Colonial Labor Institutions, Marriage Markets, and HIV: Evidence from Mozambique*

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January 16, 2023

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Abstract

European colonizers used several main institutions to extract wealth from African labor. Narrative evidence suggests that two of them – one pushing young men into circular migration and another restricting their mobility – differentially impacted marriage markets with bride price. Specifically, migrants' earnings may have made them marriageable earlier, thus narrowing spousal age gaps, while low wages under mobility-restricting regimes would have widened these disparities, which later became a major HIV risk factor. I test such hypotheses and their implications using the arbitrary border within Mozambique that separated these institutions for a half-century (1893-1942). Historically, men married earlier on the migrant-sending side, even after the border was erased and circular migration rates converged. Today, this area has lower HIV prevalence and smaller age gaps but similar development outcomes. These results show that differences between extractive colonial institutions matter and that marriage markets are a channel through which history can shape the present.

Keywords: Extractive Institutions, Circular Migration, Bride Price, Age Gap, HIV

JEL Classification: D02, I15, J12, O15, N47

*I am indebted to Hoyt Bleakley, Eduardo Montero, Achyuta Adhvaryu, and Dean Yang for their thoughtful guidance and encouragement. I thank them and James Allen, George Alter, Pablo Fernández-Cebrián, Price Fishback, Omar Galárraga, Ezra Goldstein, Elisa Maffioli, Jennifer Mayo, Felix Meier zu Selhausen, Alexander Persaud, Tauhid Rahman, Ana Reynoso, Elyce Rotella, Augustin Tapsoba, Laura Taylor, Felipe Valencia Caicedo, and conference and seminar participants at Arizona, Clark, DemSemX, Development Day, EHA, Michigan, MWEHC, NBER DAE Summer Institute, NEUDC, RIDGE Economic History Workshop, and the YSI-EHES Economic History Graduate Webinar for helpful comments and suggestions. I also thank Zijun Li, Abby Lin, and Emily Schmitt for providing outstanding research assistance, and Carlos Lopes Brito for sharing a copy of the 1940 map of Mozambique. I am grateful for financial support from a National Institute on Aging training grant (T32AG000221) and the Marshall Weinberg Endowment, both through the University of Michigan Population Studies Center.

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1. Introduction

After European powers partitioned Africa at the end of the nineteenth century, they began extracting wealth from their colonies by imposing several types of institutions. Amin (1972) underscored the significance of these regimes in African history and development by grouping present-day countries into "macro-regions" where one predominated.[1] In East and Southern Africa, the main institution was the *labor reserve* that pushed an "army of short-term male [migrant] labor" to work in mines and on settlers' farms so that the colonial state could heavily tax their wages; and in the Congo Basin, it was the *concession*, or a grant of "land (and the Africans living on [it]) to private companies" that heavily restricted the population's mobility, creating a captive pool of low-wage labor (Roberts, 2017, p. 585).[2] Figure 1 highlights these groups of countries.

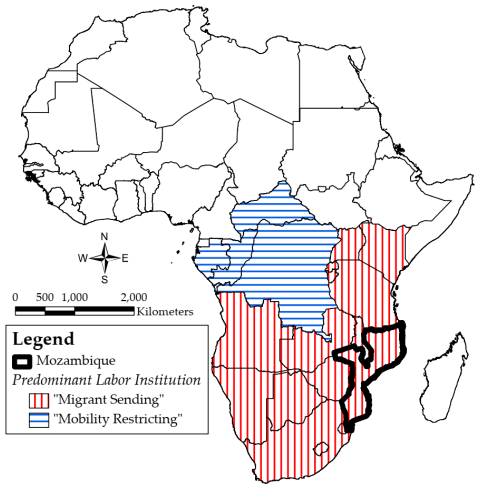
Because the two institutions (henceforth migrant-sending and mobility-restricting) organized much of colonial economic activity in the respective macro-regions, they likely had significant impacts on the historical trajectories of these parts of Sub-Saharan Africa. It is notable that today, the countries there have many of the world's highest HIV prevalence rates and are among its poorest. To effectively combat these global health and wealth disparities, policies must be suited to work in and address the social and historical contexts giving rise to them (Nunn, 2020). Understanding whether major elements of colonial history like these extractive regimes played a role—and if so, through which channels—is an important step in that direction.

However, there is no causal evidence on the impacts of the decision to establish one form of extraction instead of another in a colony. Throughout what is now the developing world, the choice was almost never between establishing an extractive institution

[1] Importantly, each macro-region contained more than one major colonizer, and each major colonizer was represented in more than one macro-region.

[2] A third institution—the *colonial trade economy*, under which coerced peasant farmers produced cash crops for export—predominated in West Africa. Because it combined features of the other two, I focus in this paper on the sharper distinctions between these regimes.

Figure 1: Institutional Macro-Regions in Africa



Notes: Map groups present-day countries by their Amin (1972) predominant colonial institution: the labor reserve ("migrant sending") or the concession ("mobility restricting"). Mozambique is the southeastern country outlined in green.

or one promoting inclusive prosperity (in the Acemoglu and Robinson, 2012, terminology). Instead, it was between *different forms of extraction*. Therefore, comparing these regimes and tracing their impacts through history can shed light on why disparities in HIV prevalence and poverty exist between and even within African countries.

The main challenge in generating such evidence is that institutions were not randomly assigned (Acemoglu, Johnson and Robinson, 2001). Instead, it was most likely distinct human and natural resource geographies in the macro-regions that led their colonizers to rely primarily on one type of extractive regime. This relationship complicates simple comparisons between them, and such factors (e.g., climate, crop suitability) are also likely to have directly affected many outcomes of interest.

The point of departure for this paper is that while a regime may have predominated in a macro-region, there were unique colonies like Mozambique in which it was not the only kind imposed (Alexopoulou and Juif, 2017). Located in southeastern Africa, this former Portuguese colony contained both a migrant-sending and mobility-restricting institution. And importantly for causal inference, the border between them was arbitrary, consisting almost entirely of straight lines defined by latitude and longitude.

In this paper, I exploit the arbitrary border between one of Africa's most important migrant-sending institutions (1897-1965), which pushed over 50,000 short-term labor migrants (henceforth circular migrants) to South African gold mines each year, and its longest-lasting mobility-restricting regime (1891-1942). I provide greater detail regarding these institutions and the differences between them in Section 2, and Figure 2a shows them on a map of Mozambique. According to historical accounts, their most important difference was indeed in men's labor mobility, which was high in the migrant-sending region but restricted across the border to create a pool of low-wage, conscriptable labor.

Because the ethnic group split by the institutional border practiced bride price, historians also noted that the higher wages from circular migration allowed young men to marry earlier than was previously possible. However, they argued that two factors limited the impact of circular migration on economic development. The massive increase in the number of young men who could enter the marriage market led to higher bride prices paid to in-laws, consuming much of their wages (Harries, 1994). In addition, parents faced incentives to use daughters' bride prices to acquire wives for unmarried sons, whose in-laws then faced the same incentives (Junod, 1912).[3] The result was circular migrants' earnings in large part being locked into a cycle of bridewealth transfers between elders rather than being saved by young men.

Therefore, the narrative evidence suggests the institutions led to lasting differences in marriage markets but only limited differences in development outcomes. The first empirical portion of the paper tests this hypothesis in the colonial era. As I describe in Section 3, I digitized detailed data from district-level summaries of two censuses and georeferenced them to maps of colonial Mozambique. I use these data and exploit the arbitrary border between the two institutions in a geographic regression discontinuity (RD) design, which estimates the causal impact of a region's historical assignment to the migrant-sending institution relative to the mobility-restricting one.

[3] Specifically, sons' wives cultivated additional land and populated it with children. Also, because sons who relied on elders for bridewealth became their cadets, it expanded elders' tax bases (Harries, 1983).

In Section 4, I study the outcomes that were different along the border two years before the end of the mobility-restricting institution (1940) and nearly two decades afterward (1960). I find that the migrant-sending regime had significantly higher rates of men's circular migration in 1940: working-age men in the migrant-sending institution were 20 percentage points (p.p.) more likely to engage in circular migration, which is a very large increase relative to the average rate of 5 p.p. in the mobility-restricting region. However, circular migration rates had converged by 1960, as labor mobility for men became much easier after the institutional border was erased.

In spite of this convergence, marriage market outcomes remained markedly different nearly two decades after the end of the mobility-restricting institution. In 1940, the ratio of married men to married women in young adult age groups was 30 p.p. higher just inside the migrant-sending region, though the difference shrank to 10 p.p. by 1960. These results suggest that the length of time circular migration had been possible for was an important determinant of marriage market outcomes.

To compare (correlates of) economic development in this period, I also examine school enrollment rates given the links between migration and human capital investment (e.g., Yang, 2008; Dinkelman and Mariotti, 2016).[4] Though the results are difficult to interpret given the history of schooling provision in the two institutions, I find slightly lower rates of schooling for boys in the migrant-sending area in 1940.[5] But two decades later—once circular migration rates and the provision of schooling were the same across the border—enrollment rates had converged, consistent with the absence of lasting differences in this aspect of economic development.

To rationalize the slow equalization of marriage outcomes and to conceptualize how it could affect the present day, I develop in Section 5 an overlapping generations model

[4] No direct measures of wealth were collected in either of the colonial censuses, likely because it would have been very difficult to do so accurately. In contrast, enrollment was easily measured.

[5] Schooling for Africans was generally provided by Protestant missionaries in the migrant-sending region and Catholics in the mobility-restricting one, though it was unavailable to the overwhelming majority of Black children under either institution. After the mobility-restricting regime ended, Catholic missions began to provide it in both regions (Morier-Genoud, 2019; Fernández Cebrián, 2021).

of a marriage market with bride price that adapts the Tertilt (2005) framework. To match the context under study, wages depend on age and sex, fathers transfer their daughters' bride prices to her brothers so they can marry in the next period, and older generations are smaller than younger ones due to mortality. At baseline, young men earn less than young women, who in turn earn less than old men. The bride price is thus greater than young women's wages (Corno, Hildebrandt and Voena, 2020), making it unaffordable for young men.[6] As a result, all marriages are between old men and young women.

I then study what happens to the marriage market after a shock that raises wages for a share of young men well above those of old men (i.e., circular migration).[7] In the first period, there is a large increase in demand for brides but the supply of young women is fixed. Therefore, the share of marriages that are cross-generational falls. This pattern is reinforced in the second period by two factors: men who married last period do not marry again in old age, and the young generation is larger than previous ones because of incentives to have more children.[8] Only by the third period can the market reach its new steady state, which may be 90 to 105 years later if a period is 30 to 35 years.

As the shock to men's wages in the mobility-restricting region only began in 1942, this slow transition could mean that there are fewer age-disparate relationships in the migrant-sending institution. Because age gaps between partners are an important risk factor for HIV's spread (de Oliveira et al., 2017; Schaefer et al., 2017), the implication is that the virus's prevalence is lower on this side of the former border.[9] Conversely, due to the convergence in circular migration, this HIV risk factor should be the same along the border (Weine and Kashuba, 2012); the same is true for schooling. These equalizations also imply that there should not be differences in these aspects of economic development.

[6] Only young women are fecund in this model (e.g., Siow, 1998). Because the purpose of marriage is procreation, all young women are married off before they lose value on the marriage market (Tertilt, 2005).

[7] Old men rarely were circular migrants because mine labor required one to be in his physical prime.

[8] The former is due to the disutility from work in old adulthood—they can consume from their wives' wages—and the larger bridewealth transfers to his unmarried brothers price him out of the market.

[9] Age gaps raise transmission because older men have been sexually active for longer, so they are more likely to have been infected. Relationships with young women spreads HIV into the next generation.

As I show in Section 6, the present-day results are consistent with my hypotheses. I examine georeferenced blood test data from two waves of the Demographic and Health Surveys (DHS) in Mozambique and find a decrease of almost 50 percent (10 percentage points, or p.p.) in HIV prevalence just inside the former migrant-sending region. This large effect is remains constant even when splitting the sample by sex. I also examine age profiles of HIV prevalence by sex near the border and show that they are consistent with the effect size. Additionally, as I hypothesized, I find no differences at the border today in wealth, schooling, or children's health, suggesting equal levels of development.

Finally, I investigate in Section 7 whether present-day marriage and dating market outcomes change at the border as they did in the colonial period. I find that there still are smaller age disparities between spouses and sexual partners in the former migrant-sending region, and that behaviors associated with these disparities are less common there as well (Evans et al., 2019; Mabaso et al., 2021). Because I find no evidence to support a number of other potential explanations (e.g., genital ulcers, transactional sex, women's autonomy), these findings suggest that the long-lasting effects of these institutions is the main channel for the HIV result.

As such, this paper contributes to four main literatures. First, a number of influential studies examine the effects of colonial institutions on modern outcomes (Acemoglu, Johnson and Robinson, 2001; Banerjee and Iyer, 2005; Dell, 2010; Michalopoulos and Papaioannou, 2014, 2016), and there is recent evidence specifically on concessions (Dell and Olken, 2020; Lowes and Montero, 2021*a*; Méndez-Chacón and Van Patten, 2021). However, we know little about the short- or long-run impacts of the colonialist's choice from a menu of extractive institutions. My contribution in this area is to provide the first evidence on this question, establishing a chain of causality across a century and establishing marriage markets as a new channel through which lasting effects arise.

Second, as transportation costs fall rapidly across the globe, it is important to understand the long-run effects of migration, both temporary and permanent (Abramitzky,

Boustan and Eriksson, 2019; Derenoncourt, 2021; Khanna, Theoharides and Yang, 2020). I contribute specifically to the literature on migration's effects on human capital, especially health (Black et al., 2015; Dinkelman and Mariotti, 2016). In the African context, there is limited evidence on the impacts of circular migration, even though it was "one of the most distinctive features of that continent's development" (Stichter, 1985, p. 1). I add to our understanding by documenting the long-run consequences of short-term labor mobility for young African men. I also show which outcomes converge and which ones remain different after the ability to engage in circular migration had equalized.

In addition, the economic analysis of non-Western marriage markets—which determine how most of the world marries—is an expanding area of study (Tertilt, 2005; Corno, Hildebrandt and Voena, 2020; Reynoso, 2021). I contribute in this field by showing how they interact with labor market conditions to shape behaviors affecting human capital in the long run (Chiappori, Iyigun and Weiss, 2009; Greenwood, Guner and Vandenbroucke, 2017; Ashraf et al., 2020), though in my case I focus on its health component. I also show how marriage markets with asset transfers, and family life in developing countries more broadly, have important effects on health and longevity (Calvi, 2020). Thus, they are vital to understand when crafting policies to remedy these consequences.

Finally, there is an emerging literature on historical shocks as a determinant of disparities in human capital, especially health (Alsan and Wanamaker, 2018; Lowes and Montero, 2021*b*). Because HIV's spread across Sub-Saharan Africa has been one of the deadliest pandemics in modern history, the spatial distribution of the virus is an important focus of studies in this area (Iliffe, 2006; Bertocchi and Dimico, 2019; Dwyer-Lindgren et al., 2019; Cagé and Rueda, 2020). In this respect, the most closely related paper is by Anderson (2018), who compares HIV prevalence along borders between countries with different legal regimes inherited from their European colonizers. I build on this work by providing evidence from within an African country, organizing the analysis with a theoretical model, and using the historical record to make a case for this channel.

2. History of the Extractive Labor Institutions

In this section, I summarize the relevant elements of southern Mozambique's history, from the intensification of Portuguese colonization in the late nineteenth century to the end of its civil war and the explosion of HIV in the late 1990s. My focus is on the creation and administration of the labor institutions along with the narrative historical evidence that describes and compares them.

2.1. Assignment of Territory to Government or Company Rule

The Berlin Conference of 1884-85 established effective occupation as the principle for European powers to maintain claims to their African colonies. To meet this standard in Mozambique, Portugal pursued a two-part strategy: projecting the colonial state outward from port cities established in the sixteenth century into the surrounding regions, and granting vast, mostly unexplored areas to private companies as concessions (Smith and Smith, 1985). Leveraging its presence in Lourenço Marques (present-day Maputo), the government assigned to itself the area from the southern international border to the Sabi River.[10] But it could not quickly establish state capacity north of the Sabi River to (tributaries of) the Zambezi River, so it granted a royal charter to the Mozambique Company in 1891 to govern this area (Newitt, 1995).[11]

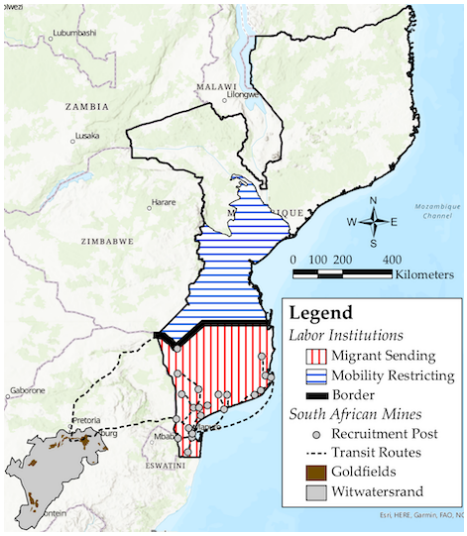
However, the Mozambique Company's territory was extended southward two years later. Figure 2a shows the final institutional boundaries. A royal decree defined this new southern border almost entirely by latitude and longitude, citing the need to effectively occupy more of the colony:

> Whereas the Mozambique Company has at its disposal important means of action, and consequently it is highly expedient that [lands south of the Sabi

[10] The government also administered a region in the north of the country around the then-capital on Mozambique Island. Because the colonial state did not establish a migrant-sending institution in the north, I omit discussion of this region for brevity. See Newitt (1995) for a detailed history of all of Mozambique.

[11] The charter was originally for 25 years but a few years later it was extended until 1942, making it the only colonial concession in Africa to last beyond the 1920s (Vail, 1976).

Figure 2: Extractive Institutions in Southern Mozambique



(a) Territorial Boundaries, 1893-1942

(b) Administrative Reorganization, 1943

Notes: Left map shows the two institutions while they existed as well as the Witwatersrand goldfields and WNLA's recruitment station and transportation network from Transvaal Chamber of Mines (1946). Right map is taken from Gengenbach (2010) and shows the administrative reorganization of Mozambique in 1943 after the Mozambique Company's concession ended. The grey area in the center of the colony is the footprint of the former mobility-restricting region.

> River] should be administered by that Company, so as to insure the proper development and defence of those territories; ... The administration and "exploitation" of the territory bounded ... on the west by ... the Limpopo [River] ... as far as the point where it is intersected by the 32nd meridian, ... by the direct line starting from the last-named point as far as that where the 32nd meridian intersects the 22nd parallel of latitude, and [by the line] following the course of the said parallel of latitude as far as the sea ... is granted to the Mozambique Company. (Great Britain Foreign Office, 1901, pp. 601-602)

2.2. *Choice and Establishment of the Labor Institutions*

Having established dominion over Mozambique to the Berlin Conference standard, "extracting wealth from African peasant society became the principal objective" of government and company officials, as they soon discovered that labor was the only resource of significance to exploit (Newitt, 1995, p. 406). However, they set up different labor institutions to accomplish this goal in their respective territories.

2.2.1. *Migrant-Sending Institution*

The colonial state created a migrant-sending institution in its zone to profit from pre-existing labor flows across the international border with the then-Transvaal Republic (the northeast of present-day South Africa).[12] The 1886 discovery of the world's largest gold deposits on the Witwatersrand led to intense demand for African workers that men from Mozambique were vital in filling (Clarence-Smith, 1985).[13] To keep wages low, the mining companies formed the monopsonistic Witwatersrand Native Labour Association (WNLA) to recruit workers on their behalf.

WNLA and Portuguese authorities signed several agreements beginning in 1897 that formalized recruitment in the colonial state's southern territory. The government derived revenues from all parts of this process: licensing fees from recruiters, payments from WNLA for each worker, and permit fees from each worker allowing them to work abroad. In addition, Portuguese officials in Johannesburg taxed wages paid on the Witwatersrand to Mozambicans (Newitt, 1995). These agreements also regulated miners' contracts and how they were paid. Contract durations were limited to one year with a possible six-month extension and a mandated rest period of six months back in Mozambique. In 1928, the colonial state and the South African government established deferred payment for miners by which they would receive half of their wages only after returning home (Wilson, 1972).[14] The Portuguese had long argued for this provision because miners spent much of their wages on the Witwatersrand—often to buy status goods—rather than in Mozambique (Harries, 1994).

In return, the colonial state granted a monopoly on labor recruitment in its territory

[12] Men could be absent from southern Mozambique for extended periods because "the role of the male in [these ethnic groups'] agricultural life was negligible" given that the savannah required little clearing and women could cultivate the loose soil (Rita-Ferreira, 1960, p. 144). Junod (1912) and Harris (1959) also noted this phenomenon and the labor mobility it had historically permitted men.

[13] Geologists estimate that one-third of all gold ever mined is from the Witwatersrand (Frimmel, 2019).

[14] In addition, the Transvaal government agreed to send up to one-half of its rail traffic through Lourenço Marques, helping Portugal realize its ambition for the city to become a major port (Clarence-Smith, 1985). Because these migrant labor and freight flows contributed heavily to the colonial state's finances, to better manage them it moved its capital from Mozambique Island to Lourenço Marques in 1902 (Newitt, 1995).

to WNLA, which also benefitted from Portugal's 1899 colonial labor code. This law pushed men ages 14 to 60 into wage labor by subjecting them "to the moral and legal obligation to seek to acquire through employment the means to subsist and improve their social condition" or face forced labor (Portugal, 1900, p. 647). To capitalize on its monopoly and the masses of men seeking paid employment, WNLA established a series of stations across southern Mozambique for recruiting workers as well as transportation infrastructure to move them from there to the Witwatersrand (see Figure 2a for this network in 1946). The magnitude of this circular migration was substantial: Appendix Figure B1 shows that except for the depths of the Great Depression, from 1920 to 1942, between 50,000 and 75,000 men annually arrived at the Witwatersrand mines from southern Mozambique. For context, this region's male population in the 1940 census was just under 565,000, around 325,000 of whom were ages 15 to 64.

2.2.2. *Mobility-Restricting Institution*

In its zone, the Mozambique Company established a mobility-restricting institution to attract large companies and settler farmers with a captive pool of low-wage workers. It issued regulations in 1900 requiring the population in its territory to engage in six months of wage labor each year, though administrators often conscripted workers on behalf of local employers offering wages too low or working conditions too harsh. Ten years later, the company formalized this forced labor system by establishing a department that could use violence to round up the workers that employers demanded (Guthrie, 2018).

The mobility-restricting bureaucracy conscripted tens of thousands of workers each year by using its police to reinforce the efforts of traditional authorities. According to correspondence between company administrators, it was common for them to tell chiefs "that on such and such a date they had to supply a certain number of men to go work; generally, ... because [some] cannot manage to organize the number of workers requested, one or more police go to help the chiefs who fell short" (as cited in Allina,

2012, p. 50). Another method of ensuring compliance was to punish wives of men who tried to flee the forced labor system (Guthrie, 2018). The company also dissuaded many from attempting to engage in circular migration by impressing "workers returning from abroad ... into forced labor almost immediately, such that they ... could not go home for any length of time unless they were willing to [be conscripted]" (Allina, 2012, p. 58).

The company abolished its forced labor bureaucracy in 1926 as a response to a League of Nations report on labor practices in Portuguese colonies, which noted that "the blacks here [in the mobility-restricting institution] tell the planters that they are the slaves of the Mozambique Company" (Ross, 1925, p. 53). However, employers soon complained that they could not find enough workers without the forced labor system. To push men into returning to these jobs, in 1927 the company doubled the annual hut tax so they would have to find wage labor and mandated that males over age 14 carry a pass book containing their picture, work history, tax payments, and place of residence. Officials frequently conducted sweeps to check that men had their pass books and met the six-month work requirement; noncompliance was punished with forced labor (Allina, 2012).

2.3. *Narrative Comparisons of the Institutions*

Given the rapacious extraction of wealth from labor under both institutions, Allina (2012, p. 94) contended that "the [migrant-sending region] was governed by the Portuguese colonial state no less exploitatively than [the mobility-restricting region was] by the company itself, and under the same labor code." Similarly, Harries (1994, p. 175) argued that "Portugal was the chief recipient of the profits of [circular migration, which] ... held back the development of southern Mozambique."[15]

[15] One contrast between the two regions was in who provided schooling to Africans, though it was not available to the vast majority of children in either one. While Protestant missions established village schools in the migrant-sending region and there were some state-run rudimentary schools in densely populated areas, the company actually supported Catholic mission schools in its territory (Allina, 2012; Morier-Genoud, 2019). A significant number of mine workers joined Protestant churches while on the Witwatersrand and missionaries followed them back to southern Mozambique, where they established a presence that included educating Africans in their local languages (Newitt, 1995). Following the colonial state's closure of many of its village schools in 1930 due to concern over foreign and Protestant influences

Nonetheless, there may have been important differences between the two institutions in marriage outcomes as a result of circular migration. Historians have closely linked the two, arguing that in Southern African societies with bride price customs, "one of the primary reasons that men took up migrant labor was to obtain the money necessary for paying bridewealth. ... Since most men intended to marry in their home areas, [it also] was critical in ... persuading them to return home" (Guthrie, 2018, p. 72). Both Junod (1912) and Fuller (1955) noted that young men worked in the mines once or twice prior to marriage, implying many stopped migrating after making the payment.

Some historians have argued that the bridewealth system limited the economic impact of circular migration in southern Mozambique. Because elders controlled social life, especially marriage, migrants' wages may have been "encapsulated within the sphere of circulating bridewealth controlled by [them]. As bridewealth was kept in trust ... to provide future generations with the means of acquiring wives, ... it could not be invested," reducing much of its potential effects on development (Harries, 1983, p. 321).

2.4. *After the End of the Mobility-Restricting Institution*

The Portuguese autocrat Salazar brought about the end of the mobility-restricting institution after rising to power. He believed the Mozambique Company's concession eroded national sovereignty and decided to let it end when its royal charter was to expire (Newitt, 1995). After the colonial state took possession of the former restricted mobility region in 1942, it reorganized Mozambique's administrative boundaries. The map in Figure 2b shows the erasure of the restricted mobility region's southern boundary as the provincial border moved north to the Sabi River.[16]

In spite of this institution's end, the extraction of wealth from labor continued through-

on the population, Catholic missions began to fill the gap but it is unclear how quickly they were able to do so: Helgesson (1994) noted that between 1929 and 1930, the number of Methodist village schools fell from 200 to six and their student population fell from over 5,400 to under 700.

[16] The Salazar regime also unified education policy across Mozambique at this time, having the Catholic Church take over—and greatly increase—schooling for Africans (Fernández Cebrián, 2021).

out the colonly until the end of Portuguese rule in 1975 (Isaacman et al., 1980; Guthrie, 2016). Nonetheless, the newly-independent Mozambique quickly fell into turmoil. To further destabilize it, apartheid-era South Africa sharply cut the number of Mozambicans on the Witwatersrand (see Appendix B1) and its security services aided the rebels in Mozambique's 1977-92 civil war (Weinstein, 2006). The country became one of the world's poorest in this period, and shortly after stability returned its HIV epidemic began to explode (Audet et al., 2010).[17]

3. Colonial Data and Empirical Strategy

Below, I describe the 1940 and 1960 census data and the geographic RD design that I use to study the differences between the territories under the two labor institutions during the colonial era. I also discuss how I address concerns regarding estimation and inference with spatial data, and I argue that the assumptions underlying the RD design hold in this setting.

3.1. Data

To compare the labor institutions' impacts while Mozambique was still under Portuguese rule, I digitized summaries of the colony's 1940 and 1960 censuses by district (Repartição Nacional de Estatística, 1942; Direcção Provincial dos Serviços de Estatística, 1966). The former are the best data available regarding the populations living under the two institutions while they both still existed. This census occurred two years before the end of the Mozambique Company's mobility-restricting regime and it was the first one in the colony's history that met basic standards for accuracy (Darch, 1983; Harrison, 1998; Havik, 2013). Nonetheless, the preface to the published summaries notes that insufficient

[17] The HIV epidemics in Mozambique and Namibia—whose decades-long civil war ended in 1990—were in the exponential growth phase in the late 1990s while those in other Southern African countries had already matured. The implication is that Mozambique's and Namibia's began substantially later, likely because internal conflict limited mobility and thus the transmission of the virus (Iliffe, 2006).

funding and inadequate staffing impacted the data collection process, although there is no mention of a differential affect in the areas under the two institutions. I address concerns regarding the influence of poor coverage by excluding observations that are extreme outliers (i.e., with values highly distinct from neighboring districts in the same institution), which plausibly arise from this issue.

In a similar vein, the 1960 data allow for the most reliable and longest-run comparison of the two regions during the colonial period. This census took place 18 years after the mobility-restricting institution ended and it was the last one before the Mozambican War of Independence (1964-74). It thus should not suffer from the kinds of problems that can arise when governments attempt to collect data while participating in internal conflicts (Barakat et al., 2002). However, I take the same approach to extreme outliers as with the 1940 data given the continued potential for inadequate coverage two decades later.

3.1.1. Outcomes of Interest

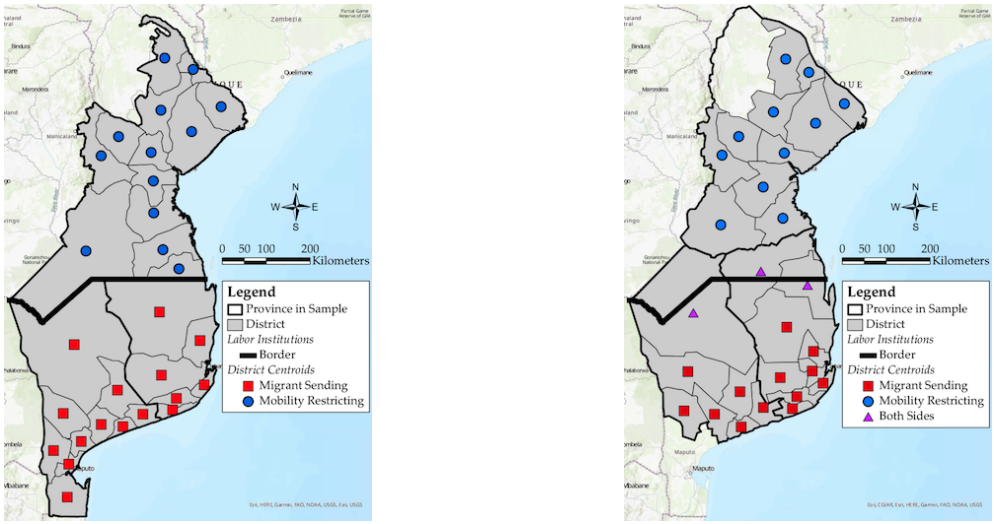
I focus on outcomes in three domains: labor markets, marriage and fertility, and human capital accumulation. The first two are of interest because of the historical narratives in Section 2, which emphasize men's circular migration and its effects on marriage as the main differences between the institutions. I include the third domain because of its relationship with development as well as the ease of measuring it accurately.

The labor market variables of interest are the share of males aged 15 to 64 ("prime-aged men") who were circular migrants and the share of prime-aged women in agricultural occupations.[18] To examine differences in marriage and fertility, I compute the share of ever-married individuals in an age group as well as the number of children ages 0 to 4 per woman ages 15 to 44.[19] For human capital accumulation, the outcome of interest

[18] Each census's questionnaire asked whether a man worked abroad but the 1960 summary tables grouped circular migrants into a category with all men who worked in a mine regardless of its location. However, nearly all men in this category would have worked abroad given the small number of mines in Mozambique, so I consider it a measure of circular migration.

[19] The child-woman ratio approximates the number of children born to women of reproductive age.

Figure 3: Maps of Georeferenced Colonial Census Data



(a) 1940 **(b)** 1960

Notes: Maps show the districts in each institution matched to census data and their centroids.

is the share of boys and girls ages 5 to 14 enrolled in school at enumeration.[20]

3.1.2. *Georeferenced Sample*

I match these district-level data to administrative maps of Mozambique from each year (Saldanha, 1940; Ministério do Ultramar, 1959). Figure 3 shows district boundaries and centroids in the areas under the two institutions in 1940 and 1960. I restrict the sample to districts within the two provinces south of the institutional border and the one north of it, and exclude the two major cities when the census summaries report their data separately.[21] While 1940 boundaries respected the institutional border, districts after the 1942 territorial reorganization did not. For the three with area on both sides in 1960—the only ones whose centroids were within 100 km of the border—I assign them to the institution containing their centroids. Below, I discuss how doing so affects the results.

[20] The numerator excludes those who had left school before enumeration.

[21] These two cities are Lourenço Marques and Beira, the capital of the province that comprised the (overwhelming majority of) the mobility-restricting region.

3.2. *Empirical Strategy*

I estimate the following RD specification to compare the impacts of the two institutions during the colonial era:

$$y_d = \alpha + \tau \text{MigrantSending}_d + f(\text{Distance}_d) + \text{Lon}_d + \epsilon_d \quad \text{for } d \in B, \tag{1}$$

where y_d is the outcome of interest for district d in the set B defined by the bandwidth restrictions above.[22] The explanatory variables are MigrantSending_d, an indicator for whether d's centroid is in that institution; $f(\text{Distance}_d)$, the RD polynomial controlling for smooth functions of a centroid's distance to the institutional border; and Lon_d, a centroid's longitude coordinate, which Kelly (2021) recommends including in RD designs to capture east-west trends.[23] I use a local linear specification estimated separately on each side with a triangular kernel (Cattaneo, Idrobo and Titiunik, 2019; Gelman and Imbens, 2019). Because observations are district-level means, I weight them by the population in the denominator (e.g., the number of prime-aged men in d when the outcome is the share who were circular migrants).

The coefficient τ in equation (1) identifies the effect of historical assignment to the migrant-sending institution *relative to historical assignment to the mobility-restricting institution*. The motivating idea is that because the border between them was arbitrary, Portuguese colonial officials quasi-randomly allocated the territory around it to one of the two institutions. I examine the arbitrariness of the border below.

3.2.1. *Addressing Concerns with Estimation and Inference*

One issue for estimating τ with the 1960 data is that there are districts with area on both sides of the border. To the extent that they group observations from one institution with those from the other, these districts will tend to obscure differences between the

[22] Because the colonial data are reported at the district level, there are too few centroids near the border to estimate the Calonico, Cattaneo and Titiunik (2014) mean squared error (MSE) optimal bandwidth.

[23] Distance_d has a near-perfect correlation with latitude ($\rho > 0.99$), so it accounts for north-south trends.

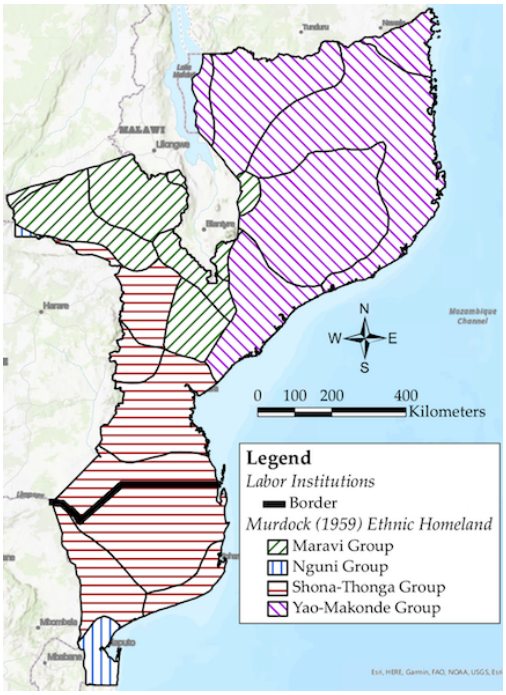
two and thus bias RD point estimates toward zero. I highlight them in the RD plots so the influence they have on the estimation is clear. Another issue that affects both census years is the potentially large bandwidth that is not necessarily MSE-optimal. I thus complement the RD estimates with the finite-sample randomization inference procedure developed by Cattaneo, Frandsen and Titiunik (2015), which is motivated by cases when there are few observations close to the cutoff. I restrict this sample to the 5 districts in each institutional zone whose centroids are closest to the border.

With respect to conducting inference in geographic RD designs, an important concern is positive spatial autocorrelation (Kelly, 2021). Due to the relatively small area under examination and the slow rate at which many outcomes change across space, estimated standard errors may be too small due to similarity among neighbors. Intuitively, assuming the statistical independence of observations would overstate the information each one adds to the estimation, leading to inflated precision. I take two steps to address this potential problem. First, I calculate Conley standard errors allowing for arbitrary spatial correlation between observations within 100 km of each other, imposing a linear decay ("Bartlett kernel") in relationships over this bandwidth (Conley, 1999; Colella et al., 2020). I report these standard errors in addition to those robust to heteroskedasticity. In addition, I calculate and report the Kelly (2021) exact p-values comparing the observed treatment effect against those generated by synthetic data with the same spatial correlation structure.

3.3. Balance on Precolonial and Geographic Traits

The assumption underlying the RD design is that all other relevant factors changed smoothly at the institutional border. To help rule out discontinuities in precolonial characteristics, Figure 4 shows that the border is entirely within one Murdock (1959) ethnic homeland. Additionally, the neighboring ethnicities are all part of the Shona-Thonga cultural group, suggesting that important behaviors and characteristics were not sub-

Figure 4: Ethnic Group Homelands in Mozambique



Notes: Map shows Murdock (1959) ethnic homelands by cultural group. The thick black line is the border between institutional regions.

Table 1: Balance Tests at the Border

	Geographic Traits				Disease Suitability	
	Elevation (1)	Rainfall (2)	Slope (3)	Soil Index (4)	Malaria (5)	TseTse (6)
Migrant Sending	-1.798	1.153	0.014	3.207	-0.270	-0.002
	(31.917)	(6.533)	(0.100)	(3.887)	(0.368)	(0.009)
	[23.254]	[4.045]	[0.054]	[2.658]	[0.244]	[0.007]
Observations	167	105	144	115	139	173
Clusters	29	19	26	20	23	30
Bandwidth	131.5	79.4	120.6	94.3	107.0	144.3
Wild Cluster Bootstrap p-value	0.950	0.866	0.812	0.435	0.504	0.827
Mobility Restricting Mean	182.7	40.94	0.179	49.19	10.84	1.259
Mobility Restricting SD	109.3	44.76	0.132	9.894	1.757	0.078

Notes: Observations are 0.25 × 0.25 degree cells. Standard errors clustered by administrative post are in parentheses and Conley standard errors using a 100-km bandwidth and a Bartlett kernel are in brackets. Regressions estimate a local linear RD specification on each side of the border using a triangular kernel and include longitude as a control. RD bandwidths are chosen to minimize mean squared error, as suggested by Calonico, Cattaneo and Titiunik (2014). Data sources and variable definitions are in Appendix A.

stantially different along the border at the time of assignment to an institution. To test whether aspects of the geographic and disease environments changed along the border, I divide Mozambique into 0.25 × 0.25 degree cells—approximately 25 km × 25 km in the study area—and estimate equation (1) clustering standard errors by third-level administrative unit ("administrative posts," shown in Figure 6b).[24] Consistent with the border being arbitrary, Table 1 shows that changes in these variables just inside the migrant-sending institution are small relative to restricted mobility means.[25]

4. Effects of the Institutions during the Colonial Era

I now turn to studying the institutions' impacts on labor markets, marriage and fertility, and human capital accumulation while Mozambique under Portuguese rule. Table 2 reports the RD estimates for each outcome of interest two years before the end of the mobility-restricting institution (Panel A) and 18 years after (Panel B), and Figure 5 presents selected RD plots. The results show that the institutions differed substantially in circular migration, marriage, and fertility while they both existed, but only marriage remained markedly different nearly two decades after the border between their respective zones was erased.

4.1. Labor Markets

4.1.1. Men's Circular Migration

Due to historians' emphasis on circular migration as the main difference between the institutions, I first examine whether it changed at the border in 1940. Table 2 Panel A Column (1) shows that prime-aged men just inside the migrant-sending institution were 21 p.p. more likely to be circular migrants. The effect size is very large given that just

[24] See Section 6.2 for details on RD bandwidth selection when using geographically disaggregated data.
[25] The high levels of spatial autocorrelation for several variables are not surprising, as they are likely constructed by interpolating across space. The implication is that these standard errors—already quite large relative to the estimates—may actually be too small.

Table 2: Comparing Institutions during the Colonial Era

	Men Migrants (1)	Women Farming (2)	Married Ages 15-34 Men (3)	Married Ages 15-34 Women (4)	Children per Woman (5)	Boys in School (6)	Girls in School (7)
Panel A. 2 Years before End of Mobility Restricting Institution (1940)							
Migrant Sending	0.207	0.015	0.208	0.035	0.202	-0.028	-0.001
	(0.089)	(0.018)	(0.073)	(0.035)	(0.098)	(0.016)	(0.006)
	[0.085]	[0.016]	[0.079]	[0.040]	[0.092]	[0.015]	[0.006]
Observations	29	29	28	28	28	29	29
Bandwidth	-503, 401	-503, 401	-503, 401	-503, 401	-503, 401	-503, 401	-503, 401
Kelly Exact *p*-value	0.059	0.643	0.126	0.559	0.000	0.256	0.863
Mobility Restricting Mean	0.047	0.958	0.583	0.846	0.848	0.050	0.006
Mobility Restricting SD					0.144		
Panel B. 18 Years after End of Mobility Restricting Institution (1960)							
Migrant Sending	-0.025	0.009	0.138	0.042	0.111	-0.014	-0.026
	(0.049)	(0.005)	(0.043)	(0.070)	(0.075)	(0.033)	(0.024)
	[0.050]	[0.006]	[0.043]	[0.065]	[0.077]	[0.029]	[0.021]
Observations	27	27	27	27	27	28	28
Bandwidth	-500, 294	-500, 294	-500, 294	-500, 294	-500, 294	-500, 294	-500, 294
Kelly Exact *p*-value	0.989	0.166	0.000	0.996	0.455	0.977	0.795
Mobility Restricting Mean	0.163	0.997	0.374	0.678	0.807	0.089	0.041
Mobility Restricting SD					0.123		

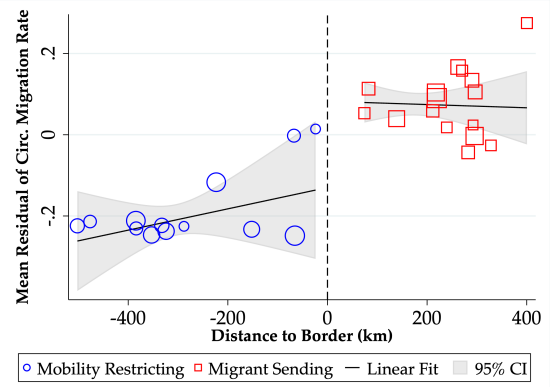
Notes: Observations are districts. Robust standard errors are in parentheses and Conley standard errors using a 100-km bandwidth and a Bartlett kernel are in brackets. Regressions estimate a local linear RD specification on each side of the border using a triangular kernel and include longitude as a control. The left (negative) and right (positive) ends of the RD bandwidth used in each panel are in kilometers. Data sources, variable definitions, and RD bandwidth selection criteria are in Section 3.

5 percent of men across the border worked abroad, and it is precisely estimated. Figure 5a shows that only in three districts under the mobility-restricting institution were any men circular migrants, two of which were along the border.

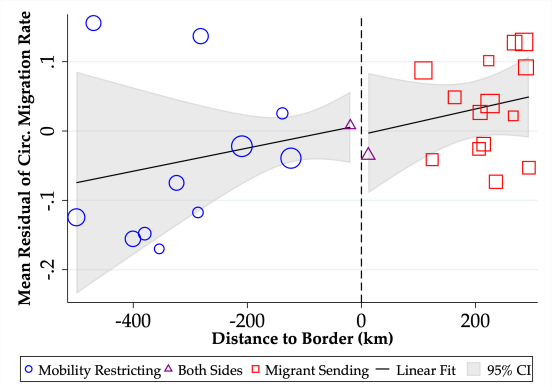
Nonetheless, there was important heterogeneity in working abroad by age. Appendix B2 shows that rates of circular migration were most different at the border among ages 15 to 24 and 25 to 34—rates were around 40 percent in the migrant-sending region for both age groups—whereas differences among older groups were much smaller as rates declined with age. This pattern is consistent with narratives regarding young men's motivations for working abroad and the physical fitness required to do so.

However, Panel B Column (1) shows convergence in men's circular migration after the mobility-restricting institution ended, when 16 percent of men from this region worked

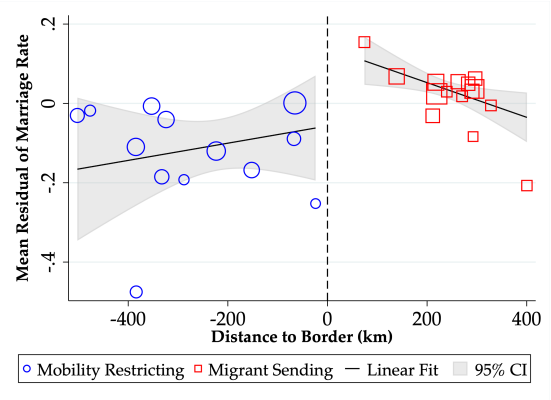
Figure 5: RD Plots for Colonial-Era Differences between Institutions



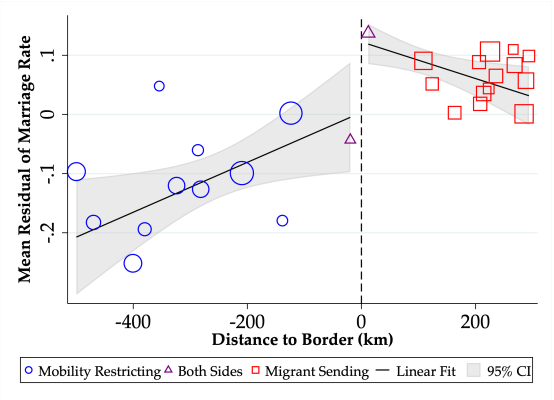
(a) Circular Migration in 1940: Men 15-64



(b) Circular Migration in 1960: Men 15-64



(c) Marriage in 1940: Men 15-34



(d) Marriage in 1960: Men 15-34

Notes: RD plots show the outcomes in each district. Local linear trends and 95% confidence intervals are estimated on each side of the institutional border using a triangular kernel and weighting by the relevant population. The running variable is distance in kilometers to the border. Data sources, variable definitions, and RD bandwidth selection criteria are in Section 3.

abroad. Figure 5b shows this convergence visually, which does not appear result from including districts with area on both sides of the border. Taken together, these circular migration results imply that the labor institutions had substantial impacts on men's occupations, and the erasure of the border between their respective regions in 1942 led to major changes in this respect.

4.1.2. Women's Agricultural Work

Next, I examine whether differences between the institutions affected women's occupations. In spite of men's absences, the estimates in Panels A and B for Column (2) show

no difference at the border in the near-universal share of prime-aged women working in agriculture. These results suggest that men's absences did not affect women's responsibility for food production. Indeed, as historical accounts claimed, this division of labor likely predated the institutions and enabled men's circular migration in the first place.

4.2. Marriage and Fertility

4.2.1. Marriage Rates

I then turn to comparing marriage market outcomes across the institutional border, as narrative evidence suggests that earning bridewealth was an important motivation for men to work abroad. I focus on the age group most heavily affected by circular migration (ages 15 to 34), as its marriage market impacts should have been most apparent in this range. I also examine fertility because its response to circular migration could have been in either direction—decreasing if it led parents to focus on child quality or increasing if more children raised subsistence agricultural output.

Panel A Column (3) shows that while the two institutions still existed, marriage rates increased at the border by 21 p.p. for men ages 15 to 34. The point estimate is large relative to rates in the mobility-restricting institution (36 percent), and notably, it is also effectively identical to the estimated 1940 discontinuity in circular migration rates. But in contrast to the convergence in migration by 1960, Panel B Column (3) shows that after the mobility-restricting regime ended, this difference remained sizable (14 p.p.) and is precisely estimated. Figures 5c and 5d show these discontinuities across time.

Another striking contrast is with the estimates for women in the same age group: in neither panel is there a substantive discontinuity in Column (4) for their marriage rates. It thus raises the possibility that marriage market matches in the mobility-restricting region were more age-similar (i.e., that young women switched from older to younger partners to soak up the increase in marriageable young men) and that this pattern may have continued after the border between institutional zones was erased. I discuss why

differences in men's marriage rates may have continued beyond those in migration rates while women's rates did not change in Section 5.

4.2.2. Children per Woman

As with men's marriage rates, the child-woman ratio also was higher on the migrant-sending side of the border in 1940. The estimate in Panel A Column (5) is of an additional 0.2 children per woman just inside the migrant-sending region, which is also large relative to the mean of 0.85 in the mobility-restricting region. The RD plot for this estimate is in Appendix B3. The positive response of fertility to circular migration (and its higher wages) suggests that Malthusian dynamics were at work, which is unsurprising given the widespread reliance on subsistence agriculture. It also raises the possibility that these higher wages were simply consumed by the additional children without raising living standards.

In contrast to the marriage results, Panel B Column (5) shows that the estimate for the fertility proxy in 1960 is smaller than the one for 1940, and it is imprecise. The reduction in size is consistent with fertility responding positively to increased rates of circular migration in the former restricted mobility region. Because marriage was generally a prerequisite for having children in this period, it is also consistent with declining but still meaningful differences in marriage at the border.

4.3. Human Capital Accumulation

Finally, I examine whether differences between the institutions appeared to affect investments in children's human capital, measured as enrollment in school. Panel A Column (6) shows that before the end of the mobility-restricting institution, boys just inside the migrant-sending region were 3 p.p. less likely to be in school. This effect is large relative to the 4-percent enrollment rate for boys in the mobility-restricting institution. It also suggests that that men's circular migration and boys' education were negatively related,

though the very limited provision of schooling in colonial Mozambique complicates this interpretation. In contrast, there is no detectible effect for girls in Column (7), although female enrollment rates in the mobility-restricting region were less than 1 percent.

However, after the mobility-restricting regime ended, the difference in boys' schooling in Panel B Column (6) became smaller and more imprecise. It is difficult to argue whether changes in schooling provision or convergence in circular migration mattered more, but clearly their combination eroded differences in enrollment for boys. There is also a larger but imprecise coefficient for girls in Column (7), though the lack of a discontinuity in 1940 suggests that the one in 1960 did not emerge due to the institutions.

4.4. Robustness and Additional Results

To address estimation concerns regarding the large bandwidth that is not MSE-optimal and the few districts with centroids near the border (see Section 3.2.1), in Appendix C1 I present results using the Cattaneo, Frandsen and Titiunik (2015) randomization inference procedure with the sample restricted to the 5 closest districts on each side. Reassuringly, the RD and randomization inference point estimates are almost completely identical, and outcomes with precisely estimated RD results also have statistically significant randomization p-values. With respect to standard errors that might be too small due to spatial autocorrelation, the Kelly (2021) exact p-values presented in each panel of Table 2 suggest that the statistically significant RD estimates are not a result of falsely inflated precision. This outcome is not entirely surprising given the controls for spatial trends and the relatively low levels of spatial autocorrelation in the residuals.

Finally, I examine in Appendix C2 whether there were colonial-era differences in transportation and health infrastructure investments by the Portuguese. Using measures of roads in 1959 and health facilities in 1962 for each 0.25 degree $\times$ 0.25 degree gridcell, I find no evidence of substantive discontinuities in these variables. I also rule out any

differences in Protestant or Catholic missionary presence earlier in the 1900s.[26] These null results imply that neither colonial state nor missionary investments differed along the border, which helps to rule out them out as channels through which the institutions affect present-day outcomes.

5. Linking Past and Present

The colonial-era results present a puzzle: namely, why did marriage market outcomes

In this section, I develop a simple overlapping generations model of a marriage market with bride price and polygyny in a Malthusian setting to make predictions about how a source of high wages for young men (i.e., circular migration) affects marriage, fertility, and living standards. The goal is to rationalize why marriage market outcomes would take longer to converge than circular migration rates, and why we might expect marriage differences to continue to today but not necessarily those in standards of living.

To do so, I draw on the models of Sub-Saharan African marriage markets in Tertilt (2005) and Corno, Hildebrandt and Voena (2020) as well as the Malthusian economies in Galor and Weil (2000) and Ashraf and Galor (2011). To match the specific context and convey the intuition in the simplest possible manner, I abstract away from the role of capital in subsistence agricultural production, eliminating the savings decision that plays a large role in the Tertilt (2005) model.[27]

[26] See Appendix B4 for maps of roads, health facilities by gridcell, and Protestant (1903) and Catholic (1929) missions. For the latter, there were no Protestant missions and only one Catholic mission within 200 km of the border in those years.

[27] Tertilt (2005) studies the macroeconomic consequences of polygyny and simulates the impact of a ban on the practice, which is beyond the scope of this paper. Also, because the male side of production—the Witwatersrand mining companies or domestic employers using forced labor—received investment from European capital markets rather than agents in the model and women worked in subsistence agriculture, it is reasonable that Black Mozambicans' savings would have little to no role in this context.

5.1. Setup

The model takes place over infinite discrete time. Individuals are either male (M) or female (F). Men make all decisions in the model: for himself if single or for his household (himself and each wife and unmarried daughter) if married.[28] After individuals are born, they live for up to 2 periods of adulthood, young (Y) and old (O). Surviving childhood is determined by parents' choices (discussed below), whereas the probability of young adults surviving into old adulthood is fixed at $1 - \mu$. Men are always fecund while only young women are fecund.[29] The discount factor is $\beta \in (0, 1)$.

5.1.1. Timing, Decisions, and Cultural Practices

At the beginning of a period, young men must work due to forced labor laws while old men can choose whether to do so, incurring a disutility δ if they do.[30] Those who work earn age-dependent incomes y_t^A, $A \in \{Y, O\}$, which are net of taxes and any costs incurred to earn them (e.g., migration).

After men work, they and (the parents of) single women enter a frictionless marriage market. Men demand $w_t^A \geq 0$ wives and parents supply $d_t^A \geq 0$ of their daughters as brides, giving their husbands control over their reproductive capacity and labor income.[31] At the end of the period, men pay bride prices p_t to their in-laws.[32]

Her parents must then transfer all of their daughters' bride prices to the chief whose authority they are under. He holds these amounts in trust and divides them equally among her surviving unmarried brothers at the beginning of the next period. I do not model how this practice arose but simply impose it on the marriage market to match the historical context discussed in Section 2.

[28] In the case of widows, I assume they run their late husbands' households exactly as they would have.
[29] This asymmetry makes fecund women scarce (Siow, 1998)
[30] This term could reflect the greater discomfort from arduous physical labor in old age.
[31] While a wife or a daughter is clearly indivisible, these quantities are best thought of as the average number of wives demanded or brides supplied by men in a generation.
[32] In Southern Africa, bride prices can be paid after a marriage occurs (Ansell, 2001).

After the marriage market closes, women work in subsistence agriculture and produce y_t^F. Married men with fecund wives then choose to have $2n_t^A$ children with an equal sex ratio. As in Tertilt (2005), polygynous men split their children equally across his wives, and they survive at a total cost of $\frac{\psi(n_t^A)^2}{w_t^A}$.[33] After they are born, households consume, all old adults and the fixed share of young adults die, and the period ends.

5.1.2. *Preferences and Budget Constraints*

Men value their own or their household's consumption in each period with log preferences. In this patrilineal society, they also gain utility from continuing their lineages by having sons who marry. While he cannot make decisions for his sons, a father influences whether they marry by marrying off daughters, ensuring that his sons (i.e., their brothers) will have more resources available when they enter the marriage market in the next period. This decision is incorporated into men's utility functions as $\lambda \log(d_t^A)$, $d_t^A \in [0, n_t^A]$, where λ captures how important lineages are.[34]

It is immediately clear that men will marry off all of their daughters ($d_t^A = n_t^A$), which makes the last term in the utility function a preference for fertility. Therefore, fathers will marry all daughters off while they are young women because potential sons-in-law will not pay for infecund wives.

If incomes for young men are low enough, they will not be able to marry when young and must incur the discomfort of working in old age to marry then.[35] As a result, they choose to consume their entire incomes when young. Substituting in the period budget constraint, their problem after surviving to old age in period t is

$$\max_{w_t^O, n_t^O \geq 0} \log\left[y_t^O + \frac{p_{t-1}}{1-\mu} - w_t^O(p_t - y_t^F) - \frac{\psi(n_t^O)^2}{w_t^O}\right] + \lambda \log(n_t^O), \tag{2}$$

[33] Note that this cost increases in the number of children and decreases with the number of wives.

[34] This preference mirrors the one for children in Tertilt (2005) and Ashraf and Galor (2011). While old men die before they can marry off new daughters, the widows who will run their households will behave exactly as they do. Thus, it is effectively equivalent and more convenient to write the problem this way.

[35] A formal statement of this condition is in the next section.

where $\frac{p_{t-1}}{1-\mu}$ is his share of his sisters' bride prices from their marriages in $t-1$.

Conversely, if young-age incomes are high enough for some men and the pain from working in old age is large enough, they will marry only when young and choose to consume from their wives' production when old.[36] Their problem as young men in t is

$$\max_{w_t^Y, n_t^Y \geq 0} \log\left(y_t^Y - w_t^Y(p_t - y_t^F) - \frac{\psi(n_t^Y)^2}{w_t^Y}\right) + \beta(1-\mu)\left[\log\left(w_t^Y y_{t+1}^F\right) + \lambda \log(n_t^Y)\right]. \quad (3)$$

Because he married when young, he does not receive any of his sisters' bride prices in old age—it gets redistributed to his unmarried brothers. Their problem as old men is similar to (2) except their share gets scaled up by the fraction who did not marry.

5.1.3. *Subsistence Agricultural Production*

Women produce subsistence agricultural output using a constant-returns-to-scale technology with labor and land as inputs, $Y_t^F = (AX)^\alpha [N_t + (1-\mu)N_{t-1}]^{1-\alpha}$, $\alpha \in (0,1)$, where A is the level of technology, X is land, and $N_t + (1-\mu)N_{t-1}$ is the number of young and old women.[37] As in Galor and Weil (2000), there are no property rights over land, so its return is zero and women's wages are the average product

$$y_t^F = \left(\frac{AX}{N_t + (1-\mu)N_{t-1}}\right)^\alpha \equiv x_t^\alpha. \quad (4)$$

5.1.4. *Population Dynamics and Marriage Market Clearing*

The number of young adults of each sex in a period is determined by the reproductive choices of men married to young women in the previous period. Its law of motion is

$$N_{t+1} = N_t n_t^Y + (1-\mu)N_{t-1} n_t^O. \quad (5)$$

[36] Formally, it requires that this pain outweighs the gains from more consumption and children: $\delta > \log\left[y_{t+1}^O + w_t^Y y_{t+1}^F - w_{t+1}^O(p_{t+1} - y_{t+1}^F) - \frac{\psi(n_{t+1}^O)^2}{w_{t+1}^O}\right] - \log(w_t^Y y_{t+1}^F) + \lambda[\log(n_t^Y + n_{t+1}^O) - \log(n_t^Y)]$.

[37] As Ashraf and Galor (2011) describe, A reflects the soil, climate, and practices used in production.

Along similar lines due to the preferences discussed in the previous section is the marriage market clearing condition. Specifically, because fathers will marry off every daughter when she is young, equating the supply of brides with demand for them yields

$$N_t = N_t w_t^Y + (1-\mu) N_{t-1} w_t^O. \tag{6}$$

5.2. *Predictions*

I solve for the equilibria of this marriage market and economy defined by the optimal choices in (2) and (3) taking the female wage in (4) and the bride price p_t as given, population evolving according to (5), and the marriage market clearing as in (6). My interest is in the steady state under low wages for young men, and what happens after high wages become available to a subset of young men.

5.2.1. Initial Steady State: Low Wages for Young Men

Suppose first young men's wages are fixed at a level y_0^Y that is less than young women's, which in turn are less than old men's: $y_0^Y < x_t^\alpha < y_0^O$.[38] The first-order conditions for (2) yield period-t old men's choices

$$n_t^O = w_t^O \frac{\sqrt{p_t - x_t^\alpha}}{\sqrt{\psi}}, \; w_t^O = \frac{\lambda\left(y_0^O + \frac{p_{t-1}}{1-\mu}\right)}{2(1+\lambda)(p_t - x_t^\alpha)}. \tag{7}$$

Substituting the expressions in (7) into (5) and (6) and solving for steady-state values denoted by 0 subscripts implies that the number of children equals the number of wives and it gives the bride price as a function of the exogenous variables:

$$w_0^O = \frac{1}{1-\mu} = n_0^O \implies p_0 = \left(\frac{AX}{N_0(2-\mu)}\right)^\alpha + \psi. \tag{8}$$

Intuitively, the number of wives married and children born must be equal for the population to be constant. Because all marriages are age-disparate, the rate of polygyny

[38] This wage pattern could reflect returns to experience in forced labor (e.g., an overseer position).

is completely determined by the level of mortality. In addition, consistent with Corno, Hildebrandt and Voena (2020), the bride price exceeds a young woman's contribution to her parents' budget in the absence of direct utility from marriage, keeping young men from entering the marriage market given their wages. Also note that a larger steady-state population implies a lower bride price because it reduces women's wages.

5.2.2. *First Periods of High Wages for a Subset of Young Men*

Now assume that much higher wages y_1^Y are available to a share $\epsilon \in (0,1)$ of young men: $y_0^Y < x_t^\alpha < y_0^O < y_1^Y$.[39] In this new regime, the expressions for period-t old men's choices are the same as in (7). However, now the ϵ share of period-t young men with high wages make decisions defined by (3):

$$n_t^Y = \frac{\sqrt{\beta(1-\mu)\lambda w_t^Y}\sqrt{y_1^Y - w_t^Y(p_t - x_t^\alpha)}}{\sqrt{\psi(\beta(1-\mu)\lambda+2)}}, \; w_t^Y = \frac{\beta(1-\mu)(\lambda+2)y_1^Y}{2[\beta(1-\mu)(1+\lambda)+1](p_t - x_t^\alpha)}. \quad (9)$$

Substituting the demands for wives into the market clearing condition (6) yields an expression for the current period's bride price as a function of the previous period's, which does not have a closed-form solution.

However, because my focus is on the consequences of the wage shock for a subset of young men rather than the steady state, it is instructive to examine the first few periods after the new wage regime begins. Consider the market clearing condition in the first period following its introduction (denoted as $t = 1$). After substituting in the initial steady-state bride price, the result is a closed-form solution for the period-1 value,

$$p_1 = x_0^\alpha + \epsilon\frac{\beta(1-\mu)(\lambda+2)y_1^Y}{2[\beta(1-\mu)(1+\lambda)+1]} + (1-\mu)\frac{\lambda\left(y_0^O + \frac{x_0^\alpha+\psi}{1-\mu}\right)}{2(1+\lambda)}. \quad (10)$$

which is clearly greater than p_0 in (8) for any reasonable cost of children's survival. Even

[39] This share could be determined by migration costs that decline with idiosyncratic ability, yielding a threshold ability level above which young men engage in circular migration. Given the high disutility from physical labor in old age discussed earlier, no old man would do so.

Table 3: Summary of Marriage Predictions

Period	Age	M Marrying	F Marrying	Share w. Age Gap
0	Y O	 $(1-\mu)N_0$	N_0	1
1	Y O	ϵN_0 $(1-\mu)N_0$	N_0	$\frac{1-\mu}{1-\mu+\epsilon}$ ↓
2	Y O	ϵN_1 $(1-\mu)(1-\epsilon)N_0$	N_1	$\frac{(1-\mu)(1-\epsilon)}{(1-\mu)(1-\epsilon)+\epsilon\frac{N_1}{N_0}}$ ↓
3	Y O	ϵN_2 $(1-\mu)(1-\epsilon)N_1$	N_2	$\frac{(1-\mu)(1-\epsilon)}{(1-\mu)(1-\epsilon)+\epsilon\frac{N_2}{N_1}}$ ↓

Notes: Table presents a summary of the marriage market model's predictions regarding age-disparate marriages. Period 0 denotes the baseline steady state and Period 1 is the first period in which circular migration is possible. The respective ages denote the young and old generations in a period. The sex-specific columns show the number of each sex and generation who marry in a period. The final column shows the share of women in age-disparate marriages.

though the new wage regime has begun, the bride price is still partially a function of variables determined in the last period—namely, the female wage, both in itself and as part of last period's bride price.

This feature along with mortality and the lag between women being born and entering the marriage market lead to a noticeably delayed adjustment. As is clear in Table 3, it takes at least another generation after higher wages become available for a subset of young men for the share of age-disparate marriages to effectively stabilize at a much lower level. Importantly, the largest part of the transition occurs in the first period and the changes get smaller in the subsequent periods.

5.3. Linking Past and Present

Given the colonial-era results and the model above, it is possible that marriage market differences have continued to today. Setting the length of a generation to be 30 years implies that marriage markets in the former mobility-restricting region would experience a large but incomplete transition in the 1940 to 1970 period. In this framework, only after 2000 period had ended would marriage outcomes complete most of their convergence with the former migrant-sending region.

If these predictions are correct, there would be clear implications for HIV prevalence and economic development today: seroprevalence should be lower just inside the migrant-sending region while there should not be substantive differences in living standards along the border.

5.3.1. HIV Prevalence

With respect to HIV, smaller age gaps between partners in sub-Saharan Africa lower the risk of contracting the virus (Schaefer et al., 2017). Intuitively, older men transmit it to younger women, who as they age transmit it to men of similar ages, perpetuating the cycle (de Oliveira et al., 2017). As such, fewer age-disparate relationships should lower HIV prevalence and give its age profile a later peak, especially for women.

Concurrent sexual partnerships, as formalized by polygyny, can also increase the risk of contracting the virus (Tanser et al., 2011). An important reason is that the probability of transmission increases with viral load, which can be very high shortly after acquiring HIV (Quinn et al., 2000). Therefore, sexual contact with multiple partners in this window raises the risk that each of them will become infected.

The equalization of circular migration in the colonial era and South Africa's severe restrictions on it after Mozambique's independence also have important implications for HIV prevalence. Converging rates of circular migration should have equalized the risks of transmission associated with this phenomenon along the border (Weine and Kashuba, 2012). In addition, the sharp reduction in it a decade before HIV exploded across Southern Africa would also delay the virus's arrival, as would restricted mobility during the 1977-92 civil war (Iliffe, 2006; Audet et al., 2010).

5.3.2. Economic Development

In contrast, the colonial-era patterns imply that there should not be any differences in levels of economic development today. Convergence in circular migration rates also

should have reduced any differences in wages, as it allowed families on both sides of the border to benefit from circular migration (Khanna, Theoharides and Yang, 2020). Moreover, the convergence in school enrollment rates for boys implies that there is no reason related to the institutions for human capital accumulation to be different.

6. Effects of the Institutions in the Present Day

Given the framework above, in this section I study the institutions' impacts on HIV prevalence and economic development today. I first describe the modern data and the refinements to the colonial-era RD estimation strategy that I use to study these present-day outcomes. Table 4 reports RD estimates for HIV prevalence and development outcomes, and Figure 7 presents graphical evidence on seroprevalence. These results show that, consistent with the conceptual framework and the absence of differences in (correlates of) development in the colonial period, HIV prevalence is much lower just inside the former migrant-sending institution while there are no substantive differences in measures of living standards today.

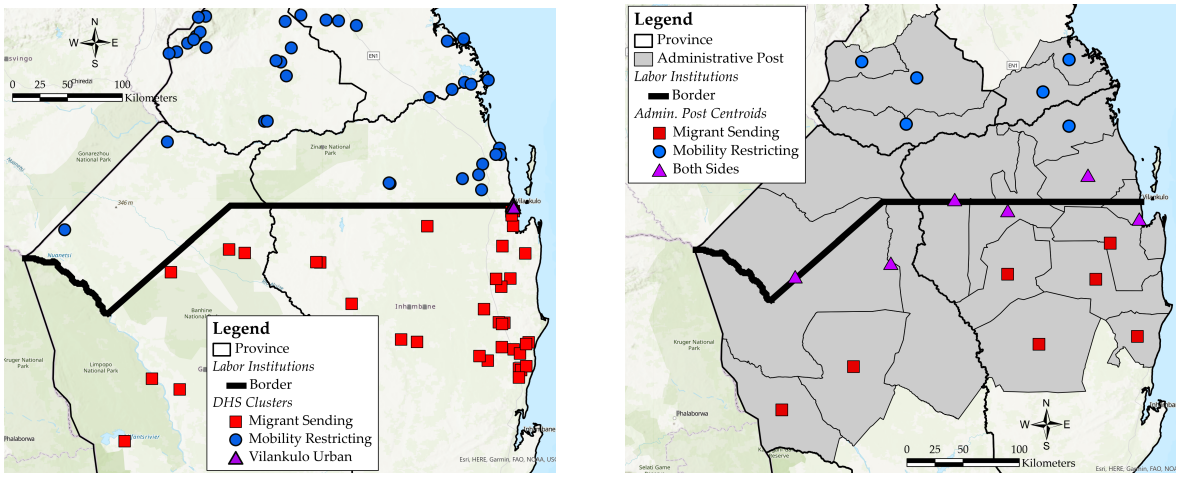
6.1. Data

To test these predictions regarding present-day HIV prevalence and economic development, I use georeferenced individual-level data from the 2009, 2011, 2015, and 2018 waves of the Demographic and Health Surveys (DHS) in Mozambique. Figure 6a shows the reported locations of the survey clusters within 200 km of the institutional border. These locations are slightly displaced for respondents' anonymity and privacy.[40]

As such, it is possible that four urban clusters along the coast have been displaced into the wrong institution. For this reason and others related to the city's recent history that I discuss in Appendix A, I remove these clusters from the sample. After doing so, all

[40] Urban clusters are displaced by up to 2 km, 99 percent of rural clusters by up to 5 km, and 1 percent of rural clusters by up to 10 km.

Figure 6: Maps of Georeferenced Survey Units



(a) DHS Clusters within 175 km **(b)** Administrative Posts within 150 km

Notes: Left map shows the reported locations of survey clusters within 200 km of the border in the 2009, 2011, 2015, and 2018 DHS waves in Mozambique. The shapefiles are from Ministério de Saúde, Instituto Nacional de Estatística and ICF Macro (2010), Ministério de Saúde, Instituto Nacional de Estatística and ICF International (2013), Ministério de Saúde, Instituto Nacional de Estatística and ICF (2018), and Instituto Nacional de Estatística and ICF (2019). Right map shows administrative posts with centroids within 200 km of the border. The underlying shapefile is from Minnesota Population Center (2020).

of the remaining ones are in the correct former institution. I discuss in the next section the implications of not knowing their precise locations for the analysis.

The outcome of interest when examining HIV is the result of blood tests for the virus from a random subset of respondents in 2009 and 2015. I restrict this analysis to adults ages 15 to 64.[41] For economic development, the variables of interest are an index of household asset ownership (measured in 2009, 2011, 2015, and 2018), an indicator for whether a child is stunted (2011), and years of schooling (2009, 2011, and 2015).[42]

[41] Most studies of HIV prevalence focus on ages 15 to 44 or 49, as this range captures current sexual activity. I use the full adult age range of HIV blood tests in the DHS data because my interest is in the institutions' effects on anyone who was ever sexually active.

[42] The index equals a household's quintile in the first principal component of a principal component analysis of its assets (1 = lowest, 5 = highest). Children are considered stunted if their height-for-age z-scores using the World Health Organization's Child Growth Standards are less than -2.

6.2. *Empirical Strategy*

As with the colonial-era analysis, I use an RD design to compare the long-run impact of historical assignment to the migrant-sending institution relative to the mobility-restricting institution. However, the individual-level DHS data and their greater geographic disaggregation allow for several additions to equation (1). I modify it to be:

$$y_{i,c} = \alpha + \tau \text{MigrantSending}_c + f(\text{Distance}_c) + \text{Lon}_c + \mathbf{X}_i\beta + \delta_t + \epsilon_{i,c} \quad \text{for } c \in B^*_{\text{MSE}} \quad (11)$$

where $y_{i,c}$ is an outcome for individual i in DHS survey cluster c and the first three right-hand side variables are as before. I also include the vector $\mathbf{X}_i$ containing individual-level controls (age, age squared, and a female indicator) and the survey-year fixed effect δ_t. The DHS data have sufficiently many clusters near the border to estimate the Calonico, Cattaneo and Titiunik (2014) MSE-optimal bandwidth, which defines the set of them in B^*_{MSE}. I continue to use a local linear RD specification with a triangular kernel.

6.2.1. *Addressing Concerns with Estimation and Inference*

An estimation issue arises from the displacement of clusters mentioned earlier. Because the displacement is random, it induces classical measurement error in the running variable, biasing the RD coefficients toward zero. For inference, I cluster standard errors by DHS survey cluster. However, one concern with this approach is that the MSE-optimal bandwidths often contain only a "small" number of clusters. As a solution, I use the wild cluster bootstrap to calculate p-values as Cameron, Gelbach and Miller (2008) recommend. Another concern is spatial autocorrelation, which again I address in part by calculating Conley standard errors using a bandwidth of approximately 100 km given the greater density of clusters. In Appendix E2, I also show results after collapsing the data into cluster-level means and calculating the Kelly (2021) exact p-values as described in Section 3.2.1.

Table 4: Effects of the Institutions in the Present Day

	HIV Positive			Assets	Schooling	
	Pooled	Women	Men	Index	Female	Male
	(1)	(2)	(3)	(4)	(5)	(6)
Migrant Sending	-0.103	-0.089	-0.097	0.067	0.377	0.224
	(0.049)	(0.053)	(0.084)	(0.322)	(0.327)	(0.782)
	[0.037]	[0.041]	[0.093]	[0.414]	[0.281]	[0.795]
Observations	860	588	212	2,513	883	815
Clusters	21	22	14	22	19	22
Bandwidth	124.4	128.3	86.5	59.6	64.8	71.5
Wild Cluster Bootstrap p-value	0.073	0.137	0.458	0.862	0.302	0.818
Mobility Restricting Mean	0.215	0.214	0.198	3.375	2.498	3.443

Notes: Standard errors clustered by DHS survey cluster are in parentheses. Regressions estimate a local linear RD specification on each side of the border using a triangular weighting kernel and include age, age squared, a female indicator, longitude, and year fixed effects as controls. Specifications use the MSE-optimal bandwidth in kilometers (Calonico, Cattaneo and Titiunik, 2014).

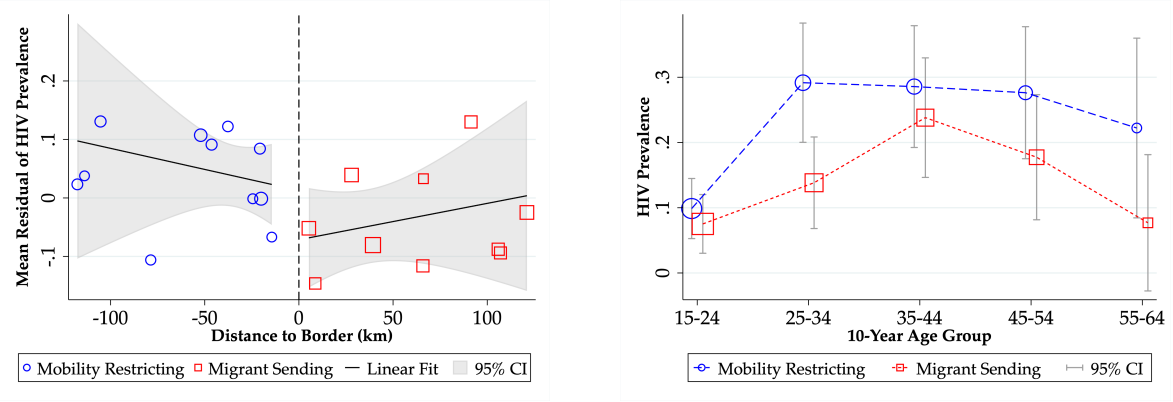
6.3. Results: HIV Prevalence

I first examine the spatial distribution of HIV among adults along the institutional border. Table 4 Column (1) pools both sexes and shows that adult HIV prevalence drops 10 p.p. just inside the migrant-sending institution, and Figure 7a shows this discontinuity visually. This point estimate is large relative to the 22 percent of the mobility-restricting institution sample who are HIV positive. In addition, the wild cluster bootstrap p-value suggests that its statistical significance is not due to false precision. I also split the sample by sex in Columns (2) and (3), which shows that this effect is of equal magnitude for women and men (see Appendix D1 for these RD plots). However, after accounting for the number of clusters the male estimate is imprecise, likely as a result of the much smaller sample size.

To rationalize the large effect sizes estimated above, I compare the age profiles of HIV prevalence in the two institutions.[43] Specifically, I calculate the mean seroprevalence for

[43] Note also that prevalence is a stock, not a flow, and even small differences in transmission rates can generate large differences in the size of an epidemic (Viboud, Simonsen and Chowell, 2016).

Figure 7: HIV Prevalence RD Plots and Age Profiles



(a) RD Plot **(b)** Age Profile within RD Bandwidths

Notes: RD plot shows the fraction HIV positive in DHS survey clusters net of age, age squared, longitude, and year fixed effects. The running variable is a cluster's distance to the border. Black lines denote linear trends on each side of the border using a triangular kernel and gray shading indicates 95% confidence intervals. Age profile shows the mean HIV prevalence within a 10-year age group within the MSE-optimal RD bandwidth in the two institutions. Shape sizes in both plot types reflect the relative number of adults in a cluster or age group.

each 10-year age group within its MSE-optimal RD bandwidth.[44] Figure 7b plots this age profile. A clear pattern emerges: HIV prevalence for every age group is lower (or at a minimum no greater) in the former migrant-sending institution than in the former restricted mobility region. It is most apparent for ages 25 to 34, when HIV prevalence peaks in the former mobility-restricting institution.

These age profiles of HIV prevalence are consistent with the de Oliveira et al. (2017) transmission cycle and its implications discussed in Section 5. The peak of women's seroprevalence in the former mobility-restricting institution is both larger than the one across the border and farther away from the male peak. This pattern could arise from relationships with wider age disparities, a channel I examine in Section 7.

6.4. Results: Economic Development

Next, I compare economic development outcomes in the former institutions. The point estimates in Table 4 are all in the direction of better outcomes in the former migrant-

[44] The HIV sample is too small to permit reliable RD estimation by age group.

sending region, though for the asset ownership index and male schooling they are a very small percentage of the mobility-restricting means. The coefficients for childhood stunting (-6 p.p.) and female schooling (0.38 years) are non-trivial relative to the respective restricted mobility means (38 percent and 2.5 years) but notably imprecise. Taken together, these results fail to provide convincing evidence that economic development changes meaningfully at the border today. They are also consistent with the equalization of circular migration and human capital outcomes in the 1960 census data. The implication is that whatever development differences there were prior to the mobility-restricting institution's abolition have disappeared in the intervening decades.

6.5. Robustness

I also show in Appendix E11 that there are no substantive differences in blood test refusal rates along the border, helping to rule out selection into testing due to history or other factors (Lowes and Montero, 2021*b*).

7. Explaining Differences in HIV Prevalence

I now study the channels that have led to to lower HIV prevalence in the former migrant-sending institution today. I focus first on age-disparate relationships given the colonial-era marriage market results in Section 4 and the age profiles of seroprevalence in Section 6. I then examine other important HIV risk factors, splitting them into ones the public health literature links to age gaps and those that are unrelated. The main result is that age gaps between spouses and sexual partners are markedly smaller and behavioral risk factors associated with them are less common just inside the former migrant-sending institution. They are the primary differences in HIV risk at the border, suggesting colonial-era patterns substantially affect current seroprevalence.

Table 5: Age-Disparate Partnerships

	Full Sample		Married		Married
	Women	Men	Women	Men	Women
	(1)	(2)	(3)	(4)	(5)
Panel A. Male-Female Age Gap	*Last Sexual Partner*				*Spouse*
Migrant Sending	-2.309	-2.042	-1.867	-1.769	-0.794
	(0.901)	(0.733)	(0.773)	(0.960)	(0.291)
	[0.703]	[0.788]	[0.708]	[1.160]	[0.221]
Observations	218	320	281	240	9,287
Clusters	14	60	22	57	15
Bandwidth	59.7	170.6	96.9	174.1	139.1
Wild Cluster Bootstrap p-value	0.131	0.053	0.048	0.230	0.072
Mobility Restricting Mean	7.34	5.68	6.91	6.75	8.38
Mobility Restricting SD	5.45	4.51	4.99	4.61	6.59
Panel B. Partners	*Multiple Sexual Partners Last Year*				*Polygyny*
Migrant Sending	-0.042	-0.066	-0.031	-0.117	-0.040
	(0.025)	(0.100)	(0.018)	(0.095)	(0.052)
	[0.035]	[0.084]	[0.025]	[0.076]	[0.068]
Observations	936	432	574	325	444
Clusters	37	46	33	57	26
Bandwidth	119.9	137.0	109.4	157.8	81.7
Wild Cluster Bootstrap p-value	0.337	0.540	0.329	0.285	0.684
Mobility Restricting Mean	0.02	0.23	0.01	0.28	0.34

Notes: Standard errors clustered by administrative post (census data) or survey cluster (DHS data) are in parentheses. Regressions estimate a local linear RD specification on each side of the border using a triangular weighting kernel and include age, age squared, longitude, and year fixed effects as controls. Specifications use the MSE-optimal bandwidth in kilometers (Calonico, Cattaneo and Titiunik, 2014).

7.1. Age-Disparate Relationships

To examine age disparities between spouses and sexual partners, I use data from the IPUMS 10-percent sample of the 2007 Mozambican census in addition to the DHS. The former allow for characteristics of a husband, wife, or live-in partner (henceforth spouse) also in the sample to be attached to an observation, which leads to a dataset with far more linked couples—and likely much more representative ones—than the DHS.[45] However, the census lacks information on sexual activity and the data are at a much coarser geographic resolution (administrative posts).[46]

[45] Inclusion in the DHS dataset of linked couples requires both partners to be present for and participate in enumeration. Because there are likely important differences between such couples and those with

The outcome of interest in both datasets is the man's age minus the woman's, which I winsorize at 90 percent due to extreme outliers at both ends of the distribution.[47] I examine age gaps between women of any age and their spouses in the census sample to make the closest link possible between colonial-era and present-day marriage market outcomes. To connect them to sexual behavior, I also study age gaps between adults in the DHS ages 15 to 49 ("reproductive age") and their most recent sexual partner.[48]

Table 5 reports the results of estimating equation (11) for age disparities in these datasets and Figure 8 presents RD plots for these outcomes. Column (1) shows that the age disparity between a woman and her linked spouse in the census is 0.8 years smaller just inside the former migrant-sending institution. This estimate is meaningful relative to the average of 8.4 years in the former restricted mobility region, and its precision does not seem to be overstated. Figure 8a shows this discontinuity visually.

In Columns (2) and (3), I examine the age disparity between sexual partners in the DHS. These estimates for women (-3.1 years) and men (-1.9 years) are even larger relative to the respective restricted mobility means (7.3 years and 5.1 years), though accounting for the number of clusters slightly reduces the precision of the women's estimate. Figure 8b shows the RD plot for men. Taken together, these results suggest age-disparate relationships are important in explaining the HIV prevalence result.

7.2. Risk Factors Associated with Age-Disparate Partnerships

While age gaps in relationships can be HIV risk factors on their own, they are also associated with behaviors facilitating transmission of the virus. They include male partners

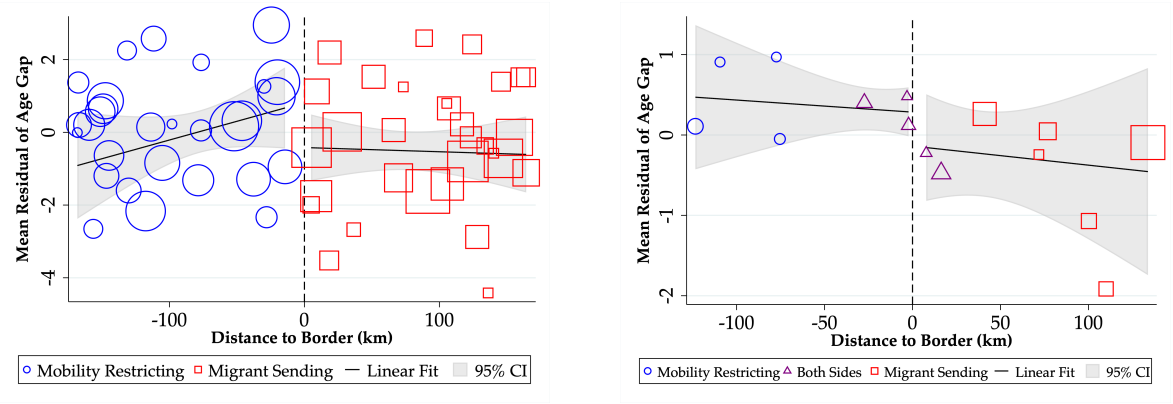
a partner absent from the survey (e.g., they are working outside of the home), selection into the DHS couples sample is a non-trivial consideration.

[46] As in the 1960 data, these administrative boundaries do not align with the former institutional border. The effects on the estimation are the same as I discussed in Section 3.2.1, and in the RD plots I take the same approach to the administrative posts with area on both sides of the border.

[47] I structure the data so that each observation is a woman linked with her spouse to account for polygyny. Thus, each woman only appears once but a man can be linked to multiple women. The 90-percent winsorization increases the precision of the RD estimate without changing its magnitude.

[48] Ninety-six percent of women and 89 percent of men in the DHS reported their most recent sexual partner was a spouse or boyfriend/girlfriend, implying respondents should know this person's age.

Figure 8: RD Plots for Age-Disparate Relationships



(a) Age Gap with Last Sexual Partner: Men **(b)** Age Gap with Spouse: Women

Notes: RD plots show the mean age disparity among the specified group in a DHS survey cluster or administrative post, net of age, age squared, longitude, and year fixed effects. The running variable is distance to the border. Black lines denote linear trends on each side of the border using a triangular kernel and gray shading indicates 95% confidence intervals. Shape sizes reflect the relative number of adults in a cluster or administrative post.

who are in concurrent relationships, an earlier sexual debut for women and girls, and not using condoms (Evans et al., 2019; Mabaso et al., 2021; Schaefer et al., 2017). I measure these outcomes among reproductive-age adults in the DHS.

Panel B Column (1) shows that men in the former migrant-sending region are 16 p.p. less likely to have concurrent sexual partners, which substantial compared to the restricted mobility mean of 26 percent. In Column (2), I estimate that girls' sexual debuts occur 0.8 years later in the former migrant-sending region, which is non-trivial relative the restricted mobility mean of 16.1 years. In contrast, the evidence on condom use in the most recent sexual intercourse is less compelling. The coefficient for men in Column (3) is large—6.5 p.p. relative to a restricted mobility mean of 7 percent—but notably imprecise, and in Column (3) there is a null RD estimate for women.

7.3. Other HIV Risk Factors

Finally, I examine other important risk factors in Sub-Saharan Africa to determine whether partner age disparities and associated behaviors are the main channels for the HIV effect in Section 6. Drawing from the literature on the virus' spread across the continent, I

Table 6: Mediation Analysis of the HIV Result

	HIV Positive: Pooled				
	(1)	(2)	(3)	(4)	(5)
Mediating Variable	*Asset Index*	*Years of School*	*Age Gap Last Sex*	*Multiple Partners*	*Condom Last Sex*
Mediation Effect	-0.007	-0.004	-0.032	0.000	-0.001
	[-0.025, 0.009]	[-0.014, 0.003]	[-0.062, -0.005]	[-0.005, 0.005]	[-0.006, 0.003]
Direct Effect	-0.124	-0.114	-0.104	-0.133	-0.112
	[-0.221, -0.022]	[-0.204, -0.018]	[-0.202, -0.000]	[-0.223, -0.038]	[-0.193, -0.026]
Total Effect	-0.131	-0.118	-0.136	-0.133	-0.112
	[-0.233, -0.028]	[-0.211, -0.023]	[-0.240, -0.029]	[-0.223, -0.039]	[-0.194, -0.027]
Mediation/Total	0.051	0.034	0.236	-0.000	0.007
Observations	610	677	319	724	645
Bandwidth	99.6	121.9	133.3	109.8	125.2
Clusters	15	21	19	18	21
Mobility Restricting Mean	0.202	0.207	0.194	0.210	0.215

Notes: Standard errors clustered by administrative post (census data) or survey cluster (DHS data) are in parentheses. Regressions estimate a local linear RD specification on each side of the border using a triangular weighting kernel and include age, age squared, longitude, and year fixed effects as controls. Specifications use the MSE-optimal bandwidth in kilometers (Calonico, Cattaneo and Titiunik, 2014).

create indicator variables for: having a genital ulcer in the past 12 months (Chen et al., 2000), a polygynous marriage (Reniers and Tfaily, 2008), a woman having ever been forced to engage in sexual activity, a man having ever paid for sex (Dunkle et al., 2004), a woman being able to decide alone on her own healthcare (Anderson, 2018), and a man having been medically circumcised (Maffioli, 2017).

In Appendix E12, I estimate equation (11) for these outcomes. The only ones with effects pointing in the direction of lower HIV prevalence in the former migrant-sending region are fewer women being forced to engage in sex (-2.4 p.p. relative to a restricted mobility mean of 8.7 percent) and more men who are medically circumcised (3.1 p.p. relative to a restricted mobility mean of 19.2 percent), but both estimates are highly imprecise. Additionally, the largest and only precisely estimated effect—6.1 p.p. more women having a genital ulcer in the last year compared to a restricted mobility mean of 0.5 percent—*increases* HIV risk in the former migrant-sending region. As such, these results suggest that the commonly-cited risk factors above do not explain my results.

8. Conclusion

Institutions play a major role in economic development (North, 1990) and there is a rich literature on the positive long-run effects of those that promote inclusive prosperity compared to those that simply extract wealth from the population (e.g., Acemoglu, Johnson and Robinson, 2001). But in what is today the developing world, there was never a choice between inclusion and extraction —colonizers instead chose between different types of extractive institutions. In spite of the importance of this decision for understanding the roots of global health and wealth disparities, there is a lack of causal evidence on their comparative impacts.

This paper shows that two extractive institutions common throughout colonial Africa can have markedly different impacts on HIV prevalence today but result in no long-run differences in economic development. Using the arbitrary border within Mozambique between a migrant-sending and mobility-restricting institution, I find that adults are substantially less likely to be HIV positive just inside the former. The colonial-era and modern evidence suggests that this effect arises from smaller age gaps between spouses and sexual partners in this region, which are consistent with the predictions of a model of a marriage market with bride price after high wages for young men become available.

These results speak to the importance of institutions in shaping present-day outcomes in the developing world. They also show that marriage markets are a channel through historical events affect the present. Additionally, these findings provide insight into the long-run consequences of migration on health and wealth, which are important to understand given how rapidly transportation costs have fallen—and continue to fall—around the world in this recent era of accelerated globalization. Such lessons are necessary for policymakers to take into account, as effectively combatting global health disparities in one of the modern era's deadliest pandemics requires a full understanding of their historical and social roots.

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Appendix A. Data Sources, Variable Definitions, and Cluster Exclusion

Geographic Traits [19]

- *Elevation*: Average altitude in meters in the 0.25 × 0.25 degree cell. Data from Danielson and Gesch (2011).
- *Rainfall*: Average precipitation in millimeters in the 0.25 × 0.25 degree cell from 1891 to 2016. Data from Schneider et al. (2020).
- *Slope*: Average slope in degrees in the 0.25 × 0.25 degree cell. Data from World Bank (2020).
- *Soil Index*: Average agricultural suitability index value for growing 16 food and energy crops from 1981 to 2010 in the 0.25 × 0.25 degree cell. Data from Zabel, Putzenlechner and Mauser (2014).

Disease Environment [19]

- *Malaria*: Average malaria transmission stability index value in the 0.25 × 0.25 degree cell. Data from Kiszewski et al. (2004).
- *TseTse*: Average tsetse fly suitability index value in the 0.25 × 0.25 degree cell. Data from Alsan (2015).

Excluding DHS Clusters within 2 km of the Border

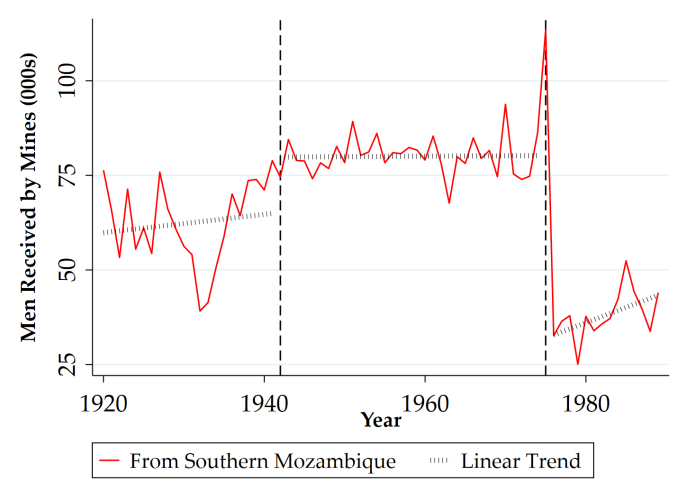
As discussed in Section 6.1, I exclude the DHS survey clusters within 2 km of the border as they may have been displaced across it. In addition, because these clusters are located beachside resort city of Vilankulo, including them in the estimation may lead to significant distortion. This city of 20,000 people has been popular with international tourists since shortly after the end of Mozambique's civil war in 1992 (Mozambique News Agency, 1999). It also has had multimillion-dollar infrastructure upgrades in the last decade, including the construction of an international airport that can handle 200,000 passengers per year (Mozambique News Agency, 2000, 2011).

While this recent history is unrelated to the differences between the institutions, it may affect outcomes of interest for clusters located there. First, the presence of a tourism industry could change the incentives to invest in human capital relative to other areas in the study. It also could attract workers from other areas with high human capital, and it could lead to higher wages to those living there even if they are not involved in tourism. Finally, the new infrastructure could enable additional commerce. Therefore, its inclusion would likely distort the RD estimation for outcomes related to economic development, marriage markets, and HIV.

Appendix B. Colonial Era: Additional Figures

B1. Annual Numbers of Witwatersrand Mine Workers from Southern Mozambique

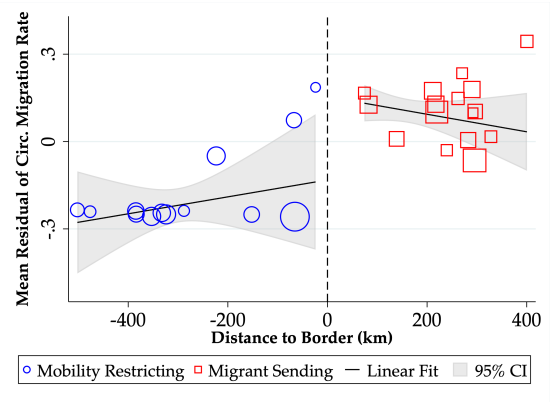
Figure B1: Southern Mozambican Men Received by Mines (000s), 1920-89 [11, 13]



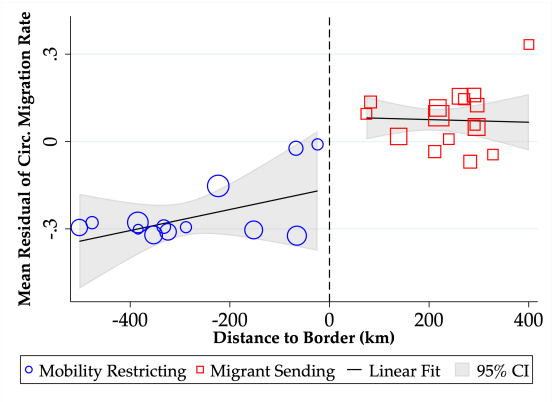
Notes: Data are from the annual reports of the Witwatersrand Native Labour Associated (as cited in Crush, Jeeves and Yudelman, 1991). The black line in 1942 denotes the end of the mobility-restricting institution, and the black line in 1975 denotes Mozambique's independence from Portugal and deterioration of relations with South Africa.

B2. RD Plots: Circular Migration

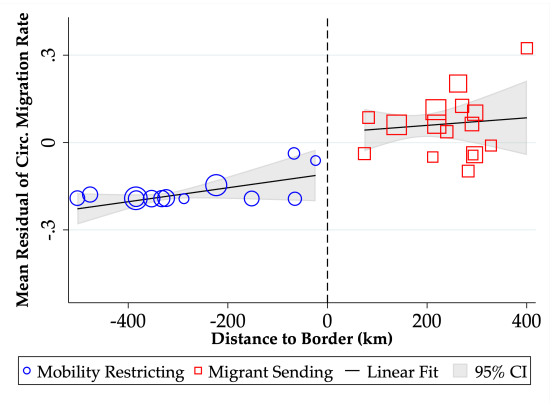
Figure B2: Men's Circular Migration Rates by Age Group [20]



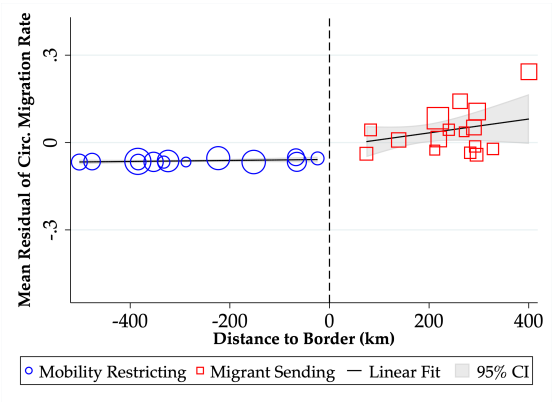
(a) Circular Migration in 1940: Men 15-24



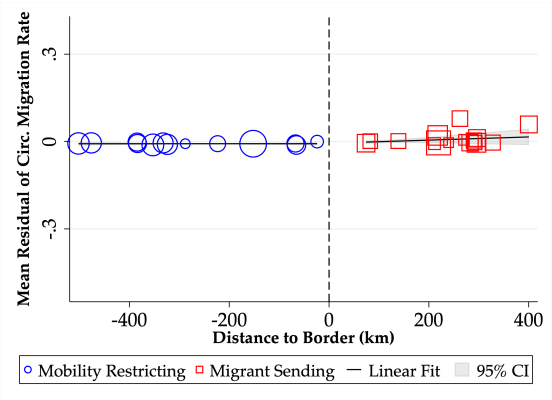
(b) Circular Migration in 1940: Men 25-34



(c) Circular Migration in 1940: Men 35-44



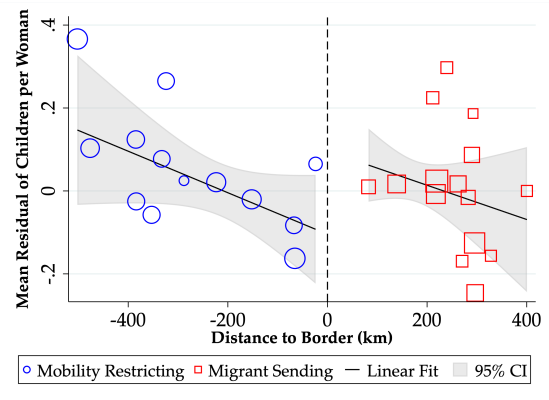
(d) Circular Migration in 1940: Men 45-54



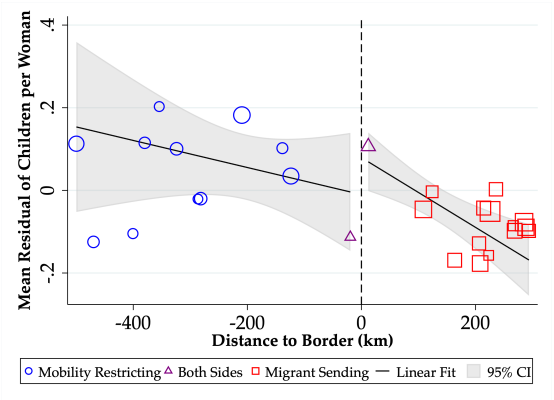
(e) Circular Migration in 1940: Men 55-64

B3. RD Plots: Fertility Measure

Figure B3: RD Plots for Fertility Measure



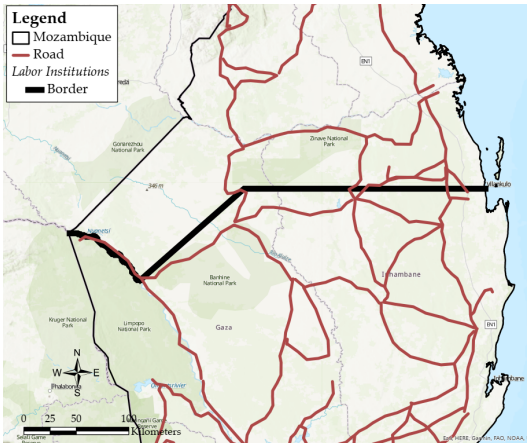
(a) Children per Woman in 1940



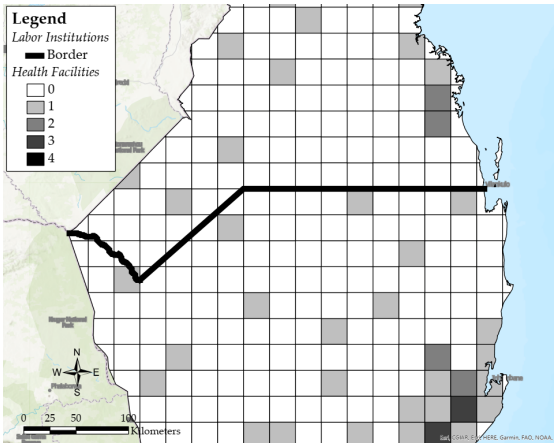
(b) Children per Woman in 1960

B4. Colonial-Era Infrastructure Investments

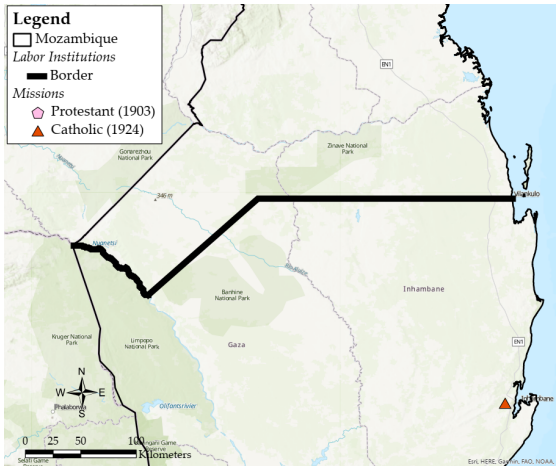
Figure B4: Colonial Infrastructure and Missionary Presence [25]



(a) Roads, 1959



(b) Health Facilities, 1962



(c) Protestant and Catholic Missions

Appendix C. Colonial Era: Robustness and Additional Results

C1. Randomization Inference

Table C1: Comparing Institutions during the Colonial Era [25]

	Men Migrants (1)	Women Farming (2)	Married Men 15-24 (3)	Married Men 25-34 (4)	Children per Woman (5)	Boys in School (6)	Girls in School (7)
Panel A. 2 Years before End of Mobility Restricting Institution (1940)							
Migrant Sending	0.195	-0.008	0.206	0.137	0.087	-0.034	0.009
	{0.014}	{0.554}	{0.056}	{0.024}	{0.192}	{0.020}	{0.714}
Observations	10	10	10	10	10	10	10
Bandwidth	-224, 218	-224, 218	-289, 218	-289, 218	-224, 220	-224, 220	-224, 218
Mobility Restricting Mean	0.117	0.960	0.263	0.768	0.757	0.038	0.002
Mobility Restricting SD					0.093		
Panel B. 18 Years after End of Mobility Restricting Institution (1960)							
Migrant Sending	-0.017	-0.001	0.118	0.202	-0.080	0.018	0.017
	{0.646}	{0.746}	{0.040}	{0.014}	{0.276}	{0.832}	{0.738}
Observations	10	10	10	10	10	10	10
Bandwidth	-282, 207	-282, 207	-287, 164	-287, 164	-282, 164	-287, 164	-282, 164
Mobility Restricting Mean	0.238	0.995	0.143	0.620	0.827	0.089	0.055
Mobility Restricting SD					0.108		

Notes: .

C2. Colonial-Era Infrastructure Investments

Table C2: Roads and Health Facilities in the Colonial Era [25]

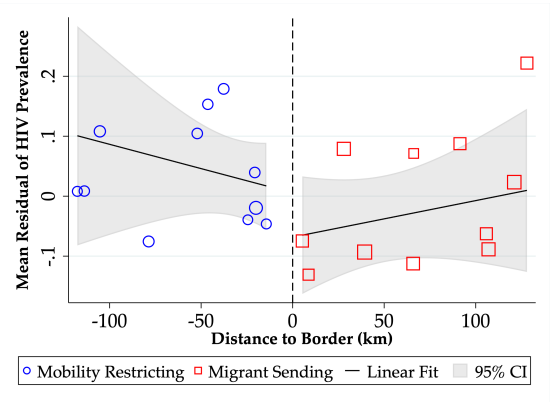
	Roads (1959)			Health Facilities (1962)		
	Any	Length	Log(Len.+1)	Any	Number	Log(Num.+1)
	(1)	(2)	(3)	(4)	(5)	(6)
Migrant Sending	0.038	3.421	-0.216	0.146	0.061	0.016
	(0.335)	(10.526)	(0.982)	(0.149)	(0.244)	(0.156)
	[0.278]	[9.322]	[0.889]	[0.219]	[0.188]	[0.121]
Observations	114	111	117	122	109	111
Clusters	23	23	24	26	23	23
Bandwidth	108.6	103.8	113.0	120.4	100.6	104.1
Wild Cluster Bootstrap p-value	0.935	0.784	0.851	0.366	0.815	0.913
Mobility Restricting Mean	0.373	10.20	1.17	0.396	0.140	0.09
Mobility Restricting SD		14.35	1.60		0.452	0.27

Notes: Standard errors clustered by DHS survey cluster are in parentheses. Regressions estimate a local linear RD specification on each side of the border using a triangular weighting kernel and include age, age squared, a female indicator, longitude, and year fixed effects as controls. Specifications use the MSE-optimal bandwidth in kilometers (Calonico, Cattaneo and Titiunik, 2014).

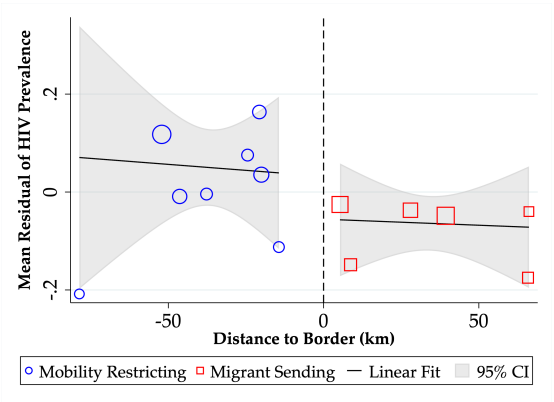
Appendix D. Modern Era: Additional Figures

D1. RD Plots: HIV Prevalence by Sex

Figure D1: HIV Prevalence



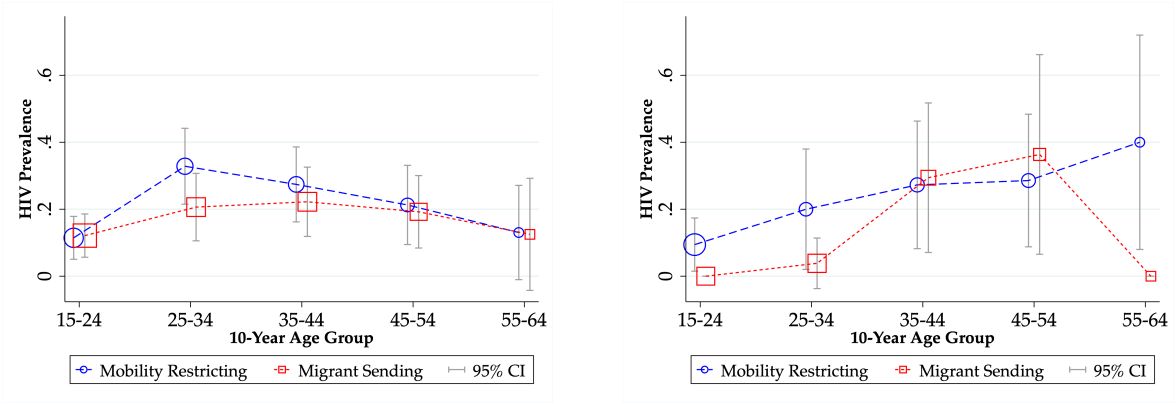
(a) Women



(b) Men

D2. Age Profiles of HIV Prevalence by Sex

Figure D2: HIV Prevalence by Sex and Age within RD Bandwidths

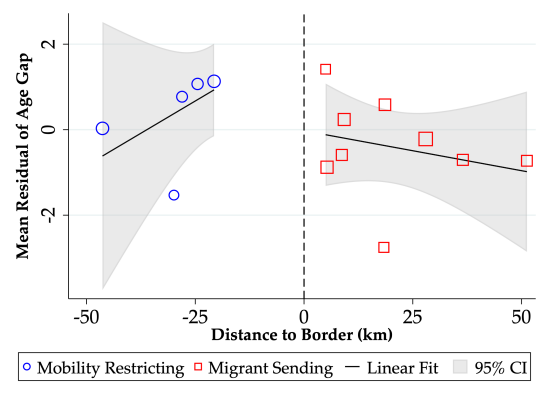


(a) Women

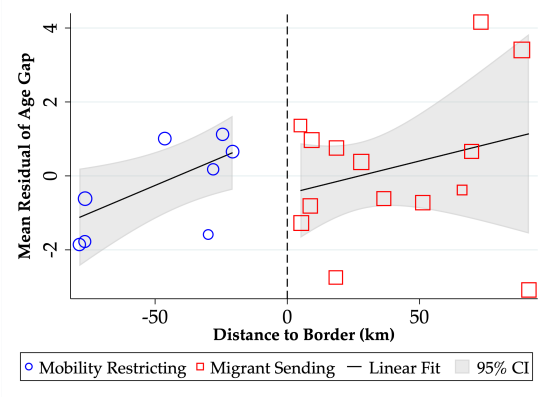
(b) Men

D3. RD Plots: Partner Age Gaps

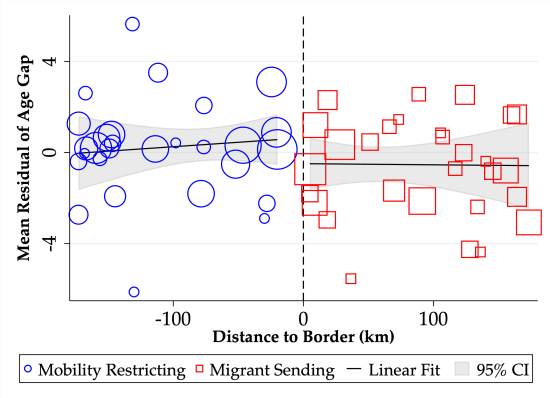
Figure D3: Male-Female Age Gap with Last Sexual Partner



(a) All Women



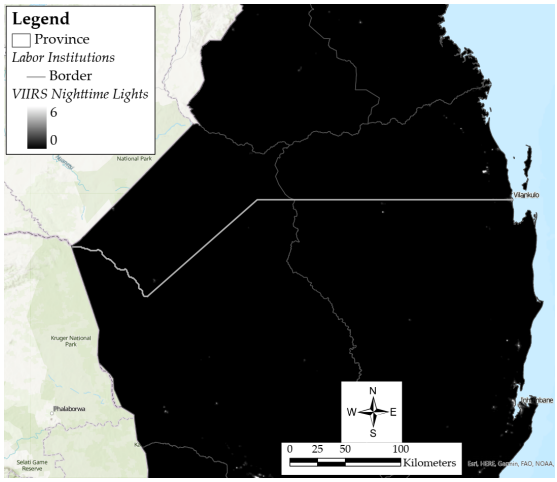
(b) Married Women



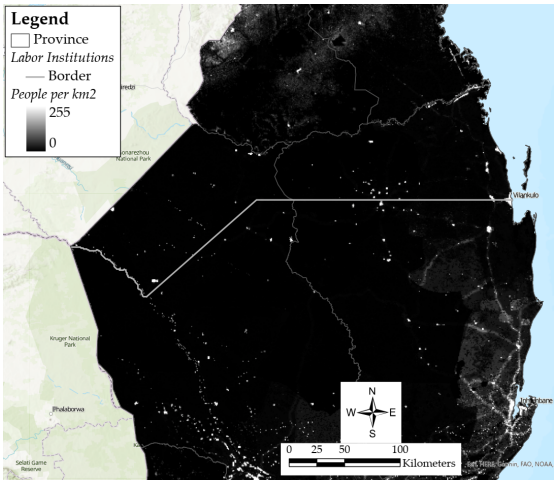
(c) Married Men

D4. Geospatial Measures of Development

Figure D4: Maps of Geospatial Measures of Development



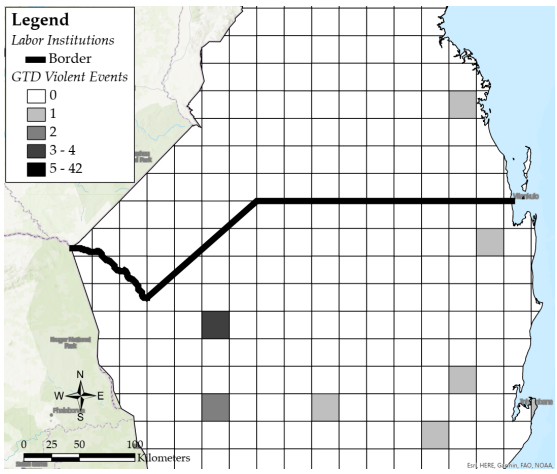
(a) VIIRS Nighttime Lights, 2019



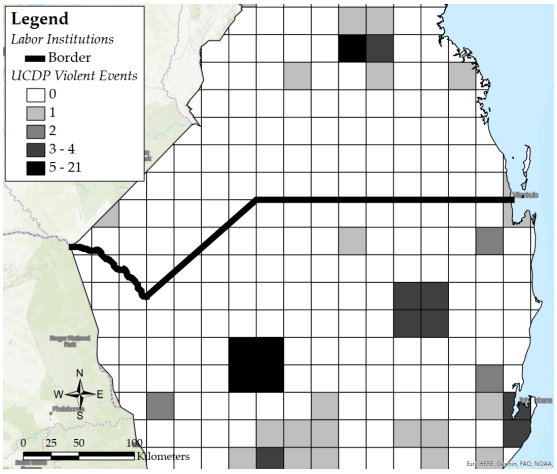
(b) Landscan Population Density, 2019

D5. Civil War Violence and Landmines

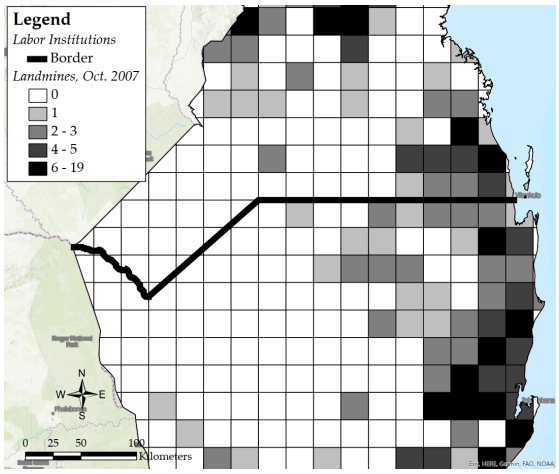
Figure D5: Maps of Civil War Violent Events and Landmines by Gridcell



(a) Global Terrorism Database, 1978-92



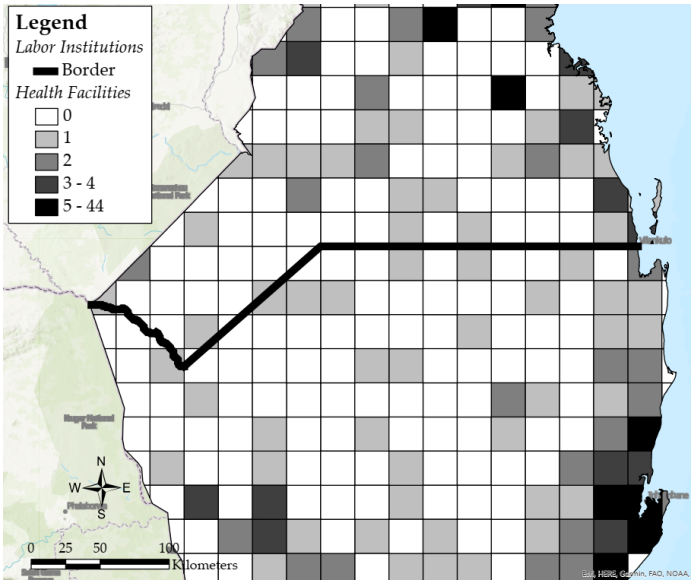
(b) Uppsala Conflict Data Program, 1989-92



(c) Known and Suspected Landmines, Oct. 2007

D6. Public-Sector Health Infrastructure

Figure D6: Public-Sector Health Facilities, 2018



Appendix E. Modern Era: Robustness and Additional Results

E1. Randomization Inference: HIV

Table E1: HIV Prevalence [37]

	Pooled (1)	Women (2)	Men (3)
Migrant Sending	-0.076	-0.064	-0.102
	{0.016}	{0.070}	{0.022}
Observations	819	540	279
Clusters	20	20	20
Bandwidth	-114, 122	-114, 122	-114, 122
Mobility Restricting Mean	0.217	0.217	0.216

Notes: .

E2. Results Using Data Collapsed into Clusters: HIV

Table E2: HIV Prevalence [37]

	Pooled (1)	Women (2)	Men (3)
Migrant Sending	-0.151	-0.112	-0.205
	(0.050)	(0.061)	(0.095)
Observations	21	22	14
Kelly Exact *p*-value	0.073	0.202	0.918

Notes: .

E3. HIV Blood Test Refusals

Table E3: HIV Blood Test Refusals [37]

	Pooled (1)	Women (2)	Men (3)
Migrant Sending	0.009	0.010	-0.006
	(0.006)	(0.006)	(0.006)
	[0.006]	[0.006]	[0.007]
Observations	478	500	141
Clusters	13	20	12
Bandwidth	148.4	176.8	132.8
Wild Cluster Bootstrap p	0.428	0.195	0.432
Mobility Restricting Mean	0.009	0.004	0.000

Notes: Standard errors clustered by DHS survey cluster are in parentheses. Regressions estimate a local linear RD specification on each side of the border using a triangular weighting kernel and include age, age squared, a female indicator, longitude, and year fixed effects as controls. Specifications use the MSE-optimal bandwidth in kilometers (Calonico, Cattaneo and Titiunik, 2014).

E4. Development Results Using Geospatial Data

Table E4: Development Results Using Geospatial Data [37]

	VIIRS Nighttime Lights			Landscan Population Density	
	Any Light	Intensity	Log(Intensity+1)	People/km^2	Log(People/km^2+1)
	(1)	(2)	(3)	(4)	(5)
Migrant Sending	0.016	0.022	-0.002	4.385	0.238
	(0.017)	(0.029)	(0.001)	(4.537)	(0.243)
	[0.016]	[0.028]	[0.001]	[3.165]	[0.197]
Observations	130	287	239	171	140
Clusters	22	73	51	29	23
Bandwidth	97.6	265.5	211.7	150.8	115.3
Wild Cluster Bootstrap p-value	0.441	0.890	0.138	0.159	0.242
Mobility Restricting Mean	0.017	0.065	0.001	10.535	0.776
Mobility Restricting SD		0.698	0.007	46.422	1.134

Notes: Standard errors clustered by DHS survey cluster are in parentheses. Regressions estimate a local linear RD specification on each side of the border using a triangular weighting kernel and include age, age squared, a female indicator, longitude, and year fixed effects as controls. Specifications use the MSE-optimal bandwidth in kilometers (Calonico, Cattaneo and Titiunik, 2014).

E5. Development Results Using Census Data

Table E5: Human Capital Results Using Census Data [37]

	Literate		Any Schooling	
	Females (1)	Males (2)	Females (3)	Males (4)
Migrant Sending	0.033	0.024	0.046	0.068
	(0.078)	(0.074)	(0.066)	(0.072)
	[0.066]	[0.057]	[0.065]	[0.069]
Observations	24,801	24,125	21,330	13,224
Clusters	14	15	13	10
Bandwidth	129.0	135.9	118.5	98.9
Wild Cluster Bootstrap p-value	0.827	0.889	0.760	0.754
Mobility Restricting Mean	0.361	0.597	0.450	0.661

Notes: Standard errors clustered by DHS survey cluster are in parentheses. Regressions estimate a local linear RD specification on each side of the border using a triangular weighting kernel and include age, age squared, a female indicator, longitude, and year fixed effects as controls. Specifications use the MSE-optimal bandwidth in kilometers (Calonico, Cattaneo and Titiunik, 2014).

E6. Civil War Violence

Table E6: Violent Events and Deaths in Mozambique's Civil War

	Any Event (1)	Log(Events+1) (2)	Any Death (3)	Log(Deaths+1) (4)
Panel A. Global Terrorism Database				
Migrant Sending	-0.002	-0.019	-0.008	-0.036
	(0.012)	(0.019)	(0.013)	(0.046)
	[0.014]	[0.021]	[0.014]	[0.050]
Observations	138	115	118	117
Clusters	23	19	20	19
Bandwidth	98.8	89.1	92.4	91.0
Wild Cluster Bootstrap *p*-value	0.906	0.589	0.669	0.637
Mobility Restricting Mean	0.015	0.000	0.000	0.000
Mobility Restricting SD		0.000		0.000
Panel B. Uppsala Conflict Data Program				
Migrant Sending	-0.039	-0.024	0.014	0.027
	(0.076)	(0.055)	(0.063)	(0.128)
	[0.053]	[0.038]	[0.048]	[0.093]
Observations	147	140	180	153
Clusters	24	23	30	27
Bandwidth	115.5	102.8	143.9	122.6
Wild Cluster Bootstrap *p*-value	0.616	0.674	0.852	0.886
Mobility Restricting Mean	0.030	0.021	0.038	0.026
Mobility Restricting SD		0.121		0.217

Notes: Standard errors clustered by DHS survey cluster are in parentheses. Regressions estimate a local linear RD specification on each side of the border using a triangular weighting kernel and include age, age squared, longitude, and year fixed effects as controls. Specifications use the MSE-optimal bandwidth in kilometers (Calonico, Cattaneo and Titiunik, 2014).

E7. Landmines

Table E7: Known and Suspected Landmines, October 2007

	Any Landmine (1)	Landmines (2)	Log(Landmines+1) (3)
Migrant Sending	0.039	-0.358	-0.078
	(0.135)	(0.604)	(0.220)
	[0.095]	[0.320]	[0.120]
Observations	202	198	207
Clusters	35	34	37
Bandwidth	157.8	153.2	173.8
Wild Cluster Bootstrap p-value	0.697	0.286	0.561
Mobility Restricting Mean	0.297	0.843	0.363
Mobility Restricting SD		2.072	0.626

Notes: Standard errors clustered by DHS survey cluster are in parentheses. Regressions estimate a local linear RD specification on each side of the border using a triangular weighting kernel and include age, age squared, longitude, and year fixed effects as controls. Specifications use the MSE-optimal bandwidth in kilometers (Calonico, Cattaneo and Titiunik, 2014).

E8. Randomization Inference: Age-Disparate Partnerships

Table E8: Age-Disparate Partnerships [40]

	Full Sample		Married		
	Women (1)	Men (2)	Women (3)	Men (4)	Women (5)
Panel A. Male-Female Age Gap	*Last Sexual Partner*				*Spouse*
Migrant Sending	-1.085	-0.678	-1.063	-1.758	-1.010
	{0.078}	{0.454}	{0.162}	{0.090}	{0.000}
Observations	236	126	202	93	5,245
Clusters	20	20	20	20	10
Bandwidth	-77, 52	-77, 52	-77, 52	-77, 52	-78, 77
Mobility Restricting Mean	6.88	5.79	6.98	7.33	8.34
Mobility Restricting SD	5.04	4.92	5.09	5.18	6.71
Panel B. Partners	*Multiple Sexual Partners Last Year*				*Polygyny*
Migrant Sending	-0.001	-0.110	0.001	-0.103	-0.021
	{1.000}	{0.068}	{1.000}	{0.234}	{0.752}
Observations	494	235	351	148	351
Clusters	20	20	20	20	20
Bandwidth	-77, 52	-77, 52	-77, 52	-77, 52	-77, 52
Mobility Restricting Mean	0.03	0.28	0.01	0.34	0.35

Notes: .

E9. Results Using Data Collapsed into Clusters: Marriage

Table E9: Age-Disparate Partnerships [40]

	Full Sample		Married		
	Women (1)	Men (2)	Women (3)	Men (4)	Women (5)
Panel A. Male-Female Age Gap	*Last Sexual Partner*				*Spouse*
Migrant Sending	-4.369	-1.103	-2.642	-0.653	-0.523
	(1.494)	(1.147)	(1.313)	(1.462)	(0.324)
Observations	14	60	22	57	15
Kelly Exact *p*-value	0.263	0.596	0.120	0.721	0.188
Moran *I* *p*-value	0.026	0	0.419	0.124	0.087
Panel B. Partners	*Multiple Sex Partners Last Year*				*Polygyny*
Migrant Sending	-0.054	-0.126	-0.027	-0.163	-0.108
	(0.052)	(0.097)	(0.031)	(0.088)	(0.052)
Observations	37	46	33	57	26
Kelly Exact *p*-value	0.597	0.212	0.511	0.098	0.130
Moran *I* *p*-value	0.008	0.320	0.014	0.134	0.709

Notes: .

E10. Second-Order Effects of Age Disparities

Table E10: Risk Factors Associated with Age Disparities [43]

	Virgin: Ages 15-24 (1)	Condom Last Sex (2)	Forced Sex Ever (3)	Decide Own Health (4)
Migrant Sending	-0.032	0.090	-0.007	-0.015
	(0.034)	(0.054)	(0.040)	(0.073)
	[0.044]	[0.070]	[0.027]	[0.090]
Observations	495	477	249	351
Clusters	58	26	22	22
Bandwidth	156.5	80.8	95.7	97.9
Wild Cluster Bootstrap p-value	0.497	0.300	0.869	0.870
Mobility Restricting Mean	0.176	0.086	0.080	0.261

Notes: Standard errors clustered by DHS survey cluster are in parentheses. Regressions estimate a local linear RD specification on each side of the border using a triangular weighting kernel and include age, age squared, longitude, and year fixed effects as controls. Specifications use the MSE-optimal bandwidth in kilometers (Calonico, Cattaneo and Titiunik, 2014).

E11. Public-Sector Health Infrastructure

Table E11: Public-Sector Health Facilities, 2018 [37]

	Any Facility (1)	Facilities (2)	Log(Facilities+1) (3)
Migrant Sending	-0.034	-0.114	-0.037
	(0.098)	(0.211)	(0.109)
	[0.150]	[0.212]	[0.127]
Observations	178	147	147
Clusters	29	24	24
Bandwidth	139.8	113.8	116.0
Wild Cluster Bootstrap p-value	0.825	0.658	0.803
Mobility Restricting Mean	0.375	0.552	0.328
Mobility Restricting SD		0.858	0.447

Notes: Standard errors clustered by DHS survey cluster are in parentheses. Regressions estimate a local linear RD specification on each side of the border using a triangular weighting kernel and include age, age squared, a female indicator, longitude, and year fixed effects as controls. Specifications use the MSE-optimal bandwidth in kilometers (Calonico, Cattaneo and Titiunik, 2014).

E12. HIV Risk Factors Unrelated to Institutions' Histories

Table E12: Unrelated HIV Risk Factors

	Genital Ulcer in Last Year		Paid for Sex	Medically Circumcised
	Women (1)	Men (2)	Men (3)	Men (4)
Migrant Sending	0.061	0.027	0.015	0.031
	(0.028)	(0.014)	(0.081)	(0.175)
	[0.030]	[0.017]	[0.062]	[0.079]
Observations	414	235	196	443
Clusters	19	26	38	54
Bandwidth	54.7	85.0	148.2	152.8
Wild Cluster Bootstrap p-value	0.077	0.216	0.838	0.846
Mobility Restricting Mean	0.005	0.008	0.085	0.192

Notes: Standard errors clustered by DHS survey cluster are in parentheses. Regressions estimate a local linear RD specification on each side of the border using a triangular weighting kernel and include age, age squared, longitude, and year fixed effects as controls. Specifications use the MSE-optimal bandwidth in kilometers (Calonico, Cattaneo and Titiunik, 2014).