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

Jon Denton-Schneider†

Clark University

April 4, 2023

Most Recent Version Here

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, Elyce Rotella, Augustin Tapsoba, Laura Taylor, Felipe Valencia Caicedo, and conference and seminar participants at Arizona, Clark, DemSemX, Development Day, EHA, Michigan, MWEHC, NBER SI DAE, NEUDC, RIDGE, 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.

†Clark University, Department of Economics, 950 Main St, 219 Jonas Clark Hall, Worcester, MA 01610. Email: jdentonschneider@clarku.edu. Website: jondentonschneider.com.

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.

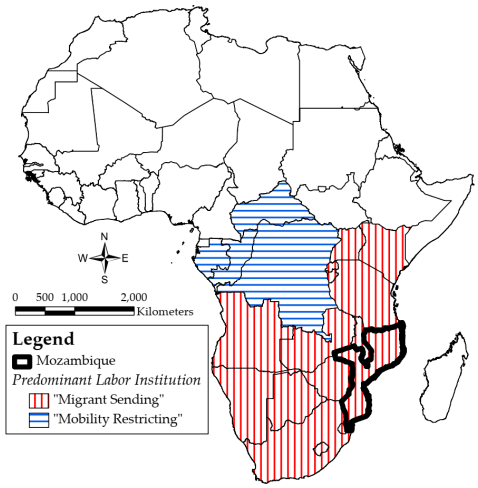
Because the two institutions (henceforth migrant-sending and mobility-restricting) organized much of colonial economic activity in their respective macro-regions, they likely had significant impacts on the historical trajectories of these parts of Sub-Saharan Africa. It is notable that today, the countries there have many of the world's highest HIV prevalence rates and are among its poorest. To effectively combat such 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 or one promoting inclusive prosperity (in the Acemoglu and Robinson, 2012, terminology). Instead, it was between *different forms of extraction*. Comparing these regimes and tracing their impacts through history can thus shed light on why disparities in HIV prevalence and poverty exist between and even within African countries, but 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 com-

[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. As 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 with bolded borders.

parisons 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 a 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.

I exploit this 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 limited across the border to keep wages low and labor conscriptable.

Because the ethnic group split by the institutional border (and those nearby) 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. First, Portuguese colonial officials heavily taxed these wages, making the colonial state "the

chief recipient of the profits of [circular migration, which] . . . held back the development of southern Mozambique" (Harries, 1994, p. 175). And second, the massive increase in the number of young men who could enter the marriage market earlier than was previously possible led to bride price inflation that consumed much of their post-tax wages, and what was left over was more likely to be spent on producing more children (Junod, 1912; Harries, 1983, 1994). As a result, little of circular migrants' high wages may have been invested in physical or human capital.

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 the arbitrary border between the two institutions in a geographic regression discontinuity (RD) design, which estimates the impact of a region's historical assignment to the migrant-sending institution relative to the mobility-restricting one.

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. While young men's marriage rates just inside the migrant-sending region were 25 p.p. higher while the border still existed, they remained substantively higher (9 p.p.) in 1960. There were also 0.26 more children per woman, a proxy for fertility, on this side of the border in 1940, though there is little robust evidence that this difference continued into 1960. But when comparing children's enrollment rates given their correlation with economic development, I find that, if anything, boys just on the migrant-sending side of the border were somewhat less likely to be in school in either period.[3] As such, these results suggest

[3] 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. An important caveat when interpreting these results is that there were changes in the (very limited) provision of schooling for Black Mozambicans across the colony during this period (Morier-Genoud, 2019; Fernández Cebrián, 2021), so these results should not be attributed to demand-side factors alone.

that the institutional differences led to lasting differences in marriage markets and short-run differences in fertility but are consistent with the lack of an effect on development.

To rationalize the slow equalization of marriage outcomes across the border and to conceptualize how it could affect the present day, I develop in Section 5 an overlapping generations model of a marriage market with bride price that adapts the frameworks in Tertilt (2005) and Corno, Hildebrandt and Voena (2020) by abstracting away from capital and having wages depend on age and sex. At baseline, young men and young women earn less than old men, so the bride price is unaffordable for young men and all marriages are between old men and young women. I then study what happens after a shock raises wages for a share of young men well above those of old men (i.e., circular migration becomes possible).[4] In the first post-shock period, the share of marriages that are age-disparate falls as high-wage young men enter the marriage market, and fertility rises as they can afford more children. In the second period, the age-disparate marriage share continues to decline as men who married last period do not re-enter the marriage market in old age, and fertility falls but remains elevated relative to the baseline value.[5] At this point, the marriage market has effectively transitioned to the new steady state.

I map these predictions onto the southern Mozambican context by assuming that a generation is 35 years – a high but not unreasonable value (Wang et al., 2023) – and setting the timeline so that one of the periods aligns with 1940. This setup allows me to use this year as the final pre-shock period in the mobility-restricting region and 1870 as the analogous period in the migrant-sending region. Therefore, the model predicts that there should be large differences in the share of age-disparate marriages along the border in 1940, which would shrink but remain visible by 1975 and, in the absence of other changes (e.g., Mozambique's 1977-92 civil war), would not fully disappear until 2010. In terms of fertility, the migrant-sending region would have higher rates through 1940, after which the mobility-restricting region's rates would surpass it in 1975 before converging in 2010. But given the migrant-sending region's head start, it should have greater population density in all periods.

I then discuss the implications of the colonial-era results and these predictions for health and wealth outcomes in this setting through the lens of the public health literature and economic intuition. Because Mozambique's first case of HIV was not until the mid-1980s, the convergence in circular migration rates by 1960 should have equalized this risk factor for the virus's transmission along the border. Instead, the main HIV risk factor

[4] Old men were far less likely to be circular migrants because mine labor was arduous.

[5] The marriage arises from the assumption that old fathers experience disutility from work and thus prefer to consume from their daughters' bride prices.

that likely differed between these regions was age disparities between partners: namely, they should have been lower in the former migrant-sending institution from the time that the virus arrived in the country. 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 should be lower on this side of the institutional border.[6] In contrast, the convergence in circular migration should have equalized wages in these regions. If men in the migrant-sending region used the period before the border was erased to invest in children's quantity rather than their quality or physical capital, then measures of economic development just inside this region should not be significantly different today from those in the mobility-restriction region, though population density may be greater in the former.

As I show in Section 6, the present-day results are consistent with these 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 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, I find no differences at the border today in wealth or schooling, suggesting equal levels of development, and there is some weak evidence of greater population density just inside the former migrant-sending region.

I then investigate in Section 7 the factors that might explain the large discontinuity in HIV prevalence at the border. I show that there are indeed substantially smaller age disparities between spouses and sexual partners in the former migrant-sending region. I also find weak evidence that risk factors associated with larger age gaps (Evans et al., 2019; Mabaso et al., 2021) – i.e., stemming from unequal bargaining power – are less common there as well. Because I find no evidence to support a number of other potential explanations (e.g., genital ulcers, transactional sex), these findings are consistent with the long-lasting effects of the institutional differences being the main channel for the HIV result. In fact, a mediation analysis using the Imai, Keele and Tingley (2010) framework estimates that the age disparity channel accounts for nearly one-quarter of the discontinuity in the virus's prevalence.

Lastly, in Section 8, I examine whether these findings might have validity beyond the southern Mozambican context. First, I frame the results above as the effect of greater historical exposure to circular migration (i.e., prior to the arrival of the virus), so I do not

[6] 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.

expect to find the main HIV result outside of this context but rather examine whether the same marriage market channels appear. To do so, I combine the georeferenced historical locations of migrant labor recruitment posts across Southern African countries with the DHS data to show that present-day distance from a post – which I assume captures greater difficulty of engaging in circular migration – is strongly associated with higher partner age gaps. While this relationship does not come close to eliminating the expected migration-HIV relationship, I find evidence that it does have an important mitigating effect, which is consistent with external validity for the marriage market channel that I found in Mozambique.

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 et al., 2022). 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.

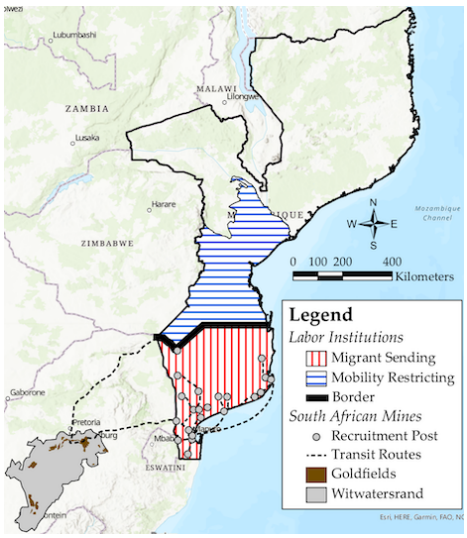
2.1. Assignment of Territory to Government or Company Rule

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.[7] 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).[8]

[7] 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.

[8] 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.

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 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 preexisting labor flows across the international border with the then-Transvaal Republic (the northeast of present-day South Africa).[9] 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).[10] 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).[11] 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

[9] 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.

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

[11] 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 B2 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."[12]

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.

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

[12] 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 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.

(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.[13]

In spite of this institution's end, the extraction of wealth from labor continued throughout 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 B2) 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).[14]

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 funding and inadequate staffing impacted the data collection process, although there is

[13] 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).

[14] 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).

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 also include fertility and human capital because of their relationship with development as well as the ease of measuring them 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.[15] 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.[16] For human capital accumulation, the outcome of interest is the share of boys and girls ages 5 to 14 enrolled in school at enumeration.[17]

3.1.2. Georeferenced Sample

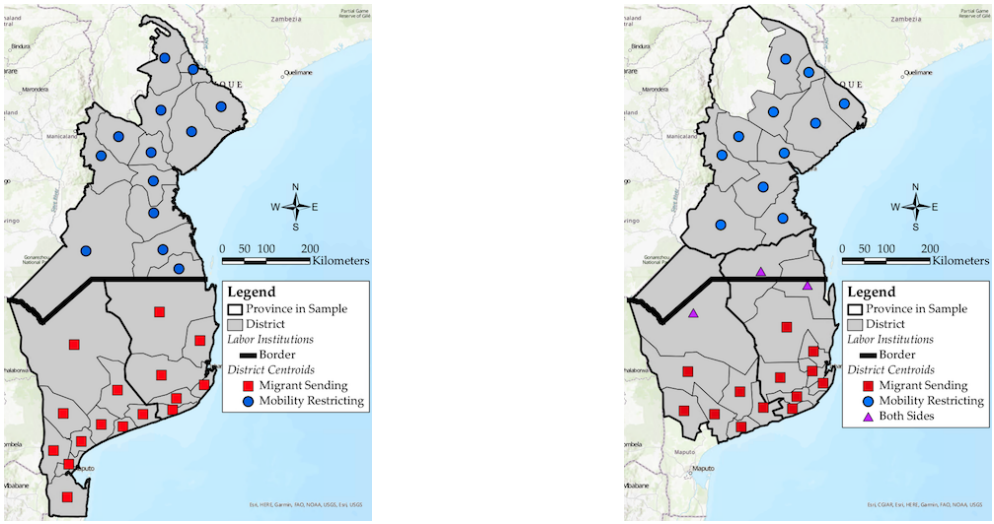
I match these district-level data to administrative maps of Mozambique from each year (Saldanha, 1940; Ministério do Ultramar, 1959). Figure 3 shows district boundaries and centroids in the areas under the two institutions in 1940 and 1960. I restrict the sample to districts within the two provinces south of the institutional border and the one north

[15] 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.

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

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

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.

of it, and exclude the two major cities when the census summaries report their data separately.[18] 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 the effects on the results.

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.[19] 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

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

[19] 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.

capture east-west trends.[20] 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, mirroring the choice between imposing different extractive institutions that faced many European colonial powers. I examine the border's arbitrariness below.

3.2.1. Addressing Concerns with Estimation and Inference

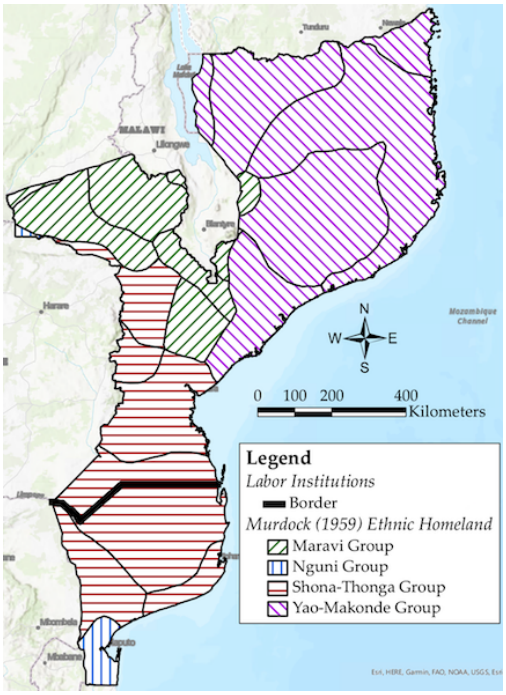
One issue for estimating τ with the 1960 data is that there are districts with area on both sides of the border. To the extent that they group observations from one institution with those from the other, these districts will tend to obscure differences between the two and thus bias RD point estimates toward zero. I highlight them in the RD plots so the influence they have on the estimation is clear. Other issues that affect both census years are the low density of observations along the border and the potentially large bandwidth that is not necessarily MSE-optimal. I thus complement the 1940 and 1960 RD estimates with the finite-sample randomization inference procedure developed by Cattaneo, Frandsen and Titiunik (2015), which is motivated by the first of these issues. I restrict the sample in these robustness checks to the 5 districts in each institutional zone with centroids closest to the border.[21]

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.,

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

[21] Given the context, I consider these tests to be far more informative than those preserving the traditional RD setup but varying the weighting kernel, polynomial order, and other estimation choices, as they are as problematic as my baseline specification when there are few observations near the cutoff.

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.

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 t-statistics against those from 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 substantially 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 $\times$ 0.25 degree cells—approximately 25 km $\times$ 25 km in the study area—and estimate equation (1) clustering standard errors by third-level administrative unit ("administrative posts," shown in Figure 7b).[22] 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.

4. Effects of the Institutions during the Colonial Era

I now turn to comparing the institutions in terms of colonial-era labor markets, marriage and fertility, and human capital accumulation. 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 most robust results are that while both institutions existed, rates of circular migration and young men's marriage were higher just inside the migrant-sending region, and some evidence points to more fertility and less schooling for boys there as well. However, nearly two decades after the border was erased, only young men's marriage rates remained higher.

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

[22] See Section 6.2 for details on RD bandwidth selection when using geographically disaggregated data.

Table 2: Effects of the Institutions in the Colonial Era

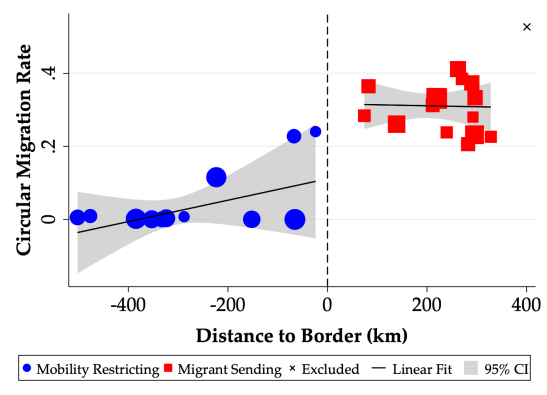
	Men Migrants (1)	Women Farming (2)	Married Ages 15-34 Men (3)	Married Ages 15-34 Women (4)	Children per Woman (5)	Boys in School (6)	Girls in School (7)
Panel A. 2 Years before End of Mobility Restricting Institution (1940)							
Migrant Sending	0.200	0.004	0.247	0.054	0.261	-0.034	-0.001
	(0.090)	(0.012)	(0.068)	(0.027)	(0.088)	(0.014)	(0.006)
	[0.087]	[0.010]	[0.070]	[0.030]	[0.089]	[0.011]	[0.006]
Observations	28	26	26	26	27	27	29
Bandwidth	-503, 329	-503, 401	-503, 329	-503, 329	-503, 401	-503, 401	-503, 401
Kelly Exact *p*-value	0.087	0.817	0.042	0.279	0.000	0.246	0.863
Mobility Restricting Mean	0.047	0.975	0.611	0.874	0.847	0.042	0.006
Mobility Restricting SD					0.150		
Panel B. 18 Years after End of Mobility Restricting Institution (1960)							
Migrant Sending	-0.058	0.000	0.085	0.057	0.080	-0.014	-0.008
	(0.046)	(0.002)	(0.063)	(0.056)	(0.076)	(0.033)	(0.022)
	[0.046]	[0.002]	[0.060]	[0.051]	[0.072]	[0.029]	[0.020]
Observations	25	25	25	28	26	28	26
Bandwidth	-500, 294	-500, 294	-500, 294	-500, 294	-500, 294	-500, 294	-401, 294
Kelly Exact *p*-value	0.993	0.989	0.002	0.180	0.090	0.957	0.940
Mobility Restricting Mean	0.124	0.997	0.355	0.678	0.847	0.089	0.049
Mobility Restricting SD					0.090		

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.

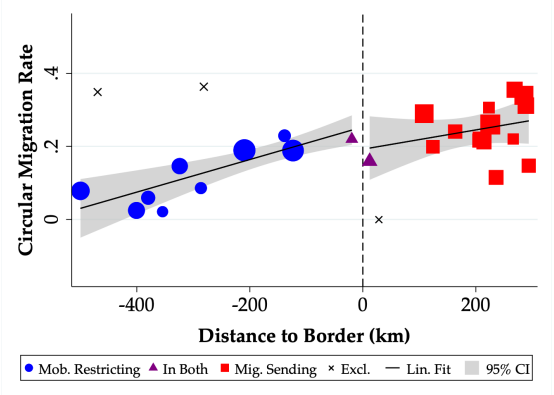
were 20 p.p. more likely to be circular migrants. The effect size is very large given that just 5 percent of men across the border worked abroad, it is precisely estimated, and this precision does not appear to be overstated due to spatial autocorrelation. Figure 5a shows that only in three districts under the mobility-restricting institution were any men circular migrants, two of which were along the border. Importantly, there was substantial heterogeneity in working abroad by age. Appendix C1 shows that rates of circular migration changed far more at the border among men ages 15 to 34 than ages 35 to 54 (28 p.p. versus 12 p.p.) as working abroad became less common with age. This pattern is consistent with narratives regarding young men's motivations to engage in circular migration and the physical fitness required to work in the gold mines.

However, Panel B Column (1) shows convergence in men's circular migration 18 years after the mobility-restricting institution ended, when 12 percent of men from this region worked abroad. Figure 5b shows this convergence visually, which does not appear to arise from including districts with area on both sides of the border. These results imply that the labor institutions substantially impacted men's occupations, but the border's

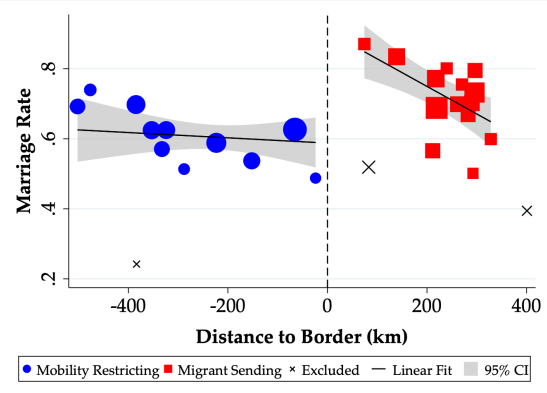
Figure 5: RD Plots for Colonial-Era Differences between Institutions



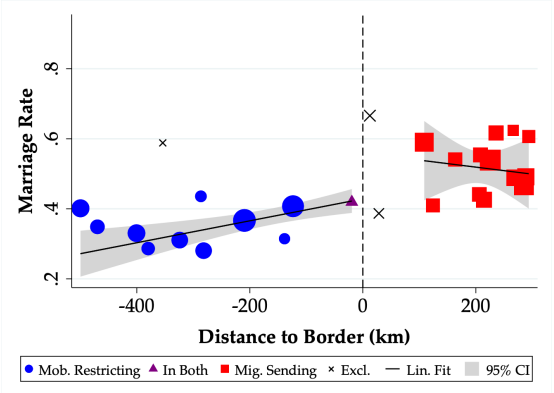
(a) Circular Migration in 1940: Men 15-64



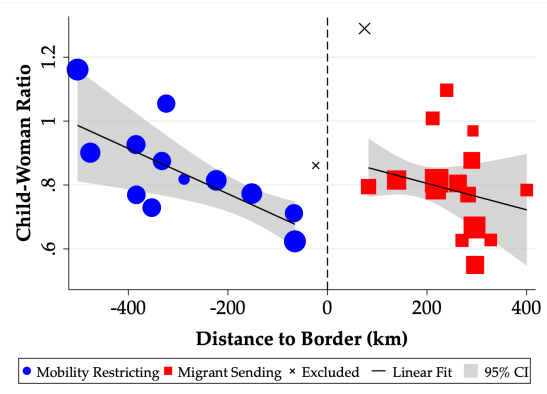
(b) Circular Migration in 1960: Men 15-64



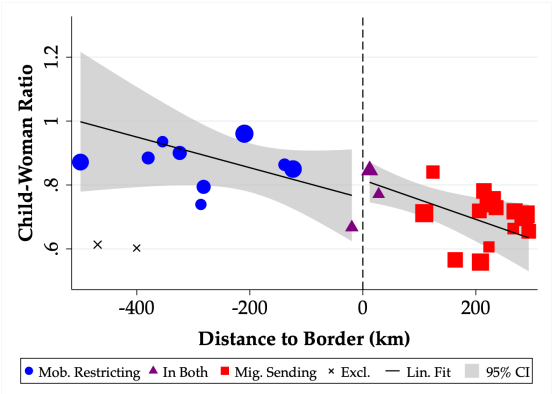
(c) Marriage in 1940: Men 15-34



(d) Marriage in 1960: Men 15-34

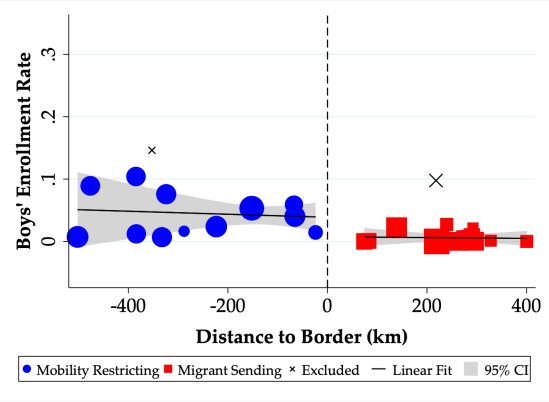


(e) Children per Woman in 1940

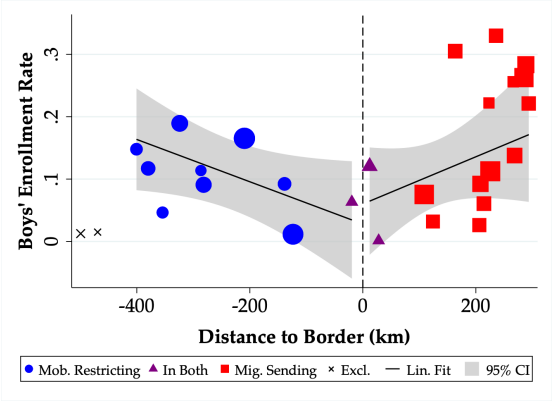


(f) Children per Woman in 1960

Figure 5: Continued



(g) Boys' Enrollment Rate in 1940



(h) Boys' Enrollment Rate in 1960

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.

erasure led to major changes in this respect in the former mobility-restricting zone.

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 women working in agriculture, and there was no 1940 difference by age group in Appendix C1. These results suggest that the institutions did not affect women's responsibility for food production, which may have been what 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 marriage market impacts should have been most apparent in this range. Panel A Column (3) shows that while the two institutions still existed, there was a 25-p.p. increase at the border in marriage rates among these men. The point estimate is large relative to rates in the mobility-restricting institution (61 percent), precisely estimated, and appears robust to concerns over spatial autocorrelation. 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 (8.5 p.p.).[23] Figures 5c and 5d show these discontinuities across time.

Another striking contrast is with the results for women in the same age group: in neither panel is there a robust, comparably sized discontinuity in Column (4) for their marriage rates. It thus raises the possibility that marriage market matches in the migrant-sending 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

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 Malthusian dynamics prevailed in this subsistence agricultural economy. As with circular migration and men's marriage rates, Panel A Column (5) shows that there was an additional 0.26 children per woman just inside the migrant-sending region in 1940, which is large relative to the mean of 0.85 in the mobility-restricting region. This discontinuity is also precisely estimated and does not appear to be a product of spatial autocorrelation. Figure 5e shows the corresponding RD plot. The positive response of fertility to circular migration (and its higher wages) suggests that these higher wages may have been consumed by additional children, which would work against them causing a long-run increase in living standards.

In a similar vein as the results for men's marriage, Panel B Column (5) shows that the estimate for this fertility proxy in 1960 is smaller than the one for 1940 (8 p.p.), though it is imprecise. The reduction in the discontinuity's size is again consistent with fertility responding positively to circular migration as greater shares of men from the former mobility-restricting region began to work on the Witwatersrand. Indeed, the RD plot in Figure 5f suggests that fertility had converged to a much greater extent than marriage rates. In Section 5, I discuss why the former may have adjusted more quickly.

[23] It is somewhat imprecise according to conventional methods, though the spatial randomization inference p-value is exceptionally small ($p = 0.002$).

4.3. Human Capital Accumulation

Finally, I examine whether the institutions differentially affected children's enrollment rates. Panel A Column (6) shows that before the end of the mobility-restricting institution, boys just inside the migrant-sending region were 3.4 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, though spatial autocorrelation may overstate its precision. It also suggests that that men's circular migration and boys' education were negatively related, consistent with either higher expected returns from brawn than brains, a preference for children's quantity rather than quality (as the fertility results may reflect), or both. As with the child-woman ratio, the 1960 estimate for boys' schooling in Panel B Column (6) is smaller and more imprecise. However, neither panel shows detectible effects on girls' schooling in Column (7). Taken together, these results suggest that fewer boys may have received schooling in the migrant-sending zone while both institutions existed, but after the border was erased, any substantive differences disappeared.[24]

4.4. Robustness and Ruling out Alternative Explanations

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 C3 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 randomization inference point estimates for circular migration and young men's marriage in 1940 and 1960 are consistent with those in Table 2, and the marriage results have statistically significant randomization p-values. But for the fertility proxy and boys' schooling, the 1940 estimates are smaller in magnitude (8.7 p.p. and -1.4 p.p.) and insignificant (p-values of 0.192 and 0.550), while the 1960 estimates have the opposite signs (-9.1 p.p. and 2.2 p.p.).

I also examine in Appendix C4 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 can also rule out any differences in Protestant or Catholic missionary presence earlier in the 1900s.[25] These

[24] As the mobility-restricting institution was ended at the same time as schooling provision expanded across the colony, any effects should be attributed to this joint treatment, not institutional changes alone.

[25] 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.

null results imply that neither the colonial state's nor missionary investments differed along the border, which helps to exclude them as channels through which the institutions might affect the present.

5. Linking Past and Present

The colonial-era results in the previous section raise two main questions. First, why did young men's marriage rates continue to be higher just inside the migrant-sending institution after the institutional border was erased and circular migration rates converged? And second, if such differences (or lack thereof) in this area continued to today, what would the implications be for health and wealth outcomes?

In this section, I provide an answer to the first question by developing and summarizing the predictions of a simple overlapping generations model of a marriage market with brideprice and polygyny, with proofs presented in Appendix D. I borrow heavily from the general equilibrium setup in the Tertilt (2005) model but make several assumptions in the spirit of Corno, Hildebrandt and Voena (2020), including abstracting away from savings and capital and adding exogenous wage heterogeneity by age (young and old) and sex (male and female).[26] My interest is in what happens to marriage and fertility following a positive shock to young men's wages (i.e., the ability to engage in circular migration). To answer the second question, I map the model's predictions onto the southern Mozambican context and discuss their implications for HIV prevalence and development through the lens of the public health literature and economic intuition.

5.1. Model 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. In the case of widows, I assume she runs her late husband's household exactly as he would have. After individuals are born, whether they survive childhood depends on their parents' choices (discussed below). If they do, they live for 2 periods of adulthood, young (Y) and old (O). Men are fecund for both while women are only when young. The discount factor is $\beta \in (0, 1)$.

[26] 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 – Portuguese employers using forced labor and Witwatersrand mining companies – receives investment from European capital markets rather than agents in the model and women work in subsistence agriculture, it is reasonable that Mozambicans' savings would have little to no role in this context.

5.1.1. *Timing and Decisions*

At the beginning of a period, all young men work due to forced labor laws while old men can choose to supply an indivisible unit of labor, $\ell_t^O \in \{0,1\}$, a decision that is affected by whether they had children in the last period, as explained below. Those who work earn age-dependent incomes y^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 in exchange for the marital transfer p_t, giving their husbands control over their reproductive capacity and future labor income.[27] I assume that bride prices can only be paid from a man's wages, so he must earn at least the market-clearing price to marry in that period (i.e., if $y^A < p_t$, then $w_t^A = 0$).[28]

After these transfers occur, the marriage market closes and young women work in subsistence agriculture, which contributes y^F to their (new) household's budget. Married men with fecund wives then choose to have $2n_t^A \geq 0$ children. As in Tertilt (2005), there is an equal sex ratio, polygynous men split their children equally across their wives, and children survive at a total cost of $\frac{\psi(n_t^A)^2}{w_t^A}$, $\psi > 0$. Following the birth of children, households consume from the remainder of men's wages, women's agricultural production, and the bride prices of any daughters married off in this period. Once these decisions are made, all old adults die, young adults become old, surviving children become young adults, and the period ends.

5.1.2. *Preferences and Budget Constraints*

Men value the consumption of the household they head with log utility and the discount factor β. Therefore, all daughters will be married off while they are young, $d_t^A = n_t^A$, as potential husbands will not pay for infecund wives. In this patrilineal society, men also value continuing their lineages. In the first period in which they have children, men experience a utility gain of the log of the number of children born in that period scaled by $\lambda \in (0,1)$, which reflects the importance placed on lineages. But if a young man ensures his lineage's continuity, he does not derive any utility from additional children when he is old.[29] In addition, if a man had children in the previous period, he would strongly prefer to spend time with them rather than work, so the (dis)utility men experience from

[27] The quantities w_t^A and d_t^A are best thought of as the average number for men in a generation.

[28] This assumption allows the higher-wage generation to price (some of) the other one out of marriage.

[29] The role of this assumption is to ensure that men only marry and have children once, which occurs in the Tertilt (2005) model because they choose to do so when it is cheapest in discounted terms. Because I abstracted away from capital, there is no intertemporal budget constraint, so an analogous mechanism is not available.

their old-age labor supply decision is $\log(1 - \mathbb{1}[n_{t-1}^Y > 0] \cdot \ell_t^O)$. Clearly, this preference implies that no old father will work.[30]

If wages for young men are too low, they will not be able to marry until old age, making their only option to consume their entire incomes while young. Substituting in the period budget constraint, their problem after reaching old age in period t becomes

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

Conversely, if young-age incomes are high enough, men will marry and have children when young and consume from only their daughters' bride prices when old. Their problem as young men in t is thus

$$\max_{w_t^Y, n_t^Y \geq 0} \log\left[y^Y - w_t^Y(p_t - y^F) - \frac{\psi(n_t^Y)^2}{w_t^Y}\right] + (\beta + \lambda) \log(n_t^Y), \tag{3}$$

which is identical to (2) except for the superscripts and the addition of utility from old-age consumption.

5.1.3. Marriage Market Clearing and Population Dynamics

Because fathers will marry off every daughter when she is young, equating the supply of brides with demand for them yields

$$1 = w_t^Y + \frac{w_t^O}{1 + \gamma_{t-1}}, \tag{4}$$

where $1 + \gamma_{t-1} = \frac{N_t}{N_{t-1}}$ is the growth rate of the young adult population of each sex from period $t-1$ to t. This number was determined in the previous period by the reproductive choices of men married to young women. Along similar lines as above, this population's law of motion is

$$1 + \gamma_t = n_t^Y + \frac{n_t^O}{1 + \gamma_{t-1}}. \tag{5}$$

[30] This assumption greatly simplifies the math and allows for closed-form solutions that provide clear intuition. Another way to achieve this result would be to assume a large but finite disutility from working in old age for all men regardless of fatherhood status, which would induce only single men to work to avoid the infinite pain from failing to continue their lineages.

5.2. *Model Predictions*

I solve for the equilibrium of this marriage market defined by the optimal choices in (2) and (3) taking wages and the bride price as given, the marriage market clearing as in (4), and population evolving as in (5).

5.2.1. Baseline Wage Regime: Steady State

The first proposition describes the steady state in the baseline case of low wages for young men, which maps onto the periods prior to the start of circular migration. The main prediction is that all young men are priced out of the marriage market.

Assumption 1. *Young men's wages do not exceed the value of young women's subsistence agricultural production by more than a certain amount, whereas old men's wages do:* $y^Y < y^F + \psi(1+\gamma_0)^2 < y^O$*, where* $1+\gamma_0$ *is the constant rate of population growth.*

Proposition 1. *Suppose that Assumption 1 holds. Then in the steady state of this marriage market with constant population growth, the bride price* p_0 *is unaffordable for young men, so only old men can marry. Therefore, all women are in age-disparate marriages* ($D_0 = 1$)*.*

Proof. See Appendix D1.

□

5.2.2. New Wage Regime: First Period

The next proposition characterizes what happens to an economy in the steady state above after a share ϵ of young men start to earn much higher wages $\tilde{y}^Y > y^O$, which is analogous to the first period in which circular migration became possible.[31] The main predictions are that high-wage young men can now enter the marriage market, which reduces the share of young women marrying old men, and their high wages increase the population growth rate.

Assumption 2. *Old men's wages exceed young women's by a greater amount than in Assumption 1:* $y^O > y^F + \psi(1+\gamma_0)^2 + \frac{(\beta+\lambda)\epsilon\tilde{y}^Y}{2(1+\beta+\lambda)}$.

Proposition 2. *Suppose that the marriage market is in the baseline steady state described above. If a share* ϵ *of young men begin to earn wages* $\tilde{y}^Y > y^O$ *and Assumption 2 holds, then in the equilibrium for the first period under this wage regime, the bride price* $p_1 > p_0$ *continues to prevent young men with low wages from marrying, the growth rate of the population of young*

[31] This subset could be determined by migration costs that decline with idiosyncratic ability and increase strongly with age, yielding a threshold ability level that only high-ability young men exceed.

adults of each sex is $1 + \gamma_1 > 1 + \gamma_0$*, and young men with high wages can marry. As a result, this period's share of young women in age-disparate marriages is* $D_1 < D_0$*.*

Proof. See Appendix D2.

□

5.2.3. New Wage Regime: Subsequent Periods

Lastly, I examine the marriage market's continued adjustment to the new wage regime after the first period in which it was introduced. The main predictions are that the share of young women marrying old men continues to fall, as last period's high-wage young men do not re-enter the marriage market in old age, while population growth falls but remains higher than the baseline steady-state level.

Assumption 3. *High wages for young men exceed a certain threshold:* $\tilde{y}^Y > \psi(1+\gamma_0)^2 \cdot \left[\frac{1-\epsilon}{1-\epsilon(1+\gamma_0)}\right]^2 \cdot \frac{2(1+\beta+\lambda)}{(\beta+\lambda)\epsilon}$.

Proposition 3. *Suppose that the marriage market in* $t \geq 2$ *has proceeded* $t-1$ *periods since reaching the equilibrium for the first period under the new wage regime described above. If Assumption 3 holds, then in the equilibrium for* t*, the bride price and population growth rate are less than in the first period but greater than in the baseline steady state, low-wage young men still cannot marry, old men who earned low wages last period as well as high-wage young men continue to marry. In addition, the share of young women in age-disparate relationships is lower than in the first period under the new wage regime* ($D_t < D_1$)*.*

Proof. See Appendix D3.

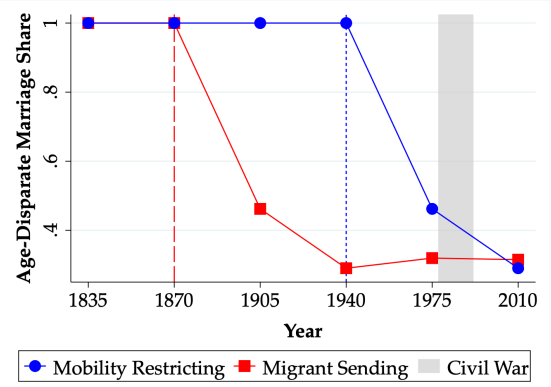
□

5.3. Mapping Predictions onto the Southern Mozambican Context

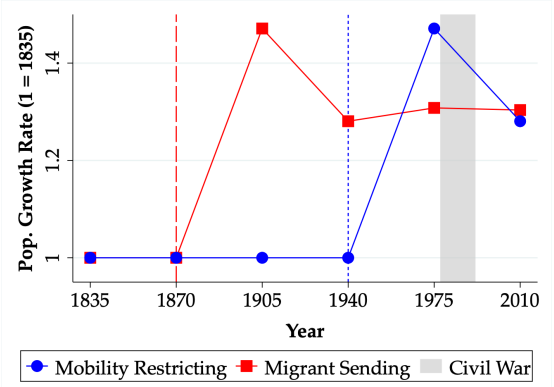
As I discuss more formally and illustrate graphically in Appendix D4, Proposition 3 implies that the transition from the baseline steady state to the new one is mostly complete after 2 periods. To understand the implications for the setting under study, I use a high but not unreasonable generation length of 35 years (Wang et al., 2023) and set the timeline so that one of the periods aligns with 1940. Doing so allows me to use this year as the last period before circular migration became possible in the mobility-restricting region, and it gives 1870 as the analogous year for the migrant-sending region.[32]

[32] Recall that gold was discovered on the Witwatersrand in 1886, which began the massive demand for circular migrant labor in South Africa.

Figure 6: Mapping Predictions onto the Southern Mozambican Context



(a) Age-Disparate Share of Marriages



(b) Population Growth Rate (Normalized)

5.3.1. *Marriage*

Under the parameter values in Appendix D4, Figure 6a shows the predicted dynamics of the share of age-disparate marriages. The 2-period adjustment process – the first high-wage men who enter the marriage market when young are also the first old men not to re-enter it – helps to rationalize why more young men just inside the former migrant-sending region were able to marry in 1960. The faster decline in the first period in which circular migration was possible also suggests that the much smaller RD estimate for this rate in Table 2 Panel B Column (3) relative to Panel A does not necessarily indicate that convergence would have continued at that rate. Indeed, absent the population displacement due to Mozambique's civil war, the model predicts that the full equalization of marriage rates would not have occurred until 2010.

5.3.2. *Population*

Figure 6b presents the predicted dynamics of fertility under the same parameter values. There is a different 2-period adjustment process in this case: population growth increases rapidly when high-wage young men and all old men marry and have children, but it declines from that peak after those high-wage young men become old and refrain from re-entering the marriage market. Nonetheless, it also helps to rationalize the decline in RD estimates across Panels A and B in Table 2 Column (5) – or even the reversal of their signs in the randomization inference in Appendix C3 – as population growth accelerated rapidly in the former mobility-restricting region. In addition, the greater number of periods of high fertility in the former migrant-sending region suggest that population levels should have been higher that side of the border, though the caveat about civil war displacement is especially important here.

5.4. Implications for Health and Wealth Outcomes

5.4.1. HIV Prevalence

Taking the colonial-era results and the model's predictions together, the clear implication for the distribution of HIV along the institutional border is that prevalence should be lower just inside the former migrant-sending region. At first glance, this notion appears counterintuitive because of the link between circular migration and HIV (Weine and Kashuba, 2012). However, the equalization of migration rates by 1960 – when the virus was just starting to spread beyond the Democratic Republic of the Congo (Faria et al., 2014) and over two decades before it was first detected in Mozambique (Audet et al., 2010) – should have eliminated differences in this transmission channel. Instead, a major HIV risk factor that likely changed at the border due to the institutions was age gaps between partners (Schaefer et al., 2017).[33] If they have been lower just on the former migrant-sending side since HIV's arrival, prevalence should be lower there today.[34]

5.4.2. Economic Development

In contrast, the colonial-era patterns and theoretical predictions suggest that there should be limited, if any, differences along the border in levels of economic development today. First, human capital investment (measured as school enrollment) was, if anything, historically lower on the migrant-sending side. Combined with the positive response of fertility to circular migration, these results suggest a prioritization of children's quantity rather than quality, so higher wages may have simply been consumed by a larger population instead of being invested in physical or human capital. And finally, convergence in circular migration rates after the border was erased should have eliminated any

[33] Intuitively, age gaps are a risk factor because older men are a very high-prevalence group in Sub-Saharan Africa. Younger women engaged in age-disparate relationships thus contract the virus from them at high rates, and as they age, they transmit it to men of similar ages, who then perpetuate the cycle (de Oliveira et al., 2017).

[34] Along with the mechanical effects modeled above, the cultural impacts of historical marriage patterns could also be important in generating continuity. Leclerc-Madlala's discussion of marriage, dating, and HIV in Southern Africa suggests how they might play a role in age-disparate relationships, which

> have antecedents in older practices that have long played a part in defining the nature of social life and the particular values and norms associated with sexuality. Many culturally inscribed assumptions and expectations that once legitimized these practices still prevail at present, and continue to influence the meanings that people attach to contemporary sexual relationships and the expectations that people have in relationships. (Leclerc-Madlala, 2008, pp. S22-S23)

differences in wages.[35]

6. Effects of the Institutions in the Present Day

Given the implications discussed 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 3 reports RD estimates for HIV prevalence and development outcomes, and Figure 8 presents graphical evidence on seroprevalence. These results show that, consistent with my predictions, HIV prevalence is much lower just inside the former migrant-sending institution but there are no substantive differences in measures of living standards today.

6.1. Data

For present-day HIV prevalence and economic development outcomes, I use georeferenced individual-level data from the 2009, 2011, 2015, and 2018 waves of the Demographic and Health Surveys (DHS) in Mozambique. Figure 7a shows the reported locations of the survey clusters within 175 km of the institutional border. These locations are slightly displaced for respondents' anonymity and privacy.[36] 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 that city's recent history (discussed in Appendix A), I remove these clusters from the sample. After doing so, all of the remaining ones are in the correct former institution. Below, I discuss the implications of not knowing their precise locations for the analysis.

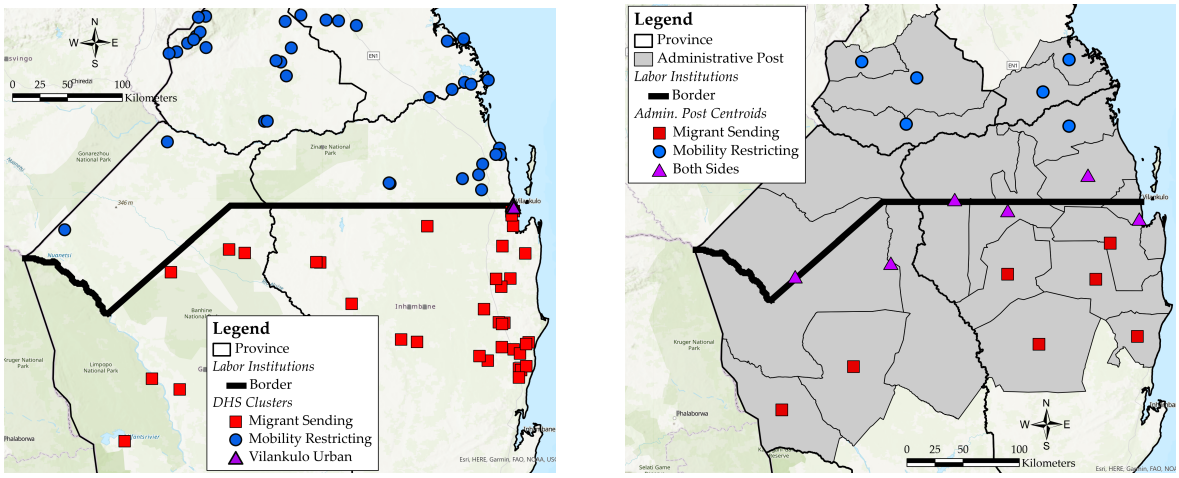
When it contains relevant outcomes, I also use the IPUMS 10-percent sample of the 2007 Mozambican census. However, these data are aggregated to third-level administrative units (administrative posts), which the map in Figure 7b of those with centroids within 150 km of the former border shows do not respect the former institutional border. I therefore consider it to be a complement to the DHS results, but one that suffers from issues discussed below.

The outcome of interest when examining HIV is the result of blood tests for the virus

[35] One channel through which it could have led to better living standards on the migrant-sending side is an earlier start to physical capital accumulation (Khanna et al., 2022), which I abstracted away from in the model. While it is not possible to test for such differences in the past, whether there are discontinuities in households' assets today is an empirical question I examine in the next section.

[36] 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 7: 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. Right map shows administrative posts with centroids within 200 km of the border.

from a random subset of respondents in 2009 and 2015. I restrict this analysis to adults ages 15 to 64.[37] For economic development, the variables of interest in the DHS 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).[38] In the census data, I focus on literacy and having ever attended school.

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 and census data and their greater geographic disaggregation allow for several additions to equation (1). I modify it to be

$$y_{i,u} = \alpha + \tau \text{MigrantSending}_u + f(\text{Distance}_u) + \text{Lon}_u + \mathbf{X}_i\beta + \delta_t + \epsilon_{i,u} \quad \text{for } u \in B^*_{\text{MSE}} \quad (6)$$

where $y_{i,u}$ is an outcome for individual i in geographic unit u (i.e., DHS survey cluster or administrative post) and the first three right-hand side variables are as before. I

[37] 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.

[38] 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.

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. These datasets have sufficiently many units 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 DHS clusters mentioned earlier. Because the displacement is random, it induces classical measurement error in the running variable, biasing the RD coefficients toward zero. In the census data, administrative posts that combine observations from each side of the border should have the same impact. As this effect was also present in the 1960 census data, I take the same approach and highlight in the RD plots the administrative posts with area on both sides so their effect on the estimation is clear.

For inference, I cluster standard errors by geographic unit, but the MSE-optimal bandwidths often contain only a "small" number of clusters. Therefore, when using the traditional RD design, I use the wild cluster bootstrap to calculate p-values as Cameron, Gelbach and Miller (2008) recommend. However, as the low density of clusters near the border can still cause problems in this setup, in Appendix F1 I complement the RD results with the Cattaneo, Frandsen and Titiunik (2015) randomization inference procedure, which is motivated by this scenario. 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 F2, 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.

6.3. Results: HIV Prevalence

I first examine the spatial distribution of HIV among adults along the institutional border. Table 3 Column (1) pools both sexes and shows that adult HIV prevalence drops 10 p.p. just inside the migrant-sending institution, and Figure 8a 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 E1 for these RD plots). However, after accounting

Table 3: 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).

for the number of clusters the male estimate is imprecise, likely as a result of the much smaller sample size.

To rationalize these large effect sizes, I compare the age profiles of HIV prevalence in the two institutions.[39] Specifically, I calculate the mean seroprevalence for each 10-year age group within the MSE-optimal RD bandwidth on each side of the border.[40] Figure 8b plots these age profiles, which show that HIV prevalence for every age group is lower in the former migrant-sending institution. It is most apparent for ages 25 to 34, when HIV prevalence peaks in the former mobility-restricting institution. These age profiles are consistent with the de Oliveira et al. (2017) HIV transmission cycle driven by age-disparate relationships: prevalence should peak at a lower level and in an older groups if partner age gaps (and thus transmission from high-prevalence men to young women) are lower.[41] In the next section, I test for such discontinuities in partner age gaps.

6.4. Results: Economic Development

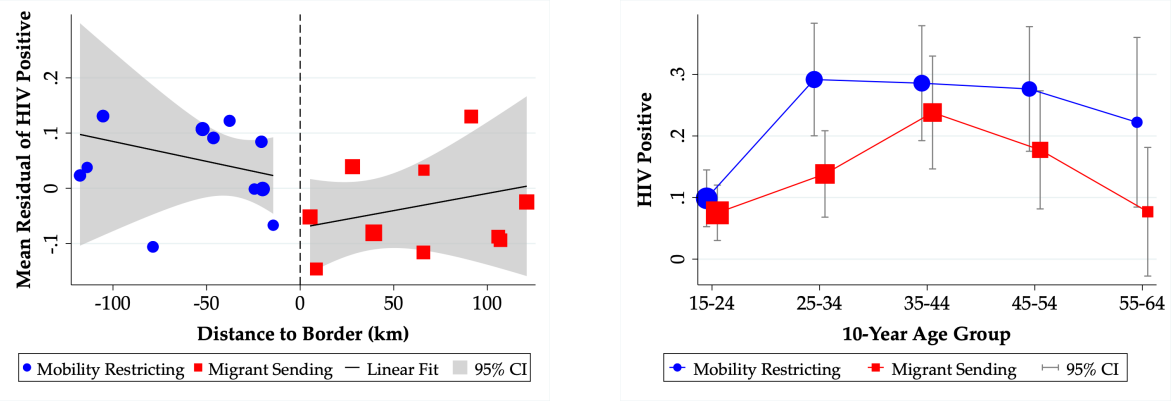
I then compare economic development outcomes in the former institutions. While the point estimates in Table 3 Columns (4) through (6) are all in the direction of better outcomes in the former migrant-sending region, none is statistically significant, and for

[39] 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).

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

[41] In Appendix E2, I show that these patterns hold within each sex, though with much more noise for men due to the sample size.

Figure 8: 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.

the asset ownership index and male schooling, they are a very small percentage of the mobility-restricting means. The coefficient for female schooling (0.38 years) is non-trivial relative to the restricted mobility mean (2.5 years) but notably imprecise. The results in Appendix F5 using data on literacy and schooling from the IPUMS 10-percent sample of the 2007 Mozambican census also show mostly small but insignificant effects in the same direction, as do results in Appendix F4 for nighttime lights. The interesting exception is population density, which has substantively positive but imprecise RD coefficients.[42] While it is difficult to interpret this result in light of large population displacements during the civil war, it is in line with the theoretical predictions in Section 5 and consistent with circular migrants' high wages being spent on more children rather than capital accumulation (i.e., increasing population density but not long-run living standards).

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 even if there were development differences prior to the border being erased – a proposition for which there is little support in Section 4 – they have disappeared in the intervening decades.

[42] See Appendix E4 for maps of nighttime lights and population density near the border in 2019.

6.5. *Robustness and Ruling out Alternative Explanations*

In Appendices F1 and F2, I find that the HIV results are robust to using randomization inference instead of the traditional RD design as well as estimating the RD after collapsing the DHS data into clusters and calculating Kelly (2021) p-values, though the sex-specific results from the spatial randomization inference procedure are not statistically significant. I also show in Appendix F3 that there are no substantive differences in the very low rates of blood test refusals along the border, helping to rule out selection into testing due to history (Lowes and Montero, 2021*b*). Data on the presence of public-sector health facilities from Maina et al. (2019) yield a similar null RD estimate in Appendix F11, suggesting that the HIV result is not driven by the availability of health care or differential public investment in health infrastructure since the colonial period.[43]

In addition, I examine measures of the intensity of Mozambique's civil war along the border, as differences in this respect could have affected both HIV and development. Reassuringly, Appendix F6 shows no substantive discontinuities in violent events or deaths during the civil war in data from the Global Terrorism Database and the Uppsala Conflict Data Program. I also find no evidence in Appendix F7 of differences at the border in known and suspected landmines reported by the Mozambican government as of October 2007 (Republic of Mozambique, 2008).[44]

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, the theoretical predictions regarding marriage in Section 5, 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 (Appendix F10) and those that are unrelated (Appendix F12). The main result in Table 4 and Figure 9 is that age gaps between spouses and sexual partners are much smaller just inside the former migrant-sending institution, and mediation analysis in Table 5 suggests that this channel accounts for nearly one-fourth of the HIV discontinuity.

7.1. *Age-Disparate Relationships*

To examine age disparities between spouses and sexual partners, I again use the DHS and 2007 census datasets. The outcome of interest in the former is the age gap between a

[43] See Appendix E6 for a map of these health facilities by gridcell.
[44] See Appendix E5 for maps of violent events and landmines by gridcell.

Table 4: Effects of the Institutions on Partner Age Disparities

	Ages 15-49		Married, Ages 15-49		Married
	Women (1)	Men (2)	Women (3)	Men (4)	Women (5)
Male-Female Age Gap with:	*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

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).

respondent of reproductive age (15 to 49) and their most recent sexual partner, measured as the man's age minus the woman's.[45] I winsorize this outcome at 90 percent due to extreme outliers at both ends of the distribution.[46] In the census data, I examine age gaps between women of any age and their spouses to make the closest link possible between colonial-era and present-day marriage market outcomes.

Table 4 reports the results of estimating equation (6) for age disparities in these datasets and Figure 9 presents RD plots for selected outcomes.[47] In Columns (1) and (2), I examine all women and men and find that age disparities decline by over 2 years just inside the former migrant-sending region. These results are large – around one-third of the means in the former mobility-restricting region – and precisely estimated, and their statistical significance is unlikely to result from too few clusters.

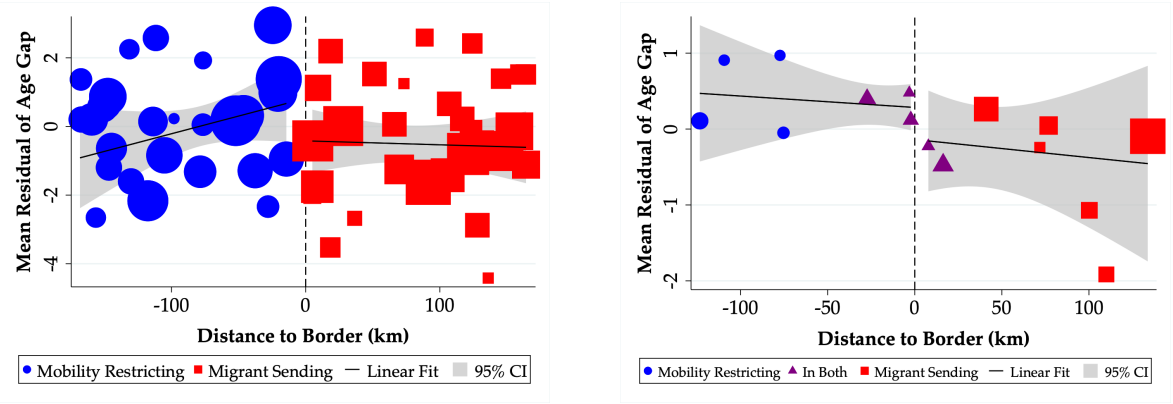
Restricting the sample to married respondents in Columns (3) and (4) yields estimates that are slightly smaller in absolute and relative terms (around -1.8 years, or about 25 percent of the mean across the former border), but the main conclusion is unchanged. In Column (5), the RD estimate for married women in the census is even smaller (-0.8 years, or just under 10 percent of the mobility-restricting mean), though there is an expected downward bias in these results and it is still precisely estimated. Taken together, these

[45] 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 that respondents would know this person's age.

[46] This winsorization increases the precision of the RD estimate without changing its magnitude.

[47] Specifically, Figures 9a and 9b correspond to Table 4 Columns (2) and (5).

Figure 9: 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.

results suggest that the HIV risk factor expected to change discontinuously at the border for historical reasons did in fact do so. Below, I examine how much of the estimated HIV discontinuity can be attributed to it.

7.2. Other Risk Factors

While age gaps in relationships can be HIV risk factors on their own, they are also associated with behaviors facilitating transmission of the virus. These risks include male partners who are in concurrent relationships (possibly formalized through polygyny), an earlier sexual debut for women and girls, and not using condoms or having been forced to have sex, all of which relate to low bargaining power (UNAIDS, UNIFEM and UNFPA, 2004; Evans et al., 2019; Mabaso et al., 2021; Schaefer et al., 2017). In Appendix F10, I compare these outcomes among reproductive-age individuals in the DHS along the former institutional border. In each case, the result suggests that women in the former migrant-sending region face fewer of these associated risks, though some of the magnitudes are quite small and no estimate is statistically significant. As such, age-disparate relationships' indirect effects seem less important than their direct impacts.

In addition, I examine other important HIV risk factors in Sub-Saharan Africa that are not plausibly linked to the historical differences between the institutions.[48] The results

[48] Drawing from the literature on the virus' spread across the continent, I create indicator variables for: having a genital ulcer in the past 12 months (Chen et al., 2000), a man having ever paid for sex (Dunkle et al., 2004), and a man having been medically circumcised (Maffioli, 2017).

Table 5: 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: Results from the Imai, Keele and Tingley (2010) mediation analysis. Bootstrapped 90-percent confidence intervals are in brackets.

in Appendix F12, show that none of these outcomes point in the direction of lower HIV prevalence in the former migrant-sending institution. Indeed, the only statistically significant result is for genital ulcers but it implies a greater likelihood of contracting the virus in this region. Therefore, it is unlikely that these factors contribute to the HIV result in the previous section.

7.3. Mediation Analysis

While the above analysis suggests that age-disparate relationships are an important contributor to the discontinuous change in HIV prevalence along the institutional border, I attempt to quantify their role using the mediation analysis framework developed by Imai, Keele and Tingley (2010). In brief, this approach aims to decompose the total effect of a treatment into its direct effect on the outcome and its effect via a mediating variable. In Table 5, I use the RD setup in equation (6) to examine the contributions of 5 variables for adults of reproductive age: the index of household asset ownership, years of schooling, the age gap with a respondent's last sexual partner, whether they have had multiple sexual partners, and whether they used a condom in their last sexual intercourse.

While the measures of economic development in Columns (1) and (2) each mediate around 5 percent of the total effect, Column (3) shows that the age gap is by far more important. In particular, it mediates nearly one-quarter of the effect that institutional differences have on HIV prevalence along the border today, which is an exceptionally large share. In line with the results regarding the indirect effects of the age gap, Columns

(4) and (5) show that these two associated risk factors mediate negligible fractions of the total effect. Taken together, this result and the others in this section imply that this HIV risk factor with historical reasons to change discontinuously at the border plays a major role in lowering HIV prevalence just inside the former migrant-sending institution.

8. External Validity

Although the RD setup provides internal validity when comparing the institutions' effects along the institutional border, it is not immediately clear that this evidence generalizes beyond Mozambique. Indeed, at first glance, the clear association between circular migration and HIV across Sub-Saharan Africa (Weine and Kashuba, 2012) seems to cast doubt on any claims of external validity. However, as I discuss below, there are important considerations when interpreting the results in this paper, and empirical tests exploiting data on mine labor recruitment throughout Southern Africa can shed light on whether the relationships identified in this setting generalize more broadly.

8.1. Interpretation

First, the effects identified in this paper are not simply due to the presence of circular migration. Rather, the historical context of this setting – one area was a migrant-sending region for 50 years more than its neighbor, which was under a mobility-restricting regime during that half-century – suggests that the estimates are better interpreted as the effect of additional historical exposure to the migrant-sending institution. As this extra treatment came during the colonial period, it is likely that the expected migration-HIV relationship did not arise along the institutional border because this risk factor changed smoothly across it by the time the virus arrived in Southern Africa (see Section 4).

8.2. Circular Migration, Partner Age Gaps, and HIV in Southern Africa

With these caveats in mind, I now study the correlations between circular migration, partner age gaps, and HIV in the Southern African countries in which the Witwatersrand mining companies established a heavy recruiting presence: eSwatini (formerly Swaziland), Lesotho, Malawi, Mozambique, and South Africa. Specifically, I combine the map in Appendix B2 of WNLA recruitment posts in these countries in 1946 with their georeferenced DHS waves, which allows me to examine these relationships among survey clusters within 25 km of a post.

Under the assumption that greater distance from a recruitment post made engaging

Table 6: Circular Migration, Partner Age Gaps, and HIV in Southern Africa

	LSO, MOZ, SWZ, ZAF		Malawi	
	Kilometers	Log(Km+1)	Kilometers	Log(Km+1)
	(1)	(2)	(3)	(4)
Panel A. Partner Age Gap: Women				
Distance from Recruitment Post	0.032	0.358	0.022	0.370
	(0.011)	(0.137)	(0.025)	(0.376)
Observations	12,054	12,054	2,901	2,901
Clusters	96	96	12	12
Wild Cluster Bootstrap p-value			0.389	0.346
Mean	5.72	5.72	5.61	5.61
Standard Deviation	5.07	5.07	4.89	4.89
Panel B. HIV Positive: Women Reporting Last Sexual Partner's Age				
Distance from Recruitment Post	-0.0043	-0.0574	-0.0019	-0.0217
	(0.0018)	(0.0198)	(0.0012)	(0.0157)
Observations	4,754	4,754	889	889
Clusters	93	93	12	12
Wild Cluster Bootstrap p-value			0.147	0.227
Mean	0.300	0.300	0.111	0.111
Panel C. HIV Positive: Women, Controlling for Age Gap				
Distance from Recruitment Post	-0.0045	-0.0595	-0.0021	-0.0245
	(0.0018)	(0.0201)	(0.0012)	(0.0159)
Observations	4,754	4,754	889	889
Clusters	93	93	12	12
Wild Cluster Bootstrap p-value			0.144	0.225
Mean	0.300	0.300	0.111	0.111

Notes: Standard errors clustered by DHS survey cluster within 25 km of a recruitment post are in parentheses. Regressions control for age, age squared, urban status, subnational region-specific quadratic polynomials in latitude and longitude, region-specific effects of altitude, and fixed effects for the nearest recruitment post and survey year. The countries examined in Columns (1) and (2) are Lesotho, Mozambique, eSwatini (formerly Swaziland), and South Africa.

in circular migration more difficult, I measure these correlations by estimating

$$y_{i,c,t} = \tau f(\text{Distance}_c) + \mathbf{X}_i\beta + \delta_{r(c)} \times \mathbf{Z}_c + \alpha_{p(c)} + \gamma_t + \epsilon_{i,c,t} \text{ for Distance}_c < 25 \text{ km}, \quad (7)$$

where $y_{i,c,t}$ is the outcome of interest (partner age gap, HIV status) for i in survey cluster c in year t, $f(\text{Distance}_c)$ is the measurement of c's distance from the nearest recruitment post (km, $\log[\text{km}+1]$), $\mathbf{X}_i$ is a vector of individual-level characteristics (age, age squared, urban indicator), $\delta_{r(c)}$ is a fixed effect for c's subnational region interacted with c's geographic characteristics in the vector $\mathbf{Z}_c$ (altitude, quadratic polynomial in latitude and longitude), and $\alpha_{p(c)}$ and γ_t are fixed effects for c's nearest recruitment post and the year

in which i was surveyed.

The coefficient of interest is τ, which measures the effect of being either 1 km (if distance is used) or 1 percent (if the log of distance is used) farther away from a recruitment post. It does so using only the variation within survey years and within 25-km zones around recruitment posts, and after controlling for a very rich set of region-specific geographic characteristics. To increase the credibility of these results, I separate out Malawi from the other countries because as Appendix B2 shows, its major exposure to circular migration came between 1967 and 1974 (Dinkelman and Mariotti, 2016), so these relationships should be less pronounced there. For inference, I cluster standard errors by the closest recruitment post and use the wild cluster bootstrap for the Malawi results, as the country only had 12 posts.

I present the results in Table 6. Panel A Columns (1) and (2) show that the age gap between women and their last sexual partners in Lesotho, Mozambique, eSwatini, and South Africa increases strongly with distance from a recruitment post. The estimates for Malawi in Columns (3) and (4) are of comparable magnitudes, although they are not statistically significant. Therefore, I interpret these results as showing that circular migration – and even only historical circular migration – has a strong negative association with partner age gaps. In Panel B, I examine the HIV status of women with observable partner age gaps. As expected, ease of (historical) circular migration is correlated with a higher likelihood of being HIV positive, but possibly less so in Malawi. However, after controlling for the partner age gap in Panel C, these relationships become stronger and more statistically significant in both groups, suggesting that the smaller age gaps closer to recruitment posts provide some protection against the HIV risk associated with circular migration. Taken together, I interpret these correlations as providing evidence in support of the external validity of the results from within Mozambique.

9. 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.

References

Abramitzky, Ran, Leah Boustan, and Katherine Eriksson. 2019. "To the New World and Back Again: Return Migrants in the Age of Mass Migration." *Industrial and Labor Relations Review*, 72(2): 300–322. [6]

Acemoglu, Daron, and James A. Robinson. 2012. *Why Nations Fail: The Origins of Power, Prosperity, and Poverty.* New York:Crown Business. [1]

Acemoglu, Daron, Simon Johnson, and James A. Robinson. 2001. "The Colonial Origins of Comparative Development: An Empirical Investigation." *American Economic Review*, 91(5): 1369–1401. [1, 6, 41]

Alexopoulou, Kleoniki, and Dácil Juif. 2017. "Colonial State Formation without Integration: Tax Capacity and Labour Regimes in Portuguese Mozambique (1890s-1970s)." *International Review of Social History*, 62(2): 215–252. [2]

Allina, Eric. 2012. *Slavery by Any Other Name: African Life under Company Rule in Colonial Mozambique.* Charlottesville, VA:University of Virginia Press. [10, 11]

Alsan, Marcella. 2015. "The Effect of the TseTse Fly on African Development." *American Economic Review*, 105(1): 382–410. [51]

Alsan, Marcella, and Marianne Wanamaker. 2018. "Tuskegee and the Health of Black Men." *Quarterly Journal of Economics*, 133(1): 407–455. [7]

Amin, Samir. 1972. "Underdevelopment and Dependence in Black Africa: Origins and Contemporary Forms." *Journal of Modern African Studies*, 10(4): 503–524. [1, 2]

Anderson, Siwan. 2018. "Legal Origins and Female HIV." *American Economic Review*, 108(6): 1407–1439. [7]

Ashraf, Nava, Natalie Bau, Nathan Nunn, and Alessandra Voena. 2020. "Bride Price and Female Education." *Journal of Political Economy*, 128(2): 591–641. [6]

Audet, Carolyn M., Janeen Burlison, Troy D. Moon, Mohsin Sidat, Alfredo E. Vergara, and Sten H. Vermund. 2010. "Sociocultural and Epidemiological Aspects of HIV/AIDS in Mozambique." *BMC International Health and Human Rights*, 10: 15. [12, 29]

Banerjee, Abhijit, and Lakshmi Iyer. 2005. "History, Institutions, and Economic Performance: The Legacy of Colonial Land Tenure Systems in India." *American Economic Review*, 95(4): 1190–1213. [6]

Barakat, Sultan, Margaret Chard, Tim Jacoby, and William Lume. 2002. "The Composite Approach: Research Design in the Context of War and Armed Conflict." *Third World Quarterly*, 23(5): 991–1003. [13]

Bertocchi, Graziella, and Arcangelo Dimico. 2019. "The Long-Term Determinants of Female HIV Infection in Africa: The Slave Trade, Polygyny, and Sexual Behavior." *Journal of Development Economics*, 140: 90–105. [7]

Black, Dan A., Seth G. Sanders, Evan J. Taylor, and Lowell J. Taylor. 2015. "The Impact of the Great Migration on Mortality of African Americans: Evidence from the Deep South." *American Economic Review*, 105(2): 477–503. [6]

Cagé, Julia, and Valeria Rueda. 2020. "Sex and the Mission: The Conflicting Effects of Early Christian Missions on HIV in sub-Saharan Africa." *Journal of Demographic Economics*, 86(3): 213–257. [7]

Calonico, Sebastian, Matias D. Cattaneo, and Rocio Titiunik. 2014. "Robust Nonparametric Confidence Intervals for Regression-Discontinuity Designs." *Econometrica*, 82(6): 2295–2326. [14, 16, 32, 33, 36, 71, 73, 74, 75, 78, 79, 80]

Calvi, Rossella. 2020. "Why Are Older Women Missing in India? The Age Profile of Bargaining Power and Poverty." *Journal of Political Economy*, 128(7): 2453–2501. [6]

Cameron, A. Colin, Jonah B. Gelbach, and Douglas L. Miller. 2008. "Bootstrap-Based Improvements for Inference with Clustered Errors." *Review of Economics and Statistics*, 90(3): 414–427. [32]

Cattaneo, Matias D., Brigham R. Frandsen, and Rocío Titiunik. 2015. "Randomization Inference in the Regression Discontinuity Design: An Application to Party Advantages in the U.S. Senate." *Journal of Causal Inference*, 3(1): 1–24. [15, 22, 32]

Cattaneo, Matias D., Nicolás Idrobo, and Rocío Titiunik. 2019. *A Practical Introduction to Regression Discontinuity Designs: Foundations.* Cambridge, UK:Cambridge University Press. [15]

Chen, Cheng Y., Ronald C. Ballard, Consuelo Beck-Sague, Yusuf Dangor, Frans Radebe, Scott Schmid, Judith Weiss, Vaness Tshabalala, Glenda Fehler, Ye Htun, and Stephen Morse. 2000. "Human Immunodeficiency Virus Infection and Genital Ulcer Disease in South Africa." *Sexually Transmitted Diseases*, 27(1): 21–29. [37]

Chiappori, Pierre-André, Murat Iyigun, and Yoram Weiss. 2009. "Investment in Schooling and the Marriage Market." *American Economic Review*, 99(5): 1689–1713. [6]

Clarence-Smith, Gervase. 1985. *The Third Portuguese Empire, 1825-1975: A Study in Economic Imperialism.* Manchester:Manchester University Press. [9]

Colella, Fabrizio, Rafael Lalive, Seyhun Orcan Sakalli, and Mathias Thoenig. 2020. "Inference with Arbitrary Clustering." [15]

Conley, T.G. 1999. "GMM Estimation with Cross Sectional Dependence." *Journal of Econometrics*, 92(1): 1–45. [15]

Corno, Lucia, Nicole Hildebrandt, and Alessandra Voena. 2020. "Age of Marriage, Weather Shocks, and the Direction of Marriage Payments." *Econometrica*, 88(3): 879–915. [4, 6, 23, 58]

Crush, Jonathan, Alan Jeeves, and David Yudelman. 1991. *South Africa's Labor Empire: A History of Black Migrancy to the Gold Mines.* Boulder, CO:Westview Press. [52]

Danielson, Jeffrey J., and Dean B. Gesch. 2011. "Global Multi-resolution Terrain Elevation Data 2010 (GMTED2010)." U.S. Geological Survey Open-File Report 2011–1073, Reston, VA. [51]

Darch, Colin. 1983. "Notas sobre Fontes Estatísticas Oficiais Referente à Economia Colonial Moçambicana: Uma Crítica Geral." *Estudos Moçambicanos*, 4: 103–125. [12]

Dell, Melissa. 2010. "The Persistent Effects of Peru's Mining Mita." *Econometrica*, 78(6): 1863–1903. [6]

Dell, Melissa, and Benjamin A. Olken. 2020. "The Development Effects of the Extractive Colonial Economy: The Dutch Cultivation System in Java." *Review of Economic Studies*, 87(1): 164–203. [6]

de Oliveira, Tulio, Ayesha B. M. Kharsany, Tiago Gräf, Cherie Cawood, David Khanyile, Anneke Grobler, Adrian Puren, Savathree Madurai, Cheryl Baxter, Quarraisha Abdool Karim, and Salim S. Abdool Karim. 2017. "Transmission Networks and Risk of HIV Infection in KwaZulu-Natal, South Africa: A Community-Wide Phylogenetic Study." *The Lancet HIV*, 4(1): E41–E50. [5, 29, 33]

Derenoncourt, Ellora. 2021. "Can You Move to Opportunity? Evidence from the Great Migration." [6]

Dinkelman, Taryn, and Martine Mariotti. 2016. "The Long-Run Effects of Labor Migration on Human Capital Formation in Communities of Origin." *American Economic Journal: Applied Economics*, 8(4): 1–35. [6, 41]

Direcção Provincial dos Serviços de Estatística. 1966. *III Recenseamento Geral da População na Província de Moçambique.* Lourenço Marques:Instituto Nacional de Estatística. [12]

Dunkle, Kristin L., Rachel K. Jewkes, Heather C. Brown, Glenda E. Gray, James A. McIntryre, and Siobán D. Harlowa. 2004. "Transactional Sex among Women in Soweto, South Africa: Prevalence, Risk Factors and Association with HIV Infection." *Social Science & Medicine*, 59(8): 1581–1592. [37]

Dwyer-Lindgren, Laura, Michael A. Cork, Amber Sligar, Krista M. Steuben, Kate F. Wilson, Naomi R. Provost, Benjamin K. Mayala, John D. VanderHeide, Michael L. Collison, and Jason B. Hall, et al. 2019. "Mapping HIV Prevalence in Sub-Saharan Africa between 2000 and 2017." *Nature*, 570: 189–193. [7]

Evans, Meredith, Kathryn Risher, Nompumelelo Zungu, Olive Shisana, Sizulu Moyo, David C. Celentano, Brendan Maughan-Brown, and Thomas M. Rehle. 2019. "Age-Disparate Sex and HIV Risk for Young Women from 2002 to 2012 in South Africa." *Journal of the International AIDS Society*, 19(1): 21310. [5, 37]

Faria, Nuno R., Andrew Rambaut, Marc A. Suchard, Guy Baele, Trevor Bedford, Melissa J. Ward, Andrew J. Tatem, João D. Sousa, Nimalan Arinaminpathy, Jacques Pépin, David Posada, Martine Peeters, Oliver G. Pybus, and Philippe Lemey. 2014. "The Early Spread and Epidemic Ignition of HIV-1 in Human Populations." *Science*, 346(6205): 56–61. [29]

Fernández Cebrián, Pablo. 2021. "Withdrawal of the State: The Provision of Primary Schooling in Mozambique under the Indigenato." [3, 12]

Frimmel, Hartwig E. 2019. "The Witwatersrand Basin and Its Gold Deposits." In *The Archean Geology of the Kaapvaal Craton, Southern Africa*. *Regional Geology Reviews*, , ed. Alfred Kröner and Axel Hoffman. Cham, CHE:Springer. [9]

Fuller, Charles Edward. 1955. "An Ethnohistoric Study of Continuity and Change in Gwambe Culture." PhD diss. Northwestern University, Evanston, IL. [11]

Gelman, Andrew, and Guido Imbens. 2019. "Why High-Order Polynomials Should Not Be Used in Regression Discontinuity Designs." *Journal of Business & Economic Statistics*, 37(3): 447–456. [15]

Gengenbach, Heidi. 2010. *Binding Memories: Women as Makers and Tellers of History in Magude, Mozambique.* New York:Columbia University Press. [8]

Great Britain Foreign Office. 1901. "Portuguese Decree, Extending the Concessions Granted to the Mozambique Company - Lisbon, December 22, 1893." In *British and Foreign State Papers, 1896-1897*. Vol. 89, , ed. Augustus H. Oakes and Willoughby Maycock, 601–602. London:H.M.S.O. [8]

Greenwood, Jeremy, Nezih Guner, and Guillaume Vandenbroucke. 2017. "Family Economics Writ Large." *Journal of Economic Literature*, 55(4): 1346–1434. [6]

Guthrie, Zachary Kagan. 2016. "Forced Volunteers: The Complexities of Coercion in Central Mozambique, 1941-1961." *International Journal of African Historical Studies*, 49(2): 195–212. [12]

Guthrie, Zachary Kagan. 2018. *Bound for Work: Labor, Mobility, and Colonial Rule in Central Mozambique, 1940-1965.* Charlottesville, VA:University of Virginia Press. [10, 11]

Harries, Patrick. 1983. "Labour Migration from Mozambique to South Africa; with Special Reference to the Delagoa Bay Hinterland, c. 1862 to 1897." PhD diss. School of Oriental and African Studies, University of London, London. [3]

Harries, Patrick. 1994. *Work, Culture, and Identity: Migrant Laborers in Mozambique and South Africa, c. 1860-1910.* Portsmouth, NH:Heinemann. [3, 9, 11]

Harris, Marvin. 1959. "Labour Emigration among the Moçambique Thonga: Cultural and Political Factors." *Africa*, 29(1): 50–66. [9]

Harrison, Graham. 1998. "Quantos Somos? The Second National Population Census of Mozambique." *Review of African Political Economy*, 25(75): 124–132. [12]

Havik, Philip J. 2013. "Colonial Administration, Public Accounts and Fiscal Extraction: Policies and Revenues in Portuguese Africa (1900-1960)." *African Economic History*, 41: 159–221. [12]

Helgesson, Alf. 1994. *Church, State and People in Mozambique: An Historical Study with Special Emphasis on Methodist Developments in the Inhambane Region.* Uppsala:Swedish Institute of Missionary Research. [11]

Iliffe, John. 2006. *The African AIDS Epidemic: A History.* Athens, OH:Ohio University Press. [7, 12]

Imai, Kosuke, Luke Keele, and Dustin Tingley. 2010. "A General Approach to Causal Mediation Analysis." *Psychological Methods*, 15(4): 309–334. [5, 38]

Isaacman, Allen, Michael Stephen, Yusuf Adam, Maria João Homen, Eugenio Macamo, and Augustinho Pililão. 1980. ""Cotton Is the Mother of Poverty": Peasant Resistance to Forced Cotton Production in Mozambique, 1938-1961." *International Journal of African Historical Studies*, 13(4): 581–615. [12]

Junod, Henri A. 1912. *The Life of a South African Tribe.* Vol. 1, London:David Nutt. [3, 9, 11]

Kelly, Morgan. 2021. "Persistence, Spatial Noise, and Randomization." [14, 15, 17, 32, 35]

Khanna, Gaurav, Emir Murathanoglu, Caroline Theoharides, and Dean Yang. 2022. "Abundance from Abroad: Migrant Income and Long-Run Economic Development." [6, 30]

Kiszewski, Anthony, Andrew Mellinger, Andrew Spielman, Pia Malaney, Sonia Ehrlich Sachs, and Jeffrey Sachs. 2004. "A Global Index Representing the Stability of Malaria Transmission." *American Journal of Tropical Medicine and Hygiene*, 70(5): 486–498. [51]

Leclerc-Madlala, Suzanne. 2008. "Age-Disparate and Intergenerational Sex in Southern Africa: The Dynamics of Hypervulnerability." *AIDS*, 22(suppl. 4): S17–S25. [29]

Lowes, Sara, and Eduardo Montero. 2021*a*. "Concessions, Violence, and Indirect Rule: Evidence from the Congo Free State." *Quarterly Journal of Economics*, 136(4): 2047–2091. [6]

Lowes, Sara, and Eduardo Montero. 2021*b*. "The Legacy of Colonial Medicine in Central Africa." *American Economic Review*, 111(4): 1284–1314. [7, 35]

Mabaso, Musawenkosi, Lungelo Mlangeni, Lehlogonolo Makola, Olanrewaju Oladimeji, Inbarani Naidoo, Yogandra Naidoo, Buyisile Chibi, Khangelani Zuma, and Leickness Simbayi. 2021. "Factors Associated with Age-Disparate Sexual Partnerships among Males and Females in South Africa: A Multinomial Analysis of the 2012 National Population-Based Household Survey Data." *Emerging Themes in Epidemiology*, 18: 3. [5, 37]

Maffioli, Elisa M. 2017. "Is Traditional Male Circumcision Effective as an HIV Prevention Strategy? Evidence from Lesotho." *PLOS ONE*, 12(5): e0177076. [37]

Maina, Joseph, Paul O. Ouma, Peter M. Macharia, Victor A. Alegana, Benard Mitto, Ibrahima Socé Fall, Abdisalan M. Noor, Robert W. Snow, and Emelda A. Okiro. 2019. "A Spatial Database of Health Facilities Managed by the Public Health Sector in Sub Saharan Africa." *Scientific Data*, 6: 134. [35]

Michalopoulos, Stelios, and Elias Papaioannou. 2014. "National Institutions and Subnational Development." *Quarterly Journal of Economics*, 129(1): 151–213. [6]

Michalopoulos, Stelios, and Elias Papaioannou. 2016. "The Long-Run Effects of the Scramble for Africa." *American Economic Review*, 106(7): 1802–1848. [6]

Ministério do Ultramar. 1959. "Carta de Moçambique." [13]

Morier-Genoud, Eric. 2019. *Catholicism and the Making of Politics in Central Mozambique, 1940-1986.* Rochester:University of Rochester Press. [3, 11]

Mozambique News Agency. 1999. "Huge Growth at Vilankulo Airport." *AIM Reports*. [51]

Mozambique News Agency. 2000. "Tourism Brings in $32 Million." *AIM Reports*. [51]

Mozambique News Agency. 2011. "President Inaugurates New Terminal at Vilankulo Airport." *AIM Reports*. [51]

Murdock, George Peter. 1959. *Africa: Its Peoples and Their Culture History.* New York:McGraw-Hill Book Company. [16, 17]

Méndez-Chacón, Esteban, and Diana Van Patten. 2021. "Multinationals, Monopsony, and Local Development: Evidence from the United Fruit Company." [6]

Newitt, Malyn. 1995. *A History of Mozambique.* Bloomington, IN:University of Indiana Press. [7, 9, 11, 12]

North, Douglass. 1990. *Institutions, Institutional Change and Economic Performance.* New York:Cambridge University Press. [41]

Nunn, Nathan. 2020. "The Historical Roots of Economic Development." *Science*, 367(6485): eaaz9986. [1]

Portugal. 1900. *Collecção Official de Legislação Portugueza: Anno de 1899.* Lisboa:Imprensa Nacional. [10]

Repartição Nacional de Estatística. 1942. *Censo da População em 1940.* Vol. 2-5, Lourenço Marques:Imprensa Nacional de Moçambique. [12]

Republic of Mozambique. 2008. "Request for an Extension of the Deadline for Completing the Destruction of Anti-Personnel Mines in Mined Areas in Accordance with Article 5, Paragraph 1 of the Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-Personnel Mines and on Their Destruction (From March 2009 to March 2014)." [35]

Reynoso, Ana. 2021. "Polygamy, Co-Wives' Complementarities, and Intrahousehold Inequality." [6]

Rita-Ferreira, A. 1960. "Labour Emigration among the Moçambique Thonga: Comments on a Study by Marvin Harris." *Africa*, 30(2): 141–152. [9]

Roberts, Richard. 2017. "Coerced Labor in Twentieth-Century Africa." In *The Cambridge World History of Slavery*. , ed. David Eltis, Stanley L. Engerman, Seymour Drescher and David Richardson, 583–609. Cambridge:Cambridge University Press. [1]

Ross, Edward Alsworth. 1925. *Report on Employment of Native Labor in Portuguese Africa.* New York:The Abbott Press. [10]

Saldanha, F. 1940. "Carta da Colónia de Moçambique: Segundo a Sua Actual Divisão Administrativa." [13]

Schaefer, Robin, Simon Gregson, Jeffrey W. Eaton, Owen Mugurungi, Rebecca Rhead, Albert Takaruza, Rufurwokuda Maswera, and Constance Nyamukapa. 2017. "Age-Disparate Relationships and HIV Incidence in Adolescent Girls and Young Women: Evidence from Zimbabwe." *AIDS*, 31(10): 1461–1470. [5, 29, 37]

Schneider, Udo, Andreas Becker, Peter Finger, Elke Rustemeier, and Markus Ziese. 2020. *GPCC Full Data Monthly Product Version 2020 at 0.25°: Monthly Land-Surface Precipitation from Rain-Gauges Built on GTS-Based and Historical Data.* Global Precipitation Climatology Center. [51]

Siow, Aloysius. 1998. "Differential Fecundity, Markets, and Gender Roles." *Journal of Political Economy*, 106(2): 334–354. []

Smith, Alan K., and Gervase Clarence Smith. 1985. "Angola and Mozambique, 1870-1905." In *The Cambridge History of Africa*. Vol. 6, , ed. Roland Oliver and G. N. Sanderson, 493–521. Cambridge:Cambridge University Press. [7]

Stichter, Sharon. 1985. *Migrant Laborers.* Cambridge, UK:Cambridge University Press. [6]

Tertilt, Michèle. 2005. "Polygyny, Fertility, and Savings." *Journal of Political Economy*, 113(6): 1341–1371. [4, 6, 23, 24]

Transvaal Chamber of Mines. 1946. "Map of Southern Africa Showing the Recruiting Systems of the Native Recruiting Corporation and the Witwatersrand Native Labour Association." [8]

UNAIDS, UNIFEM, and UNFPA. 2004. "Action against AIDS Must Address Epidemic's Increasing Impact on Women, Says UN Report." [37]

Vail, Leroy. 1976. "Mozambique's Chartered Companies: The Rule of the Feeble." *Journal of African History*, 17(3): 389–416. [7]

Viboud, Cécile, Lone Simonsen, and Geraldo Chowell. 2016. "A Generalized-Growth Model to Characterize the Early Ascending Phase of Infectious Disease." *Epidemics*, 15: 27–37. [33]

Wang, Samer Al-Saffar, Jeffrey Rogers, and Matthew W. Hahn. 2023. "Human Generation Times across the Past 250,000 Years." *Science Advances*, 9(1): eabm7047. [4, 27]

Weine, Stevan M., and Adrianna B. Kashuba. 2012. "Labor Migration and HIV Risk: A Systematic Review of the Literature." *AIDS and Behavior*, 16(6): 1605–1621. [29, 39]

Weinstein, Jeremy M. 2006. *Inside Rebellion: The Politics of Insurgent Violence.* New York:Cambridge University Press. [12]

Wilson, Francis. 1972. *Labour in the South African Gold Mines, 1911-1969.* New York:Cambridge University Press. [9]

World Bank. 2020. *World Slope Model in Degrees.* The World Bank Group. [51]

Yang, Dean. 2008. "International Migration, Remittances and Household Investment: Evidence from Philippine Migrants' Exchange Rate Shocks." *Economic Journal*, 118(528): 591–630. []

Zabel, Florian, Birgitta Putzenlechner, and Wolfram Mauser. 2014. "Global Agricultural Land Resources: A High Resolution Suitability Evaluation and Its Perspectives until 2100 under Climate Change Conditions." *PLOS ONE*, 9(12): e114980. [51]

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

Geographic Traits [16]

- *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 [16]

- *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

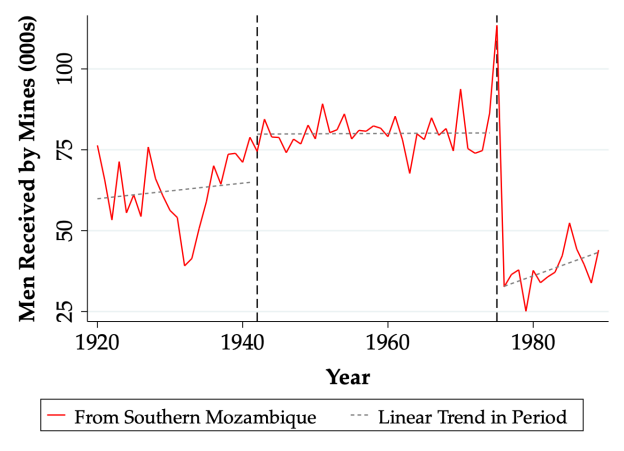
As discussed in Section 6.1, I exclude the DHS survey clusters within 2 km of the border as they may have been displaced across it. In addition, because these clusters are located beachside resort city of Vilankulo, including them in the estimation may lead to significant distortion. This city of 20,000 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

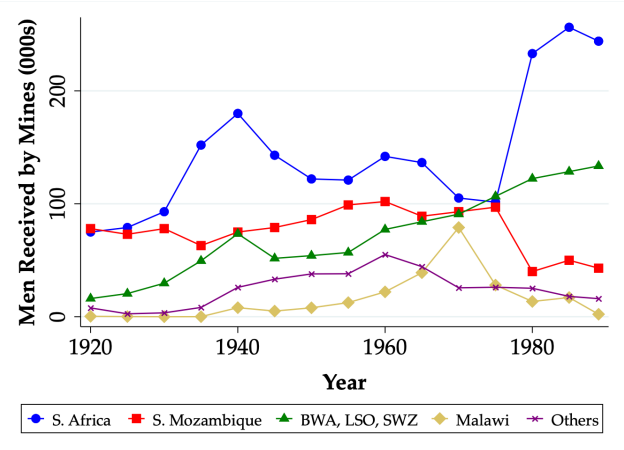
Figure B1: Southern Mozambican Men Received by Mines (000s), 1920-89 [10, 11]



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. Annual Numbers of Witwatersrand Mine Workers from Southern Mozambique

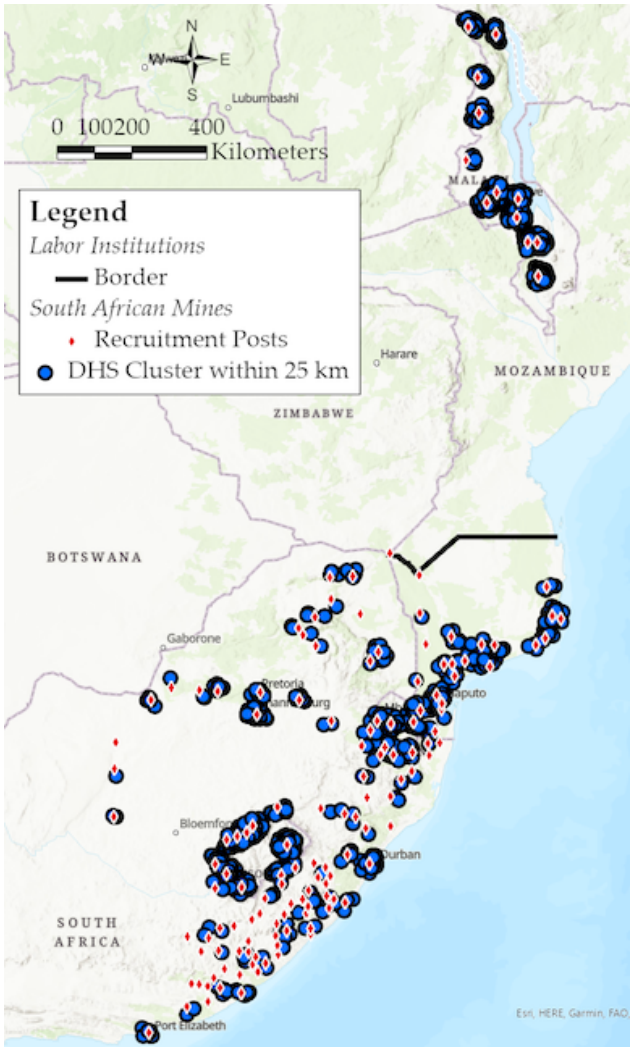
Figure B2: Southern Mozambican Men Received by Mines (000s), 1920-89 [10, 11]



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.

B3. Map of WNLA Recruitment Posts and DHS Clusters

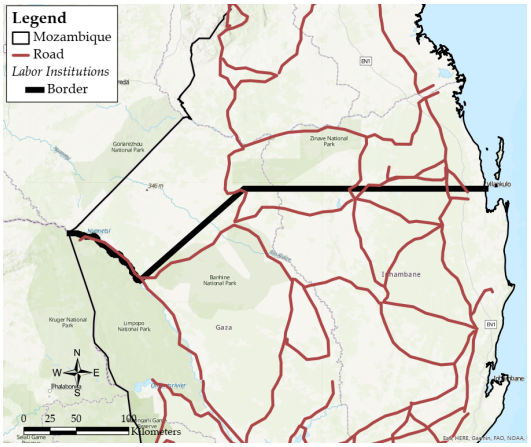
Figure B3: 1946 WNLA Recruitment Posts and Nearby DHS Clusters



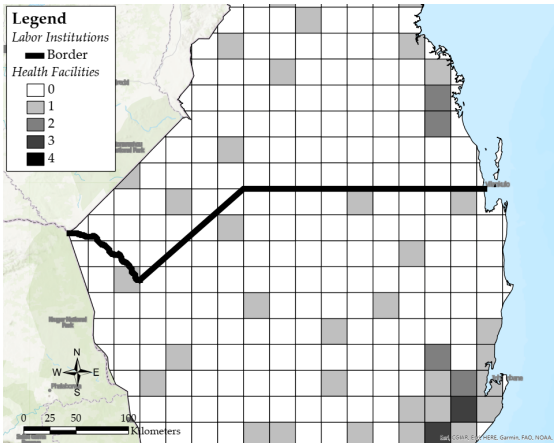
Notes: Map shows 1946 WNLA recruitment posts (red diamonds) in South Africa, Lesotho, Swaziland, Mozambique, and Malawi as well as DHS survey clusters (blue circles) within 25 km of a post.

B4. Colonial-Era Infrastructure Investments

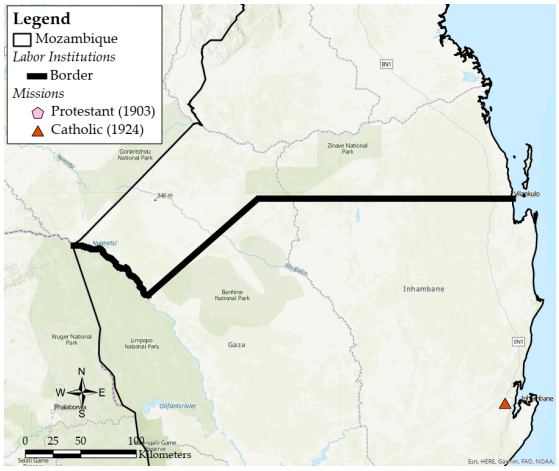
Figure B4: Colonial Infrastructure and Missionary Presence [22]



(a) Roads, 1959



(b) Health Facilities, 1962



(c) Protestant and Catholic Missions

Appendix C. Colonial Era: Robustness and Additional Results

C1. Circular Migration

Table C1: Circular Migration by Age Group, 1940 [17]

	Men Migrants		Women Farming	
	Ages 15-34 (1)	Ages 35-54 (2)	Ages 15-34 (3)	Ages 35-54 (4)
Migrant Sending	0.274	0.117	0.002	0.004
	(0.119)	(0.069)	(0.006)	(0.006)
	[0.110]	[0.067]	[0.005]	[0.005]
Observations	28	28	26	26
Bandwidth	-503, 329	-503, 329	-503, 401	-503, 401
Mobility Restricting Mean	0.077	0.027	0.997	0.997

Notes: .

C2. Marriage Rates

Table C2: Marriage Rates among Ages 35-54 [20]

	1940		1960	
	Men 35-54 (1)	Women 35-54 (2)	Men 35-54 (3)	Women 35-54 (4)
Migrant Sending	0.014	-0.002	0.042	0.036
	(0.029)	(0.012)	(0.030)	(0.015)
	[0.031]	[0.012]	[0.028]	[0.013]
Observations	28	28	27	27
Bandwidth	-503, 401	-503, 401	-500, 294	-500, 294
Mobility Restricting Mean	0.950	0.968	0.897	0.959

Notes: .

C3. Randomization Inference

Table C3: Effects of the Institutions in the Colonial Era [22]

	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	0.195	-0.008	0.172	0.030	0.087	-0.014	0.009
	{0.014}	{0.554}	{0.030}	{0.272}	{0.192}	{0.550}	{0.714}
Observations	10	10	10	10	10	10	10
Bandwidth	-224, 218	-224, 218	-224, 220	-224, 220	-224, 220	-224, 218	-224, 218
Mobility Restricting Mean	0.117	0.960	0.574	0.891	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	0.172	0.056	-0.091	0.022	0.017
	{0.646}	{0.746}	{0.022}	{0.270}	{0.248}	{0.788}	{0.738}
Observations	10	10	10	10	10	10	10
Bandwidth	-282, 207	-282, 207	-282, 207	-282, 207	-282, 207	-282, 164	-282, 164
Mobility Restricting Mean	0.238	0.995	0.358	0.713	0.827	0.085	0.055
Mobility Restricting SD					0.108		

Notes: .

C4. Colonial-Era Infrastructure Investments

Table C4: Roads and Health Facilities in the Colonial Era [22]

	Roads (1959)			Health Facilities (1962)		
	Any (1)	Length (2)	Log(Len.+1) (3)	Any (4)	Number (5)	Log(Num.+1) (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: .

Appendix D. Marriage Market Model Linking Past and Present

D1. Proof of Proposition 1

The first-order conditions for (2) are $w_t^O = n_t^O \frac{\sqrt{\psi}}{\sqrt{p_t - y^F}}$, $n_t^O = \frac{\sqrt{\lambda w_t^O}\sqrt{y^O - w_t^O(p_t - y^F)}}{\sqrt{\psi(2+\lambda)}}$, which yield

$$w_t^O = \frac{\lambda y^O}{2(1+\lambda)(p_t - y^F)}, \; n_t^O = \frac{\lambda y^O}{2(1+\lambda)\sqrt{\psi}\sqrt{p_t - y^F}}. \tag{D1}$$

If old men are indeed the only ones marrying in this steady state, then substituting the demand for wives in (D1) into (4) gives the marriage market-clearing bride price as

$$p_t = y^F + \frac{\lambda y^O}{2(1+\lambda)(1+\gamma_{t-1})}, \tag{D2}$$

which increases with daughters' contributions to household budgets and old men's wages, and decreases with population growth that makes young daughters less scarce. Consistent with Corno, Hildebrandt and Voena (2020), the bride price is strictly larger than young women's contributions to their households' budgets.

In the steady state with constant population growth $1 + \gamma_0$, substituting old men's demand for children in (D1) and the bride price in (D2) into the expression for population growth in (5) yields

$$1 + \gamma_0 = \left[\frac{\lambda y^O}{2\psi(1+\lambda)}\right]^{\frac{1}{3}}, \tag{D3}$$

which is a function of time-invariant parameters. It is intuitive that the population growth rate increases as as children's survival becomes relatively more affordable, either by increasing old men's wages or decreasing the cost of keeping them alive.

To verify the conjecture that only old men can marry, I substitute (D3) into (D2) to solve for the bride price as a function of the parameters:

$$p_0 = y^F + \psi\left[\frac{\lambda y^O}{2\psi(1+\lambda)}\right]^{\frac{2}{3}} = y^F + \psi(1+\gamma_0)^2. \tag{D4}$$

The intuition for the second equality is that the optimal numbers of wives and children equate the net cost of an additional bride, $p_0 - y^F$, with her share of the cost of more surviving offspring, $\psi\left(\frac{n_0^O}{w_0^O}\right)^2 = \psi(1+\gamma_0)^2$. By the assumption on wages, p_0 is strictly larger than young men's wages and strictly smaller than old men's, so young men can only consume their incomes in this steady state. The fact that only old men can marry implies that all marriages are age-disparate ($D_0 = 1$).

D2. Proof of Proposition 2

For the ϵ share of young men with high wages, the first-order conditions for (3) simply replace λ and y^O in (D1) with $\beta + \lambda$ and $\tilde{y}^Y$:

$$\tilde{w}_t^Y = \frac{(\beta+\lambda)\tilde{y}^Y}{2(1+\beta+\lambda)(p_t - y^F)}, \; \tilde{n}_t^Y = \frac{(\beta+\lambda)\tilde{y}^Y}{2(1+\beta+\lambda)\sqrt{\psi}\sqrt{p_t - y^F}}. \tag{D5}$$

If old men's wages are above this period's bride price, then the marriage market clearing condition (4) and the population law of motion (5) will incorporate them as well as the young men with high wages. The resulting bride price is

$$p_1 = y^F + \psi(1+\gamma_0)^2 + \frac{(\beta+\lambda)\epsilon\tilde{y}^Y}{2(1+\beta+\lambda)}, \tag{D6}$$

which is strictly larger than p_0 in (D4). Intuitively, the greater number of participants in the marriage market drives up demand for brides but their supply was determined in the previous period, so the price increases. It also continues to prevent young men earning the original wage y^Y from marrying, and by assumption it still allows old men to marry.

Similarly, the population law of motion simplifies to

$$1 + \gamma_1 = \sqrt{(1+\gamma_0)^2 + \frac{(\beta+\lambda)\epsilon\tilde{y}^Y}{2\psi(1+\beta+\lambda)}} = \frac{\sqrt{p_1 - y^F}}{\sqrt{\psi}}, \tag{D7}$$

where the second equality comes from rearranging the terms in (D6). To see that this expression means that population growth is higher than in under the baseline wage regime, note that (D4) implies $1 + \gamma_0 = \frac{\sqrt{p_0 - y^F}}{\sqrt{\psi}}$ and it was shown previously that $p_1 > p_0$. In addition, if ϵ or $\tilde{y}^Y$ increased (which would raise the bride price), the population growth rate would increase because the high-wage segment of the young male population would produce more children, either because there are more high-wage young men or they have more resources.

The above implies that this period's bride price can be expressed in the same format as (D4): $p_1 = y^F + \psi(1+\gamma_1)^2$. Substituting these representations of the period bride prices into the first-order conditions in (D1) gives old men's demand for young wives as $w_1^O = \frac{(1+\gamma_0)^3}{(1+\gamma_1)^2}$. Therefore, the share of women in age-disparate relationships is now $D_1 = \frac{w_1^O}{1+\gamma_0} = \frac{(1+\gamma_0)^2}{(1+\gamma_1)^2} < 1$, so it is less than the baseline steady-state value.

D3. Proof of Proposition 3

I proceed by induction. In the base step, I show that the proposition holds for $t = 2$. The first-order conditions for the $1 - \epsilon$ share of old men who begin the period unmarried and the ϵ share of high-wage young men are identical to (D1) and (D5). If they are the only ones participating in this period's marriage market, then (4) yields a bride price of

$$p_2 = y^F + \frac{\psi(1-\epsilon)(1+\gamma_0)^3}{1+\gamma_1} + \frac{(\beta+\lambda)\epsilon\tilde{y}^Y}{2(1+\beta+\lambda)}, \tag{D8}$$

which is strictly less than p_1 in (D6) because $\frac{1-\epsilon}{1+\gamma_1} < \frac{1}{1+\gamma_0}$. The assumption on young men's wages implies that the last term in (D8) is larger than the last term in (D4). As a result, $p_2 > p_0$, which verifies the conjecture that high-wage young men and old men who earned low wages as young men are the only ones participating in this period's marriage market. It also gives population growth as

$$1+\gamma_2 = \frac{\sqrt{p_2 - y^F}}{\sqrt{\psi}}, \tag{D9}$$

so it follows the same pattern as the bride price: $1+\gamma_0 < 1+\gamma_2 < 1+\gamma_1$.

For these old men, the decrease in the bride price allows them to marry $w_2^O = \frac{(1+\gamma_0)^3}{(1+\gamma_2)^2}$ young wives. While this number is larger than in the previous period, the share of young women in age-disparate relationships is less than in the first period: $D_2 = \frac{(1-\epsilon)(1+\gamma_0)^3}{(1+\gamma_1)(1+\gamma_2)^2} < D_1$. To see why, note that this relationship holds if and only if $(1+\gamma_2)^2 > (1-\epsilon)(1+\gamma_0)(1+\gamma_1)$, which can be shown to be true by using (D9) and substituting in the rearranged form of the first equality in (D7). The intuition is that already-married men abstain from work in old age, so the composition of men marrying in this period skews further toward the young.

In the inductive step, suppose that the proposition is true for $t = k$. Using the same logic as above and the inductive hypothesis $1+\gamma_k > 1+\gamma_0$, it is straightforward to show that, if only high-wage young men and old men who earned low wages in the previous period marry in $k+1$, then

$$p_{k+1} = y^F + \frac{\psi(1-\epsilon)(1+\gamma_0)^3}{1+\gamma_k} + \frac{(\beta+\lambda)\epsilon\tilde{y}^Y}{2(1+\beta+\lambda)}. \tag{D10}$$

Therefore, $p_0 < p_{k+1} < p_1$ and $1+\gamma_0 < 1+\gamma_{k+1} < 1+\gamma_1$, which again verifies that these men are the only ones who marry. In addition, population growth takes the form

$$1+\gamma_{k+1} = \frac{\sqrt{p_{k+1} - y^F}}{\sqrt{\psi}}. \tag{D11}$$

Old men's demand for brides $w_{k+1}^O = \frac{(1+\gamma_0)^3}{(1+\gamma_{k+1})^2}$ implies that the share of age-disparate marriages is $D_{k+1} = \frac{(1-\epsilon)(1+\gamma_0)^3}{(1+\gamma_k)(1+\gamma_{k+1})^2}$. Using (D11) and the inductive hypothesis $1+\gamma_0 < 1+\gamma_k$ to follow the same procedure as in the base step, it is clear that $D_{k+1} < D_1$.

D4. New Wage Regime: Steady State

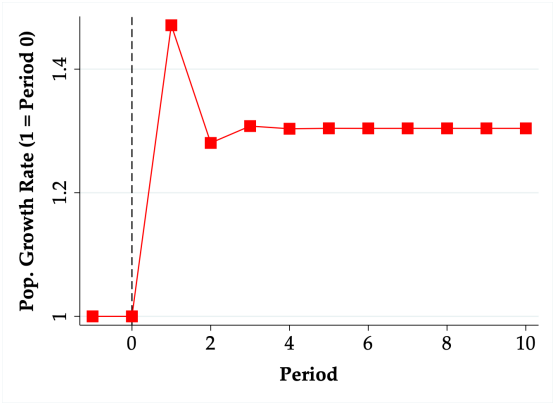
The new steady state of this marriage market is characterized by a population growth rate $1 + \gamma_T$ that is implicitly defined by replacing the k and $k+1$ subscripts in (D10) and (D11) with T and rearranging the latter expression to equal 0. Although this rate lacks a closed-form representation, I can use the parameter choices summarized and justified in Table D1 to graphically illustrate the predictions above and the steady state of this marriage market in Figure D1. Intuitively, steady-state values are not very different from those in $t = 2$, as Proposition 3 shows that it and each subsequent period have effectively the same inputs.

Table D1: Parameter Choices for Graphical Illustration of Theoretical Predictions

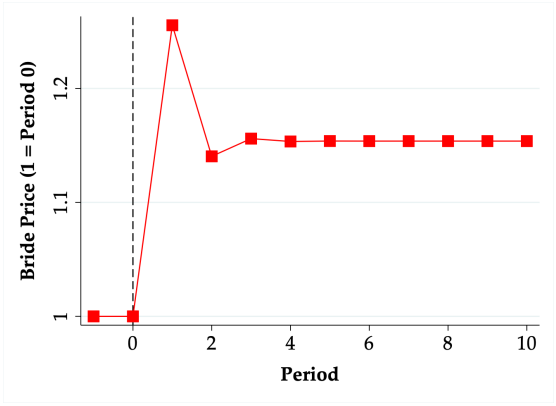
Parameter	Description	Value	Justification
β	Discount rate	0.7	Annual discount rate of 0.99 over 35-year period
λ	Importance of continuing lineage	0.5	None; only affects level of population growth
y^O	Old men's wages	1.0	Normalization
y^Y	Young men's low wages	0.6	Satisfies Assumption 1
y^F	Young women's wages	0.5	Satisfies Assumptions 1 and 2
$\tilde{y}^Y$	Young men's high wages	2.0	Satisfies Assumption 3
ψ	Cost of a child's survival	0.1	Ensures population growth is positive
ϵ	High-wage share of young men	0.3	Table C1 Column (1)

Notes: Parameters used to create the graphs in Figures 6 and D1.

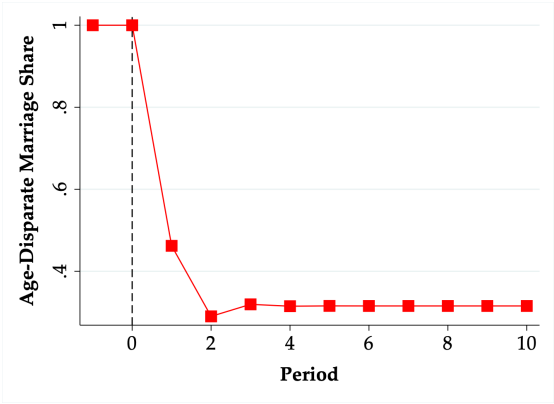
Figure D1: Graphical Illustration of Theoretical Predictions



(a) Population Growth Rate (Normalized)



(b) Bride Price (Normalized)



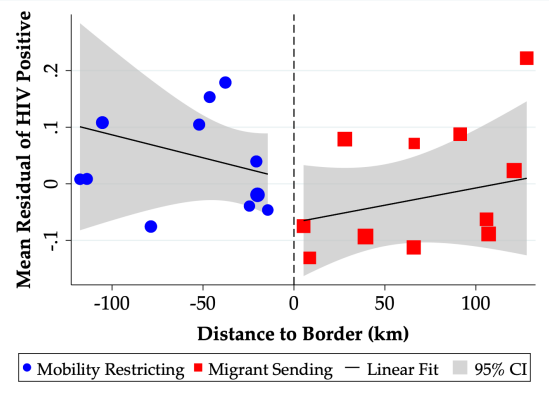
(c) Age-Disparate Share of Marriages

Notes: Plots show the evolution of each outcome when the marriage market is under the baseline wage regime through Period 0 and the new wage regime is imposed in Period 1.

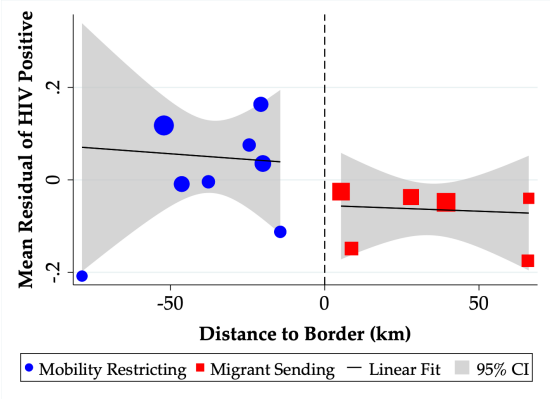
Appendix E. Modern Era: Additional Figures

E1. RD Plots: HIV Prevalence by Sex

Figure E1: HIV Prevalence



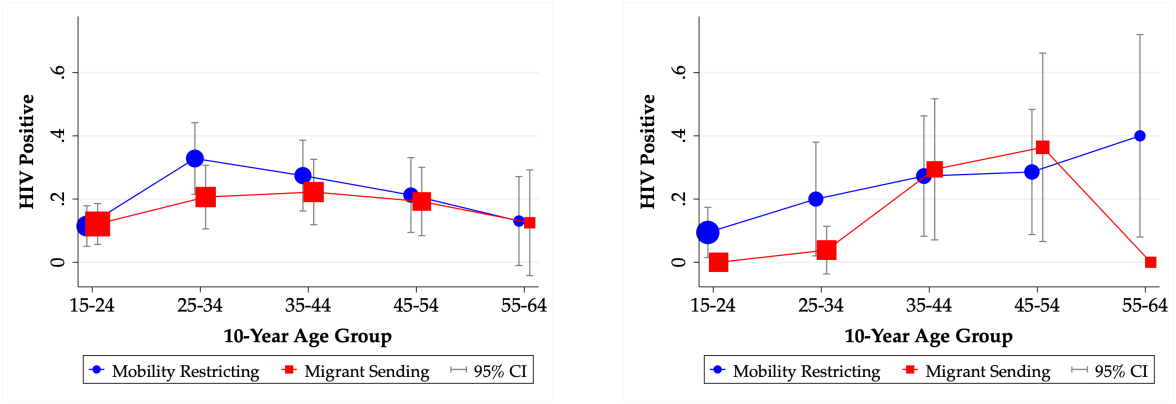
(a) Women



(b) Men

E2. Age Profiles of HIV Prevalence by Sex

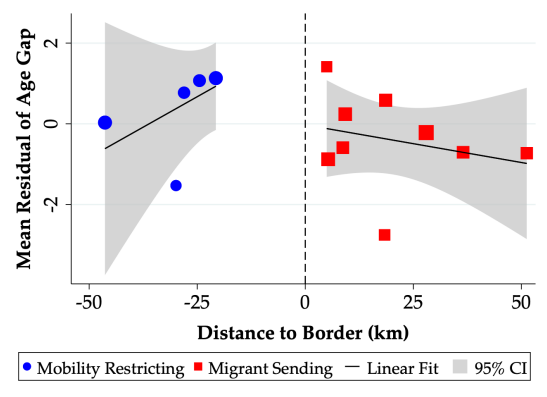
Figure E2: HIV Prevalence by Sex and Age within RD Bandwidths



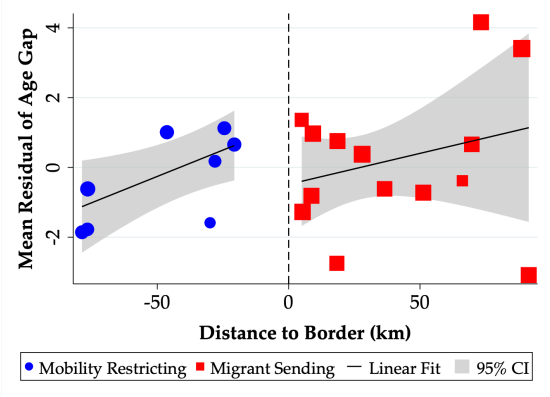
(a) Women **(b)** Men

E3. RD Plots: Partner Age Gaps

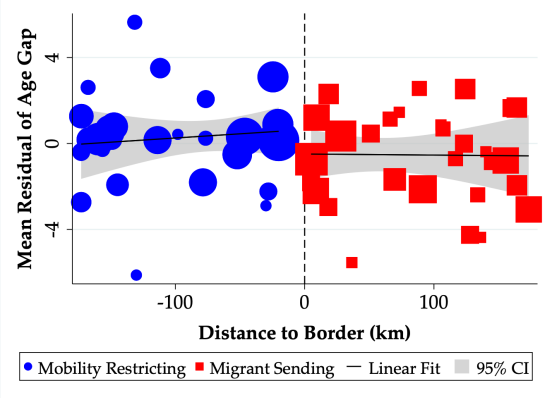
Figure E3: Male-Female Age Gap with Last Sexual Partner



(a) All Women



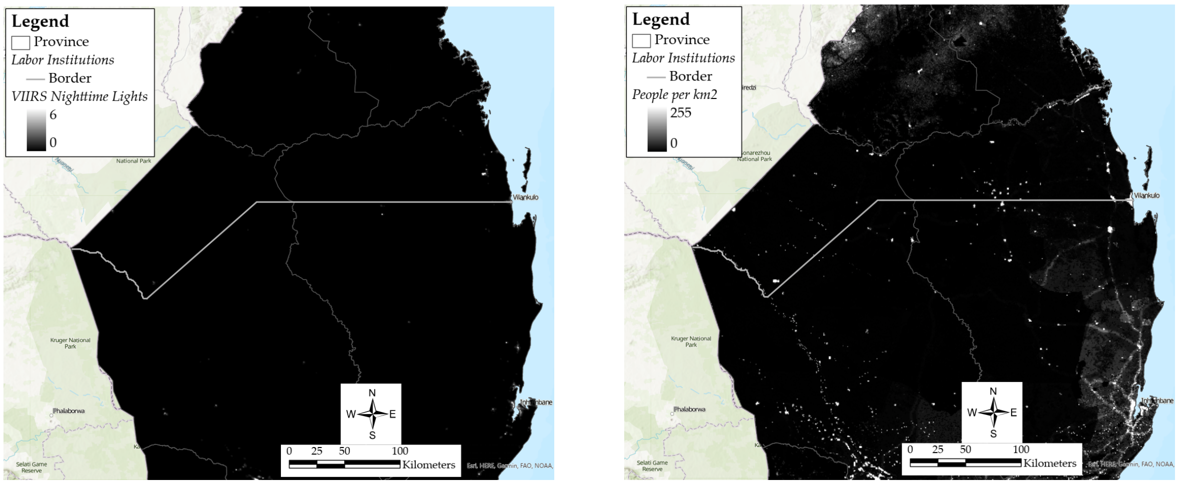
(b) Married Women



(c) Married Men

E4. Geospatial Measures of Development

Figure E4: Maps of Geospatial Measures of Development

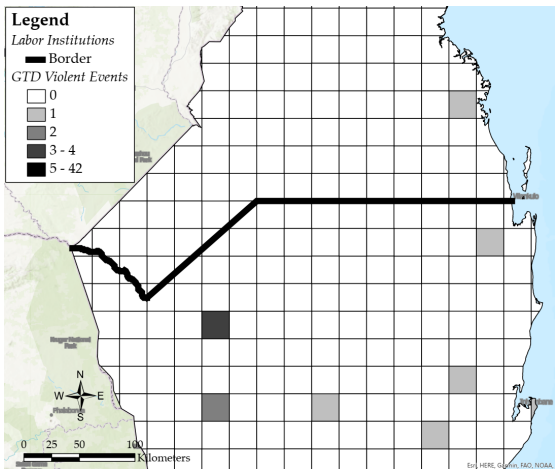


(a) VIIRS Nighttime Lights, 2019

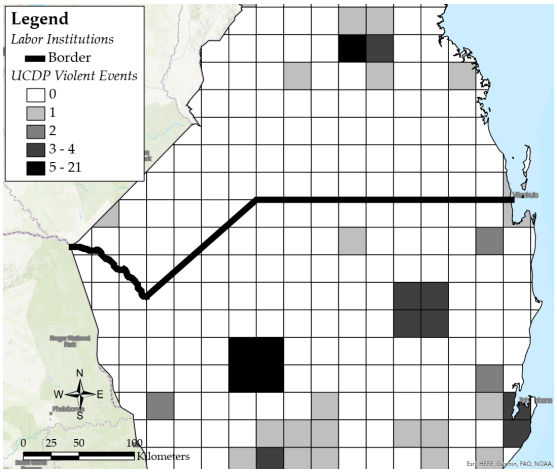
(b) Landscan Population Density, 2019

E5. Civil War Violence and Landmines

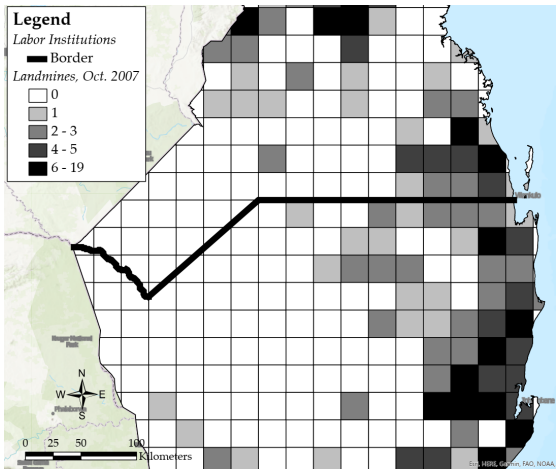
Figure E5: Maps of Civil War Violent Events and Landmines by Gridcell



(a) Global Terrorism Database, 1978-92



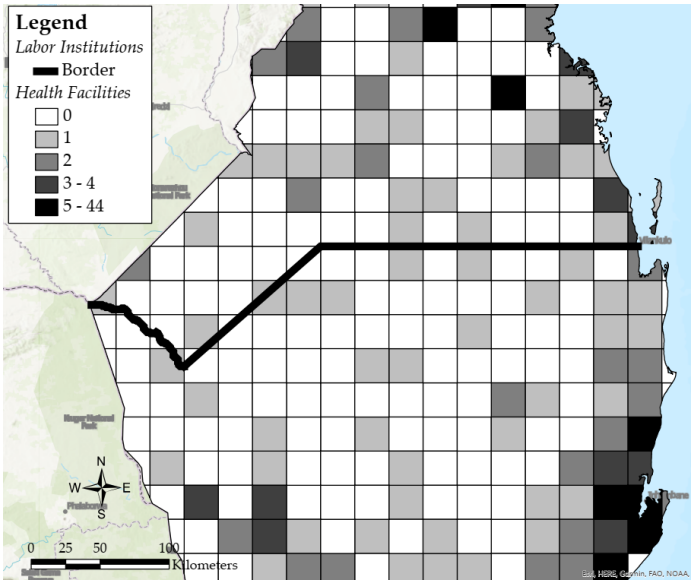
(b) Uppsala Conflict Data Program, 1989-92



(c) Known and Suspected Landmines, Oct. 2007

E6. Public-Sector Health Infrastructure

Figure E6: Public-Sector Health Facilities, 2018



Appendix F. Modern Era: Robustness and Additional Results

F1. Randomization Inference: HIV

Table F1: HIV Prevalence [32]

	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: .

F2. Results Using Data Collapsed into Clusters: HIV

Table F2: HIV Prevalence [32]

	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: .

F3. HIV Blood Test Refusals

Table F3: HIV Blood Test Refusals [32]

	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).

F4. Development Results Using Geospatial Data

Table F4: Development Results Using Geospatial Data [32]

	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: .

F5. Development Results Using Census Data

Table F5: Human Capital Results Using Census Data [32]

	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).

F6. Civil War Violence

Table F6: 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).

F7. Landmines

Table F7: 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).

F8. Randomization Inference: Age-Disparate Partnerships

Table F8: Age-Disparate Partnerships [35]

	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: .

F9. Results Using Data Collapsed into Clusters: Marriage

Table F9: Age-Disparate Partnerships [35]

	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: .

F10. HIV Risk Factors Associated with Age-Disparate Relationships

Table F10: Risk Factors Associated with Age Disparities [37]

	Men	Women				
	Multiple Partners (1)	Polygynous Marriage (2)	Virgin: Ages 15-24 (3)	Condom Last Sex (4)	Forced Sex Ever (5)	Decide Own Health (6)
Migrant Sending	-0.066	-0.040	-0.032	0.090	-0.007	-0.015
	(0.100)	(0.052)	(0.034)	(0.054)	(0.040)	(0.073)
	[0.084]	[0.068]	[0.044]	[0.070]	[0.027]	[0.090]
Observations	432	444	495	477	249	351
Clusters	46	26	58	26	22	22
Bandwidth	137.0	81.7	156.5	80.8	95.7	97.9
Wild Cluster Bootstrap p-value	0.540	0.684	0.497	0.300	0.869	0.870
Mobility Restricting Mean	0.231	0.343	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).

F11. Public-Sector Health Infrastructure

Table F11: Public-Sector Health Facilities, 2018 [32]

	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).

F12. HIV Risk Factors Unrelated to Institutions' Histories

Table F12: 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).

F13. Circular Migration and Development Outcomes in Southern Africa

Table F13: Asset Ownership and Schooling Near WNLA Recruitment Posts

	LSO, MOZ, SWZ, ZAF		Malawi	
	Kilometers	Log(Km+1)	Kilometers	Log(Km+1)
	(1)	(2)	(3)	(4)
Panel A. Asset Index				
Distance from Recruitment Post	-0.010	-0.132	-0.002	0.001
	(0.006)	(0.067)	(0.009)	(0.084)
Observations	62,274	62,274	31,013	31,013
Clusters	96	96	12	12
Wild Cluster Bootstrap *p*-value			0.844	0.988
Mean	3.59	3.59	3.44	3.44
Standard Deviation	1.40	1.40	1.45	1.45
Panel B. Years of Schooling				
Distance from Recruitment Post	-0.019	-0.132	-0.007	-0.057
	(0.015)	(0.176)	(0.027)	(0.257)
Observations	61,925	61,925	28,080	28,080
Clusters	96	96	12	12
Wild Cluster Bootstrap *p*-value			0.824	0.833
Mean	8.25	8.25	6.50	6.50
Standard Deviation	10.84	10.84	6.13	6.13

Notes: .