History, Path Dependence and Development: Evidence from Colonial Railroads, Settlers and Cities in Kenya

Short title: History, Path Dependence and Development[*†]

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Abstract: Little is known about the extent and forces of path dependence in developing countries. Colonial era railroad construction in Kenya provides a natural experiment to study the emergence and persistence of spatial equilibrium. Data spanning over one century shows that railroads determined the location of European settlers, Asian traders, and the main cities at independence. Europeans then left, Asians departed, and railroads declined in the immediate post-independence period, constituting local shocks to physical and human capital. Yet the colonial cities persisted. We test four explanations for path dependence based on institutional persistence, technological change, sunk investments, and spatial coordination failures.

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Cities are the main engines of growth (Lucas, 1988). By agglomerating people, cities facilitate the exchange of goods and ideas, increasing aggregate productivity (Glaeser & Gottlieb, 2009), and therefore can promote growth in developing countries (Henderson, 2010; Duranton, 2014). Studying why cities emerge and persist has become crucial to our understanding of this growth process, and the evolution of spatial inequality both across and within countries (Desmet & Henderson, 2014).

The development and urban literatures have argued over whether geography (i.e., natural advantages) or history (i.e., man-made advantages) are the main determinants for the spatial distribution of economic activity (i.e., cities). Studies have shown that geography has a strong influence on spatial development, in both rich and poor countries (Gallup, Sachs & Mellinger, 1999; Beeson, DeJong & Troesken, 2001; Rappaport & Sachs, 2003; Bosker & Buringh, 2010; Maloney & Caicedo, 2015). One implication of geography as a driver for development is that localised historical shocks should only have temporary effects. Davis & Weinstein (2002, 2008), Bosker et al. (2007, 2008) and Miguel & Roland (2011) use the war time bombing of Japan, Germany and Vietnam respectively, to test whether these shocks had long-term effects on the relative ranking of cities that were disproportionately demolished. Many of these destroyed cities recovered their population, which therefore showed that serial correlation explained urban persistence. Davis & Weinstein (2002) concluded that there is only one spatial equilibrium, which is determined by geography. If only geography matters, regional policies could be ineffective in altering regional development.

Conversely, the literature has also established that localised historical shocks can have permanent spatial effects. For example, Redding, Sturm & Wolf (2011) showed how the division of Germany, despite later reunification, permanently changed the location of its main airports. Likewise, Nunn & Puga (2012) demonstrated how the slave trade permanently altered the location choice of Africans, although the trade ended one century ago. These studies, and others (Bosker et al., 2008; Bleakley & Lin, 2012; Michaels & Rauch, 2013; Ahlfeldt et al., 2014; Jedwab & Moradi, 2015), show how there may be path dependence in space. It suggests the existence of multiple spatial equilibria, with the selection of one of these equilibria being determined by history. This historical importance leaves a role for regional policies since they may alter regional development.

Local increasing returns have been advanced as the main explanation for path dependence. Krugman (1991) contrasts the role of "history" and "expectations" in explaining increasing returns. First, fixed costs can be a source of increasing returns where man-made advantages (or history in the Krugmanian sense) may account for the path dependence. Examples include ports (Fujita & Mori, 1996), or durable housing (Glaeser & Gyourko, 2005). Second, given local increasing returns, factors must also be co-located in the same locations. Intervening are spatial coordination failures, as it is not obvious which locations will have these factors. Cities solve this problem by signalling to productive agents where they could expect others to locate (Bleakley & Lin, 2012; Jedwab & Moradi, 2015). However, politics may also be a factor of path dependence if governments purposely use public expenditure to preserve an existing spatial distribution (Davis & Weinstein, 2002).

In this paper, we use a series of large exogenous shocks to investigate the extent and forces of urban path dependence in a developing country. We focus on Kenya, for which we created a new dataset on railroads, European & Asian settlements, and city growth at a fine spatial level over one century (473 locations, *approx.* 16 x 16 km, from 1901 - 2009).

We first show how the construction of the *colonial railroad* created a new spatial equilibrium in Kenya. For geo-strategic reasons, the British coloniser built a railroad from Mombasa, on the coast, to Lake Victoria, in the hinterland. Although the line crossed Kenya from east to west, the ultimate objective was to link the coast to Uganda (across Lake Victoria), where the Nile originates; the control of which was regarded as a vital asset in the Scramble for Africa. Our results show that the railroad had a strong impact on European settlement, establishing cities from where the *European settlers* managed their commercial farms and specialised in urban activities. *Asian settlers* then established themselves as traders in those cities. Both groups were relatively skilled. Investments in public physical capital thus attracted human capital during the colonial era. We then use various standard identifications strategies to attempt to measure causal effects.

We test the persistence of this spatial equilibrium using three local negative shocks in the immediate post-independence period. First, the *European settlers* left following the Lancaster House Agreement of 1962 which required settlers to choose their citizenship after independence. Their refusal to renounce British citizenship resulted in an exodus from

Kenya. Second, many *Asian settlers* departed following the Trade Licensing Act of 1967, that discouraged them from owning or managing commercial establishments. Third, the *colonial railroad* declined in the 1960s-1970s, mainly due to mismanagement and a lack of maintenance in the sector, but also as extensive investments in sealed roads continued to escalate, especially in locations farther away from the railroads. Thus, the three factors that gave rise to the spatial equilibrium in the first place disappeared, and an entirely different spatial distribution could have emerged in the post-independence period. However, we find that locations that were disproportionately affected by these large shocks to physical capital and human capital remain relatively more urban and developed today.

We use data on colonial and post-colonial infrastructure to investigate the channels of path dependence. We contrast four different explanations based on institutional persistence, technological change, sunk investments and spatial coordination failures. First, we find that institutional persistence, for example the fact that the new African political elite may have preserved the colonial spatial equilibrium in order to better control the resources of the country, does not account for path dependence. Second, we verify that path dependence is not explained by changes in transport technology, as measured by roads (that replaced rail), and the diffusion of knowledge, as measured by schools (that trained Africans who replaced the settlers). Third, colonial cities were better endowed in infrastructure (e.g., hospitals) at independence. We find that colonial sunk investments partially explains path dependence. Fourth, we argue that persistence is also explained by the fact that the early emergence of the railroad and settler cities served as a mechanism to coordinate spatial investments in subsequent periods. In particular, we contend that expectations (i.e., spatial coordination failures) may matter as much as history (i.e., sunk investments), which suggests that regional policies may be ineffective if they do not also change expectations.

This study makes the following contributions to the literature. First, the natural experiment allows us to examine the emergence and persistence of a spatial equilibrium. Studying an initially unurbanised country – Kenya had only four coastal cities before colonisation – allows us to analyse the emergence of the equilibrium. We then use multiple shocks, the construction and demise of railroads, and the respective settlement and subsequent exodus of Europeans and Asians, to test for the persistence of the equilibrium. If geography is timeinvariant, having several symmetrical shocks helps identify the role of increasing returns (Ahlfeldt et al., 2014). Second, we exploit shocks to physical capital (railroads) and human capital (skilled settlers), and their interactions, to test their role in path dependence. Jedwab & Moradi (2015) focus on rail building in Ghana. Kenya, unlike Ghana, was a settler colony and saw a significant influx of European and Asian settlers along the railroads. We find similar results no matter the shock studied. Third, we study the mechanisms of urban path dependence, which few papers have done with the exceptions of Bleakley & Lin (2012), Michaels & Rauch (2013) and Jedwab & Moradi (2015). We find that both (colonial) sunk investments and the solving of spatial coordination failure matters. Institutional persistence – a well-documented mechanism of path dependence *across* countries (Acemoglu, Johnson & Robinson, 2001) – does not appear to be a significant channel *within* Kenya.[1]

Our focus on transportation is associated with the recent literature on railroads and economic growth (Atack et al., 2010; Banerjee, Duflo & Qian, 2012; Baum-Snow et al., 2012, 2014; Donaldson, 2015; Donaldson & Hornbeck, 2015). For Africa, Jedwab & Moradi (2015) find that railroads, a typical investment in *physical capital* during the colonial era, had a strong impact on long-term development. In addition, the Kenyan context allows us to study the relationship between *human capital* and city growth (see Henderson (2007) and Glaeser & Gottlieb (2009) for two recent surveys). The literature has shown how cities helped disseminate knowledge, which then promoted their growth (Glaeser, Scheinkman & Shleifer, 1995; Glaeser & Saiz, 2004; Moretti, 2004; Gennaioli et al., 2013; de la Roca & Puga, 2014). The literature on human capital spillovers in developing countries is scarcer (Henderson, 2010). The departure of settlers may have had asymmetric spatial effects in Kenya. Yet, the cities with more settlers at independence, and thus a larger exodus post-independence, were not durably affected by the shock. This suggests that human capital may not be critical for city growth in our context, but rather cities solve a spatial coordination problem for skilled workers. In other words, skilled workers sort themselves

[1]The literature has also shown how path dependence can be explained by land institutions (Libecap & Lueck, 2011; Brooks & Lutz, 2014). However, we do not find evidence of this channel in our context.

in the cities, which is consistent with the literature on spatial sorting (Combes, Duranton & Gobillon, 2008; Young, 2013; Behrens, Duranton & Robert-Nicoud, 2014). The result that human capital may have not mattered locally in 20th century Kenya is in line with Michaels, Rauch & Redding (2013) and Glaeser, Ponzetto & Tobio (2014) who find that human capital externalities were lower in the U.S. in the 19th century than in the 20th century. Our interpretation of this result is that human capital externalities may matter more for a skill-intensive economy, which Kenya was not during our period of study.

Lastly, the paper contributes to the literature on the economic effects of expulsions. Waldinger (2010), Acemoglu, Hassan & Robinson (2011), Yuksel & Yuksel (2014) and Pascali (2014) find negative local effects of the expulsions or elimination of Jews in various contexts. These negative spillovers are explained by the fact that the Jews were skilled and part of the middle class. Chaney & Hornbeck (2015) then find that the expulsion of Morisco farmers in 17th century Spain had positive effects on the per capita income of non-Moriscos, as the expulsion of the former freed land for the latter. Our context is different in that the Europeans and the Asians were the economic elite of Kenya's colonial cities. The fact that we find no negative effects for the exodus of either group is consistent with the Malthusian hypothesis that a population decline may cause temporary increases in income per capita, which in turn leads to population convergence (the negative short-run effects disappear in the long-run). It also shows that the human capital of the settlers was not essential to the local Kenya economy (although their expulsion may have had aggregate effects).

The article proceeds as follows. Section 2 and 3 discusses the historical background and presents the assembled data. Section 4 shows the emergence of the colonial spatial equilibrium. Section 5 studies the persistence of this spatial equilibrium. Section 6 discusses the results.

1. Historical Background

This section discusses the construction and demise of the colonial railroad, the mass inward migration and subsequent exodus of Europeans and Asians. The following summary draws from Hill (1950), Morgan (1963), Soja (1968), Sorrenson (1968) and Kapila (2009).

1.1 *Construction and Demise of the Colonial Railroad*

Kenya was extremely poor in the late 19th century. With the exception of Nairobi, founded in 1899, there were only four towns in 1901, all of which were on the coastline. The various tribes were geographically separated by the Rift Valley, which served as a buffer zone between them (see "Kikuyu", "Kalenjin", "Luhya", "Luo" and "Maasai" in Figure 1). Economic activity was constrained by high trade costs. Kenya lacked navigable waterways. Draft animals had not been adopted due to the Tsetse fly. Head-loading was the main means of transport, and very costly. Figures in Hill (1950) indicate a 1902 freight rate of 11 shillings (s) per ton mile for head porterage as compared to 0.09s per ton mile by rail.

The Uganda Railway was constructed between 1896-1901, mostly for geopolitical reasons. The British thought that by linking Uganda to the coast they could unify all their colonies in Northern, Eastern and Southern Africa.[2] The British perceived Lake Victoria, the source of the Nile River, to be vital for their interests in Egypt. The railroad shielded the region against competing European powers, allowing faster transport of troops. Secondly, Uganda was seen to hold vast wealth with further trade potential. Linking Lake Victoria to the coast would open up Uganda to trade. Kenya was merely a transit territory en route to Uganda. The construction was debated fiercely within the British parliament. Critics doubted the usefulness of the railroad "from nowhere to utterly nowhere".

Rail placement was driven by one objective, as evidenced in parliamentary records and railroad surveys at that time: connecting Kisumu (on Lake Victoria) to Mombasa via Nairobi at the least possible cost. Nairobi was chosen as the intermediary node because it supplied rail construction workers and steam locomotives with water. At the time a swamp, Nairobi became the railroads headquarters in 1899 and the capital soon thereafter. Rail placement between the nodes was determined by topography. The mainline established the general

[2] Web Appendix Figure 1 shows a map of the "Cape to Cairo Railway", a plan to unify British Africa by rail.

urban pattern of Kenya. Soja (1968) explains that the equal distribution of urban centres at key points along the main route reflects the weak influence of local factors in the initial urban growth. Various branch lines were constructed in the 1910s and 1920s (see Figure 2, and Web Appendix Figure 2 for a description of each line). No lines were built post-1930.

Rail traffic rose until independence, as shown in Figure 3 (see "tons per km per million of population transported by rail"). Railroads then declined in the immediate post-independence period. Firstly, political and economic instability had a damaging effect on public investments (World Bank, 2005).[3] Tracks, locomotives and rolling stock were in disrepair by the 1970s. The Kenya Railways Corporation was overstaffed, and service quality was poor, which reduced both traffic and revenue. Secondly, the first governments of Kenya invested heavily in roads (Burgess et al., 2014). Roads were three times cheaper to build, but maintenance costs were much higher than for railroads. Kenya's total length of good-quality roads also increased threefold from independence to the present. Rent-seeking favoured construction projects prone to embezzlement, such as building new roads. Maintaining railroads was of no use in this regard. Rail traffic collapsed (see Figure 3), and accounts for 5-10% of total traffic now (World Bank, 2005). Thus, while few hinterland locations were connected to the coast in the colonial era, almost all locations are now connected, and a different spatial distribution could have emerged in the post-independence period.

1.2 *Colonial Settlement; Independence Exodus*

The railroad placement led to a curious situation whereby it traversed sparsely settled areas with no Kenyan freight to transport. European settlement was encouraged to create an agricultural export industry, which would increase rail traffic. Land was alienated and offered to European settlers, whose numbers increased to 60,000 at independence (see Figure 3). Figure 4.a shows the standardised number of Europeans by location in 1962.

[3]This instability includes the difficult transition to independence in 1963, demise of democracy in 1969, the death of president Kenyatta in 1979, and the economic crisis of the 1970s and 1980s.

Initially, farmers were the most numerous group among the settlers, accounting for 40% in 1921, but their share decreased to 15% by 1962. They immigrated to grow coffee, tea, sisal, wheat and maize, which they mostly exported to Europe (these crops accounted for 75% of exports in the 1930s). According to the 1962 Census, 60% of Europeans worked in the private industrial and service sectors, whereas the public sector employed 25%. Instead, 70% of Europeans could be considered as skilled if we only focus on occupations.[4]

The labour force for the construction of the railroad were recruited from India. Many of the 30,000 Indian workers stayed on, forming the nucleus of the Asian community whose numbers increased to 180,000 at independence (see Figure 3). Asians were not however allowed to own land, so they mainly filled positions in the urban economy. Figure 4.b shows the standardised number of Asians by location in 1962. Comparing Figures 4.a and 4.b confirms that the Asians disproportionately settled in the urban areas along the railroad lines, whereas the Europeans sometimes lived further away from the lines. The 1962 Census shows that 98% of Asians were employed in the private non-agricultural sector, and the commercial sector in particular (40%). Using the same broad definition of skills as for the Europeans, we find that 95% of them were skilled.[5]

Non-Africans took a privileged position in schooling. According to the *Statistical Abstract* of 1960, educational expenditures per European (Asian) students were 21 (6) times higher than that of African students. The higher expenditures reflected educational attainment and the more costly secondary and higher education. While Africans were mostly limited to primary school attendance, with primary and secondary gross enrolment rates of 65% and

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[4]Based on the *International Standard Classification of Occupations*, we consider skilled as: "Professionals, technical and related workers", "Administrative and managerial workers", "Clerical and related workers" and "Sales workers". We include clerks and sales workers as they were relatively skilled for that time (in terms of literacy and numeracy). The skilled share remains high at 60% when excluding these two groups.

[5]If we use the stricter definition of skills, about 30% of Asians were skilled. The skilled share is lower, simply because we reclassify clerks and sales workers (many of whom were Asian) as unskilled.

3% respectively. However, the expansion of education to Africans only began in the 1950s. Barely 20% and 0.5% of Africans older than 25 years in 1960 had ever attended a primary and secondary school respectively.

The number of towns with a population in excess of 2,000 inhabitants increased from 5 in 1901 to 42 at independence (and 247 today). The cities served various functions. First, the Europeans lived in towns from where they managed their farms. Second, the cities were trading stations through which export crops were transported to the coast, and imported goods dispatched from the coast. Part of the surplus generated by exports was spent on locally produced urban goods and services. The private industrial and service sectors expanded as a result. Third, a few towns became administrative seats. The areas where Europeans settled to grow crops or specialise in urban activities came to be known as the White Highlands. Demand for African labour grew in these areas. Lastly, the Asian settlers distributed themselves as traders across the European, as well as non-European cities.

As a result, Europeans and Asians only accounted for 2% of Kenya's population at independence, they represented the agricultural, industrial, commercial, political, and educational backbone of the country. This all changed after the Lancaster House Agreement of 1962, that led to independence from Britain in 1963. When required to adopt Kenyan citizenship, most settlers refused to relinquish their British passports. Approximately 50,000 Europeans left Kenya and sold their land (see 1962-1969 in Figure 3). Under various redistribution schemes, their farms were transferred to 60,000 African families (Hazlewood, 1985). Policies of Africanisation also affected Asians. The Kenya Immigration Act 1967 required non-citizens to acquire work permits. In the same year, the Trade Licensing Act limited non-citizens to trade only in six "General Business Areas" (the railroad nodes, and three other towns), while they were excluded from dealing in most goods. Approximately 100,000 Asians used their British citizenship to migrate to Britain. Facing this wave of emigration in the early 1970s, the British government withdrew the right of entry from Asians with colonial British passports, halting the exodus (see 1962-1979 in Figure 3).

2. New Data on Kenya, 1895-2010

We compile a new data set of 473 locations, the third level administrative units as of 1962 (with a median area of 256 sq km, *approx.* locations of 16 x 16 km), for the following years: 1901 (six years after the Protectorate was established), 1962 (one year before independence), 1969, 1979, 1989, 1999 and 2009 (the census years). We obtain the layout of rail lines in GIS from *Digital Chart of the World*. We then use various documents to recreate the history of rail construction. We know when each line was completed. Our analysis focuses on the rail network in 1930, as thereafter it did not change. For each line, we create four dummies equal to one if the Euclidean distance of the location's centroid to the line is 0-10, 10-20, 20-30 or 30-40 km. We then also identified explorer routes from the coast to Lake Victoria and located various branch lines that were planned but not built. Lastly, we exploit the GIS road database from Burgess et al. (2014).[6]

We use census gazetteers to construct a GIS database of localities above 2,000 inhabitants. Since our analysis is at the location level, we use GIS to construct the urban population for each location-year observation. While we have exhaustive urban data, we only have georeferenced population data in 1962 and 1999. The population census of 1962 was the first census that reliably enumerated the African population. To proxy for the population distribution in 1901, we digitised a map of historical settlement patterns that shows the location of the main sedentary and pastoralist groups in the 19th century. From census data, we obtain the number of Europeans and Asians for each location in 1962. We digitised and geocoded the European voter registry of 1933. We used the address, sector and occupation of male voters to proxy for the number, and human capital of Europeans in the same year. Locations do not cover the same area, so we control for location area in the regressions. Lastly, we have data on commercial agriculture (e.g., coffee cultivation) in 1962. We also have data on infrastructure provision (e.g., schools and hospitals) and economic development (e.g., poverty rates and satellite night-lights) in 1962 and/or 2000.

3. Colonial Railroads, Settlers and Cities at Independence

[6]Data sources and variable construction are described in detail in the Web Appendix.

In this section we show how rail building determined the location of European and Asian settlers, and the main cities at independence. Evidence on the mechanisms by which railroads spurred population growth completes the analysis.

3.1 *Main Econometric Specification*

We follow a simple strategy whereby we compare the European, urban, Asian and African populations of connected and non-connected locations (l) in 1962:

$$zPop_{l,62} = \alpha + Rail_{l,62}\beta + \omega_p + X_l\zeta + \nu_{l,62} \quad (1)$$

Where $zPop_{l,62}$ is the standard score (z) of European / urban / Asian / African population of location l in 1962. $Rail_{l,62}$ are dummies capturing rail connectivity in 1962: being 0-10, 10-20, 20-30 or 30-40 km away from a line. We include eight province fixed effects ω_p and a set of controls X_l to account for physical geography, pre-existing settlement patterns and other potentially contaminating factors. We have a cross-section of 473 locations. However, we exclude the locations that are unsuitable for agriculture, defined as the locations where arid soils account for more than 10% of total area (see Figure 1). We also drop the three rail nodes of Mombasa, Nairobi and Kisumu.[7] The remaining 403 non-arid non-nodal locations belong to the South. If we use the full sample, we run a risk of comparing the southern and northern parts of Kenya, whose geography and history differ. If unobservable factors correlated with the railroad explain why the South was historically more developed than the North, excluding the northern locations should give us more conservative estimates. We express all population numbers in standard (z-)scores. This has two advantages. First, while non-standardised values differ greatly (e.g., European vs. African population), the coefficients β can be readily compared across outcomes. Second, the population grew over time, so the coefficients will increase for later periods, unless we standardise the variables.

[7] These nodes have grown for political reasons. Including them would make us overestimate the rail effects.

Interpretation of the coefficients is therefore improved by the standardised values.

3.2 *Exogeneity Assumptions, Controls, and Identification*

In the case of European, urban and Asian population, which were almost nil in 1901, results should be interpreted as long-differenced estimations for the period 1901-1962. Regarding the African population, it is important to control for historical settlement patterns, as there was no exhaustive census before 1962. The measures of historical settlement we have at our disposal are: (i) the area shares (%) of "major settled groups" and "pastoralist groups", and a "isolated groups" dummy, for the 19th century, (ii) a "city in 1901" dummy (there were only three non-nodal cities then), and (iii) a "provincial capital in 1901" dummy. We add various geography variables that also help us capture the initial distribution of African population: A "coastal location" dummy if the location borders the sea, the area share of lakes (%), the Euclidean distances to the coast and the nearest lake (km), average annual rainfall (mm) and temperature (degrees), the mean and standard deviation of altitude (m), the shares of arid soils (%), and soils (%) suitable for agriculture, coffee or tea, and area (sq km). If the variables are adequate controls for baseline African population levels, this regression may also be interpreted as a long-differenced estimation. Besides, these geographical factors may have also determined the potential for population growth post-1901, hence the need to control for them in the regressions.

Table 1 shows the mean of each variable for various groups of locations. Columns (1) and (2) report the means for the locations within 10 km and between 10 and 40 km from a line, respectively. To test whether the 0-10 km cells differ from the 10-40 km cells, we regress each variable on a dummy equal to one if the cell is within 10 km from a line and test if the difference is significant once we include the province fixed effects (column (2)). The 0-10 km cells are less rugged, which could lead to an upward bias. They have less rainfall, are less suitable for coffee and tea, and were historically less populated (see "Area share of pastoralists" and "Isolated Groups Dummy"). This could lead to a downward bias, if population growth had been faster in denser areas. We obtain similar differences if we compare the 0-10 km cells with the 40+ km cells (column (3)). However, even if some differences are significant, they remain small in absolute terms. Thus, the directionality of any bias is not obvious. Our identification strategies that attempt measuring the causal effects follow Jedwab & Moradi (2015).

Spatial Discontinuities. The locations cover the same area as Boston. Neighbouring locations should thus have similar characteristics. We include 21 ethnic group or 35 district fixed effects to compare the neighboring locations of a same group or district.[8] As in Michalopoulos & Papaioannou (2013), ethnic group fixed effects help us control for geography and pre-colonial and post-colonial local institutions and economic patterns.[9] Alternatively, we include a fourth-order polynomial of the longitude and latitude of the location centroid, in order to flexibly control for unobservable spatial factors. Lastly, we will use nearest neighbour matching to compare railroad locations with non-railroad locations that had a similar probability of being "treated" based on observable factors.

Mainline. While the placement of the mainline could be considered as exogenous to future population growth, the branch lines were endogenous, as the British sought to connect areas of high potential. However, the branch lines turned out to be unprofitable, which questions the coloniser's ability to appraise the potential of various areas at the time (Hill, 1950). We test that the results hold if the rail dummies are defined using the mainline only.

Placebo Lines. We identify various "counterfactual routes" for the rail as a placebo check of our identification strategy. Figure 2 shows their location. First, explorer routes from

[8]Web Appendix Figures 3 and 4 map the ethnic groups and districts. There are 19 and 12 locations by ethnic group and district, respectively (but only 6 locations by district if we compare the 0-10 km locations with the 0-20 km locations). We thus compare the treated locations with only a few neighbouring locations.

[9]We use the same ethnic group boundaries as in Michalopoulos & Papaioannou (2013), who themselves use the Murdock map (1959) digitized by Nunn & Wantchekon (2011). Murdock (1959) depicts the locations of the major ethno-linguistic groups in Africa before the colonial era, thus before the location of ethnic groups was affected by the railroad in our analysis. The ethnic group boundaries then overlap with the district boundaries.

the coast to Lake Victoria tended to traverse areas with good locational fundamentals in terms of physical and economic geography (see Web Appendix Figure 5). Second, various branch lines were proposed in 1926 but not built (see Web Appendix Figure 6). These extensions failed to materialise for either economic viability or tightening budgets during the Great Depression. When compared to the locations within 10 km from these "placebo" lines (column (4) of Table 1), the railroad locations are of a higher elevation, less suitable for tea, and less populated. This could lead to a downward bias and give conservative estimates. We test that: (i) no spurious effects are found for the placebo lines, and (ii) the main effects are robust to using the placebo locations as a control group for the railroad locations.

Least Cost Path (LCP). Based on topography, the LCP agrees with the actual placement of the main line (see Figure 2). From various historical sources we obtained the construction costs associated with slopes of 0-1%, 1-5% and 5-10%. Slopes of 10% or more and lakes were systematically circumvented by the railroad. We then subdivided Kenya into 70 million 90m*90m pixels and performed an LCP analysis between the three nodes (see Web Appendix Figures 7 and 8 for a detailed description of how we build this LCP). As an instrument for the mainline, we will use the distance from this LCP based on the slopes and the lakes, while simultaneously controlling for these variables at the location level. Consequently, the exogenous variation provided by the instrument does not come from the individual geographical characteristics of each location, which may directly influence future population growth, but from the multiple interactions of these geographical characteristics across all the locations between the nodes.[10]

A related question is whether physical geography is a confounding factor in that it may have determined both rail placement and population growth. First, we will systematically control for geography in our regressions, and find that geographic variables had little effect on European, urban and Asian settlement. Second, the ethnic group or district fixed effects should minimise these issues, since identification only comes from differences within these

[10]The explorer routes used as placebo lines are to some extent least cost paths "by foot", as the explorers traveled by foot then. This is one additional reason to use them as counterfactuals for the railroad lines.

homogenous territorial units. Third, placebo locations appear to have a better physical geography than railroad locations. Using them as a control group could lead to a downward bias. Lastly, the LCP instrumentation only relies on the multiple interactions of local geographical factors across space, and not location-specific geographical factors.

3.3 *Main Results at Independence*

Table 2 shows the main results. Rail connectivity has strong positive effects on European, urban, Asian and African population growth in 1901-1962, but these effects decrease as we move away from the railroad and are zero after 30 km, 10 km, 10 km and 20 km respectively (columns (1)-(4)).[11] We then further study the effects of the railroad on European settlement. In columns (5)-(7), the dependent variable is the number of European men who registered as voters at each location in 1933 and reported their occupation as farmers (column (5), non-farmers (column (6)), and which could be considered skilled using the broad definition (column (7)). We find a significant effect up until 10 km, and not 30 km as before. The cultivation of European crops (coffee, tea, wheat and maize only, as we do not have data on sisal) has also expanded along the lines (column (8)). Agricultural development was thus one of the mechanisms by which the rail contributed to growth in these areas.[12]

[11]Web Appendix Table 1 shows the coefficient of each control for the regressions with European, urban, and Asian populations as dependent variables (columns (1)-(3)). Geographical variables have little effect on the growth of these populations, and are jointly insignificant for urban and Asian populations.

[12]Another mechanism may be the establishment of the "imperial peace" over these areas. One concern here is whether the fact that some tribes were hostile to colonisation could be a confounding factor in rail placement and non-African settlement. There is no evidence that hostile native populations played any role in rail placement. The coloniser established the Protectorate in 1895, while the mainline was built between 1896 and 1901. Two tribes opposed its construction; the Nandis (see "Kalenjin" in Figure 1) and the Kisiis ("Luo").

3.4 *Alternative Identification Strategies and Robustness*

Table 3 displays the results when we implement the identification strategies. Column (1) replicates our main results from Table 2 (columns (1), (2) and (4)). For the sake of simplicity, we focus on the 0-30 km dummy for European settlement (Panel A), and the 0-10 km dummy for urban and Asian populations (Panels B and C), as there are no effects beyond. Results are unchanged if we include 21 ethnic group fixed effects (column (2)), 35 district fixed effects (column (3)) or a fourth-order polynomial of the longitude and latitude of the location's centroid (column (4)). Column (5) shows that the effects remain high when using nearest neighbour matching (without replacement; common support; trimming at 20%).[13] The effects then slightly increase when the rail dummies are defined using only the mainline (column (6)). The effects are thus actually lower for the more endogenous branch lines. For each dependent variable, we then create a placebo dummy equal to one if the location is less than X km from a placebo line (X = 30, 10 and 10 km respectively). One issue is that some of the placebo lines overlap with the area of influence (0-30 or 0-10 km) of the existing lines, causing a correlation between the treatment and placebo dummies. We thus drop the railroad locations, in order to only compare placebo locations with other control locations. Column (7) shows no significant positive placebo effects.[14] In column (8),

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The surveyed route of the mainline was confirmed before these groups expressed their discontent, and was not changed as a result of that discontent (Kapila, 2009). Besides, the coloniser did not have difficulties enforcing rail construction. There was an armed railway police force wherever the rail went, and African forces were no match against European military technology. Lastly, railroad effects will hold when including ethnic group fixed effects, which should capture any spatial heterogeneity in terms of ethnic discontent and pacification.

[13]The effects are robust to using different matching estimators: nearest with replacement, radius, kernel and local (see Web Appendix Table 3).

[14]Web Appendix Table 4 shows that the placebo effects are generally small and not significant when considering each placebo line individually.

we use the placebo locations as a control group of the railroad locations. The effects are positive and significant for European and Asian population, not for urban population (the effect remains high, but standard errors are high due to the low number of observations, 154). Column (9) shows that the effects increase when instrumenting the rail dummies with four dummies for being within 0-10, 10-20, 20-30 and 30-40 km from the LCP while simultaneously controlling for the percentages of area with a slope between 1 and 5%, 5 and 10% and more than 10% (the IV F-statistics are 1,909.5, 21.9 and 21.9 respectively).[15]

Results hold if we (see Web Appendix Table 5): (i) use the full sample, (ii) drop the controls, (iii) control for the distances to each node and their squares to account for spatial spillovers from these cities, (iv) use the distance to the rail stations to define the rail dummies, (v) control for whether the location is within 10 km from a paved or improved road in 1962, (vi) replace the rail dummies by a dummy equal to one if the location is crossed by the rail, or, (vii), the distance of the location to the rail and its square, (viii) use logs of the population variables as dependent variables, (ix) use Conley standard errors (cut-off of 50 km) to account for spatial autocorrelation. The same table shows that: (x)-(xi) the rail raises the probability of having a city and the urbanisation rate, and (xii)-(xiii) the result on urban growth is robust to using other population thresholds to define a locality as a city.[16]

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[15]Results generally hold when we use the four rail dummies (0-10, 10-20, 20-30 and 30-40 km) with each identification strategy (see Web Appendix Table 2). The main exception is for the instrumental variables (IV) strategy, as the railroad effects then become insignificant. We now have four instruments for four endogenous variables instead of only one endogenous variable as before. Additionally, many cross effects of the four LCP dummies on the four railroad dummies in the four first stage regressions are, by construction, nil (e.g., the 30-40 km LCP dummy does not have any impact on the 0-10 km rail dummy). This gives us multiple "weak" instruments, and the IV F-statistic becomes low (2.3) and standard errors disproportionately increase as a result (Angrist & Pischke, 2009, see p.205). The IV results of Table 2 should thus be taken with caution.

[16]Since the European, urban and Asian populations were close to 0 initially, the observed effects reflect a change in the aggregate level of economic activity, and not a reorganisation

4. Demise of Railroads, Exodus of Settlers and Path Dependence

We document the persistence of the spatial equilibrium despite the demise of railroads and the exodus of Europeans and Asians. We then study the channels of path dependence.

4.1 *Main Results on Path Dependence*

The railroad locations have lost their initial advantage in terms of transportation (physical capital) and settlers (human capital). Should we expect these locations to remain relatively more developed today? We test this hypothesis by studying their relative urban growth between 1962 and 2009. We run this model for 403 non-arid non-nodal locations l:

$$zUpop_{l,09} = a + Rail_{l,62}\gamma + zEuro_{l,62}\theta + zAsian_{l,62}\kappa + zUpop_{l,62}\lambda + \omega_p + X_l\pi + v_{l,09} \quad (2)$$

The dependent variable ($zUpop_{l,09}$) is the z-score of urban population in 2009. The z-scores of the European ($zEuro_{l,62}$), Asian ($zAsian_{l,62}$) and urban ($zUpop_{l,62}$) populations in 1962 are the main variables of interest. We include the same province fixed effects (ω_p) and controls (X_l) as before.

Column (1) of Table 4 shows the persistence of the colonial spatial equilibrium, as there is no significant negative effect for the locations along the railroad lines, despite the demise of the railroads post-1962 (the coefficients of the 10-20, 20-30 and 30-40 km rail dummies are not shown). Likewise, there is no significant negative effect for the locations with more Europeans and Asians in 1962, despite their exoduses post-1962. A corollary of the fact that the three large shocks did not have any negative effects is that the distribution of the urban population today should be strongly explained by the distribution at independence, which is exactly what we find. In particular, a one standard deviation in the urban population in 1962 is associated with a 0.74 standard deviation in the urban population in 2009. This high correlation shows how stable the colonial spatial equilibrium has become post-

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of existing economic activity.

independence, and thus provides direct evidence for urban path dependence.

Column (1) shows the average effects of the shocks for all locations, no matter their initial urban population size in 1962. However, when we interact the shock variables with the standard score of the urban population in 1962 as in column (2), in order to study the specific effects of the shocks for the existing cities at independence, we also find no significant negative effects.

The decline of the railroad took place in the 1960s-1970s, while the exodus of the Europeans and Asians took place in the 1960s and 1970s, respectively.[17] When using urban population in 1979 as the dependent variable (columns (3)-(4)), we only find a negative short-term effect for the urban locations with more Asians in 1962 (column (4)).[18] In columns (5)-(6) and (7)-(8), we also verify that there are no negative long-term effects of the shocks when using as dependent variables the percentage of non-poor in 1999 (defined at the national poverty line), or average satellite night light intensity in 2000 (as in Henderson, Storeygard & Weil (2012)). We control for the z-score of the urban population in 1999 in columns (5)-(8), in order to compare cities of similar sizes. This suggests that the railroad cities are wealthier than the non-railroad cities today ceteris paribus.[19]

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[17]In Web Appendix Table 6, we find that results hold if: (i) we also study the interacted shocks of the demise of the railroads and the exoduses of Europeans and Asians (columns (1)-(2)); (ii) instead of using the z-scores of Europeans and Asians in 1962 we use their population shares the same year (columns (3)-(4)); and (iii) instead of using the z-scores of urban population in 1962 and 2009 we use the urbanization rates in 1962 and 1999 (columns (5)-(6)).

[18]As the three shocks take place at roughly the same time, we cannot easily disentangle the short-term effects of each shock.

[19]We study the dynamics of urban path dependence between 1962 and 2009, using data on urban population for the intermediary years 1969, 1979, 1989 and 1999. In Web Appendix Figure 9, we study the effect of the 0-10 rail dummy at each year, by running repeated cross-sectional regressions, a panel regression with location and year fixed effects, or the panel regression with location-specific linear trends. In all cases, we find a strong

A significant fraction of Europeans were farmers. After independence, their farms were transferred to African families that often kept growing the same crops on the same land. Land being a fixed geographical resource, the departure of European farmers may not provide a satisfying test of the path dependence hypothesis, as these locations may still have the same natural advantages. We use the address, sector and occupation of male voters from the European voter registry of 1933 to test if the departure of specific European subgroups had indeed negative effects, thus invalidating the hypothesis.[20] We run the same regression as in column (2) of Panel A except we replace the z-scores of European population in 1962 ($zEuro_{l,62}$) by the z-scores of the number of European male workers in 1933. Panel B of Table 4 shows no negative effects for the interaction of the number of these Europeans in 1933 and the urban population in 1962, no matter how we define the z-score of the European population, for example using all professions (column (1)), the private non-agricultural sector only (column (3)), or the skilled workers only based on the broad definition (column (5)) or the strict definition (column (7)) (see the notes below the table for a full description of the eight different definitions used). Even when restricting the European group to the most skilled subgroup, we find no significant negative effects of the exodus (column (8)).

4.2 *Potential Channels of Path Dependence*

We now investigate the channels of path dependence, in particular the fact that the distribution of the urban population today is almost entirely explained by the distribution

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effect in 1901-1962, and no extra effect for any period post-1962.

[20]We know the number of workers for the following nine sectors: “agriculture”, “industry”, “commerce”, “transport”, “government”, “religion”, “education”, “health”, and “personal services”. For the occupations, we use the standard HISCO classification with seven groups: “Professional, technical and related workers”, “Administrative and managerial workers”, “Clerical and related workers”, “Sales workers”, “Service workers”, “Agricultural, animal husbandry and forestry workers, fishermen and hunters” and “Others”.

of the urban population at independence. Our preferred approach is to see how the effect of urban population in 1962 on urban population in 2009 (0.74***, see column (1) of Table 4) varies as we include controls proxying for the various channels. If a channel matters, including proxies for it should absorb some of the effect of urban population in 1962 on urban population in 2009. How much it does then tells us about the magnitude of the contribution of that specific channel. Note however that these results are only suggestive, without better data at our disposal, and should be interpreted with caution.

Institutional persistence. The African governments of the post-independence period have been dominated by two ethnic groups: the Kikuyus and the Kalenjins (see Figure 1). Burgess et al. (2014) showed that the areas that shared these ethnicities have received disproportionately more public investments as a result. We could thus expect more urban persistence in the Kikuyu-Kalenjin (KK) areas. Conversely, these governments may have had a specific interest in preserving the colonial cities of the non-KK areas so as to better control their population. In that case, we could expect more urban persistence in the non-KK areas. Column (1) of Table 5 shows the baseline effect of urban population in 1962 on urban population in 2009 (0.74***). The effect remains the same when adding 21 ethnic group fixed effects and 35 district fixed effects in order to control for post-independence ethnic politics (column (2)). Districts are the primary administrative units of Kenya, and are as such the unit level at which public resources are (mis-)allocated (Burgess et al., 2014).[21] Second, the effect is unchanged if we also control for the numbers of provincial police headquarters, divisional police headquarters, police stations and police posts for each location in 1962 (column (4)), i.e. the main institutions of law enforcement at the local level. Lastly, the persistence of colonial (i.e. pre-1962) land institutions may also produce path dependence. For each location, we know the area shares (%) of five different land regimes in 1938: *alienated land* (by the Europeans), *land available and suitable for alienation*, *native reserves*,

[21]Likewise, the results hold when dropping (or restricting the sample to) those locations in which the Kikuyus and the Kalenjins represent more than 50% of the population in 1962 (not shown, but available upon request).

forest and *rest of the colony*.[22] These land regimes should proxy for both rural and urban land institutions, since the cities of the alienated areas were different in terms of labor and housing markets from the cities of the native areas (Morgan, 1963; Kapila, 2009). Also controlling for land regimes does not, however, change the main effect (column (4)).[23]

Technological change in transport and human capital diffusion. Path dependence could be explained by technological change, in the sense that railroads were replaced by roads at nearby sites. The railroad locations did not entirely lose their "absolute" access to transportation, even if they lost their initial "relative" advantage as roads were built away from the rail. Yet, the baseline effect (column (1)) remains the same if we control for roads in 1962 via two dummies equal to one if the location is within 10 km from a paved road or an improved road (column (5)). The effect is also unchanged if we additionally control for roads in 2009 via two dummies again (column (6)). As we control for roads in both 1962 and 2009, we control for roads that were built following the decline of railroads. Lastly, while Europeans and Asians were the most skilled workers of the colonial economy, they were eventually replaced by Africans trained at the existing schools at independence. The effect is only slightly reduced when we additionally control for the number of secondary schools in 1962 (column (7)), and the numbers of primary and secondary schools in 2009

[22]The source is an official land map that we digitized in GIS. No such map could be found for other years

[23]If institutions do not appear to explain path dependence, we believe physical geography does not either. Firstly, column (4) of Web Appendix Table 1 shows the coefficients of the physical geography variables for our baseline regression (column (1) of Table 6). We find no effect of any of the variables on urban persistence between 1962 and 2009. Secondly, we use three shocks: The departure of Europeans post-1962, the departure of Asians post-1967, and the decline of the rail in the 1960s-1970s. While European settlement may have been partially influenced by geography, since many Europeans were farmers, it was not the case for urban and Asian settlement (or the skilled Europeans). Geography is thus unlikely to account for path dependence.

(column (8)), to control for the opening of new schools in 1962-2009.[24]

Sunk investments. Colonial investments into public infrastructure are “sunk” to the extent that they are immobile in the short-run and costly to rebuild elsewhere. People will be less mobile and initial advantages have long-term effects. We consider as sunk: (i) secondary schools, (ii) hospitals, (iii) health clinics, (iv) police stations (of any of the types listed above), (v) post offices (whether local post offices or postal agencies), (vi) paved roads (and improved roads too), and (vii) industries (any among the following types: important industrial town, minor industrial town, important industrial centre, minor industrial centre, and potential industrial centre). No location had any of these types of infrastructure in 1900. In Web Appendix Table 7, we use model (1) to show that in 1962 railroad locations had better sunk infrastructure as defined above. These effects on infrastructure in 1962 are in turn reduced when we control for total population in 1962, and even more so when controlling for European settlement in 1962. This suggests that railroads increased population densities during the colonial era, and public goods (for Europeans mostly) were created as a result. The railroad locations may then still be over-supplied with such public goods today, which would keep them attractive and produce path dependence. Column (9) of Table 5 shows that the baseline effect (column (1)) is only slightly reduced when we control for roads (via the two dummies for paved and improved roads), human capital infrastructure (via the numbers of schools, hospitals and health clinics), and police stations and post offices (by including the numbers of any of their subtypes) in 1962.[25] While colonial public capital matters for path dependence, we also need to control for colonial private capital. In column (10), we additionally control for the z-score of European crop

[24]We focus on secondary schools, because the few existing universities at independence were located in the railroad nodes (Nairobi and Mombasa). Provision of primary schools was extensive and no data is available on their location. In 1959, there were 4,700 primary schools. In 2007 there were 31,000 schools.

[25]Our analysis is biased if we omit other expensive public assets in existence at independence. However, there were no universities, airports, dams, power stations or ports in the non-nodal locations at that time.

cultivation. This allows us to capture the spatial distribution of the private cash crop sector. However, the effect is not reduced. The effect is then significantly reduced if we add five dummies equal to one if the location contains any of the subtypes of industrial towns or centres listed above in 1962 (0.47***, see column (11)). This emphasises the role of industrial agglomeration effects. Lastly, these cities may have also persisted due to their larger market potential (MP) at independence. Indeed, Bosker et al. (2007) show that spatial interdependencies between cities must be taken into account when studying path dependence. Following Harris (1954), for each location i we estimate $MP_i = \Sigma_{j \neq i}(Y_j / D_{ij}^{\alpha})$ where Y_j is a measure of economic development of location j and D_{ij} is the network distance (in hours) via the road network in 1962 between location i and location j.[26] α is the distance decay parameter. For our analysis, we create nine measures of market potential based on $Y_j = \{$total population, urban population, European crop cultivation (acres)$\}$ in 1962 and $\alpha = \{1, 2, 3\}$. By using several α, we remain agnostic about how economic interactions work across space. We also control for the z-scores of these nine measures of market potential in column (12). The coefficient of urban path dependence is barely reduced, at 0.45***.[27] Ultimately, when including many controls for sunk investments, the baseline effect is reduced by about 40%.[28]

[26]Using the GIS road network in 1962, we performed a least cost path analysis for each of the 473x473 pairs of locations, assuming that transportation speeds of 50, 35 and 20 km per hour on paved, improved and dirt roads. These parameters were obtained from Buys, Deichmann & Wheeler (2010) who also study Africa.

[27]Web Appendix Table 8 shows the effect is also not reduced when using three measures of market potential based on the sums of total population, urban population and crop cultivation within 6 hours by road from the location (excluding the own location), thus mimicking the market access analysis of Baum-Snow et al. (2012).

[28]We do not control for the housing stock, as data is not available on this dimension at independence. Firstly, durable housing may explain urban persistence when cities economically decline (Glaeser & Gyourko, 2005). However, except for a few buildings in hard materials, most non-nodal Kenyan towns at independence consisted of houses built

Coordination problem. If there are returns-to-scale, factors must be co-located in the same locations. There is a spatial coordination problem as it is not obvious which locations should have the factors. Then, it makes sense to locate factors in locations that are already developed, e.g. the railroad and settler cities. If this were true, higher population densities today should be directly explained by higher population densities in the past. Other factors than labor then "follow" people, instead of people following these other factors. We first verify that railroad locations have higher densities of factors today (2009). Panel A of Web Appendix Table 9 shows that railroad locations have more primary and secondary schools, hospitals, health clinics and dispensaries, are more likely to be crossed by a paved or improved road, and have more adults aged 25 years or older who have completed primary, secondary or tertiary education. Panel B then shows that this is fully explained (with the exception of paved road access) by the fact that they also have higher population densities. Secondly, in column (14) of Table 6, we show that controlling for these contemporary factors only slightly modifies the baseline effect of urban population in 1962 (column (13)). This result suggests that locations that are more populated today have higher densities of contemporary factors as a result of the higher population densities, and not the other way around (otherwise, the contemporary factors should have absorbed the baseline effect). Additionally controlling for sunk investments (column (15)) reduces the effect (0.42**), since sunk investments matter. Further controlling for technological change and institutional persistence does not change the effect (column (16))). Thus, the effect remains high even when controlling for the various channels (given the data at our disposal). One interpretation of this residual effect, provided it is indeed a residual effect, is that it captures the fact that the newly created cities helped solve a spatial coordination problem. These results may thus point to the following outcome: railroad locations have

with traditional materials that were not highly resilient to time (Soja, 1968). Secondly, cities well endowed with durable housing infrastructure can collapse (e.g., Detroit) while cities with initially little housing infrastructure can expand very fast (e.g., Houston). Indeed, building costs have relatively decreased over time (Bleakley & Lin, 2012). Likewise, most Kenyan cities have grown at a fast pace. Thus, building costs, even if non-negligible, should not really explain path dependence.

higher densities today, because people co-locate where there are more people in the past, as they expect these places to keep thriving. There were then more people in the past because of the population effect during the colonial period.

Related to this, the Kenyan context allows us to discuss the role of human capital in urban growth and persistence. The locations that lost skilled settlers post-independence did not relatively "lose" over time (see column (1) of Table 4). Analogously controlling for the numbers of schools at independence and today did not strongly modify, and thus explain, the relationship between urban population in the past and urban population today. The railroad locations are nonetheless better endowed in skilled workers today, since they exhibit higher shares of adults with primary, secondary or tertiary education (see Panel A columns (8)-(10) of Web Appendix Table 9). Even when controlling for population densities (Panel B) and the supply of primary and secondary schools (Panel C) today, we still find that railroad locations are better endowed with skilled workers. If anything, this suggests that, once cities were created, human capital may have not been that critical for city growth, and that it is skilled workers that rather spatially sorted themselves in the cities.

To summarise, sunk investments and spatial coordination failures appear to be the channels of path dependence in our context, with potentially equal contributions to both.

5. Discussion

If cities are the main vehicles of economic growth, studying why cities can emerge and persist in developing countries is crucial to our understandings of the growth process and the evolution of spatial inequality. In this paper, we have used a natural experiment and new data to study the emergence and persistence of a spatial equilibrium in Kenya. The construction of the colonial railroad had a strong impact on European, Asian and urban settlement patterns. These railroad locations remain relatively more developed today, although they have lost their initial advantage in terms of public physical capital (transportation) and human capital (the settlers) post-independence. The railroad and settler cities then mostly persisted due to sunk investments – the fact that they were relatively better endowed in infrastructure at independence – and because they helped solve spatial coordination failures – the fact that their early emergence served as a mechanism to coordinate spatial investments in the colonial and subsequent periods.

Our results make the following contributions. First, by studying an initially unurbanised country, we directly study the emergence of a spatial equilibrium, and by using three shocks to both physical and human capital, we directly study the persistence of that equilibrium. In the end, we believe that we provide evidence for path dependence in space, and the existence of multiple spatial equilibria. Second, our results suggest that both colonial sunk investments and the resolution of spatial coordination failures during the colonial era account for path dependence in our context. Our results thus complete the previous analyses of Bleakley & Lin (2012) and Jedwab & Moradi (2015). Third, local increasing returns suggest that regional policies can alter regional development (Davis & Weinstein, 2002). However, if spatial equilibria persist because they also solve spatial coordination failures, regional policies may be less effective. Indeed, expectations could be more difficult to adjust than infrastructure stocks, as already suggested by Krugman (1991). Lastly, human capital does not appear to have been critical for local economic growth in post-independence Kenya, thus suggesting that human capital externalities may not be as present as in more skill-intensive economies, in line with Michaels, Rauch & Redding (2013) and Glaeser, Ponzetto & Tobio (2014) who study the U.S. over two centuries. This result is in line with a world where the positive correlation between human capital and city growth may stem from spatial sorting instead. All these reasons thus show the importance of studying the extent and forces of urban path dependence in the specific context of developing countries.

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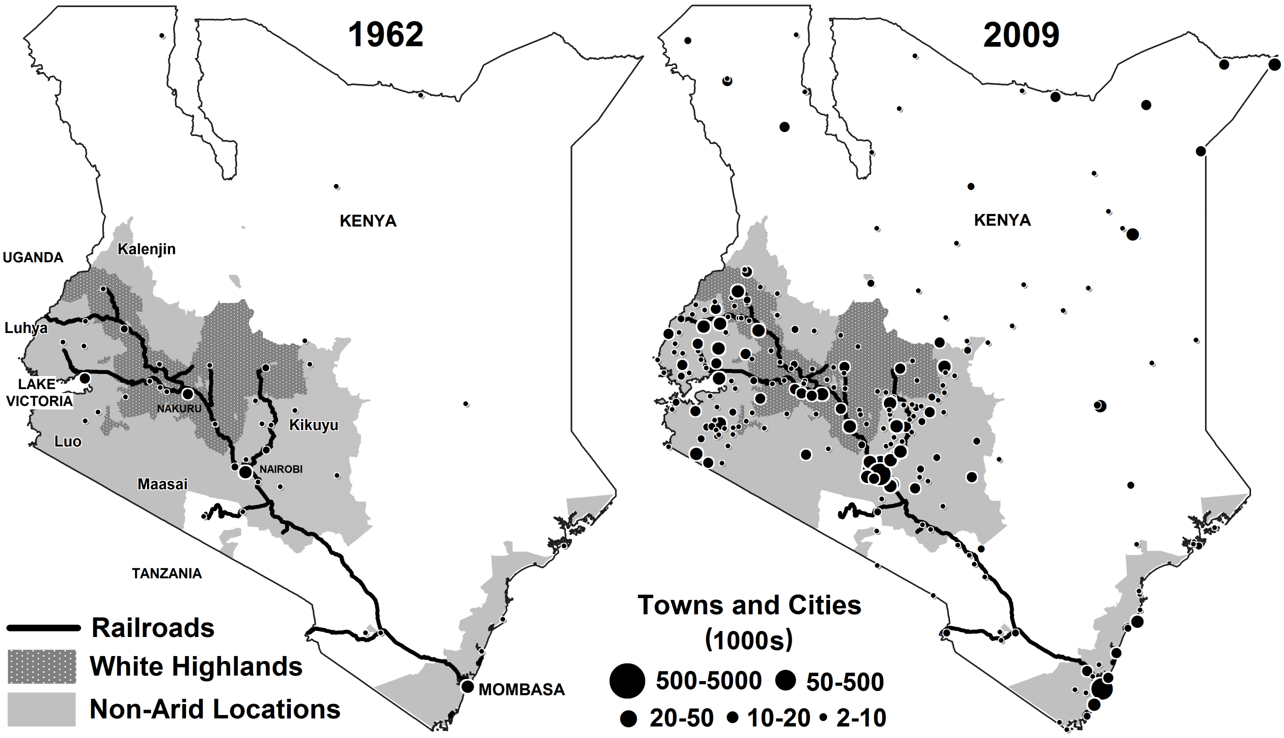
Figure 1

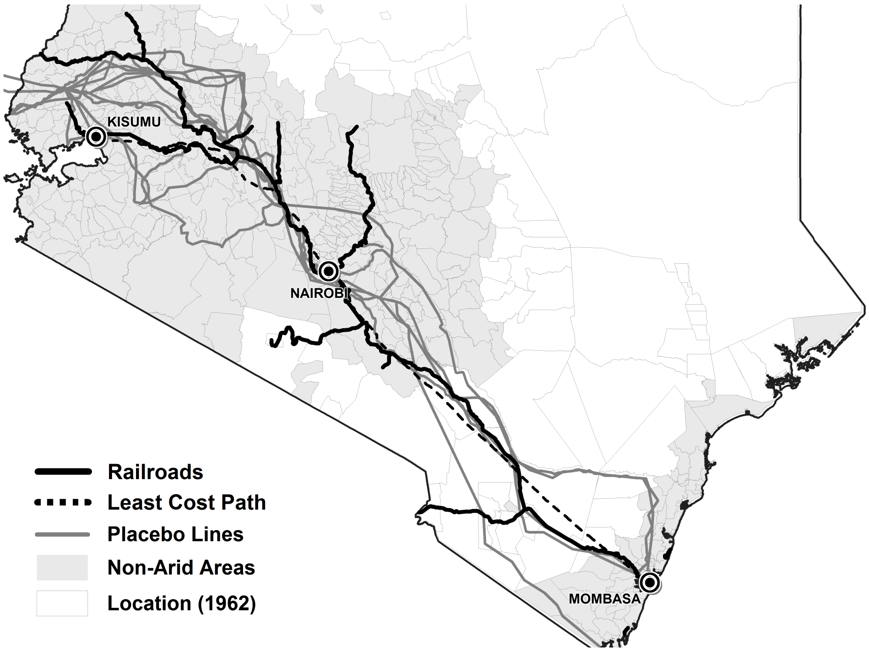
Colonial Railroads, European Settlement and City Growth in Kenya, 1962-2009



Notes: The map shows railroads and cities in Kenya in 1962 and 2009. Kenya's railroad lines were all built before the country gained independence in 1963. The main line from Mombasa on the coast to Lake Victoria in the west was built between 1896-1903 linking Uganda to the coast. The non-arid areas are "locations" where arid soils account for less than 10% of the total area (N = 403 out of 473 locations). The White Highlands were areas where Europeans settled during the colonial period. Cities are localities where population exceeded 2,000 inhabitants in 1962 (N = 42) and 2009 (N = 247). There were only 5 cities in 1901, and all of them except Nairobi (established in 1899) were on the coast. See Web Appendix for data sources.

Figure 2

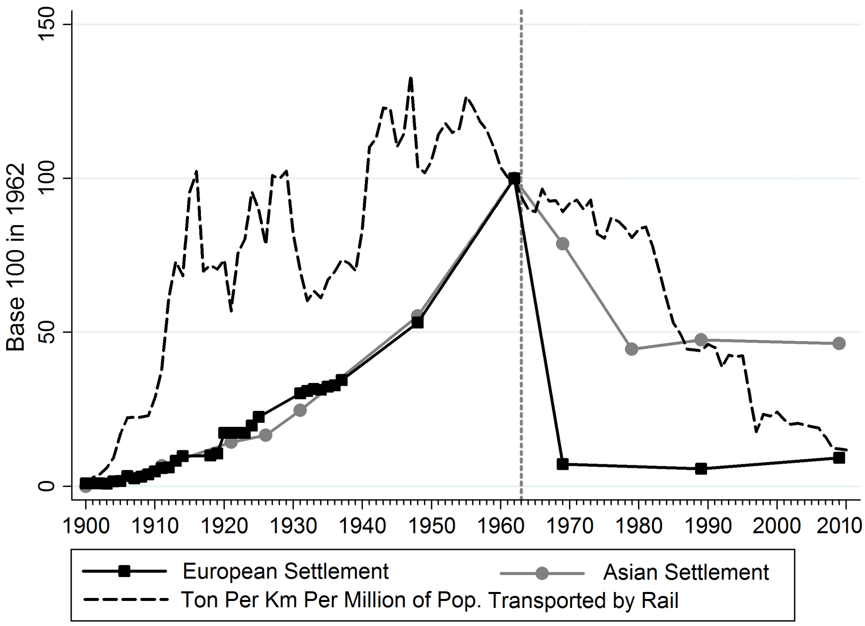
Colonial Railroads, Least Coth Path and Placebo Lines



Notes: The map shows the railroad lines and the placebo lines. The main line from Mombasa to Lake Victoria (Kisumu) was built in 1896-1903 to link Uganda to the coast. The branch lines were built between 1913 and 1930 (see Web Appendix Figure 4 for a detailed description of the main line and each branch line). The map shows several placebo lines: the routes of 19th century explorers Thomson (1883), Fischer (1885), Jackson (1899), Lugard (1889), Pringle (1893), Mackinnon and Sclater (1897), Austin and Pringle (1899) and MacDonald (1899) as well as proposed but unbuilt branch lines Nakuru-Sergoit (1926), Kericho-Sotik (1926), Thika-Donyo Sabuk (1926) and Machakos (1926) (see Web Appendix Figures 5 and 6 for a detailed description of each route). It also shows the least cost paths (LCP) between Mombasa, Nairobi and Kisumu, based on construction costs associated with different slopes and the proximity to lakes (see Web Appendix Figures 7 and 8 for a detailed description on how we build the LCP). The non-arid areas are locations where arid soils account for less than 10% of the total area. See Web Appendix for data sources.

Figure 3

Railroad Traffic and European and Asian Settlements, 1900-2010

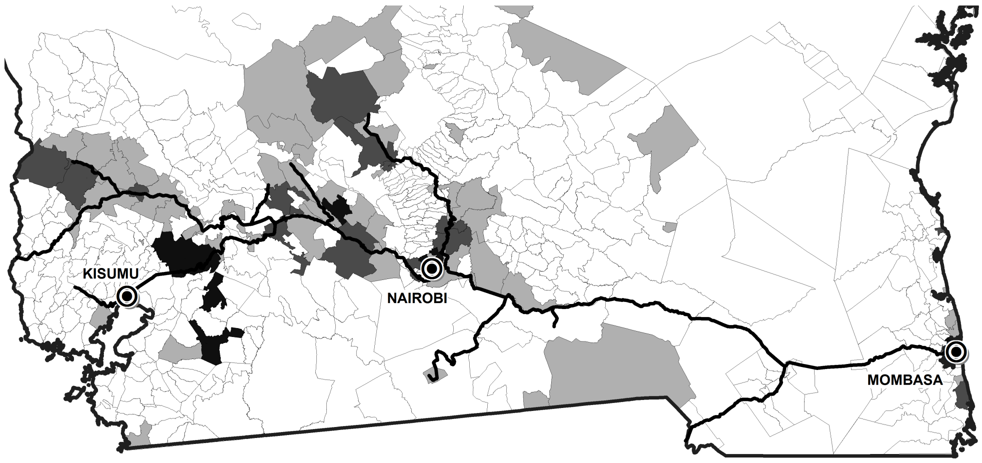


Notes: The graph shows railroad traffic and the numbers of Kenyan Europeans and Kenyan Asians (base 100 in 1962) in 1900-2010. *Tons per km per million of population Transported by Rail* represents the volume of goods transported by rail per capita, measured in metric tons per kilometre of rail network and per million of population. There were 55,759 Europeans and 176,597 Asians in 1962. The vertical dotted line indicates the year 1963, when Kenya gained independence. See Web Appendix for data sources.

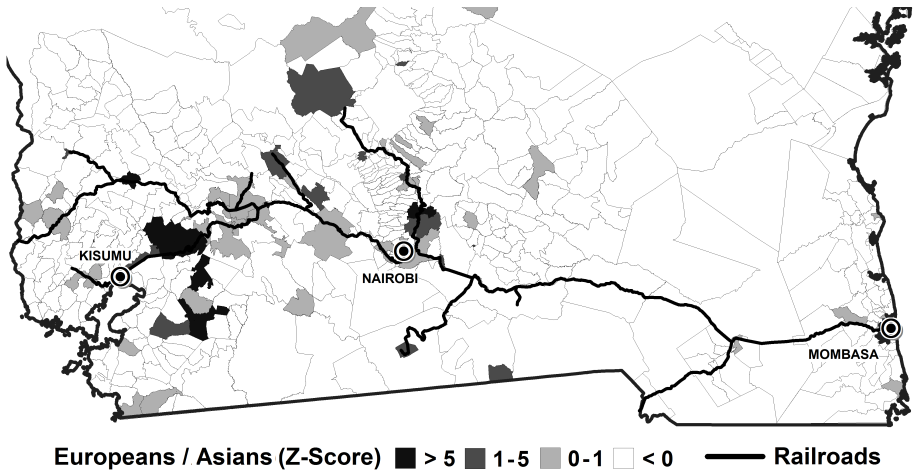
Figure 4

Colonial Railroads and European and Asian Settlements, 1962

a. Number of Europeans (Z-Score)



b. Number of Asians (Z-Score)



Notes: The map shows the railroad lines and the z-scores of the number of Europeans (Figure 4.a) and the number of Asians (Figure 4.b) for each location in 1962. See Web Appendix for data sources.

Table 1

Summary Statistics (Mean) for Treated and Control Locations

Cells:	(1) 0-10 km	(2) 10-40 km	(3) > 40 km	(4) Placebo
Physical Geography:				
"Coastal location" dummy	0.04	0.04	0.11	0.03
Distance to the coast (km)	452	467	411	473
Area share of lakes (%)	0.0	0.0	0.0***	0.0
Distance to a lake (km)	23.4	23.7	26.1**	24.9*
Average annual rainfall (mm)	1,163	1,274***	1,093	1207*
Average annual temperature (degrees)	18.7	19.3	21.2	19.8**
Altitude: mean (m)	1,632	1,543	1,172*	1,486**
Altitude: standard deviation (m)	105	133***	139**	110
Share of arid soils (%)	0.0	0.0	0.0**	0.0
Share soils suitable for agriculture (%)	84.6	83.8	70.8	80.6
Share soils suitable for coffee (%)	21.7	23.3*	12.5**	12.5*
Share soils suitable for tea (%)	4.2	19.7***	9.0***	11.2***
Area (sq km)	262	345	425	258
Pre-Existing Settlement Patterns:				
Area share of "major settled groups" (%)	43.7	59.4***	59.6**	55.4***
Area share of "pastoralists" (%))	17.5	12.4	15.0	13.6
"Isolated groups" dummy	0.31	0.19*	0.16	0.24*
"City in 1901" dummy	0.00	0.00	0.02	0.00
"Provincial capital in 1901" dummy	0.03	0.01	0.00	0.02
Number of observations:	80	171	152	119

Notes: This table shows the mean of each variable for various groups of locations. Column (1), (2), (3) and (4) report the means for the locations within 10 km from a railroad, the locations between 10 and 40 km from a railroad, the locations beyond 40 km from a railroad line, and the locations within 10 km from a placebo line respectively. In columns (2)-(4), we test that the 0-10 km locations and the control locations (10-40 km; > 40 km; Placebo) are not significantly different. To do so, we regress each variable on a dummy equal to one if the location is within 10 km from a railroad line, and show whether the 0-10 km locations and the control locations are significantly different, once we include eight province fixed effects (robust SE's: * p<0.10, ** p<0.05, *** p<0.01). See Web Appendix for data sources.

Table 2

Colonial Railroads, Non-African Settlement and Cities, 1901-1962

	N.Inhabitants 1962 (z)				N.Euro. Workers 1933 (z)			Euro.Crops
Dependent Variable:	Euro.	Urban	Asian	African	Ag.	Non-Ag.	Skilled	1962 (z)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Rail Dummy, 0-10 km	0.78***	0.37***	0.49***	0.37***	0.57***	0.34*	0.42**	0.44**
	(0.22)	(0.14)	(0.15)	(0.13)	(0.19)	(0.18)	(0.18)	(0.17)
Rail Dummy, 10-20 km	0.28***	0.09	0.06	0.29***	0.13	-0.02	-0.01	0.31**
	(0.09)	(0.11)	(0.09)	(0.11)	(0.08)	(0.07)	(0.07)	(0.12)
Rail Dummy, 20-30 km	0.25*	0.04	0.08	0.11	0.18	0.04	0.00	0.31
	(0.15)	(0.13)	(0.13)	(0.17)	(0.15)	(0.08)	(0.08)	(0.22)
Rail Dummy, 30-40 km	0.11	-0.14	-0.13	0.01	-0.07	-0.13	-0.10	-0.02
	(0.10)	(0.11)	(0.13)	(0.15)	(0.09)	(0.11)	(0.09)	(0.10)
Province FE, Controls	Y	Y	Y	Y	Y	Y	Y	Y
Number of Observations	403	403	403	403	403	403	403	403
R-squared	0.20	0.34	0.28	0.38	0.25	0.20	0.17	0.26

Notes: OLS regressions using data on 403 non-arid locations for the year 1962. Robust SE's in parentheses; * $p<0.10$, ** $p<0.05$, *** $p<0.01$. In columns (1)-(4), the dependent variable is the z-score of European population, urban population, Asian population, and African population in 1962 respectively. In columns (5)-(7), it is the z-score of the number of European male workers in the 1933 voter registry. In columns (5) and (6), we only consider the workers of the agricultural (*Ag.*) and non-agricultural (*Non-Ag.*) sectors, respectively. In column (7), we only consider the workers with the following occupations (*Skilled*): "professional, technical and related workers", "administrative and managerial workers", "clerical and related workers" and "sales workers". In column (8), the dependent variable is the z-score of the area (thousand acres) devoted to European crop cultivation (coffee, tea, wheat and maize) in 1962. All regressions include 8 province fixed effects and the controls listed in Table 1. See Web Appendix for data sources.

Table 3

Alternative Identification Strategies, 1901-1962

Strategy:	*Baseline Results* (1)	*Ethnic FE* (2)	*District FE* (3)	*Long. Lat.* (4)	*Nearest Neighbor* (5)	*Main Line* (6)	*Placebo Effect* (7)	*Control: Placebo* (8)	*IV: LCP* (9)
Panel A:	***Dependent Variable*: Number of European Inhabitants in 1962 (z)**								
Rail 0-30 km	0.37***	0.49***	0.16*	0.33***	0.39***	0.55***	-0.03	0.29***	0.67***
	(0.10)	(0.14)	(0.10)	(0.11)	(0.10)	(0.17)	(0.05)	(0.10)	(0.21)
Observations	403	403	403	403	357	403	187	281	403
Panel B:	***Dependent Variable*: Number of Urban Inhabitants in 1962 (z)**								
Rail 0-10 km	0.34**	0.34**	0.25**	0.34**	0.49*	0.47*	0.03	0.31	0.46*
	(0.14)	(0.14)	(0.13)	(0.15)	(0.26)	(0.26)	(0.07)	(0.23)	(0.24)
Observations	403	403	403	403	384	403	323	154	403
Panel C:	***Dependent Variable.*: Number of Asian Inhabitants in 1962 (z)**								
Rail 0-10 km	0.46***	0.47***	0.39***	0.46***	0.58**	0.50**	-0.02	0.51**	0.61**
	(0.15)	(0.15)	(0.13)	(0.15)	(0.28)	(0.25)	(0.05)	(0.24)	(0.26)
Observations	403	403	403	403	384	403	323	154	403
Province FE, Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y

Notes: OLS regressions using data on 403 non-arid locations for the year 1962. Robust SE's in parentheses; * p<0.10, ** p<0.05, *** p<0.01. Column (1) replicates the main results of Table 2. For the sake of simplicity it employs only the 0-30 km (European pop.), 0-10 km (urban pop.) and 0-10 km (Asian pop.) rail dummies. In columns (2) and (3), we include 21 ethnic group FE and 35 district FE respectively. In column (4), we include first, second, third and fourth order polynomials of the longitude and latitude of the location's centroid. In column (5), we use nearest neighbour matching (without replacement; common support; trimming at 20%). In column (6), we show the effect for the main line, while controlling for the effect (30, 10 and 10 km respectively) of the branch lines. In column (7), we drop the locations less than X = 30 km (Panel A) and 10 km (Panels B-C) from a railroad line, in order to compare the placebo locations with the other control locations. In column (8), the placebo locations are the control group: First we use the locations less than 30 km (Panel A) and then 10 km (Panels B-C) from a placebo line. In column (9), we instrument the rail dummy (here defined using the main line only) by four dummies equal to one if the location is within 10, 10-20, 20-30 and 30-40 km from the least cost paths between Mombasa, Nairobi and Kisumu, while also controlling for the percentages of area with a slope between 1 and 5%, between 5 and 10% and more than 10% respectively (we also add a dummy equal to one if the cell is within 10 km from a branch line). The *Kleibergen-Paap rk Wald* F stat. are 1,909.5, 21.9 and 21.9 respectively. See Web Appendix for data sources.

Table 4

Colonial Railroads, Non-African Settlement and Economic Development, 1901-2009

Panel A: Dependent Variable:	Urban Pop. 2009 (z)		Urban Pop. 1979 (z)		Non-Poor 1999 (%)		Night Light Intensity 2000	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Rail Dummy, 0-10 km	0.14	0.04	0.04	-0.01	6.17***	6.08***	1.59**	1.72**
	(0.11)	(0.12)	(0.08)	(0.09)	(1.92)	(1.93)	(0.69)	(0.71)
N.Europeans (z, 1962)	0.12**	0.15*	0.09	0.08*	-0.45	-0.60	0.65*	0.72**
	(0.06)	(0.08)	(0.06)	(0.05)	(0.48)	(0.57)	(0.35)	(0.35)
N.Asians (z, 1962)	-0.08	0.15	-0.01	0.19	2.80	5.34***	-0.76	-0.74
	(0.22)	(0.24)	(0.18)	(0.16)	(1.93)	(1.87)	(0.59)	(0.53)
Urban Pop. (z, 1962)	0.74***	0.82***	0.90***	1.15***	-0.91	-4.60	0.87	0.12
	(0.27)	(0.21)	(0.21)	(0.30)	(1.68)	(4.98)	(0.64)	(0.64)
Urban Pop. x Rail 0-10 km		-0.04		-0.02		4.05		1.01
		(0.35)		(0.37)		(5.38)		(1.00)
Urban Pop. x N.Europeans		-0.04		0.11		-1.46		0.21
		(0.10)		(0.08)		(1.80)		(0.38)
Urban Pop. x N.Asians		-0.01		-0.10**		-0.49		-0.12
		(0.06)		(0.05)		(0.71)		(0.22)
Urban Pop. (z, 1999)					0.09	0.13	1.24**	1.21**
					(1.04)	(1.18)	(0.49)	(0.49)
Province FE, Controls	Y	Y	Y	Y	Y	Y	Y	Y
R-squared	0.60	0.64	0.90	0.90	0.72	0.73	0.54	0.55
Panel B:	Dependent Variable: Urban Pop. 2009 (z) (Specification: Panel A Column (2))							
	All	*Non-Ag.*	*Private*	*Private 2*	*Skilled*	*Skilled 1*	*Skilled 2*	*Skilled 3*
N.Europeans (z, 1933)	0.34*	0.30**	0.27*	0.26*	0.27**	0.24*	0.23	0.18
	(0.18)	(0.13)	(0.15)	(0.14)	(0.13)	(0.13)	(0.15)	(0.15)
Urban Pop. (z, 1962) x N.Europeans (z, 1933)	-0.02	-0.02	-0.01	-0.01	-0.02	-0.00	-0.00	-0.02
	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)

Notes: OLS regressions using data on 403 non-arid locations for the year 2009. Robust SE's in parentheses; * p<0.10, ** p<0.05, *** p<0.01. The 10-20, 20-30 and 30-40 km rail dummies (and their interactions with Urban Pop. in col. (2), (4), (6) and (8)) are included (coeff. not shown). Columns (5)-(6): The dependent variable is the share of the non-poor pop. in 1999. Columns (7)-(8): It is the mean night light density in 2000. Panel B: Same regression as in column (2) of Panel A, except we replace N.Europeans (z, 1962) by the z-score of the number of European male workers in 1933 in/with: (1) *All*: All professions, (2) *Non-Ag.*: The non-agri. sector, (3) *Private*: The private non-agri. sector (excl. those who work for the colonial administration or the religious groups), (4) *Private 2:* The industrial sector or the high-productivity service sectors (excl. those who work for the personal service industry), (5) *Skilled*: The following occupations: "professional, technical and related workers" (ptrw), "administrative and managerial workers" (amw), "clerical and related workers" (crw) and "sales workers" (sw), (6) *Skilled 1*: Skilled excl. sw, (7) *Skilled 2*: Skilled 1 excl. crw, and (8) *Skilled 3*: Skilled 2 excl. amw. All regressions include 8 province FE, the controls listed in Table 1, and a dummy equal to one if the location is a "General Business Area". See Web Appendix for data sources.

Table 5

Investigation of the Channels of Urban Path Dependence

Dependent Variable:	Urban Population in 2009 (z)			
Channel: *Institutional Persistence*	*Baseline* (1)	*(1) + Spatial FE* (2)	*(2) + Police 1962* (3)	*(3) + Land Regimes 1938* (4)
Urban Pop. (z, 1962)	0.74*** (0.27)	0.74*** (0.28)	0.76*** (0.28)	0.76*** (0.28)
Channel: *Technological Change*	*(1) + Roads 1962* (5)	*(5) + Roads 2009* (6)	*(6) + Schools 1962* (7)	*(7) + Schools 2009* (8)
Urban Pop. (z, 1962)	0.74*** (0.27)	0.74*** (0.27)	0.68*** (0.23)	0.67*** (0.21)
Channel: *Sunk Investments*	*(1) + Infra. 1962* (9)	*(9) + Crops 1962* (10)	*(10) + Indu. 1962* (11)	*(11) + Market Pot. 1962* (12)
Urban Pop. (z, 1962)	0.63** (0.25)	0.64** (0.25)	0.47*** (0.18)	0.45*** (0.17)
Channel: *Coordination Problem*	*Baseline* (13)	*(13) + Infra. 2009* (14)	*(14) + (12)* (15)	*(15) + (8) + (4)* (16)
Urban Pop. (z, 1962)	0.74*** (0.27)	0.70*** (0.24)	0.42** (0.18)	0.47*** (0.17)

Notes: OLS regressions using data on 403 non-arid locations for the year 2009. Robust SE's in parentheses; * p<0.10, ** p<0.05, *** p<0.01. Same specification as in col.(1) of Table 5. We show how the coeff. of Urban Pop. (z, 1962) varies as we add various controls. *Spatial FE:* 21 ethnic group and 35 district FE. *Police 1962:* Numbers of provincial and divisional police headquarters, police stations and posts. *Land Regimes 1938:* Area shares of five land regimes. *Roads 1962* and *2009*: Dummies if within 10 km from a paved road or an improved road. *Schools 1962:* Number of secondary schools. *Schools 2009:* Numbers of primary and secondary schools. *Infra. 1962:* Roads 1962 + Schools 1962 + Numbers of hospitals and health clinics. *Post-offices 1962:* Numbers of post-offices and postal agencies. *Crops 1962:* Z-score of the area devoted to Euro. crop cultivation. *Indu. 1962:* Dummies to one if the location contains an important industrial town (IT), a minor IT, an important industrial center (IC), a minor IC, or a potential IC, respectively. *Market Pot. 1962:* Nine measures of market potential based on {total pop., urban pop., Euro. crop cultivation} x three distance decay parameters {1, 2, 3}. *Infra. 2009:* Roads 2009 + Schools 2009 + Numbers of hospitals, health centers and dispensaries, and shares of 25+ adults having completed primary, secondary or tertiary education. See Web Appendix for data sources.