)	1.626 (3.196)
Observations	11,090	14,317	11,359	14,317
	Years of education		Literacy	
RC	−0.217 (0.696)	0.198 (0.652)	−0.119 (0.092)	−0.049 (0.082)
Observations	11,416	14,248	2,326	2,881
	Woman ht./age pctl.		Child ht./age pctl.	
RC	−0.343 (2.683)	−0.118 (2.508)	7.099 (6.175)	5.836 (5.529)
Observations	2,435	2,952	1,474	1,937
<i>Panel B: Women’s Outcomes</i>				
	Modern use (contra.)		Modern knowledge	
RC	0.022 (0.074)	0.024 (0.071)	0.000 (0.011)	−0.000 (0.010)
Observations	852	978	2,404	2,915
	Remuneration		Household purchases	
RC	0.009 (0.213)	0.064 (0.195)	−0.015 (0.067)	0.022 (0.060)
Observations	1,170	1,403	1,292	1,636

Notes. The table reports bias-corrected regression discontinuity point estimates for the RC Concession, with robust standard errors following [Calonico et al. \(2014b\)](#). Standard errors are clustered at the DHS cluster level and reported in parentheses. All regressions use a local linear specification with a triangular kernel and control for survey year and province fixed effects; individual-level outcomes also control for sex, age, and age squared, except women’s outcomes, which omit sex, and woman height, which also omits sex. Optimal bandwidths are chosen using the MSE-minimising procedure suggested by [Cattaneo et al. \(2019\)](#). *Household purchases* is the average of indicators for whether the woman participates in decisions on major and daily household purchases.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Contemporary Mining Activity. Section 4.3 controls for distance to the nearest MRDS producer at the UMHK boundary; the analogous specification at the RC boundary, reported in Appendix C.1, leaves the RC null intact. The contrast is not driven by differential exposure to active extraction or proximity to mineral sites at the boundary.

In summary, the RC development and women’s outcomes support a narrow but informative claim. At a comparable corporate boundary on the same mineral belt, with similar extraction intensity and the same concessionary form, no analogue of the UMHK discontinuity exists. Whatever generated the UMHK boundary effect may thus not be a feature of Copperbelt mining as such, but of the specific combination of paternalistic investment, family settlement, and household incorporation that distinguished the UMHK regime from the RC. Section 5.4 traces this place-based legacy to its dominant spatial channel.

5.4 Urbanisation and Agglomeration

The final and perhaps most durable legacy of the UMHK’s settlement policy was the creation of dense urban clusters. Urbanisation can generate significant welfare gains through agglomeration economies (Duranton and Puga, 2004; Melo et al., 2009; Donovan et al., 2024), arising from shared infrastructure, labour pooling, and knowledge spillovers (Puga, 2010). Unlike the colonial state, which lacked the fiscal capacity to subsidise urban density and faced pressures to remain fiscally self-supporting (van Waijenburg, 2018; Frankema and Booth, 2019), the UMHK internalised these fixed costs (housing, sanitation) to solve the coordination failure of settlement.

Table 9 reports the concession-level urbanisation discontinuities for the UMHK and the RC. The former UMHK concession area remains markedly more urbanised than its surroundings today, with clear discontinuities in built surface, nightlights, piped water, and electricity access. By contrast, the RC boundary exhibits much weaker and statistically insignificant discontinuities across the same urbanisation outcomes. This pattern suggests that superior development outcomes may be explained by a greater capacity to realise agglomeration ben-

efits. UMHK’s investments in healthcare and housing embedded an urban character that has persisted well beyond the colonial period.

Furthermore, the urban character of the former RC concession has proved fragile in the postcolonial period. [Mususa \(2012\)](#) documents a process of ‘villagisation’ in Zambian mining towns following the industry’s decline, where the withdrawal of corporate welfare forced residents to revert to rural subsistence strategies like charcoal burning and well-digging to survive. Unlike the resilient urban structure in the Congo, the Zambian urban fabric deteriorated considerably once the golden era of mine-provided services ended.

To test urbanisation as the primary mediating channel, I repeat the baseline analysis in [Table 10](#), while controlling for a contemporary urban household indicator. After controlling for current urban status, the UMHK concession coefficient becomes small and statistically insignificant for wealth index, education, literacy, and women’s height, while remaining significant for log wealth score and child height. These results imply that the historical, corporate-driven divergence in settlement patterns and urbanisation accounts for a large share of the positive development discontinuities observed today. The UMHK’s policies appear to have curated a specific demographic density that lowered the cost of service delivery and sustained the demand for education long after the corporation’s departure.

The same test applied to women’s outcomes reveals a more heterogeneous picture. [Table 11](#) reports results for contraception, remuneration, and household spending control. For contraception use, the baseline UMHK effect attenuates once urban household status is absorbed but remains statistically significant, while the urban household coefficient is itself positive and significant. Contraception knowledge is imprecisely estimated throughout. Remuneration attenuates more sharply and becomes statistically insignificant once urban household status is included, while women’s participation in household purchase decisions remains statistically significant after absorbing urban composition. The urban household channel therefore explains part, but not all, of the bargaining-power discontinuity observed at the UMHK boundary.

Table 9: UMHK and RC Concession Urbanisation Outcomes

	Optimal (1)	Wide (2)	Optimal (3)	Wide (4)
<i>Panel A: UMHK Concession</i>				
	Nightlights		Built-up Surface	
UMHK	4.117** (1.727)	4.201** (1.645)	0.405*** (0.128)	0.415*** (0.122)
Observations	9,660	10,738	9,660	10,738
Bandwidth (km)	150.80	200.00	150.99	200.00
	Electricity		Water	
UMHK	0.559*** (0.141)	0.583*** (0.141)	0.425** (0.188)	0.406** (0.184)
Observations	9,660	10,738	8,992	10,738
Bandwidth (km)	154.03	200.00	126.86	200.00
<i>Panel B: RC Concession</i>				
	Nightlights		Built-up Surface	
RC	1.799 (2.078)	1.051 (2.031)	−0.208 (0.147)	−0.146 (0.124)
Observations	11,090	14,317	11,090	14,317
Bandwidth (km)	41.67	100.00	42.90	100.00
	Electricity		Water	
RC	−0.091 (0.194)	0.012 (0.168)	−0.003 (0.162)	0.102 (0.146)
Observations	11,442	14,277	2,403	2,913
Bandwidth (km)	47.82	100.00	46.64	100.00

Notes. The table reports bias-corrected regression discontinuity point estimates for agglomeration and infrastructure outcomes, with robust standard errors following Calonico et al. (2014b). Standard errors are clustered at the DHS cluster level and reported in parentheses. All regressions use a local linear specification with a triangular kernel and control for survey year and province fixed effects. *Nightlights* and *Built-up Surface* are cluster-level outcomes and use only these controls; *Electricity* and *Water* additionally control for sex, age, and age squared. Optimal bandwidths are chosen using the MSE-minimising procedure suggested by Cattaneo et al. (2019). *Nightlights* is the luminosity measured by VIIRS. *Built-up Surface* is an index (0–1) from the Global Human Settlement Layer. *Electricity* and *Water* are binary indicators for household access to electricity and piped water (including public taps), respectively.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 10: UMHK Concession and Urban Development Outcomes

	Baseline (1)	Mechanism (2)	Baseline (3)	Mechanism (4)
<i>Panel A: Asset Wealth</i>				
	Wealth index		Log(wealth score)	
UMHK	1.527*** (0.559)	0.414 (0.291)	13.101*** (4.296)	2.801*** (1.033)
Urban Household		2.192*** (0.180)		19.768*** (0.778)
Observations	8,992	8,522	8,992	8,041
Clusters	51	48	51	45
Bandwidth (km)	122.84	113.08	122.42	98.10
<i>Panel B: Education</i>				
	Years of education		Literacy	
UMHK	1.499** (0.668)	0.141 (0.327)	0.258** (0.106)	0.041 (0.042)
Urban Household		2.584*** (0.329)		0.412*** (0.046)
Observations	8,962	8,962	2,372	2,458
Clusters	51	51	48	50
Bandwidth (km)	119.23	123.23	111.17	117.09
<i>Panel C: Health</i>				
	Woman ht./age pctl.		Child ht./age pctl.	
UMHK	13.810** (6.047)	4.717 (4.033)	17.576*** (4.440)	13.438*** (3.359)
Urban Household		16.443*** (3.740)		7.701** (3.500)
Observations	808	847	802	789
Clusters	48	51	52	51
Bandwidth (km)	107.80	118.61	130.34	123.63

Notes. The table reports bias-corrected regression discontinuity point estimates testing urbanization as a mediator, with robust standard errors following [Calónico et al. \(2014b\)](#). Columns (1) and (3) reproduce the baseline optimal bandwidth results. Columns (2) and (4) include an indicator for urban households to test the mechanism. Standard errors are clustered at the DHS cluster level and reported in parentheses. All regressions use a local linear specification with a triangular kernel and control for survey year and province fixed effects; individual-level outcomes also control for sex, age, and age squared, except woman height, which omits sex. *Urban Household* is a binary indicator for whether the DHS cluster is classified as urban. See previous tables for definitions of outcome variables.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 11: UMHK Concession and Urban Women’s Outcomes

	Baseline (1)	Mechanism (2)	Baseline (3)	Mechanism (4)
<i>Panel A: Contraception</i>				
	Contraception use		Contraception knowledge	
UMHK	0.107*** (0.035)	0.082*** (0.032)	0.128 (0.078)	0.042 (0.073)
Urban Household		0.048** (0.021)		0.180*** (0.031)
Observations	1,830	1,849	1,683	1,556
Bandwidth (km)	155.72	163.28	117.53	105.27
<i>Panel B: Income and Expenses</i>				
	Remuneration		Household purchases	
UMHK	0.836** (0.358)	0.487 (0.361)	0.155** (0.064)	0.140** (0.064)
Urban Household		0.690*** (0.105)		0.016 (0.145)
Observations	1,024	1,024	569	533
Bandwidth (km)	115.11	106.55	105.96	103.95

Notes. The table reports bias-corrected RD point estimates testing urbanisation as a mediating channel for the UMHK concession effect on women’s outcomes, with robust standard errors following [Calonico et al. \(2014b\)](#). Columns (1) and (3) report MSE-optimal bandwidth estimates without an urban control. Columns (2) and (4) add an indicator for urban household location; *Urban Household* reports the coefficient on this indicator from a triangular-kernel weighted OLS regression at the same MSE-optimal bandwidth. Standard errors clustered at the DHS cluster level in parentheses. All regressions use a local linear specification and control for age, age squared, survey year, and province fixed effects. All outcomes are for women respondents. *Remuneration* is an ordinal scale (0 = no earnings, 1 = in-kind, 2 = mixed, 3 = cash only). *HH purchases* is the average of indicators for whether the woman participates in decisions on major and daily household purchases.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

These attenuation patterns suggest that urbanisation is an important channel through which the UMHK legacy persists. For most development outcomes, the concession coefficient decreases once current urban household status is included, consistent with the view that the historical effect operates largely through the durable settlement geography created by the company. In this sense, the long-run discontinuities appear to reflect the path-dependent accumulation of human capital and service access in denser communities. A smaller set of outcomes is less fully absorbed by the urban control, especially children’s height-for-age and women’s reproductive autonomy and participation in household purchase decisions.

The latter is more suggestive of a household-level channel distinct from current urban residence. The UMHK’s corporate welfare regime appears to have formalised family roles in ways that persist in intra-household decision-making today. For child height, by contrast, incomplete attenuation need not imply a mechanism separate from urbanisation itself. A more natural interpretation is that urbanisation operated through offsetting channels: the same density that increased income and improved access to services may also have intensified crowding, communal sanitation use, and exposure to infectious disease, thereby dampening the net gains in children’s physical growth.

Congestion. The child-height results therefore qualify a simple agglomeration account. Rapid urbanisation can generate congestion and disease externalities that offset some of the productivity gains associated with density ([Grover et al., 2023](#)). This helps rationalise why the UMHK discontinuity is larger for wealth than for child height (see [Benshaul-Tolonen, 2019](#); [Von der Goltz and Barnwal, 2019](#)). It is also consistent with the preliminary evidence in Appendix E.1, where households inside the former concession seem more likely to rely on shared taps and latrines, infrastructure that may have supported urban growth historically but that can also increase disease exposure under persistent high density.

Taken together, the evidence points to a primarily spatial legacy of corporate labour policy. The UMHK’s settlement regime generated a more durable urban structure, and that

transformation accounts for much of the long-run discontinuity in development outcomes. Appendix E.2 further shows that this persistence is unlikely to be driven by extractive transport infrastructure alone. At the same time, some effects, particularly on intra-household decision-making, indicate a separate household-bargaining channel.

6 Conclusion

This paper investigates the long-run developmental effects of the institutional contracts governing the extraction of mineral wealth. The UMHK’s paternalistic Labour Stabilisation model generated persistent gains in human capital and wealth that endured decades after the firm disappeared. In contrast, the Rhokana Corporation’s reliance on circular migration left no comparable legacy. The findings indicate a specific mechanism of institutional persistence: path-dependent urbanisation. The divergence between the two concessions suggests that corporate policy can affect city formation, thereby converting temporary resource rents into permanent spatial advantages. The results also highlight the unintended social consequences of corporate design. The monetisation of the family unit, rooted in the firm’s need to secure a stable workforce, has persisted as a household-level cultural norm. This implies that corporate institutions may reshape social norms as profoundly as state interventions.

Finally, these historical lessons offer a critical perspective on modern extractive strategies. Contemporary enclave or ‘fly-in, fly-out’ mining models, which minimise local integration, structurally resemble the Rhokana Corporation’s approach (see Haglund, 2009). This analysis suggests they may fail to generate the agglomeration externalities necessary for sustained local development. The contrast between the UMHK and RC demonstrates that sustainable resource-led growth requires institutions that align corporate profit maximisation with long-term community stability. This paper provides micro-founded evidence that under specific constraints, private firms can mimic the state, delivering public goods and institutional quality that shape the long-run trajectory of development.

Declaration of generative AI and AI-assisted technologies in the manuscript preparation process

During the preparation of this work the author used Claude Code, Gemini, and Codex in order to streamline legacy code and improve language of the final manuscript. After using this tool/service, the author reviewed and edited the content as needed and takes full responsibility for the content of the published article.

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Appendix

A Historical and Spatial Context

A.1 Historical Timelines

Figures A.1 and A.2 provide detailed operational timelines that visually map the major historical milestones for the two concessionary companies: the Union Minière du Haut-Katanga (UMHK) and the Rhokana Corporation (RC). The first timeline traces the history of the UMHK from its establishment in 1906, through the introduction of its Labour Stabilisation Programmes to its nationalisation in 1966. In parallel, the second timeline charts the history of the RC, which was formed through a merger in 1931 and operated until 1969.

A.2 Spatial Setting and Boundary Context

Figure A.3 provides additional historical context, showing the obsolete Rhodesia Congo Border Concession (RCBC), which fully contained the smaller Nkana concession. The paper’s analysis focuses exclusively on the Nkana boundary, representing the Rhokana Corporation’s effective sphere of influence. The larger RCBC boundary does not contaminate any findings, as virtually all data clusters used in the Nkana analysis lie entirely within its territory, precluding any confounding effects from the outer border.

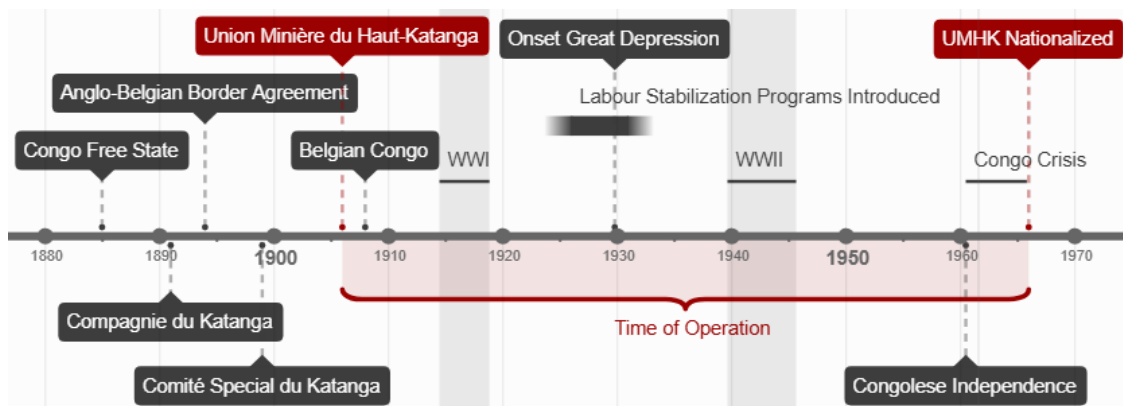


Figure A.1: UMHK Concession Timeline

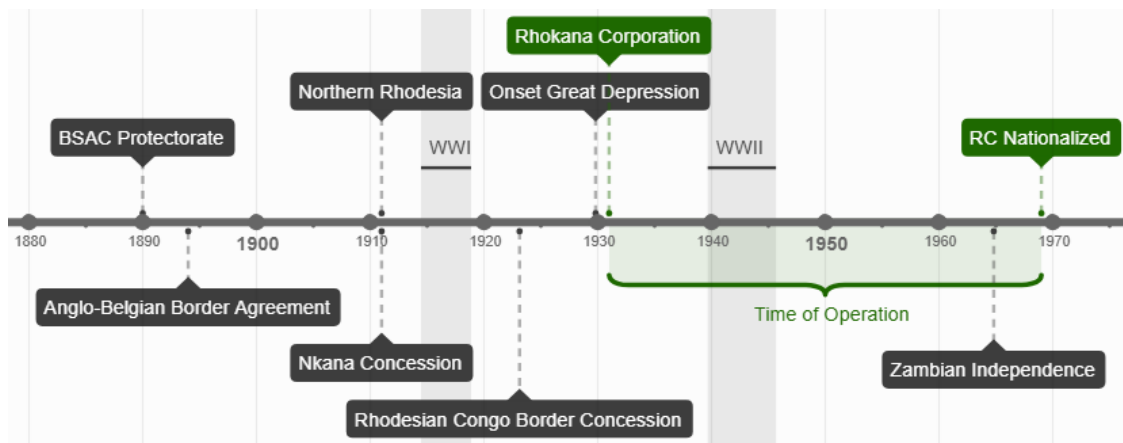


Figure A.2: RC Concession Timeline

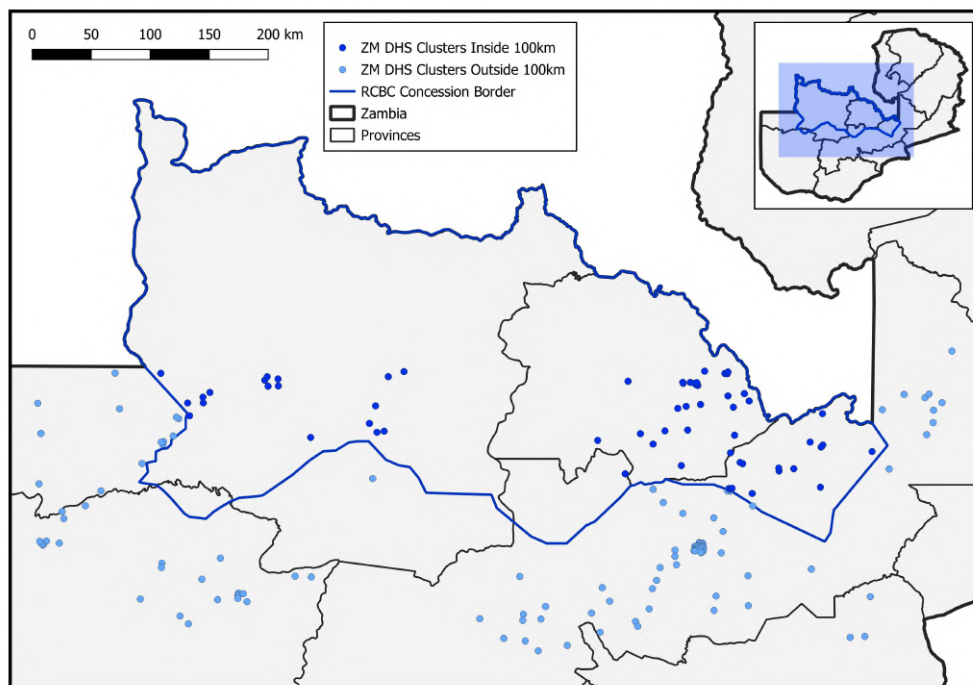


Figure A.3: RCBC Concession Boundary and DHS Clusters

A.3 Post-Independence Context

After Congolese independence in 1960, the UMHK experienced a tumultuous end. It was heavily involved in the Congo Crisis, a three-year unilateral Katangese secession that lasted until 1963. The Republic of Katanga proclaimed its independence from Congo under Moïse Tshombe on 11 July 1960. The UMHK supported Tshombe’s rebellion, fearing nationalisation by the then Congolese Prime Minister Patrice Lumumba.⁷ It took an invasion by the United Nations (Operation Grand Slam) to reunite the country in 1963. Three years later, the UMHK was nevertheless nationalised by President Joseph-Désiré Mobutu. In less than a decade, the company became a shadow of its former self: mining production fell by 70% due to gross mismanagement, lack of maintenance, and theft by Mobutu’s regime.

B Identification and Validity

B.1 Geographic and Precolonial Balance

Table B.1 presents further summary statistics and estimates of geographic variables near the RC concession boundary. Figure B.1 shows that pre-colonial characteristics are mechanically balanced at the RC boundary: the concession (including the 100km bandwidth around it) lies wholly inside the Lamba ethnic group of the EA. Nor does the concession coincide with any contemporary administrative borders.

B.2 Cross-Boundary Comparability

For the difference-in-discontinuities design to yield valid comparisons, outcome variables should exhibit similar baseline levels across both countries. Large differences in means could introduce ceiling or floor effects that mechanically constrain RD estimates, while substantial variance differences would complicate the interpretation of effect sizes. Table B.2 presents

⁷In 1961, Lumumba was murdered in the State of Katanga with the help of Belgian partisans (De Vos et al., 2004). In 2002, Belgium formally apologised for its involvement in the execution.

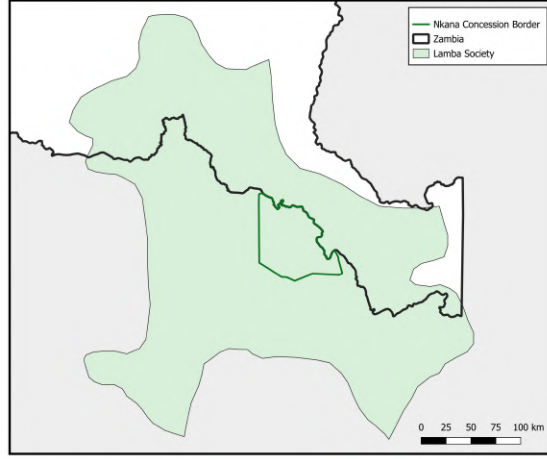


Figure B.1: RC Concession Boundary and the Lamba Ethnic Group

Table B.1: RC Concession Balance Test and Difference-in-Discontinuities

Variable	Panel A: RC Concession Balance (BW 50 km)			Panel B: DiDisc Estimates	
	(RD Est.)		RD Coeff. (SE)	(BW 50 km)	(BW 100 km)
	Inside Mean (1)	Outside Mean (2)		DiDisc Coeff. (SE) (4)	DiDisc Coeff. (SE) (5)
Elevation	1272.99	1258.43	2.27 (28.15)	−1.45 (140.82)	−20.76 (138.23)
Ruggedness	69.88	76.29	−4.25 (6.33)	−11.10 (26.58)	−3.83 (27.33)
Rainfall (avg.)	1226.98	1171.85	11.32 (7.32)	−12.49 (30.23)	−19.98 (30.33)
Rainfall (st. dev.)	5.11	8.31	−2.07 (1.54)	−0.60 (3.43)	0.95 (3.45)
Land suitability	96.90	96.98	−0.07** (0.03)	−0.04 (0.25)	0.04 (0.28)
Malaria suitability	3.88	4.30	−0.41 (0.34)	0.03 (1.90)	0.16 (1.90)

Notes. The unit of observation is a 20 km × 20 km grid cell. Panel A reports balance tests for the RC concession boundary. Columns (1) and (2) present means inside and outside the concession within a 50 km bandwidth. Column (3) reports the bias-corrected RD coefficient and robust standard error (in parentheses) using the optimal bandwidth procedure from [Cattaneo et al. \(2019\)](#). Standard errors are clustered at the territory level. Panel B reports Difference-in-Discontinuities (DiDisc) estimates. Columns (4) and (5) interpret the effect on the discontinuity of being at the UMHK border relative to the RC border, using bandwidths of 50 km and 100 km respectively.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

descriptive statistics for the control side of each boundary, comparing Congo and Zambia. The results confirm that baseline characteristics are similar: means and standard deviations are comparable across all outcomes. For example, literacy rates differ by ≈ 5 percentage points (69 vs. 74), and wealth indices are nearly identical (2.88 vs. 2.91). This balance supports the validity of comparing RD estimates across the two boundaries.

Furthermore, the central continuity assumption should also hold between the concessions of both colonies for the spatial difference-in-discontinuities design to be valid. This implies that there should not be any geographic or pre-colonial demographic difference-in-discontinuities for both the concession boundaries. Table B.1 presents difference-in-discontinuities balance tests for the geographic characteristics at 50km and 100km bandwidths, constructed analogously to equation 2. There is little sign of any large differences in geographic discontinuities around the concession boundaries. Only rainfall appears to be significantly different, but the magnitude of the difference makes it unlikely to threaten the DiDC identification strategy.

B.3 Boundary Assignment and Measurement Issues

The public DHS cluster coordinates are randomly displaced for confidentiality, which introduces measurement error in the running variable near concession boundaries. This concern is discussed in the main text, where the likely implication is attenuation of the true discontinuity rather than mechanical amplification. In the present setting, the assignment of the main mining cities remains stable because the displacement algorithm does not move DHS clusters across major internal administrative boundaries, and the obsolete outer RCBC boundary shown in Figure A.3 does not intersect the effective Nkana analysis window.

Table B.2: Difference-in-Discontinuities Descriptive Statistics

	UMHK (DRC)		RC (Zambia)		Difference (UMHK – RC)	
	Inside (1)	Outside (2)	Inside (3)	Outside (4)	Inside (5)	Outside (6)
<i>Panel A: Development Outcomes</i>						
Wealth index	4.354 (1.126)	2.882 (1.409)	4.238 (0.921)	2.907 (1.365)	0.116 (0.208)	–0.025 (0.057)
Log(wealth score)	7.892 (8.567)	–3.912 (10.159)	7.605 (8.463)	–2.958 (10.649)	0.288 (1.703)	–0.954** (0.436)
Years of education	4.878 (4.874)	3.756 (4.261)	5.850 (4.710)	4.092 (4.163)	–0.972** (0.390)	–0.336*** (0.082)
Literacy	0.839 (0.368)	0.685 (0.464)	0.891 (0.312)	0.738 (0.440)	–0.052 (0.038)	–0.053*** (0.010)
Woman ht./age pctl.	30.928 (27.870)	22.893 (25.567)	29.813 (25.793)	24.181 (24.571)	1.115 (2.353)	–1.288** (0.542)
Child ht./age pctl.	33.188 (36.157)	29.491 (36.636)	26.798 (32.830)	25.422 (33.181)	6.391** (2.999)	4.069*** (0.644)
<i>Panel B: Urbanisation Outcomes</i>						
Nightlights	8.214 (7.711)	2.405 (7.248)	7.638 (6.496)	3.568 (8.261)	0.576 (1.800)	–1.163*** (0.390)
Built surface	0.541 (0.362)	0.183 (0.311)	0.401 (0.280)	0.105 (0.231)	0.141* (0.079)	0.078*** (0.014)
Electricity	0.595 (0.491)	0.138 (0.345)	0.549 (0.498)	0.207 (0.405)	0.046 (0.095)	–0.069*** (0.016)
Water	0.684 (0.465)	0.228 (0.420)	0.622 (0.485)	0.320 (0.467)	0.063 (0.092)	–0.092*** (0.020)

Notes. The table reports descriptive statistics for both sides of each concession boundary, to assess whether baseline differences or ceiling effects may account for the estimated DiDC effects. “Inside” refers to the concession interior (*distance* > 0) and “Outside” to the concession exterior (*distance* < 0). Columns (1)–(4) report means and standard deviations (in parentheses) for the UMHK (DRC) and RC (Zambia) boundaries. Columns (5) and (6) report the difference (UMHK – RC) from a regression of the outcome on a UMHK boundary indicator, with standard errors clustered at the DHS cluster level in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

C Robustness and Sensitivity

C.1 Contemporary Mining and Geology Controls

The main text reports a contemporary-mining robustness check that adds distance to the nearest MRDS Producer of any commodity to the UMHK baseline specifications. Table C.1 reports the corresponding broader appendix robustness, replacing that control with distance to the nearest MRDS site of any type. This specification is intentionally broader and captures both active extractive-site geography and mineral-location geography.

I report the analogous RC robustness exercises using the same two contemporary-mining controls. Table C.2 adds distance to the nearest MRDS Producer of any commodity to the baseline RC specifications, while Table C.3 replaces that measure with distance to the nearest MRDS site of any type. These tables confirm that the RC concession results are insensitive to alternative controls for contemporary mining and underlying mineral endowments.

C.2 Alternative RD Specifications

The paper’s baseline findings demonstrate considerable robustness, holding firm against several alternative specifications of the regression discontinuity (RD) design. A primary check involves substituting the baseline local linear polynomial with a local quadratic polynomial to ensure the results are not driven by the specific functional form. Table C.4 confirms that the positive UMHK discontinuities remain under the quadratic model, with wealth effects staying strongest, education effects attenuating, and health outcomes remaining positive.

Similarly, Table C.4 shows that the null effects observed at the RC boundary continue to hold, with no significant discontinuities emerging. Furthermore, the results are stable across different bandwidth selection procedures. The main analysis consistently presents findings using both an optimal bandwidth calculated via a MSE-minimising procedure and a wider, fixed bandwidth. The consistency of the results across these different bandwidths demonstrates that the findings are not an artefact of a specific sample size around the cut-off.

Table C.1: UMHK Concession Development and Women's Outcomes with Geology and Extractive-Site Controls

	Optimal (1)	Wide (2)	Optimal (3)	Wide (4)
<i>Panel A: Development Outcomes</i>				
	Wealth index		Log(wealth score)	
UMHK	1.151** (0.516)	1.391*** (0.487)	10.142** (4.415)	11.661*** (4.154)
Observations	9,174	10,738	9,174	10,738
	Years of education		Literacy	
UMHK	1.106* (0.647)	1.484** (0.616)	0.188* (0.101)	0.266*** (0.096)
Observations	8,962	10,704	2,458	3,025
	Woman ht./age pctl.		Child ht./age pctl.	
UMHK	10.006* (5.488)	11.973** (5.085)	16.679*** (4.284)	16.487*** (4.105)
Observations	822	1,022	802	971
<i>Panel B: Women's Outcomes</i>				
	Modern use		Modern knowledge	
UMHK	0.074** (0.034)	0.070** (0.032)	0.045 (0.053)	0.080 (0.054)
Observations	1,729	2,039	1,556	2,039
	Remuneration		Household purchases	
UMHK	0.646* (0.393)	0.775** (0.357)	0.106 (0.066)	0.086 (0.068)
Observations	1,024	1,407	569	666

Notes. The table reports bias-corrected regression discontinuity point estimates using a local linear specification with a triangular kernel, estimated separately on each side of the concession boundary, with robust standard errors following Calonico et al. (2014b). Standard errors are clustered at the DHS cluster level and reported in parentheses. Optimal bandwidths (in km) are selected using the MSE-minimising procedure from Cattaneo et al. (2019). All regressions control for province fixed effects. Individual-level outcomes additionally control for sex, age, and age squared, except women's outcomes and woman height, which omit sex. All regressions additionally control for distance to the nearest MRDS site of any type. *Household purchases* is the average of indicators for whether the woman participates in decisions on major and daily household purchases.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table C.2: RC Concession Development and Women's Outcomes with Contemporary Mining Activity Controls

	Optimal (1)	Wide (2)	Optimal (3)	Wide (4)
<i>Panel A: Development Outcomes</i>				
	Wealth index		Log(wealth score)	
RC	0.230 (0.396)	0.676* (0.355)	2.777 (3.482)	6.283** (3.098)
Observations	11,090	14,203	11,090	14,203
	Years of education		Literacy	
RC	0.726 (0.660)	1.102* (0.628)	0.120 (0.079)	0.156** (0.074)
Observations	11,416	14,134	2,353	2,861
	Woman ht./age pctl.		Child ht./age pctl.	
RC	1.476 (3.277)	0.998 (3.605)	2.005 (2.878)	2.748 (2.923)
Observations	2,876	3,664	1,692	2,870
<i>Panel B: Women's Outcomes</i>				
	Modern use		Modern knowledge	
RC	0.078 (0.070)	0.073 (0.068)	0.016 (0.011)	0.010 (0.010)
Observations	829	958	2,404	2,895
	Remuneration		Household purchases	
RC	0.265 (0.212)	0.322* (0.193)	-0.062 (0.067)	0.020 (0.060)
Observations	1,170	1,398	1,292	1,624

Notes. The table reports bias-corrected regression discontinuity point estimates using a local linear specification with a triangular kernel, estimated separately on each side of the concession boundary, with robust standard errors following Calonico et al. (2014b). Standard errors are clustered at the DHS cluster level and reported in parentheses. Optimal bandwidths (in km) are selected using the MSE-minimizing procedure from Cattaneo et al. (2019). All regressions control for province fixed effects. Individual-level outcomes additionally control for sex, age, and age squared, except women's outcomes and woman height, which omit sex. All regressions additionally control for distance to the nearest MRDS Producer of any commodity. *Household purchases* is the average of indicators for whether the woman participates in decisions on major and daily household purchases.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table C.3: RC Concession Development and Women's Outcomes with Geology and Extractive-Site Controls

	Optimal (1)	Wide (2)	Optimal (3)	Wide (4)
<i>Panel A: Development Outcomes</i>				
	Wealth index		Log(wealth score)	
RC	-0.090 (0.354)	0.310 (0.338)	0.073 (3.085)	3.011 (2.917)
Observations	11,090	14,203	11,090	14,203
	Years of education		Literacy	
RC	-0.148 (0.686)	0.365 (0.642)	-0.103 (0.091)	-0.031 (0.082)
Observations	11,181	14,134	2,326	2,861
	Woman ht./age pctl.		Child ht./age pctl.	
RC	1.486 (3.280)	1.191 (3.549)	2.521 (2.607)	3.299 (2.782)
Observations	2,768	3,664	1,692	2,870
<i>Panel B: Women's Outcomes</i>				
	Modern use		Modern knowledge	
RC	0.003 (0.073)	0.007 (0.071)	0.002 (0.011)	0.002 (0.010)
Observations	829	958	2,404	2,895
	Remuneration		Household purchases	
RC	0.079 (0.205)	0.139 (0.186)	0.003 (0.063)	0.039 (0.059)
Observations	1,170	1,398	1,292	1,624

Notes. The table reports bias-corrected regression discontinuity point estimates using a local linear specification with a triangular kernel, estimated separately on each side of the concession boundary, with robust standard errors following Calonico et al. (2014b). Standard errors are clustered at the DHS cluster level and reported in parentheses. Optimal bandwidths (in km) are selected using the MSE-minimizing procedure from Cattaneo et al. (2019). All regressions control for province fixed effects. Individual-level outcomes additionally control for sex, age, and age squared, except women's outcomes and woman height, which omit sex. All regressions additionally control for distance to the nearest MRDS site of any type. *Household purchases* is the average of indicators for whether the woman participates in decisions on major and daily household purchases.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table C.4: UMHK and RC Concession Quadratic Specifications

	Optimal (1)	Wide (2)	Optimal (3)	Wide (4)
<i>Panel A: UMHK Concession</i>				
	Wealth Index		Log(Wealth Score)	
UMHK	1.729*** (0.669)	1.746*** (0.667)	14.800*** (5.298)	14.786*** (5.304)
Observations	9,660	10,738	9,660	10,738
	Years of Education		Literacy	
UMHK	1.424* (0.846)	1.511* (0.849)	0.258** (0.127)	0.251** (0.127)
Observations	9,740	10,704	2,724	3,025
	Woman Ht./Age Pctl.		Child Ht./Age Pctl.	
UMHK	18.584*** (6.187)	18.558*** (6.170)	10.744** (5.142)	10.942** (5.066)
Observations	957	1,022	848	971
<i>Panel B: RC Concession</i>				
	Wealth Index		Log(Wealth Score)	
RC	0.173 (0.565)	0.111 (0.457)	2.397 (5.092)	1.611 (4.030)
Observations	11,640	14,317	11,464	14,317
	Years of Education		Literacy	
RC	-0.215 (0.929)	-0.018 (0.867)	-0.132 (0.118)	-0.107 (0.110)
Observations	11,838	14,248	2,462	2,881
	Woman Ht./Age Pctl.		Child Ht./Age Pctl.	
RC	2.616 (3.318)	2.050 (2.969)	10.744 (9.051)	9.655 (8.023)
Observations	2,483	2,952	1,534	1,937

Notes. The table reports robustness checks using a *quadratic* polynomial specification. Standard errors are clustered at the DHS cluster level and reported in parentheses. All regressions use a triangular kernel and control for survey year and province fixed effects; individual-level outcomes also control for sex, age, and age squared, except woman height, which omits sex. Optimal bandwidths are chosen using the MSE-minimising procedure suggested by Cattaneo et al. (2019). Panel A reports results for the UMHK concession; Panel B reports results for the RC concession. See previous tables for full variable definitions.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

D Pooled Difference-in-Discontinuities

D.1 Setup and Identification

This appendix section reports the pooled cross-country comparison between the UMHK and RC concession boundaries. The relative effect of exposure to each concession is estimated using a spatial difference-in-discontinuities (diff-in-disc) design that compares the discontinuity at the UMHK boundary to the discontinuity at the RC boundary, according to the intuition in [Grembi et al. \(2016\)](#), adapted to a spatial context. Following the same RD shorthand as in equation (1), the stacked specification is:

$$Y_{i,c,b} = \alpha + \beta_1 \text{Concession}_{i,c,b} + \beta_2 \text{UMHK}_b + \beta_3 (\text{Concession}_{i,c,b} \times \text{UMHK}_b) \\ + f(\text{distance}_{c,b}) + \text{UMHK}_b \cdot g(\text{distance}_{c,b}) + \gamma \mathbf{X}_{i,c,b} + \epsilon_{i,c,b} \quad (2)$$

where $b \in \{\text{UMHK}, \text{RC}\}$ indexes the concession boundary, $\text{distance}_{c,b}$ is the signed distance (km) from cluster c to boundary b (positive inside the concession, negative outside), and $\text{Concession}_{i,c,b} = \mathbf{1}\{\text{distance}_{c,b} > 0\}$. UMHK_b is an indicator equal to 1 if the observation is located near the UMHK concession boundary and 0 otherwise; its interaction with the running-variable polynomial $g(\cdot)$ allows the smooth function of distance to differ across the two boundaries. $\mathbf{X}_{i,c,b}$ follows the baseline specification, with sex, age, and age squared for individual-level outcomes (woman height omits sex), and survey year together with province-by-country fixed effects throughout; cluster-level urbanisation outcomes use survey year and province-by-country fixed effects only (see also [Butts, 2023](#)). The coefficient of interest is β_3 , which captures the differential discontinuity at the UMHK boundary relative to the RC boundary.

Following the same RD conventions as equation (1), specification (2) is implemented non-parametrically as the difference between two bias-corrected local-linear RD estimates, one at each boundary. For each b , I estimate $\hat{\tau}_b$ by local-linear regression of Y on distance with a triangular kernel, fitted separately on each side of the cutoff at a fixed bandwidth

of $h = 100$ km, with covariates $\mathbf{X}$ entering linearly, and bias-corrected point estimates and heteroskedasticity-robust standard errors clustered at the DHS cluster level following Calonico et al. (2014b). The reported difference-in-discontinuities estimate and standard error are

$$\hat{\tau}_{\text{DiDC}} = \hat{\tau}_{\text{UMHK}} - \hat{\tau}_{\text{RC}}, \quad \text{SE}(\hat{\tau}_{\text{DiDC}}) = \sqrt{\text{SE}(\hat{\tau}_{\text{UMHK}})^2 + \text{SE}(\hat{\tau}_{\text{RC}})^2},$$

where the standard error assumes independence of the two country samples. As a parametric robustness check (Panel B of Table D.2), I also estimate equation (2) directly by OLS, with f and g linear in *distance* and fully interacted with *Concession* and *UMHK*, at fixed bandwidths of 50 and 100 km.

Appendix B.1 shows that geographic and precolonial characteristics vary smoothly across both concession boundaries, supporting the identification strategy. Appendix B.2 discusses the broader cross-boundary comparability conditions, while Appendix B.3 addresses potential contamination from the obsolete Rhodesian Congo Border Concession (RCBC).

D.2 Pooled DiDC Estimates

Panel A of Table D.1 reports the diff-in-disc estimates for key household and individual outcomes. The relative discontinuities remain clearly positive for wealth, literacy, and women’s height, and are statistically significant for those outcomes. Estimates for years of education and child height remain positive but are more imprecisely estimated. Panel B reports the analogous urbanisation comparisons, where built surface and electricity remain the clearest positive relative discontinuities, while nightlights and water are less precisely estimated. Overall, the pooled comparison points in the same direction as the separate concession-level RD results, but more selectively. In magnitude terms, the significant DiDC estimates, while reduced, remain economically meaningful when compared to the single-country UMHK RD coefficients.

Table D.1: Difference-in-Discontinuities Development and Urbanisation Outcomes

<i>Panel A: Development Outcomes</i>			
	Wealth index	Log(wealth score)	Years of education
DiDC	1.472** (0.703)	11.412** (5.529)	1.278 (0.962)
Observations	22,582	22,582	22,484
Mean dep. var.	3.671	2.616	4.695
Std. dev. dep. var.	1.358	10.949	4.533
	Literacy	Woman ht./age pctl.	Child ht./age pctl.
DiDC	0.291** (0.140)	13.585** (6.859)	11.513 (7.180)
Observations	5,185	3,722	2,661
Mean dep. var.	0.757	27.855	20.705
Std. dev. dep. var.	0.429	25.671	27.789
<i>Panel B: Urbanisation Outcomes</i>			
	Nightlights	Built surface	
DiDC	2.574 (2.799)	0.497*** (0.185)	
Observations	22,582	22,582	
Mean dep. var.	4.933	0.308	
Std. dev. dep. var.	6.509	0.341	
	Electricity	Water	
DiDC	0.470** (0.219)	0.368 (0.247)	
Observations	22,542	11,272	
Mean dep. var.	0.386	0.475	
Std. dev. dep. var.	0.487	0.499	

Notes. The table reports difference-in-discontinuities (DiDC) estimates, calculated as the difference between bias-corrected RD effects at the UMHK boundary (DRC) and the RC boundary (Zambia). Both RD specifications use local linear regression with a triangular kernel and a fixed 100 km bandwidth, with bias-corrected point estimates and robust standard errors following [Calonico et al. \(2014b\)](#). Results are robust to the use of MSE-optimal asymmetric bandwidths selected separately for each boundary following [Cattaneo et al. \(2019\)](#). Standard errors are clustered at the DHS cluster level and reported in parentheses; DiDC standard errors assume independence between countries. All regressions control for survey year and province-by-country fixed effects; individual-level outcomes also control for sex, age, and age squared, except woman height, which omits sex. *Nightlights* (VIIRS) and *Built surface* (GHSL) measure urbanisation intensity. *Electricity* and *Water* are binary indicators for household access.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

D.3 DiDC Robustness

Table D.2 assesses the sensitivity of the pooled difference-in-discontinuities estimates to bandwidth choice and functional form. Panel A reports non-parametric estimates using two alternative bandwidths: the MSE-optimal bandwidth selected separately for each boundary, and a narrower fixed bandwidth of 50 km. Panel B replaces the non-parametric local linear specification with a parametric pooled OLS regression that fully interacts linear distance terms with boundary-side and treatment indicators, estimated at bandwidths of 50 km and 100 km. The broad comparative pattern remains visible for the majority of core outcomes.

D.4 Interpretation and Caveats

The pooled DiDC results should be read as complementary to the separate concession-level RD comparisons in the main text. They are informative about cross-boundary divergence in a unified specification, but they combine different country settings. For that reason, the main text relies on the separate UMHK and RC border discontinuities for the core comparative argument, while the pooled DiDC exercise remains an exploratory benchmark.

E Mechanisms and Spillovers

E.1 Congestion and Disease Environment

While the main analysis highlights the positive economic returns of agglomeration, rapid urbanisation can concurrently generate negative externalities, such as congestion and increased disease transmission, that may partially offset development gains. Table E.1 investigates this mechanism by examining infrastructure risk and the disease environment.

Infrastructure Risk. Panel A reveals that households within the former UMHK concession are significantly more likely to rely on high-risk communal infrastructure, specifically

Table D.2: Bandwidth Sensitivity and Parametric Estimation

<i>Panel A: Bandwidth Sensitivity (Non-parametric)</i>					
	Wealth index	Years of education	Woman ht./age pctl.	Nightlights	Electricity
Optimal BW	1.742** (0.698)	1.713* (0.965)	14.149** (6.616)	2.339 (2.701)	0.650*** (0.240)
BW 50 km	2.120*** (0.750)	1.743* (0.979)	13.858** (6.684)	0.677 (3.341)	0.543** (0.273)
	Log(wealth score)	Literacy	Child ht./age pctl.	Built surface	Water
Optimal BW	14.179** (5.643)	0.377*** (0.140)	10.511 (7.598)	0.614*** (0.195)	0.428* (0.248)
BW 50 km	14.591*** (5.297)	0.400*** (0.140)	11.643 (8.480)	0.501** (0.232)	0.445* (0.262)
<i>Panel B: Parametric Estimation</i>					
	Wealth index	Years of education	Woman ht./age pctl.	Nightlights	Electricity
BW 50 km	1.834*** (0.686)	1.749** (0.883)	12.220* (7.015)	6.057** (3.005)	0.578*** (0.203)
BW 100 km	1.435** (0.568)	1.685** (0.724)	13.835*** (5.044)	5.825** (2.618)	0.628*** (0.190)
	Log(wealth score)	Literacy	Child ht./age pctl.	Built surface	Water
BW 50 km	14.509*** (5.475)	0.260** (0.132)	14.890** (6.199)	0.654*** (0.185)	0.562** (0.251)
BW 100 km	12.363*** (4.795)	0.277*** (0.106)	12.549** (5.173)	0.641*** (0.163)	0.417* (0.228)

Notes. The table reports difference-in-discontinuities (DiDC) estimates under alternative specifications. The main specification (reported separately) uses non-parametric local linear regression with a fixed 100 km bandwidth. Panel A varies the bandwidth: ‘Optimal BW’ uses the MSE-optimal bandwidth from Cattaneo et al. (2019); ‘BW 50 km’ uses a fixed 50 km bandwidth. Both use bias-corrected point estimates and robust standard errors following Calonico et al. (2014b), clustered at the DHS cluster level. Panel B reports parametric estimates from a pooled OLS regression of the outcome on boundary-side indicators, a treatment indicator (inside concession), their interaction, and linear distance terms fully interacted, with controls for survey year and province-by-country fixed effects; individual-level outcomes also control for sex, age, and a quadratic age term, except woman height, which omits sex, while nightlights and built surface use only survey year and province-by-country fixed effects. Standard errors are clustered at the DHS cluster level. DiDC standard errors in Panel A assume independence between the UMHK and RC boundaries. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

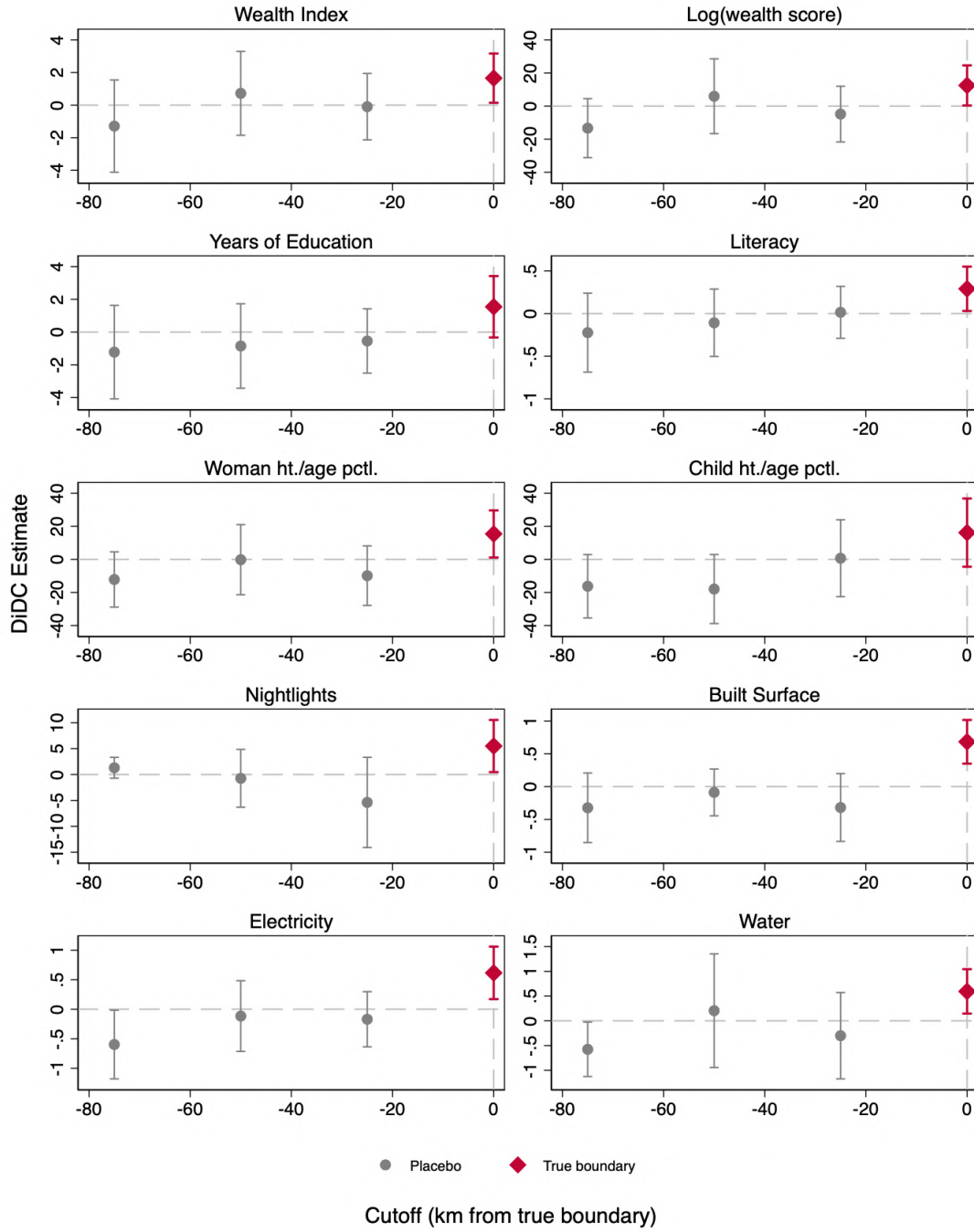


Figure D.1: Difference-in-Discontinuities Estimates at Placebo Boundaries

Notes. The figure displays DiDC bias-corrected point estimates and 95% robust confidence intervals. The red diamond represents the estimate at the true concession boundary (0 km). Gray circles represent estimates at placebo cutoffs located at 25 km, 50 km, and 75 km distances from the true boundary. Confidence intervals are based on robust standard errors clustered at the DHS cluster level.

shared toilets and public taps, compared to those outside the boundary. These facilities serve as proxies for urban crowding and are vectors for disease.

Disease Environment. Consistent with higher density, Panel B presents positive (though insignificant) coefficients for communicable diseases like diarrhoea and coughing. In contrast, Panel C suggests that children experience less fever, and have an overall lower mortality rate inside of the former UMHK concession. The negative coefficient for fever is likely driven by the lower prevalence of malaria in dense urban environments.

This preliminary evidence of congestion costs, coupled with insignificant but large coefficients on childhood disease occurrence, provides a plausible explanation for the observed pattern where the positive discontinuity in health outcomes (e.g., child height) is smaller in magnitude than the discontinuity in wealth. It suggests that while the UMHK’s settlement policies generated economic surplus through density, that same density introduced countervailing health risks that dampened physical development.

E.2 Transportation Infrastructure

One potential explanation for persistent differences in development is colonial-era transportation infrastructure. Railways and roads were often central to colonial economic strategies (Storeygard, 2016; Jedwab and Moradi, 2016; Donaldson, 2018), though their impacts on long-run development vary depending on local context.

Both the UMHK and RC concessions relied on rail infrastructure to export minerals, but neither region maintained strong domestic connectivity after independence. The Benguela Railway, a key route for UMHK mineral exports via Angola, was later destroyed during the Angolan Civil War (Figure E.1). Road infrastructure deteriorated significantly in the DRC, illustrated by the common notion that “a journey that took one hour in the colonial period now takes a full day” (Van Reybrouck, 2010).

Table E.1: UMHK Concession Congestion Outcomes

	Optimal (1)	Wide (2)	Optimal (3)	Wide (4)
<i>Panel A: Infrastructure Risk</i>				
	Public Tap		Shared Toilet	
UMHK	0.296* (0.164)	0.256 (0.160)	0.111 (0.190)	0.078 (0.169)
Observations	9,174	10,738	6,752	8,607
Clusters	52	61	48	61
Bandwidth (km)	130.77	200.00	108.43	200.00
<i>Panel B: Communicable Disease</i>				
	Diarrhea		Cough	
UMHK	0.033 (0.037)	0.047 (0.038)	0.073 (0.049)	0.067 (0.051)
Observations	1,559	1,907	1,452	1,902
Clusters	51	61	48	61
Bandwidth (km)	124.10	200.00	113.57	200.00
<i>Panel C: Mortality</i>				
	Child Survival		Fever	
UMHK	0.067** (0.034)	0.078** (0.033)	−0.066 (0.051)	−0.073 (0.054)
Observations	1,616	2,144	1,484	1,901
Clusters	47	61	49	61
Bandwidth (km)	101.13	200.00	115.93	200.00

Notes. The table reports bias-corrected regression discontinuity estimates testing congestion and disease mechanisms, with robust standard errors following [Calonico et al. \(2014b\)](#). Standard errors are clustered at the DHS cluster level and reported in parentheses. All regressions use a local linear specification with a triangular kernel and control for sex, age, age squared, survey year, and province fixed effects. Optimal bandwidths are chosen using the MSE-minimising procedure suggested by [Cattaneo et al. \(2019\)](#). *Public Tap* is an indicator for households relying on a shared public tap/standpipe. *Shared Toilet* is an indicator for using an improved toilet shared with other households. *Diarrhea*, *Cough*, and *Fever* are indicators for symptoms experienced by the child in the last two weeks. *Child Survival* is an indicator equal to 1 if the child is alive.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$



Figure E.1: Map of the Benguela Railway

Table E.2 compares changes in road networks over time. Column (1) shows that the former UMHK area experienced a larger deterioration than its surroundings. In contrast, column (2) shows modest improvements in the RC area’s roads. Yet this is not reflected in current differences in development outcomes.

These patterns are consistent with previous findings that colonial “mine-to-port” infrastructure often failed to generate broad-based local development (Bonfatti and Poelhekke, 2017), and therefore may not account for the long-run divergence. Instead, they reinforce the interpretation that labour policies and urbanisation, rather than extractive transport routes, are the primary mechanisms of persistence in this setting.

Table E.2: UMHK and RC Concession Infrastructure Development

	UMHK Concession Roads 2010 (km) (1)	RC Concession Roads 2020 (km) (2)
Concession	−3.851** (1.687)	7.119* (4.268)
Road network in 1968	0.812*** (0.055)	1.122*** (0.102)
Observations	832	154
Bandwidth (km)	200.00	100.00

Notes. The table reports cross-sectional regression results for road network length (km) in each 20 km × 20 km grid cell. Column (1) analyses the UMHK region (DRC) measuring roads in 2010. Column (2) analyses the RC region (Zambia) measuring roads in 2020. Both models control for the historical road network in 1968. The concession coefficients capture the relative change in infrastructure over the post-colonial period. Standard errors are clustered at the territory level and reported in parentheses.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$