

Neubert, Magnus; Nikolić, Stefan

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Regular article

Why railways fail: Colonial railways and economic development in Habsburg Bosnia–Herzegovina[☆]

Magnus Neubert^{a,b} ,* Stefan Nikolić^c ^a Martin-Luther-Universität Halle-Wittenberg, Universitätsring 3, 06108 Halle, Germany^b Leibniz Institute of Agricultural Development in Transition Economies (IAMO), Halle, Germany^c Loughborough University, Epinal Way, LE11 3TU Loughborough, United Kingdom

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ABSTRACT

Are railways always a harbinger of prosperity? We examine the economic effects of railways in Bosnia–Herzegovina under Habsburg colonial rule. Our novel dataset consistently tracks the non-agricultural population share of over 4500 settlements in Habsburg Bosnia in 1885, 1895, and 1910, based on census records. Applying the inconsequential units approach, with least-cost paths as our instrumental variable, we estimate the effect of railway access on occupational change. In settlements directly connected to imperial railways and competition, non-agricultural activity declined as craftsmen returned to agriculture. By contrast, the new railway network temporarily accelerated non-agricultural activity, primarily by attracting factories and foreign labor. Railway access generated more sustained non-agricultural employment growth in settlements with higher human capital and stronger law enforcement. Overall, our findings suggest that colonial railways did not uniformly promote economic development: while railway access reshaped local occupational structures, lasting positive effects depended on local development preconditions.

1. Introduction

Transport infrastructure has paved the way for modern economic growth in the past and remains a key part of economic policy today, especially in developing countries.¹ A large literature documents that improvements in transport infrastructure generally foster economic development by reducing trade costs and improving market access (Redding and Turner, 2015; Donaldson and Hornbeck, 2016; Fenske et al., 2023). At the same time, growing evidence highlights that these effects are highly heterogeneous and depend on local conditions. For example, Okoye et al. (2019) show that colonial railways in Nigeria

generated sizable and persistent gains only in regions with low pre-railway access to export ports, while having little effect elsewhere. More broadly, infrastructure investments may reinforce existing urban agglomerations by attracting labor and economic activity from rural areas (Faber, 2014; Tang, 2014). Understanding the conditions under which transport infrastructure generates broad-based gains therefore remains an important open question.

This paper examines the economic impact of railways built for extracting natural resources in a colonial setting — Bosnia–Herzegovina

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* Corresponding author.

E-mail address: magnus.neubert@wiwi.uni-halle.de (M. Neubert).¹ China's Belt and Road Initiative, for example, invests heavily in the infrastructure of developing countries to promote economic development.

under Habsburg rule.² The multi-ethnic region resembles modern-day, low-income countries where agriculture and small-scale, non-agricultural activities dominate the economy. This historical context enables us to study how railway access reshaped local occupational structures over time, and to assess the conditions under which transport infrastructure contributed to more sustained forms of economic development.³ We distinguish between the normal-gauge railway line that directly integrated Bosnian settlements into the Habsburg imperial market and exposed them to external competition, and narrow-gauge railways that primarily integrated the internal Bosnian market while remaining partially insulated from imperial producers.⁴

Prior to the Habsburg occupation, under Ottoman rule, Bosnia–Herzegovina had a rudimentary road network and only one short-lived, normal-gauge railway.⁵ Habsburg authorities first reconstructed this line to connect the region to the imperial network and subsequently constructed a new railway network of more than 1500 kilometers of narrow-gauge tracks aligned with colonial objectives. Historical accounts either praise the construction of railways as an economic achievement or criticize it as a vehicle for extraction. We empirically examine how railways affected local occupational structures.

We introduce a novel dataset tracking occupational change in over 4500 settlements during Habsburg rule in Bosnia–Herzegovina. We collected data from each population census that the Habsburg authorities conducted in Bosnia. The census data distinguishes the agricultural from the non-agricultural population in 1885, 1895, and 1910. This allows us to measure economic development of a settlement with the share of its non-agricultural population.⁶ We georeferenced all settlements and transport infrastructure in Bosnia–Herzegovina using GIS software and historical maps. Our treatment comes from the reconstructed normal-gauge railway and the roll out of the narrow-gauge railway network, constructed in three waves that closely corresponded with census years.

We estimate the effect of railway access on occupational change at the settlement-level applying both OLS and instrumental variable approaches. Our identification strategy compares settlements with and without railway access, distinguishing treatment by construction wave to capture changes between census periods. This allows us to examine how railway expansion affected occupational structures over time. We control for pre-treatment differences, district fixed effects, and a range of settlement-level characteristics that could confound the estimated effects. To address endogeneity concerns in railway placement, we employ the inconsequential unit approach, using least-cost paths as an instrumental variable. We focus the analysis on settlements that were quasi-randomly located along least-cost paths between main nodes.

² Bosnia–Herzegovina fell under Austro-Hungarian rule in July 1878, by the Treaty of Berlin. Austria-Hungary was a multi-national constitutional monarchy in Central Europe between 1867 and 1918, and constituted the last phase in the evolution of the Habsburg Empire. Bosnia–Herzegovina gets its name from the river *Bosna* and *Herzog*, a historical title (meaning duke). We will occasionally use Bosnia for short when referring to the country as a whole (not a specific region).

³ Historical settings have enhanced our understanding of the long-run development impact of infrastructure investments (Hanlon and Hebllich, 2022).

⁴ The technical difference between normal- and narrow-gauge is the track width which is 1435 mm and 760 mm, respectively. The rolling stock has to match the track width and cannot operate on both railways. Normal-gauge railways are more costly to construct, since curves require a larger radius making for longer routes. Narrow-gauge railways are easier to construct in rugged territory, but they have a lower capacity limit, since the rolling stock is smaller and can handle a smaller freight volume.

⁵ This isolated and 115 km long normal-gauge railway had operated only from 1873 to 1875.

⁶ Sectoral change, that is the shift of population outside of agriculture into higher value-added, secondary and tertiary sectors, is an indicator of initiated economic development (Kuznets, 1973; Herrendorf et al., 2014).

We have three main findings. First, integration into the more mature Habsburg market led to a decline in local non-agricultural employment in parts of Bosnia–Herzegovina. The share of population engaged outside of agriculture fell in settlements directly connected to the imperial railway network. This effect operated through reduced transport costs, as normal-gauge railways allowed uninterrupted movement of goods between Bosnia and the rest of the Empire. By contrast, narrow-gauge railways required costly reloading at border entrepôts, limiting exposure to external competition. Seamless access to imperial markets intensified competition from more productive industrial manufacturers, displacing local small-scale production in settlements along the normal-gauge lines.

Second, the construction of narrow-gauge railways generated a positive but temporary increase in non-agricultural employment. Settlements receiving access to narrow-gauge railways experienced a short-run rise in the share of the population engaged outside of agriculture. Further analysis suggests that this increase was related to the inflow of foreign workers. The construction and operation of railway tracks, stations, and rolling stock required a substantial non-agricultural workforce, while limited schooling and training in Bosnia constrained the supply of skilled local labor. As a result, Habsburg authorities relied largely on importing engineers and workers from elsewhere in the Empire.

Third, narrow-gauge railways had a longer-term impact on local occupational change in settlements endowed with human capital and secured by law enforcement. While schooling and public safety are widely viewed as important for local economic development, not all settlements in Bosnia had equal access to these development preconditions. We exploit spatial variation in access to public elementary schools and armed forces to examine heterogeneous effects of railway access. While narrow-gauge railways initially increased non-agricultural employment regardless of local schooling, only settlements with access to public elementary schools experienced continued growth in non-agricultural employment over the longer run. Similarly, access to armed forces started to condition the economic effect of narrow-gauge railways in unstable areas in the period leading up to the First World War.

In sum, our results suggest that a substantial reduction of transport costs and the integration of a pre-industrial economy into an industrialized market can hinder local proto-industrial activity. At the same time, railway infrastructure can foster more sustained non-agricultural employment growth in areas endowed with sufficient human capital and effective law enforcement. Transport infrastructure is therefore not a silver bullet for economic development: railway effects depend critically on local development preconditions and can generate both displacement and longer-term gains.

1.1. Contribution

Our study contributes primarily to the literature on the economic effects of transportation infrastructure. A large body of work examines how roads, highways, and railways shape outcomes such as education, innovation, employment structure, land values, urban development, urbanization, migration, trade, specialization, and economic growth in modern,⁷ historical,⁸ and long-term perspective.⁹ Our analysis contributes to this literature from a historical perspective, while offering insights that speak to broader debates in development economics.

⁷ Studies focusing on modern outcomes have examined the effects of highways (Baum-Snow, 2007; Faber, 2014; Agrawal et al., 2017; Baum-Snow et al., 2020), roads (Adukia et al., 2020; Aggarwal, 2018; Asher and Novosad, 2020), and various transport infrastructure (Banerjee et al., 2020) in developed and developing countries.

⁸ Recent studies have examined the economic impact of railways in the late 19th and early 20th century in the US (Donaldson and Hornbeck, 2016), India (Donaldson, 2018; Chaudhary and Fenske, 2023; Fenske et al., 2023), Japan (Tang, 2014; Yamasaki, 2025), Chile (Forero et al., 2021), Ottoman

The Bosnian case is comparable to road and railway construction in overseas colonies such as India and sub-Saharan Africa. First, these investments often represented the first large-scale transport infrastructure in regions characterized by high pre-existing transport costs. Second, transport infrastructure served colonial economic interests by facilitating the extraction of raw materials and opening new markets for manufactured goods. Our study adds the unique case of a European colony contiguous with its metropolitan core. Previous research on sub-Saharan Africa finds that colonial transport infrastructure promoted agricultural specialization and urban population growth, but did not lead to sustained shifts in occupational structure. Interestingly, we find that colonial railways in Bosnia either displaced local non-agricultural activity or generated only temporary increases in non-agricultural employment, depending on railway type and local conditions. Our findings provide a new perspective on how railways affect local occupational structure in less developed economies and complement existing evidence drawn largely from more developed economies (Berger, 2019; Bogart et al., 2022; Braun and Franke, 2022). Our results also relate to work showing that early colonial investments in public goods can shape spatial economic patterns that persist over long horizons (Jedwab et al., 2017; Bertazzini, 2022). While the data and context do not allow extending the analysis to the present day, we document sustained changes in occupational structure spanning several decades in settlements with better access to public schools and law enforcement.

We also contribute to the broader debate on the economic legacy of colonialism. While one strand of the literature emphasizes potential long-run developmental benefits of colonial investments (Iyer, 2010; Mahoney, 2010; Lee and Schultz, 2012; Mattingly, 2017; Dell and Olken, 2020), another highlights their persistent adverse effects (Mahoney, 2003; Dell, 2010). Our findings emphasize the central role of human capital (Glaeser et al., 2004; Putterman and Weil, 2010; Easterly and Levine, 2016) and institutions (Acemoglu et al., 2001; Acemoglu and Johnson, 2005) in mediating the economic effect of colonial infrastructure. Our results indicate that transport infrastructure alone was insufficient to foster lasting local development without complementary investments in human capital and state capacity.

Lastly, we contribute to the literature on the economic development of Bosnia–Herzegovina within the Habsburg Empire. Existing work has estimated economic growth and convergence (Komlos, 1983; Good, 1986; Good and Ma, 1999; Schulze, 2000) and, more recently, examined regional development and market integration across the Empire (Schulze, 2007; Schulze and Wolf, 2009; Reinold, 2023a,b). Our study is the first quantitative analysis to focus specifically on Bosnia–Herzegovina under Habsburg rule using settlement-level evidence. We show that railway expansion generated heterogeneous and often limited local economic gains. In this sense, our findings lend empirical support to more cautious assessments of Bosnia–Herzegovina's economic performance under Habsburg rule (Hrelja, 1961; Lampe and Jackson, 1982; Hauptmann, 1983; Juzbašić, 2002), rather than to more optimistic accounts (Sugar, 1963; Palairet, 1993, 1997).

Empire (Hanedar and Uysal, 2020), French Algeria (Maravall, 2019), England and Wales (Bogart et al., 2022), Germany (Braun and Franke, 2022), Italy (Cicarelli et al., 2021), the Netherlands (Koopmans et al., 2012), Prussia (Hornung, 2015), Sweden (Berger and Enflo, 2017; Berger, 2019), and Switzerland (Büchel and Kyburz, 2020).

⁹ Jedwab and Moradi (2016), Jedwab et al. (2017), Okoye et al. (2019), and Bertazzini (2022) investigated long-term effects of transportation infrastructure in sub-Saharan Africa. Marein (2022) studied persistent effects of colonial roads in Puerto Rico.

2. Background and conceptual framework

2.1. Economic development of Habsburg Bosnia–Herzegovina

The Habsburg Empire occupied Bosnia–Herzegovina in 1878 according to the Treaty of Berlin and formally annexed the former Ottoman province in 1908. Habsburg Bosnia–Herzegovina was a mountainous and landlocked region located in Southeast Europe in almost exactly the same borders as modern Bosnia–Herzegovina. Imperial Austria and Hungary appointed the *Landesregierung* (provincial government) and sent their civil servants to run the administration in order to develop and modernize the backward region (Ruthner, 2014; Donia, 2014, 2021). However, the empire imposed financial self-reliance, focused their economic policy on extracting abundant resources, and left the feudal Ottoman agrarian relations untouched.

When the Habsburg Empire occupied Bosnia–Herzegovina, the industrial sector had 2 sawmills, 2 flour mills, 3 breweries, an iron working center near Vareš, and salt production around Tuzla (Chester, 2007). The agricultural sector was still feudally organized. Under Habsburg rule, agricultural production doubled between 1882 and 1896. In 1904, 64 factories were in public ownership and employed 14,848 workers, whereas 44,327 private enterprises employed 83,899 workers. However, 71% of these enterprises were run by the owner alone, 9% were small establishments (1–2 employees), and 3% were medium-scale factories (3–19 employees). Only a small number of enterprises (0.3%) were categorized as large-scale establishments (>19 employees), predominantly in extractive sectors such as mining and timber (Schmid, 1914).

Human capital was a severe bottleneck for the economic development of Bosnia–Herzegovina. The first Habsburg census of Bosnia–Herzegovina (1879) reports the existence of 499 *mektebs* (Quran schools), 18 *medresa* (Islamic middle schools), and around 30 *ruždije* (reformed elementary schools). The *mektebs* focused on religious instructions and did not provide much practical knowledge, many pupils failing to even learn to read and write. The 54 Roman-Catholic and 56 Christian-Orthodox elementary schools in 1879 alone followed the European standard of elementary schools and professional teachers instructed their pupils along a modern curriculum in Serbo-Croatian language (Džaja, 1994, pp. 65–83).¹⁰ The provincial administration established 38 (1880) and another 101 (1881) non-confessional elementary schools. The imperial standard was applied including four years of elementary schooling, practical curriculum, and the native language as classroom language. In 1908, schooling became obligatory for all 7-years-old children that live within 3 km of an elementary school. From 1895 to 1910 the number of elementary schools grew from 263 to 458, excluding the *mektebs*, which did not qualify as elementary schools. Still, even by 1910, elementary school enrollment rate was only 17.5%.¹¹

Law and order was the key concern of the Habsburg administration in Bosnia after the military campaign in 1878. Law enforcement was delegated to the local police established immediately after the occupation. Military corps aided the police in keeping major social unrest in check. The 1895 census reported 221 police stations and another 254 military positions spread across the province. By 1906, the police corps counted 2300 men operating more than 200 police stations (Finanzministerium, 1906). Since the very beginning of Habsburg occupation, fierce resistance of the native population against the

¹⁰ The poor quality of the *mektebs* compared to the non-Islamic schools explains the literacy differences across the religions: 94.6% of the Muslim, 89.9% of the Christian-Orthodox and 77.4% of the Roman-Catholic population were illiterate in 1910 (Schmid, 1914, pp. 698–736).

¹¹ According to Finanzministerium (1906, p.20), 352 elementary schools existed, of which 239 were public, 103 confessional, and 10 private. This means 267 settlements had an elementary school and 1714 settlements were in reach of an elementary school.

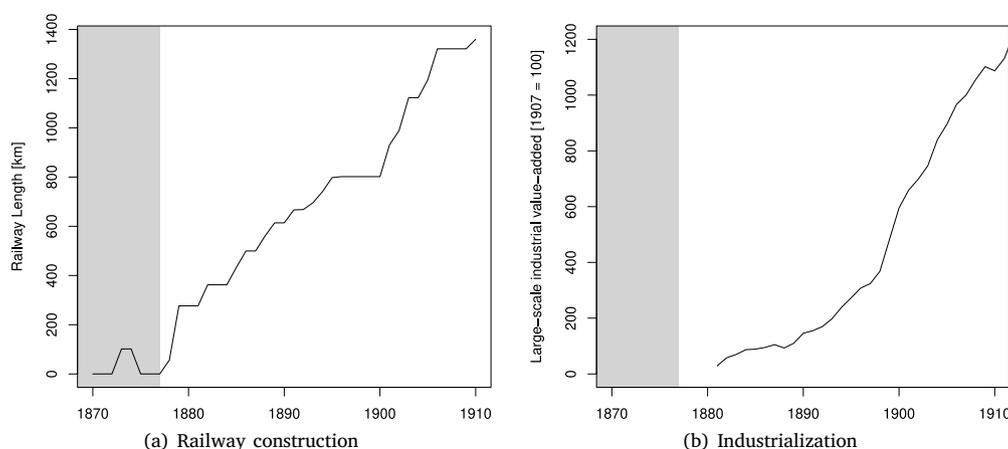


Fig. 1. Railways and economic development in Bosnia–Herzegovina.

Note: Gray areas indicate the Ottoman era.

Source: (a) own GIS data (see Section 3); (b) Palairat (1993).

new regime shattered the belief in long-term peace in the province. Occasional upheavals among the Serb population and banditry from beyond the border threatened public safety and everyday business.

2.2. Railways in Habsburg Bosnia–Herzegovina

Fig. 1 illustrates railway expansion and economic development in Bosnia–Herzegovina. During the 40 years of Habsburg rule (1878–1918), more than 1500 km of railways were built. However, railway construction in Bosnia–Herzegovina was neither coherently planned nor executed. It remained restricted by the colonial rivalry of Austria and Hungary, provincial budget constraints, as well as the local geological and geopolitical environment.¹²

When the Habsburg Empire took over Bosnia–Herzegovina, the sparse road network was in bad shape and no railway was in operation. Only a 115 km isolated normal-gauge track existed in the North-West of the province, connecting Banja Luka and Dobrljin (opened in 1872, the railway shut down already in 1875). Habsburg authorities quickly reconstructed the normal-gauge railway placing it in operation in 1879. Already in 1882, with the construction of the Dobrljin-Sisak section across the border in Croatia-Slavonia, Bosnia's normal-gauge railway became connected to the imperial network.

Bosnia's new, narrow-gauge railway network was constructed in three waves. The first wave (1879–1882) aimed to secure control over Sarajevo, the provincial capital, immediately after the occupation. As a result, the first narrow-gauge railway line rapidly spread from the Austro-Hungarian border at Bosanski Brod southward to Zenica where a coal mine was set up to provide fuel for the locomotives. By 1882, railways reached Sarajevo. Narrow-gauge railways allowed crossing Bosnia's rugged terrain and narrow valleys. In addition, excess rails and sleepers for narrow-gauge railways left over from the nearby and recently completed Timișoara–Orșova line (today Romania) were available. The choice of narrow-gauge for the trunk line, however reasonable at that time given the budget and time constraints, determined the track width for subsequent railways.

During the second construction wave (1885–1895), economic interests became decisive. In order to extract the abundant resources of Bosnia–Herzegovina, the north–south trunk line branched out. In 1885, the manganese ore mines at Čevljanović received railway access. By 1886, the eastward branch to Tuzla opened, accessing rich coal

fields, salt springs, and the most productive agricultural area of Bosnia–Herzegovina. By 1895, other branch lines reached the forests of the Usora valley and the center of Bosnian mining and metal industry in Vareš.

During the same period, sea access became urgent, but competing interests between Austria and Hungary impeded any railway through Bosnia to reach their large ports on the Adriatic sea.¹³ Hungary only agreed to the railway from Sarajevo via Mostar to Metković (opened in 1891), which was a poor harbor because it was located 21 km inside the Neretva river delta and was only accessible by small ships. Since the connection to Metković did not provide the badly needed access to a proper harbor, the *Spalatobahn* was proposed, which would connect the coastal city of Split in Austrian Dalmatia with the Zenica-Sarajevo line. The westward section Lašva-Bugojno via Travnik with a south–north branch from Donji Vakuf to Jajce was completed on the Bosnian side in 1895. On the Dalmatian side, the section from Split to inland Sinj was completed only in 1903. But the conjunction of both sections ultimately failed because of Hungarian opposition.

The third construction wave (1901–1906) was determined by the political deadlock between Austria and Hungary that rendered railway construction in Bosnia–Herzegovina almost impossible. To circumvent the Austro-Hungarian deadlock, forestry railways became a tool for developing the railway network in the interest of Bosnia–Herzegovina, because they were de facto not required to get imperial approval. Two important forestry railways were completed by 1906. One traversed the Krivaja river valley in central Bosnia. The other (*Steinbeisbahn*) linked Knin (Dalmatia) to Drvar, Oštrej, and later Ribnik and Čardak in western Bosnia, but remained isolated from the main railway network.

Only mounting tensions in the Balkans forced the Austrian and Hungarian governments to agree on new railways in Bosnia–Herzegovina, because they served their joint military interests. The *Dalmatier-Bahn* was taken into operation in 1901 and ran to Zelenika in the Bay of Kotor, with a branch line to Trebinje near the Montenegro border. The branch line to Dubrovnik also made economic sense, since it connected Bosnia–Herzegovina with a slightly better suited harbor than Metković. The last line to be built in the province before the First World War was the *Ostbahn* connecting Sarajevo with the Serbian and Ottoman border from 1906 onwards.

¹² Chester (2007) provides a thorough historical account of railways in Bosnia–Herzegovina.

¹³ The Hungarian agenda of making Rijeka overtake Austrian Trieste as the most important Habsburg port hindered the construction of a railway that would transport timber, ores, coal, and agricultural products to the Adriatic sea.

Although of respectable length, the Bosnian railway network did not equally reduce transport costs across the province. The main reason for uneven transport costs were railway tracks of different standard, which determined the degree of integration with the imperial railway network. The normal-gauge line connected directly to the imperial standard at the border-town Dobrljin, allowing passengers and freight to move uninterrupted between northwest Bosnia and the rest of the Empire. By contrast, Bosnia's narrow-gauge railways were not compatible with the imperial network. All traffic leaving Bosnia–Herzegovina via narrow-gauge railways had to be reloaded at the border, in Brod, from narrow- to normal-gauge rolling stock. Reloading costs, together with high railway tariffs, resulted in only moderate reductions in relative transport costs along narrow-gauge lines.¹⁴ Moreover, lacking a proper harbor, most exports were routed via Brod to Rijeka before being shipped onward, further limiting cost savings.

Railways brought many foreign workers from the Empire to Bosnia. According to the 1885 census, 25,405 Austro-Hungarian citizens and another 2165 people from other states lived permanently in Bosnia–Herzegovina only seven years after the occupation. This represents more than 2.1% of the population. By 1895, this number rose to 64,450 and 3022, respectively, and those foreigners accounted for 4.3% of the population. The Habsburg administration reports in 1906 that 9016 persons worked in Bosnia's public service (civil servants, teachers, police officers, etc.) of which two-thirds were from Austria-Hungary (*Finanzministerium, 1906, p.30*). Since Bosnian railways were publicly operated by the *Bosnische Staatsbahn*, those numbers include 1365 railway workers of which 85% were Austro-Hungarian citizens (*Finanzministerium, 1906, p.579*). Moreover, *Sugar (1963, pp. 167–171)* estimates that as much as a quarter of the industrial workforce consisted of foreign workers. In 1904, 11.2% of all self-employed tradespeople in Bosnia–Herzegovina were foreigners (*Finanzministerium, 1906, p. 346*). Foreigners thus dominated public service and railway operation, but were also over-represented among industrial workers and self-employed tradespeople.

Alternative modes of transport were not as important as railways. The only navigable river was the Sava that demarcated the northern border of Bosnia–Herzegovina, while the other larger rivers within the province were suitable for floating timber at most. Road infrastructure was neglected as railways when Austria-Hungary took over the province from the Ottomans. The provincial government refurbished and expanded the road network, yet in the absence of motorized vehicles at the time, roads facilitated rather local and short-distance trade. Long-distance transport operated predominantly via railways.

2.3. Conceptual framework

Empirical research on transportation infrastructure and economic development yields heterogeneous results. While aggregate welfare effects are generally found to be positive (*Fogel, 1964; Herranz-Loncán and Fourie, 2018; Jedwab and Storeygard, 2019*), the spatial distribution of economic activity in response to transport investments remains more contentious. Conceptually, one can distinguish between *lifting* and *shifting* effects. Aggregate growth gains may arise from lower transport costs, market integration, and economies of scale that lift productivity. At the same time, gravity models predict that transport infrastructure can shift economic activity from rural areas toward agglomeration centers (*Head and Mayer, 2004; Redding and Turner, 2015*).

Many empirical studies find positive level or growth effects of transport infrastructure in accessed locations (*Atack et al., 2008; Berger, 2019; Banerjee et al., 2020; Ciccarelli et al., 2021; Braun and Franke, 2022*). Another strand of literature, however, associates those positive

¹⁴ Railway tariffs in Bosnia–Herzegovina were on average 127% and 131% higher than Austrian and Hungarian tariffs, respectively (*Finanzministerium, 1906, p.575*).

effects with relocation from non-accessed to accessed areas (*Chandra and Thompson, 2000; Büchel and Kyburz, 2020; Bogart et al., 2022*). In some cases, transport infrastructure has even reduced industrial activity in peripheral regions by reinforcing agglomeration in urban centers (*Faber, 2014*). *Tang (2014)*, for example, finds that railways in nineteenth-century Japan concentrated factory production in populous regions without generating positive aggregate effects. Overall, the conditions under which aggregate gains dominate spatial reorganization effects remain less understood.

Transport infrastructure may shape economic outcomes in developing economies through different channels, including education (*Aggarwal, 2018; Okoye et al., 2019; Adukia et al., 2020; Chaudhary and Fenske, 2023*), innovation (*Agrawal et al., 2017*), land and housing values (*Donaldson and Hornbeck, 2016; Braun and Franke, 2022; Ferni-hough and Lyons, 2022*), specialization (*Forero et al., 2021; Fajgelbaum and Redding, 2022*), and state capacity (*Acemoglu et al., 2015*). Yet these mechanisms are often examined in isolation, and their interaction with transport infrastructure is rarely studied empirically. We draw on *Hirschman (1958)* and his notion of *absorptive capacity*, defined as the availability of skills and public goods that enables local communities to respond to new development opportunities. In this framework, investments in transport infrastructure can encourage new productive activities, but insufficient education or weak law enforcement may prevent those investments and, thus, a positive response to railway access.

Lastly, our framework relates to the literature on the economic legacy of colonialism. Following *Acemoglu et al. (2001, 2002)* long-run outcomes depend critically on whether colonial rule established inclusive institutions and provided public goods, or relied on extractive institutions that undermined development incentives. Where colonial authorities transplanted European institutions and invested in public goods, economic performance was often stronger in the long run (*Iyer, 2010; Mahoney, 2010; Lee and Schultz, 2012; Mattingly, 2017; Dell and Olken, 2020*). Conversely, colonial systems based on forced labor and insecure property rights undermined economic development (*Mahoney, 2003; Dell, 2010*). Habsburg Bosnia represents a hybrid case: while the administration introduced modern institutions, it relied on resource extraction to finance them, resulting in spatially uneven provision of public goods. This institutional environment provides a useful setting to study how transport infrastructure interacted with local absorptive capacity to shape occupational outcomes.

We use the context of colonial Bosnia–Herzegovina and newly assembled historical data to empirically examine heterogeneity in the effects of railway access, focusing on whether settlements with greater human capital and stronger law enforcement experienced more sustained non-agricultural employment gains.

3. Data

This section describes our newly collected spatial data on economic development and railway expansion in Bosnia–Herzegovina under Habsburg colonial rule. One of the contributions of this paper is our detailed, settlement-level dataset, which we hope will be of use to other scholars interested in development of the South-East European economy.

3.1. Economic development

To measure local economic development, we have digitized settlement-level data on population and occupational structure from Habsburg censuses of Bosnia–Herzegovina. The censuses recorded population in towns and villages in 1879, 1885, 1895, and 1910, and from 1885 onward distinguish between agricultural and non-agricultural occupations. We use the non-agricultural population share to track changes in local occupational structure over time. While this measure does not distinguish between small-scale trades and larger industrial

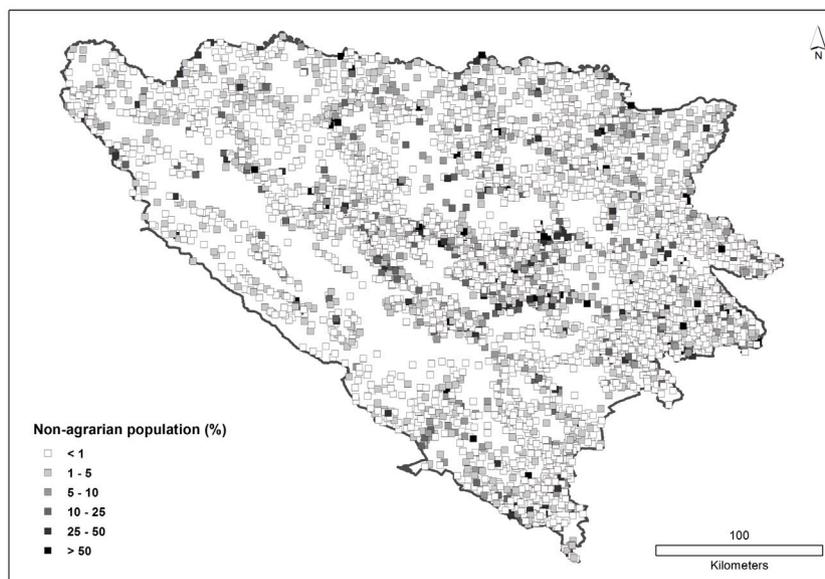


Fig. 2. Share of non-agricultural population in Bosnia-Herzegovina, 1910.

Source: Own illustration based on the population census of 1910.

activities, it provides a consistent indicator of shifts between agriculture and non-agriculture across settlements in the Bosnian context.

We were able to match 4646 settlements across four census years, and geolocate 4590 of them using geographic information system (GIS) software, online atlases, and historical maps.¹⁵ We observe the population of each matched settlement in 1910. Other years miss some observations. We focus on geolocated settlements for which we have occupational data from 1885 to 1910; a total of 4554 settlements. Fig. 2 illustrates our sample of non-agricultural population shares at settlement-level in 1910. These towns and villages account for 90% or more of total population in each census year, making our sample representative for the entire country.

Furthermore, we also obtain data on the location of factories as indicator for large-scale industrial activities. We draw on Austro-Hungarian land surveys from 1885 and 1910 to geolocate factories and validate their number with the administrative reports on large-scale enterprises (Finanzministerium, 1906). Land survey maps contain additional information allowing us to distinguish the factories by sector and power source. We identify a total number of 72 (85) establishments of which 44 (42) are saw mills and 3 (26) are steam-driven in 1885 (1910). The figures suggest extensive and intensive growth in the industrial sector.

3.2. Railways

We track the expansion of Bosnia's railway network using historical sources and GIS software. We georeferenced small-scale historical maps of the third Austro-Hungarian land survey (1:25,000) and military-geographic surveys (1:75,000) illustrating the transport network in Bosnia.¹⁶ The historical maps are appropriately detailed to enable precise tracing of railways with GIS software. We first drew a polyline

¹⁵ The matching was a laborious effort since settlement names are not fully consistent across censuses. Most issues arise from differences in spelling, rather than name changes. In addition, we differentiated settlements that share the same name with respect to the larger administrative unit in which they are located. Where necessary, we merged settlements to ensure consistency over time (e.g. we often merged two adjacent settlements prefixed with "upper" and "lower").

¹⁶ These surveys were conducted and issued by the K.u.k. Militärgeographisches Institut. Digital maps are available via the Austrian Bundesamt für Eich- und Vermessungswesen.

shapefile of the entire railway system in 1910. Using information on opening dates of each railway line (Chester, 2007), we then created shape files for each construction wave. Fig. 3 maps the railway system in Habsburg Bosnia-Herzegovina distinguishing the three construction waves.

Table 1 reports summary statistics for the settlements in our dataset. The non-agricultural population share increased in settlements that received railway access. Between 1895 and 1910, non-agricultural employment declined in settlements with access to the normal-gauge railway. Settlements without railway access experienced little change in occupational structure over this period.

In addition, we code an indicator variable for the presence of railway stations using information from the 1895 and 1910 censuses. We use railway stations as an alternative treatment to test the robustness of our results.

3.3. Additional variables

Any causal effect of railways can only be established conditional on a number of confounding factors. For this purpose, we collected additional data to control for other transport infrastructure, geographical, cultural, and other factors.

We control for industrial railways and roads. Industrial railways were minor extensions of the regular railway network or isolated and often temporary tracks used exclusively to transport raw materials. We georeferenced these lines based on the same historical maps employed for the main railway network. We geocoded the road network at the beginning and end of our sample period based on the same historical maps as for railways.

Next, we control for first-nature geography, including rivers, elevation, and soil suitability. We created a shapefile of waterways using the same historical maps as for railways. We obtained elevation from the European Digital Elevation Model (European Environment Agency, 2016) and suitability of rain-fed wheat from FAO (2020).

We account for second-nature geography with local market access and settlement status. Using population censuses, we coded the administrative hierarchy of settlements. The censuses note whether a settlement held town or market status. We approximate local market access by log distance from a settlement to the nearest town or market.

We control for Bosnia's diverse cultural landscape. Historical censuses document religious denomination of the population by settlements. In 1910, for example, the main groups were Orthodox Christians

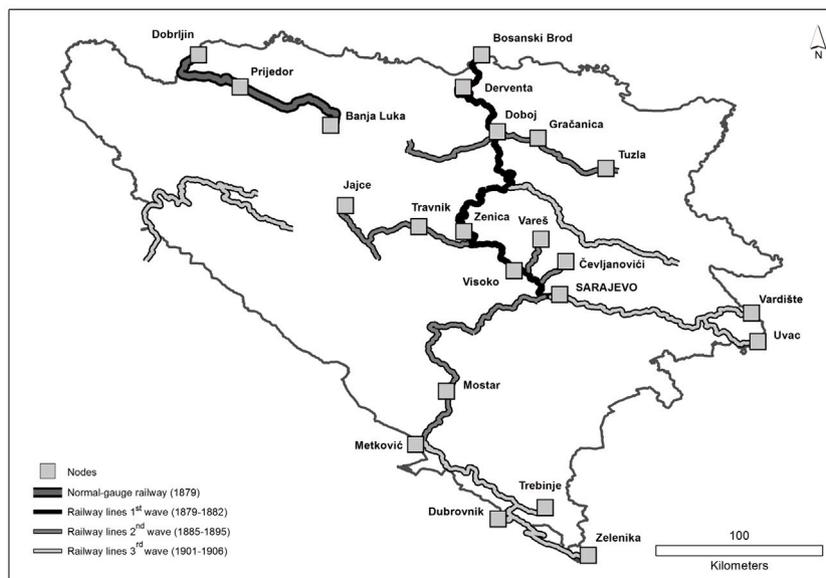


Fig. 3. Railway network in Bosnia–Herzegovina, 1878–1910.
 Source: Own illustration based on the sources noted in Section 3.

Table 1
 Summary statistics.
 Sources: See Section 3.

	Full sample		Normal-gauge	Narrow-gauge			no railway
	Mean	SD	1879	1st wave	2nd wave	3rd wave	
Non-agricultural population share, 1885	0.020	0.067	0.052	0.041	0.060	0.024	0.018
Non-agricultural population share, 1895	0.026	0.094	0.133	0.089	0.093	0.046	0.021
Non-agricultural population share, 1910	0.033	0.101	0.113	0.115	0.110	0.099	0.026
Foreign population share, 1885	0.010	0.057	0.031	0.018	0.007	0.009	0.010
Foreign population share, 1895	0.016	0.065	0.072	0.036	0.030	0.017	0.015
Roman Catholic population share, 1895	0.184	0.343	0.292	0.284	0.335	0.072	0.179
Roman Catholic population share, 1910	0.190	0.343	0.305	0.299	0.336	0.105	0.185
Distance to factory [km], 1885	27.99	24.2	9.81	23.55	13.54	43.75	28.35
Distance to factory [km], 1910	17.19	12.4	8.29	8.6	7.09	15.9	17.85
Road access	0.187	0.390	0.440	0.494	0.800	0.180	0.156
River access	0.141	0.348	0.440	0.728	0.588	0.577	0.099
Distance to nearest town or market [km]	11.1	6.6	9.3	6.2	7	14.02	11.24
Wheat suitability	5052	1870	6415	5234	4436	4269	5088
Elevation [m]	569.1	302.3	161.8	299.8	454.1	488.1	583.6
Religious fractionalization index, 1885	0.139	0.191	0.159	0.209	0.249	0.115	0.134
Religious fractionalization index, 1895	0.146	0.192	0.165	0.241	0.261	0.126	0.140
Human capital	8.231	4.955	6.499	5.616	5.199	6.113	8.467
Law enforcement	6.058	3.261	3.859	4.478	4.869	4.970	6.178
Observations	4554		25	81	165	110	4173

Notes: Road access is a binary variable indicating if a settlement is within 1 km of road in 1885. River access is a binary variable indicating if a settlement is within 1 km of river. Elevation is measured in meters. Religious fractionalization index follows Alesina et al. (2003). Human capital is distance to nearest non-Islamic elementary school in 1895. Law enforcement is distance to nearest armed forces in 1895. Distance is measured in km.

(43%), Muslims (32%), and Roman Catholics (23%). A small number of Jews and Protestants were also recorded. Based on census data, we calculate the religious fractionalization index following Alesina et al. (2003).

We rely on Habsburg censuses of Bosnia for three additional variables: foreigners, schools, and law enforcement. First, censuses of 1885 and 1895 report the number of permanent residents with a foreign citizenship and separate this group into imperial foreigners and foreigners from outside the Austro-Hungarian Empire. We use these data to measure the share of foreigners in the total population. Next, censuses provide two types of settlement-level data on elementary schooling. The 1885 census recorded the number of teachers in a settlement, teaching

in Roman Catholic, Christian Orthodox, or public non-confessional schools.¹⁷ The 1895 census contains a rich set of information about public schools and their confessional ties. In our estimations, we will focus on non-Islamic elementary schools, because they taught modern curricula by professional teachers. Third, we measure the presence of law enforcement, taking into account both police and military forces. The census of 1895 reports the military population and the existence of a police station at the settlement level.

¹⁷ Clerics, giving lessons in Islamic and Jewish schools, were reported in a separate census category.

4. Empirical strategy

Our baseline empirical strategy is cross-sectional estimation that exploits spatial variation in railway access across settlements and census periods. This approach allows us to examine how different types of railways affected local occupational outcomes across space and over time. We later complement this analysis with two-way fixed effects panel specifications that provide robust average estimates, showing a positive association between railway access and occupational change. Our main contribution lies in leveraging the spatial and temporal structure of the data to identify which railways mattered, in which periods, and under what local conditions.

4.1. Cross-sectional fixed effects model

We estimate the settlement-level effects of railway access on local occupational structure in Bosnia–Herzegovina during Habsburg rule. We use OLS to estimate models of the form:

$$NA_{id} = \alpha_d + \beta_n RAnormal_{id} + \sum_{w=1}^3 \beta_w RAnarrow_{idw} + \gamma X_{id} + \epsilon_{id} \quad (1)$$

where NA_{id} denotes the non-agricultural population share in settlement i , located in district d , measured in 1895 or 1910. Four railway treatment variables are of interest. $RAnormal_{id}$ is a binary indicator variable equal to 1 if a settlement lies within 1 km of the normal-gauge railway.¹⁸ $RAnarrow_{idw}$ is a set of three binary variables indicating if a settlement received access to narrow-gauge railways during the first, second, or third construction wave w .¹⁹

We include a vector of other settlement-level controls, X_{id} , capturing pre-treatment population (in 1885 or 1895), other transport infrastructure (industrial railways, roads), geography (rivers, elevation, and wheat suitability), market access (distance to the nearest town or market), religious fractionalization (in 1885 or 1895), human capital (log distance to elementary school, 1895), and law enforcement (log distance to the nearest armed forces, 1895).²⁰ The vector also includes a lagged dependent variable (measured in 1885 or 1895), allowing us to estimate changes in occupational structure 1885–1895 and 1895–1910 while accounting for respective pre-treatment differences across settlements.

District fixed effects, α_d , control for unobserved characteristics common to settlements within the same district. Because the error term, ϵ_{id} , may be correlated across settlements connected to similar parts of the railway network, we account for spatial correlation using (Conley, 1999) standard errors with a distance cutoff of 15 kilometers, which approximately corresponds to the area of an average district.

4.2. Instrumental variables

Estimating Eq. (1) by OLS implies the assumption that railway access was randomly assigned to settlements. This assumption is unlikely to hold for all settlements since railways were often constructed to connect economically important regions and urban centers. Thus,

¹⁸ A 1 km distance cutoff for railway access implies a catchment area of 3.14 km² around the settlement center (using the formula for the area of a circle). Increasing the threshold to 2 km enlarges the catchment area to 12.57 km². Habsburg censuses did not report the area of settlements in Bosnia. Braun and Franke (2022) document that in 19th century Württemberg the median area of a parish was 8.6 km²; Büchel and Kyburz (2020, p. 173) report that the median 19th century Swiss municipality was less than 7 km². Therefore, the 1 km threshold seem a reasonable approximation of railway access for Bosnian settlements.

¹⁹ See Section 2 for details on each construction wave.

²⁰ All control variables are measured in 1885 or 1895, except for elevation and wheat suitability, which are based on modern FAO data.

railway access may be correlated with numerous observable and unobservable settlement characteristics. A standard way to solve this endogeneity issue is the *inconsequential units* instrumental variable (IV) approach.²¹ The basic idea, applied in our context, is that consequential places (e.g. large urban centers) received railway access because of economic or strategic considerations. By contrast, inconsequential places gained railway access because they were randomly located on a cost-minimizing route connecting consequential places. The IV approach bases inference on a randomly chosen subset of settlements (i.e. inconsequential places). Being near the cost-minimizing route serves as the instrumental variable. The major challenges are to select the consequential places that are to be excluded from the sample and to create least-cost paths connecting them. As explained below, we adapt this established approach to fit our context.

Consequential places. Most studies select consequential places (also called nodes) either based on local observable characteristics or in combination with historical planned routes.²² We also follow this approach. We selected 22 settlements as the main nodes based on two general criteria: economic and strategic importance. Our selection is informed by an early railway plan, observed pre-railway settlement characteristics, and historical literature (see Section 2). Table A.1 lists the nodes and summarizes their selection criteria. Hillebrandt's plan of Bosnian railways drew six nodes along the envisioned trunk line: Sarajevo, the capital and largest town; Mostar, the second largest town; Bosanski Brod, the connection at the Austro-Hungarian border, and Dobo, the terminus of that railway segment; Metković, an important harbor; and Zenica, a large coal mine. In line with the railway plan, the rest of the nodes that we included are either large urban areas, important sources of raw materials, military-strategic locations, or a combination of these characteristics.²³ In our estimations, we drop the main nodes and all settlements in 7 km radius around them from the sample.²⁴ This reduces the sample by approximately 8%. In addition, we exclude district capitals, which were more likely to receive railway access due to their administrative importance. Excluding district capitals therefore helps focus the analysis on settlements for which railway access is more plausibly exogenous.

Least-cost paths. We drew a least-cost path between nodes that had railway access during Habsburg rule between 1878 and 1910. We connected nodes with least-cost paths in chronological order of their railway access. Starting with the least-cost path from Banja Luka to Prijedor, we continued until each node has at least one railway connection. Knowing the exact year when a node received railway access allows us to calculate the least-cost network for any given year in the studied period. We use this variation in our analysis of railway access effects in different periods. Importantly, we do not expect a perfect correlation between least-cost paths and actual railways. By design, the least-cost paths simulate a network based on selected nodes; they do not cover all locations on the actual network, neither do they establish all possible connections between the nodes, as this would introduce noise into the estimates.

For the selected inter-node lines, we draw cost-efficient routes factoring in distance, slope, and river crossings.²⁵ In order to estimate the

²¹ Chandra and Thompson (2000) pioneered this approach which was also applied, for example, by Banerjee et al. (2020).

²² For example, Büchel and Kyburz (2020) in their study of Switzerland selected consequential places combining 20 most populous locations in 1850 that held historical town status with 23 locations listed as central junctions in early railway plans.

²³ An approach based solely on one of these characteristics would inevitably leave out some important nodes and therefore bias our estimates.

²⁴ Bogart et al. (2022) report that in the late 19th century the built-up area of Birmingham, one of the largest industrial towns in Britain, was 7 km. We use this cutoff as a most conservative approach to measure urban agglomeration. In robustness checks, we also experimented with other thresholds, but the results remained qualitatively unchanged.

cost parameters, we gather information from [Chester \(2007\)](#) and [Sugar \(1963\)](#) on the total construction costs of Bosnian railway lines built by 1910, and combine it with information on actual railway length to arrive at construction costs per kilometer. We use GIS to calculate the slopes covered by the actual route of the tracks. A regression of total construction costs per kilometer on the routes' average slope yields estimated construction costs of 12,000 crowns per kilometer and an additional 26,000 crowns penalty per degree climbed.²⁶ The costs of building bridges are approximated based on information on bridge construction cost in nineteenth-century Switzerland. We feed these cost parameters to the LCP algorithm to calculate least-cost paths.²⁷ Finally, for each construction wave, we code an instrumental variable that equals 1 for each settlement that was within 1 km of a least-cost path available in that construction wave, and zero otherwise. This means that we use four instrumental variables for the four railway treatments.

Exclusion restrictions. To ensure the validity of our instrumental variables two exclusion restrictions must hold. First, the instrumental variables must be correlated with the endogenous variables. Second, the instrumental variables must affect our dependent variable entirely through railway access. This condition may be violated if an instrumental variable is correlated with settlement characteristics affecting occupational change. To alleviate this concern, we control for many potential confounding factors at settlement-level, as well as fixed differences across districts. Thus, the baseline identifying assumption is that settlement location along a least-cost path affect changes in occupational structure only through railway access, conditional on observed settlement-level controls and district fixed effects.

5. Results

In this section, we present our empirical results. We first examine the effects of railway access on occupational change. We then explore potential mechanisms and heterogeneous effects across settlements, before reporting a series of robustness checks and extensions.

5.1. Occupational change

[Table 2](#) presents OLS and IV estimates of [Eq. \(1\)](#). Columns 1 and 3 report OLS results, while Columns 2 and 4 present the corresponding instrumental variable estimates. All specification include the full set of settlement-level control variables and district fixed effects. As explained in [Section 4](#) we focus identification on settlements that were quasi-randomly located on a least-cost path between major railway nodes.

Our first main finding is that access to narrow-gauge railways generated a positive but temporary increase in non-agricultural employment. Instrumental variable estimates suggest that railway access increased the non-agricultural population share by 2.5 percentage points in settlements connected during the second construction wave (Column 2) and by 4.9 percentage points in settlements treated in the third construction wave (Column 4). These effects correspond to average annual increases of 0.25 percentage points between 1885 to 1895 and of 0.33 percentage points between 1895 to 1910.²⁸ Given that the average non-agricultural population in the sample was 1.9% in 1895 and 2.5% in 1910, these

²⁵ The literature offers two standard ways to connect the selected nodes: straight lines and least-cost paths. For example, [Banerjee et al. \(2020\)](#) applied the former and [Büchel and Kyburz \(2020\)](#) and [Bogart et al. \(2022\)](#) the latter approach. In our setting, however, straight-line instruments yield low F-statistics. This reflects the mountainous terrain of Bosnia–Herzegovina, where railway placement was strongly shaped by topography and engineering constraints. For this reason, we rely on least-cost paths.

²⁶ The relative values of the estimated construction costs are in line with the ones reported by [Bogart et al. \(2022\)](#) for 19th century England and Wales.

²⁷ We explain the calculation in detail in the appendix.

effects are economically meaningful. While the estimated treatment effect of second wave access remains positive in the subsequent period (1895–1910), it loses precision and becomes insignificant, indicating that the initial increase in non-agricultural employment did not persist uniformly across settlements. We find no substantial effects associated with the first construction wave.

Our second main finding is that access to normal-gauge railways led to a decline in non-agricultural employment. Instrumental variable estimates show that normal-gauge railway access reduced the non-agricultural population share by 2.9 percentage points between 1885 and 1895, and by a further 0.4 percentage points between 1895 and 1910. These estimates correspond average annual declines of 0.29 percentage points in the earlier period, and of 0.027 percentage points in the later period. The effect is large and statistically significant in 1895, while it is smaller and no longer statistically significant by 1910.²⁹ The results indicate that settlements connected to normal-gauge railways experienced a pronounced contraction of local non-agricultural activity in the period between 1885 and 1895, followed by limited subsequent change.

Several factors could explain why our instrumental variable estimates tend to be higher than our OLS estimates. First, OLS may understate the true effect of railway access if locations selected for railway construction had lower pre-existing economic potential. Controlling for observable factors may not fully capture these disadvantages, biasing the OLS coefficient downward. Second, the IV estimates identify a Local Average Treatment Effect (LATE), that is, the effect for settlements whose access to railways was influenced by our instrument. If these “marginal” areas benefited more than the average treated settlement, the IV estimates will exceed the OLS Average Treatment Effect (ATE). Third, our railway access variable can suffer measurement error, for example, due to imprecise historical mapping of railways. Classical measurement error tends to attenuate the OLS coefficient toward zero, leading to downward bias relative to IV. Fourth, to the extent that our instrument is only weakly correlated with actual railway access, IV estimates may be imprecise. We do not believe this to be the case, since the Kleibergen–Paap F-statistics in our regressions are much greater than the conventional cutoff of 10. Lastly, if the exclusion restriction is violated, the IV estimate may capture more than the effect of railway access. Considering our standard approach includes both settlement-level controls and district fixed effects, we believe this is unlikely to account for the discrepancy between the OLS and IV estimates.

5.2. Foreigners

We next examine whether railway access affected occupational change by attracting foreign workers. By 1885, 27,570 foreigners lived permanently in Bosnia–Herzegovina, and this number more than doubled over the next decade, with the foreign population share rising from 2.1% to 4.3%. Foreign workers played a central role in the construction, maintenance, and operation of the Bosnian railway network. By 1906, 85% of employees of the public railway company were foreigners ([Sugar, 1963](#), pp. 167–171). Industrial companies, particularly in

²⁸ Annualized effects are obtained by dividing the estimated intercensal change in non-agricultural employment by the number of years between censuses, and thus reflect average exposure over the period rather than assuming that all settlements received railway access at the beginning of the interval.

²⁹ Descriptively, however, we observe that the accessed settlements experienced a decline in the absolute non-agricultural population from 2010 (13.7% share) to 1686 (9.8% share) between 1895 and 1910. During the same period, the non-agricultural population in the control settlements of the districts accessed by the normal-gauge railway also fell from 1830 (3.1%) to 1125 (1.6%). The three accessed districts were the only districts in Bosnia that saw a total loss of the non-agricultural population by 1707 persons (–9.7%) from 1895 to 1910 (reduction of the share from 16.9% to 13.1%).

Table 2
Railway access and occupational change.

	(1)	(2)	(3)	(4)
	Non-agricultural population share			
	1895		1910	
	OLS	IV	OLS	IV
Railway access 1879 (normal-gauge)	0.031 (0.027)	-0.029** (0.012)	-0.025** (0.011)	-0.004 (0.011)
Railway access 1879–1882 (1st wave)	0.015 (0.014)	0.018 (0.018)	0.006 (0.012)	0.025 (0.018)
Railway access 1885–1895 (2nd wave)	0.019** (0.008)	0.025** (0.011)	0.006 (0.011)	0.029 (0.025)
Railway access 1901–1906 (3rd wave)	0.004 (0.006)	0.005 (0.007)	0.041*** (0.014)	0.049*** (0.011)
Controls	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes
Kleibergen–Paap F statistics		34.40 218.21 286.17 435.29		34.50 218.49 285.19 433.66
Dep. Var. μ	0.019	0.019	0.025	0.025
R ²	0.228	0.225	0.360	0.357
Observations	4140	4140	4140	4140

Notes: Table reports results of OLS and IV estimation of Eq. (1). Controls are lagged dependent variable, log population in 1885 (Cols. 1–2) or 1895 (Cols. 3–4), industrial railway access, road access in 1885, log distance to nearest town/market (market access), log distance to elementary school (human capital), log distance to armed forces (law enforcement), religious fractionalization index in 1885 or 1895, river access, log wheat suitability index, and log elevation. Conley standard errors are given in parentheses. ***, **, and * refer to $p < 0.01$, $p < 0.05$, and $p < 0.10$, respectively.

Table 3
Railway access and population share of foreigners.

	(1)	(2)	(3)	(4)	(5)	(6)
	Foreign population share					
	Total, 1895		Imperial, 1895		Catholics, 1910	
	OLS	IV	OLS	IV	OLS	IV
Railway access 1879 (normal-gauge)	0.013 (0.012)	-0.009 (0.023)	0.002 (0.003)	-0.005 (0.019)	0.014* (0.008)	-0.002 (0.015)
Railway access 1879–1882 (1st wave)	-0.002 (0.006)	0.000 (0.006)	-0.003 (0.005)	-0.000 (0.005)	-0.014 (0.012)	-0.004 (0.012)
Railway access 1885–1895 (2nd wave)	0.020*** (0.006)	0.024*** (0.008)	0.016*** (0.006)	0.019*** (0.006)	-0.006 (0.006)	0.005 (0.013)
Railway access 1901–1906 (3rd wave)	0.001 (0.003)	0.004 (0.004)	0.001 (0.003)	0.005 (0.004)	0.028*** (0.009)	0.024*** (0.006)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes	Yes	Yes
Dep. Var. μ	0.015	0.015	0.015	0.015	0.175	0.175
R ²	0.617	0.616	0.682	0.682	0.944	0.944
Observations	4140	4140	4140	4140	4140	4140

Notes: Controls are lagged dependent variable, log population in 1885 (Cols. 1–4) or 1895 (Cols. 5–6), industrial railway access, road access in 1885, log distance to nearest town/market (market access), log distance to elementary school (human capital), log distance to armed forces (law enforcement), religious fractionalization index in 1885 or 1895, river access, log wheat suitability index, and log elevation. Conley standard errors are given in parentheses. ***, **, and * refer to $p < 0.01$, $p < 0.05$, and $p < 0.10$, respectively.

the timber sector, were also predominantly foreign-owned and relied heavily on foreign labor. Population censuses allow us to measure the settlement-level share of foreigners, enabling us to assess whether changes in non-agricultural employment following railway construction were related to foreign workers.

Table 3 presents OLS and IV estimates of Eq. (1), replacing the non-agricultural population share with the foreign population share as the dependent variable. Columns 1 and 2 measure the effect of railway access on the share of foreigners in 1895. Columns 3 and 4 focus on the railway effect on the share of Austro-Hungarian (Imperial) citizens in the same year. Columns 5 and 6 use the share of Roman Catholics in 1910 as a proxy for foreign population, reflecting the dominant religion in Austria-Hungary.³⁰ In all specifications, we control for pre-treatment

³⁰ By comparison, in Bosnia–Herzegovina, about a fifth of the population was Roman Catholic.

levels of foreign population shares, allowing us to capture the effect of railway access on subsequent growth in the foreign population.

Table 3 shows that gaining access to narrow-gauge railways during the second and third construction wave is associated with an increase in the foreign population share. Construction of narrow-gauge railways between 1885 and 1895 raised the share of foreigners by 2.4 percentage points (Column 2), with most of the effect driven by immigrants holding Austro-Hungarian citizenship (Column 4).³¹ Expressed in annual terms, narrow-gauge railways increased the foreign population share by 0.24 percentage points per year during the second wave and by at least 0.16 percentage points per year during the third wave. Given that the average settlement in our sample had a foreign population share of 1.5% in 1895, the estimated effects are economically meaningful.

³¹ Columns 1 and 2 report the effect on all foreign citizen, whereas Columns 3 and 4 focus on foreigners holding Austro-Hungarian (Imperial) citizenship.

Second-wave railway access accounts for 37% of total foreigners arriving in the treated settlement between 1885 and 1895.³² Importantly, access to second-wave railways has no statistically significant effect on foreign population shares in the subsequent period (Column 6), suggesting that the inflow of foreigners was largely temporary. Lastly, we find no significant effects of access to normal-gauge railways on foreign population shares.

In sum, the pattern emerging from Table 3 resembles the effects of narrow-gauge railway on non-agricultural employment reported in Table 2, both in magnitude and timing. Narrow-gauge railways attracted foreigners during the second and third construction waves, but we find no evidence that the foreign population share continued to grow beyond the respective construction periods. This suggests that the temporary increase in non-agricultural employment associated with narrow-gauge railways was influenced by the inflow of foreign workers engaged in railway-related.

5.3. Human capital

We explore heterogeneous effects of railway access conditional on two contextually important factors: human capital and law enforcement.³³ Variation in access to elementary schools across Bosnia–Herzegovina allows us to study how lower-tail human capital conditioned the effect of railways on local occupational change. Human capital has been shown to be an important determinant of local development (Gennaioli et al., 2013). We therefore expect that settlements with access to schooling experienced more sustained increases in non-agricultural employment following railway access than otherwise similar settlements without schooling access. We use settlement-level data on the location of non-Islamic elementary schools to estimate how the effects of railway access varied with local human capital endowments.

We re-estimate Eq. (1) separately in two subsamples defined by proximity to non-Islamic elementary school and report the results in Fig. 4. The full dots denote the estimated effects of railway access for settlements located within the distance threshold to a school, while hollow points represent estimates for settlements located beyond this threshold. The horizontal axis reports the distance cutoff used to divide the sample.³⁴

The results show that human capital conditioned the effects of railways on local occupational change with a time lag. Our baseline estimates (Table 2) established that narrow-gauge railways generated only temporary increases in non-agricultural employment. The conditional estimates in Fig. 4 reveal that these effects persisted in the subsequent, post-construction period, but only in settlements with access to schooling. In settlements located within one kilometer of both a non-Islamic elementary school and a narrow-gauge railway, the non-agricultural population share increased by approximately 1.7 percentage points per year between 1885 and 1895, and by 0.9 percentage points per year between 1895 and 1910. These effects are substantially larger

³² Our back-of-the-envelope calculation takes the 1895 population of the treated settlements during the second wave, multiplies it with the estimated coefficient ($39,685 \cdot 0.024$), and divides it by the change in total foreigners between 1885 and 1895 in the treated settlements (2557).

³³ The effects of railways are seldom uniform in size and sign. For example, Bogart et al. (2022) find a population growth effect close to zero for the bottom six deciles. Braun and Franke (2022) estimate a larger effect for more industrialized parishes. Fenske et al. (2023) estimate larger railway effects for initially smaller and more isolated cities.

³⁴ For example, at the zero distance threshold, the full dot gives the railway access estimate for settlements with a non-Islamic school, whereas the hollow point reports the estimate for settlements without a non-Islamic school. At the 1 km distance threshold, the full dot gives the railway access estimate for settlements within the threshold distance of a non-Islamic school, whereas the hollow point reports the estimate for settlements beyond the threshold distance of a non-Islamic school. And so on.

than the corresponding unconditional effects, indicating that access to schooling played an important role in sustaining non-agricultural employment growth. The effects are strongest for settlements within three kilometers of a school, consistent with contemporary Bosnian legislation that mandated school attendance for children living within that distance of a school.

5.4. Law enforcement

Spatial variation in the location of armed forces enables us to examine whether the effects of railway access depended on local law enforcement. We expect railway access to have had larger effects on occupational change in settlements with stronger law enforcement, as secure property rights provide incentives for investment and are essential for economic development (Besley, 1995). In such settings, crafts and other non-agricultural activities were more likely to be developed. We use settlement-level data on police stations and military corps to proxy the reach of law enforcement, measured by the log distance to the nearest armed forces.

We re-estimate Eq. (1) separately in the two subsamples defined by the distance to armed forces and present the results in Fig. 5. Full dots denote the estimated effects of railway access for settlements located within the distance threshold to armed forces, while hollow points represent estimates for settlements located beyond this distance threshold. The horizontal axis indicates the distance cutoff used to divide the sample.

The results suggest that access to law enforcement conditioned the longer-run effects of railway access on local occupational change. Specifically, during the period 1895–1910, settlements connected to second-wave narrow-gauge railways experienced more sustained increases in non-agricultural employment when located close to armed forces (Fig. 5(b)). In settlements located within one kilometer of armed forces, the non-agricultural population share increased by approximately 1 percentage point per year between 1895 and 1910. The magnitudes of this conditional effect is comparable to that associated with access to schooling over the same period. By contrast, Fig. 5(a) shows no statistically significant differences between settlements with and without access to law enforcement for the contemporaneous effect of the second construction wave.

In short, access to law enforcement conditioned the longer-run effects of narrow-gauge railways on local occupational change in settlements where the rule of law was more fragile. The effect became salient in the final period of our analysis leading up to the First World War.

5.5. Robustness

5.5.1. Alternative samples

We test the robustness of our results to alternative sample restrictions. As discussed, our baseline sample excludes railway nodes and all settlements within a 7 km radius of the nodes. While this sample restriction is necessary to avoid endogeneity, we might underestimate the railway effect by excluding agglomeration centers from the sample. We thus re-estimate Eq. (1), varying the radius around the nodes that determines the sample restriction. Figure B.1 reports the results of this exercise. The point estimates on the far right within each sub-figure reproduce our baseline results. The size of the point estimates is very stable at different cut-offs, which suggests that by restricting the sample we do not underestimate the magnitude of the railway effects. The same coefficients as in our baseline remain highly statistically significant in most cases.

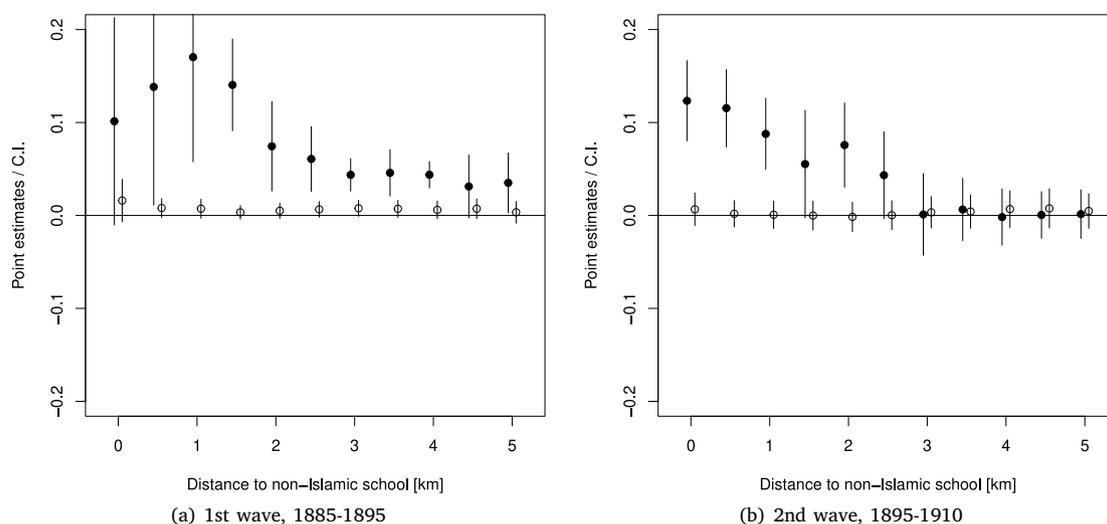


Fig. 4. Railway effect on occupational change conditional on human capital.

Notes: the X-axis labels the thresholds to split the sample into treatment and control subsamples, with respect to treatment with human capital as measured by proximity to a non-Islamic elementary school. A full point represents a coefficient in a treatment sample and the hollow point represents a coefficient in a control sample. Vertical lines around point estimates represent 90% confidence intervals. (a) shows the effect of the first wave of narrow-gauge railways (1879–1882) on occupational change during the post-construction period (1885–1895), conditional on human capital. (b) shows the conditional effect of the second wave of narrow-gauge railways (1885–1895) on occupational change in the subsequent period (1895–1910).

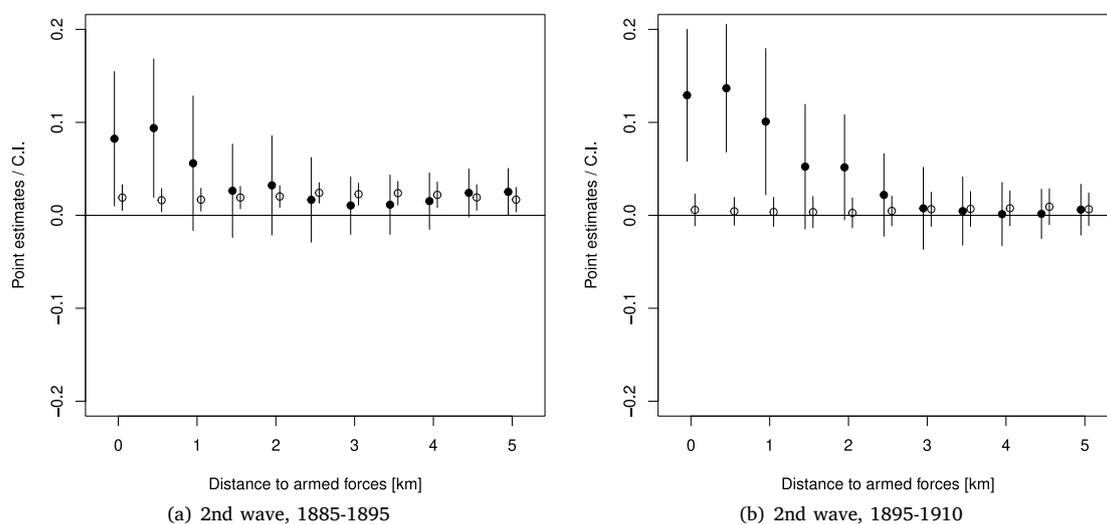


Fig. 5. Railway effect on occupational change conditional on law enforcement

Notes: the X-axis labels the thresholds to split the sample into treatment and control subsamples, with respect to treatment with law enforcement as measured by proximity to armed forces. A full point represents a coefficient in a treatment sample and the hollow point represents a coefficient in a control sample. Vertical lines around point estimates represent 90% confidence intervals. (a) shows the effect of the second wave of narrow-gauge railways (1885–1895) on occupational change in the same period, conditional on the distance to the armed forces. (b) shows the conditional effect of the same railways as in (a) yet in the subsequent period (1895–1910).

5.5.2. Sensitivity to controls

We examine the sensitivity of our baseline results to the choice of control variables using a leave-one-out robustness exercise. Specifically, we sequentially re-estimate the baseline specification while excluding, in turn, controls for pre-treatment population, alternative transport infrastructure (industrial railways and roads), geographic characteristics (rivers, elevation, and soil suitability), market access, religious fractionalization, human capital, and law enforcement. Tables B.1 and B.2 report the results. The baseline estimates are reported in the first column for comparison with the alternative specifications shown in the subsequent columns. Across all specifications, the estimated effects of railway access remain stable in sign and magnitude and continue to

be statistically significant, suggesting that the baseline results are not driven by any particular set of controls.

5.5.3. Additional controls

We next control for two potentially confounding factors: serfdom and religion. Bosnia was among the last few European countries to abolish serfdom. During the Ottoman period the Muslim landowners controlled most of the arable land while most of the Christian population were serfs. Austro-Hungarian rule introduced some changes such as permitting serfs to purchase land from the landlords, but it never ended feudal relationships (Sugar, 1963). According to the census in 1910, around a third of the agricultural population were some form of

serfs (*kmets*). Moreover, landholdings in Bosnia were largely distributed along religious lines. Muslims accounted for 85% of landlords but only for 6% of serfs. The main religious groups (Muslims, Orthodox Christians, and Roman Catholics) were more equally represented among free peasants. We therefore additionally control for land relations and religious segregation.

Table B.3 presents results of controlling for the share of serfs in settlement population. Table B.4 reports the estimates after controlling for religious composition. In both cases, the baseline results remain qualitatively unchanged. The contemporaneous effects of the second and third wave remain similar in size and statistical significance. The IV effect of the normal-gauge railway on occupational change in the period 1885–1895 is statistically significant and estimated with a negative sign also in the two robustness checks.

5.5.4. Alternative control — forestry railways

The isolated railways in western Bosnia (Fig. 3) primarily served small forestry towns and did not feature major railway nodes. To assess whether this affects the local average treatment effects identified by our IV strategy, we conduct a robustness check in which we exclude these forestry railways from the third-wave treatment and instead include them as part of the industrial railway control. The results, reported in Table B.5, show that the estimated LATEs remain qualitatively unchanged relative to our baseline IV specifications.

5.5.5. Non-agricultural employment in 1885

Our baseline specifications are designed to explain changes in non-agricultural employment (1885–1895 and 1895–1910), rather than potential immediate effects between the initial railway treatments and the level of non-agricultural employment in 1885.

To address this, we conduct an additional exercise in which we regress initial railway treatments – normal-gauge railways and first-wave narrow-gauge railways – on the level of non-agricultural employment observed in 1885. The results, reported in Table B.6, show that access to the normal-gauge railway is already associated with a significantly lower non-agricultural population share in 1885, while railway access in the first wave (1879–1882) has no statistically significant effect. Later waves of railway access, included as placebo treatments, are also insignificant. These results suggest that our baseline estimates do not mask an omitted immediate positive effect of early railway access.

5.5.6. Placebo railways

Recent work emphasizes that the estimated effects of infrastructure investments can be confounded if treatment assignment is correlated with settlement centrality or other latent characteristics that also shape economic outcomes (Borusyak and Hull, 2023). In our setting, more central settlements may have been more likely to receive railway access and to differ systematically from other locations along additional, unobserved dimensions. Our baseline specifications address these concerns by including district fixed effects, which absorb broad differences in centrality and regional market access, and by controlling for alternative modes of transport such as roads, rivers, and industrial railways. As an additional check on the plausibility of exogenous exposure, we implement a placebo test based on railway lines that were planned but not completed during the study period.³⁵

Table B.7 reports estimates using these placebo railways as treatments. We find no statistically or economically significant differences between settlements located along planned railway lines and other control settlements. This absence of effects mirrors the lack of pre-treatment trends for the third construction wave and suggests that settlements eventually receiving railway access were not systematically different prior to treatment.

³⁵ We used the extension of the Steinbeisbahn built during WWI and the grand railway proposal for Bosnia discussed since 1907 and finally accepted by parliament in 1912 (Chester, 2007, pp. 110–118).

6. Extensions

6.1. Two-way fixed-effects

Non-agricultural population share. We complement our baseline cross-sectional analysis with two-way fixed effects panel specifications. Specifically, we estimate panel models of our baseline outcome variable – the non-agricultural population share – using both OLS and instrumental variable approaches. The balanced panel consists of 4140 settlements observed in three census years (1885, 1895, and 1910). We evaluate the effects of three treatment variables. The first is railway access, defined as a binary indicator equal to one if a settlement was located within one kilometer of a railway line, consistent with our baseline specifications. The second treatment variable measures years of railway operation, capturing the number of years a settlement had access to the railway network. The third treatment variable is an indicator for railway stations, equal to one if a settlement had direct access to a station.

The panel specifications include settlement fixed effects and census-year fixed effects, thereby accounting for time-invariant settlement characteristics and common temporal shocks. While this approach has the econometric advantage of producing average treatment effects that control for unobserved heterogeneity along both spatial and temporal dimensions, it also aggregates away substantial spatial and temporal variation in the data. As a result, the panel estimates provide a useful complement to our baseline analysis, but obscure much of the heterogeneity in railway effects across space and time that is central to our main findings.

The results reported in Table B.8 indicate a positive average association between all three measures of railway exposure and occupational change. Instrumental variable estimates suggest that railway access increased the non-agricultural population share by approximately 3.8 percentage points on average over the period 1885–1910 (Column 2). The magnitude of this average effect is comparable to the estimates obtained from our cross-sectional analysis (Table 2). Years of railway operation are also positively associated with occupational change, with each additional year of access corresponding to an increase of about 0.3 percentage points in the non-agricultural population share (Column 4). Access to a railway station yields comparatively larger coefficients, consistent with the idea that stations provided more direct access to freight and passenger services.

Population. While our primary outcome captures changes in occupational structure, it does not directly measure welfare. A comprehensive welfare analysis accounting for general equilibrium adjustments in wages, prices, rents, and migration is not feasible in the Bosnian context due to data limitations. As a reduced-form complement, we therefore examine population responses to railway access using panel regressions with location and census-year fixed effects. Population changes can reflect shifts in local economic opportunities and living conditions. While population growth should not be interpreted as a direct measure of welfare, these estimates provide suggestive evidence on whether railway-connected settlements became relatively more or less attractive over time.

Table B.9 reports the results of panel estimation of railway access measures and population in the period between 1879 and 1910. The balanced panel consists of 3964 settlements observed in four census years (1879, 1885, 1895, 1910). The coefficient of 0.259 (Column 2) implies that railway access is associated with an increase in population of approximately 30 percent on average, relative to the counterfactual without railway access.³⁶ Column 4 suggests that each additional year of railway operation is associated with an approximately 2 percent increase in population, on average. Settlements with a railway station

³⁶ As the dependent variable is log population and railway access is a binary indicator, the percentage effect is $100 \times (e^{0.259} - 1) \approx 29.6\%$.

had, on average, substantially larger populations – on the order of two to three times those of otherwise comparable settlements – consistent with stations being located in settlements that developed as regional transport and commercial hubs.

6.2. Factories

While our occupational data distinguish agricultural from non-agricultural employment, they do not identify the type of non-agricultural activities. To further investigate the role of industrial activity in shaping non-agricultural employment, we use the newly-collected factory data and calculate the distance from each settlement to the nearest factory.

Figure B.2 provides descriptive evidence that nearly half of all factories and more than two-thirds of steam-driven factories in 1910 were located within one kilometer of a railway. Moreover, the association between proximity to factories and non-agricultural employment strengthened over time (Figure B.3). Already in 1885, settlements located within one kilometer of a factory recorded a non-agricultural population share that was about 3 percentage points higher than the full-sample mean. By 1910, this difference had increased to approximately 14 percentage points for settlements within the same distance. These patterns suggest that occupational changes observed between 1885 and 1910 were at least partially related to factory employment.

To assess more formally whether the changes in non-agricultural employment documented in our baseline results are linked to factory activity, we examine the relationship between railway access and the spatial location of factories. Specifically, we replace the non-agricultural population share with the log distance from each settlement to the nearest factory in 1910 and re-estimate our baseline specification following Eq. (1). To account for pre-existing industrial patterns, we control for distance to the nearest factory in 1885. Including this lagged dependent variable allows us to determine whether railway access is associated with changes in factory proximity between 1885 and 1910, rather than pre-existing differences.

The results, reported in Table B.10, show a strong association between railway access and proximity to factories only for the second construction wave. Settlements that received railway access between 1885 and 1895 experienced a reduction in distance to the nearest factory of approximately 32 percent between 1885 and 1910. By contrast, we find no comparable relationship for other railway waves. This pattern suggests that second-wave railways – constructed primarily to facilitate the extraction and transport of raw materials – disproportionately attracted factory industry during the studied period. These findings support our interpretation that the temporary increase in non-agricultural employment associated with narrow-gauge railways was, at least in part, driven by the factory industry.³⁷

We next examine whether the effects of railway access on industrial location varied with local development conditions, using factory data rather than occupational outcomes. Mirroring the heterogeneity analysis in Sections 5.3 and 5.4, we condition the impact of railway access on proximity to human capital and law enforcement. Instead of non-agricultural employment, the outcome variable is now the log distance to the nearest factory. We distinguish between all factories, steam-powered factories, and sawmills. This distinction allows us to assess whether human capital and public safety disproportionately shaped the location of more technologically advanced production – proxied by steam power – or large-scale, capital-intensive activities such as sawmilling.

Figures B.4 and B.5 present the results of this heterogeneous analysis. Overall, the estimated effects of railway access on factory proximity

³⁷ Factory location data are available only for 1885 and 1910 and therefore capture industrial outcomes over the entire study period; unlike the occupational census data, they do not allow us to separately estimate effects for the sub-periods 1885–1895 and 1895–1910.

are strongest in settlements close to elementary schools and armed forces, and decline gradually with distance. Conditioning on human capital, first-wave railways are most strongly associated with the proximity of all factories and steam-powered factories, while second-wave railways appear to have been particularly important for sawmills. Conditioning on law enforcement, second-wave railways show the strongest association with proximity to all factories and sawmills. These patterns are consistent with human capital facilitating the adoption of more advanced production technologies and with law enforcement reducing risks associated with capital-intensive investment, thereby shaping which types of factories responded to railway access.

7. Discussion

7.1. Transport costs matter

The construction of the Bosnian railway network lowered transport costs across the province, but the magnitude of these reductions varied substantially by railway type. Transport costs fell much more in settlements connected to the normal-gauge railway than in settlements with access to narrow-gauge lines. Because the normal-gauge railway matched the imperial network, passengers and freight could move uninterrupted between northwestern Bosnia and the rest of the Empire. By contrast, Bosnia's narrow-gauge railways were incompatible with the imperial network and required cargo to be unloaded and reloaded at the provincial border before further distribution, making transport via narrow-gauge lines relatively more expensive.

When the Austro-Hungarian administration connected the normal-gauge line to the imperial network, northwestern Bosnia became directly integrated into the imperial market. Lower transport costs enabled industrial manufacturers from the imperial core to sell their products locally, exposing Bosnian craftsmen to intensified competition. [Besarović \(1913, pp. 11–13\)](#) documents that many craftsmen were unable to scale production in small workshops and were less productive than imperial manufacturers. Weavers, tanners, and furriers were driven out of the market by imports. As a result, artisanal producers exited non-agricultural activities and returned to agriculture. Any newly-created jobs associated with railway access were insufficient to offset these losses. Lower transport costs thus induced a spatial reallocation of non-agricultural activity away from the peripheral region toward established economic centers within the Empire. Similar agglomeration effects have been found in other contexts and appear to depend on the relative backwardness of the regions gaining market access ([Faber, 2014](#); [Tang, 2014](#); [Chandra and Thompson, 2000](#)).

By contrast, narrow-gauge railways did not reduce transport costs to the same extent and, therefore, did not generate comparable competitive pressures on local producers. Instead, narrow-gauge railways primarily integrated the domestic Bosnian market while partially insulating traditional crafts from direct competition with imperial industrial manufacturers. Despite the absence of internal tariffs within the Empire, high railway tariffs and the cost associated with reloading freight at the provincial border effectively provided a degree of protection for local producers, analogous to infant-industry protection ([Lee, 1997](#); [Chang, 2003](#); [Melitz, 2005](#)). However, as we discuss below, limited human capital and weak law enforcement conditioned the ability of the native population to respond to the opportunities created by domestic market integration.

7.2. Railways and foreigners

The construction of narrow-gauge railways generated a temporary increase in non-agricultural employment in settlements receiving railway access. Building and maintaining railway infrastructure, including tracks, rolling stock, and stations, required a substantial non-agricultural workforce. In addition, railway traffic stimulated local service activities, such as trade, communication, and hospitality. Such

short-run employment effects of transport infrastructure are well documented in other contexts (Ghani et al., 2016). Regions gaining access to transport infrastructure move to a new equilibrium ahead of the hinterlands, without necessarily experiencing faster growth thereafter.

In Bosnia, many of the new non-agricultural jobs created by railway construction and operation were filled by foreign workers, primarily from Austria-Hungary. Our finding that foreign labor increased non-agricultural employment is consistent with historical accounts. Chester (2007, p. 19) reports that the contractor responsible for the first railway from Bosanski Brod to Sarajevo was unable to recruit a sufficient local workforce despite offering high wages: “In the event virtually all of the 4000 men and 40 engineers ultimately employed on the contract had to be brought to Bosnia from other, often quite distant parts of the Monarchy”. While local supply of skilled labor gradually increased over the course of the occupation, limited skill levels and reluctance toward imperial employment likely constrained participation by the native population.

Foreign labor participation extended beyond railway construction. Much of the public sector in Bosnia–Herzegovina, including the public railway company, relied on civil servants from other parts of the empire. Schmid (1914, pp. 51–67) reports that most of the Ottoman civil servants left the province and were replaced by officials from Austria-Hungary. Although the civil service formally opened to native applicants after 1885, their numbers grew only slowly. Similarly, new businesses were typically founded and operated by foreigners, a pattern common across the Balkan peninsula. As Sugar (1982) describes: “New emerging industries often owned by foreigners were also run by foreign workers, since the natives lacked the required skills”. In the case of the wood processing factory in Teslić, for example, 41% of the foremen were foreigners, while more than 90% of the workers were locals (Gavrilović et al., 2018).

In sum, the provincial government faced a severe shortage of qualified local labor in Bosnia–Herzegovina. To construct, maintain, and operate the railway network, Habsburg authorities relied predominantly on foreign workers, as domestic labor supply adjusted only slowly to increased demand for non-agricultural skills. One important reason for this constraint was the underdeveloped schooling system, which we discuss next.

7.3. Conditions for sustained development

Human capital endowments shaped how settlements responded to the opportunities created by railway access. Settlements located near non-Islamic elementary schools experienced more sustained increases in non-agricultural employment following railway construction. Evidence from factory locations reinforces this interpretation: railways were more strongly associated with proximity to factories – particularly steam-powered and other capital-intensive establishments – in areas with greater access to schooling. Human capital thus facilitated not only occupational change but also the adoption and operation of more advanced production technologies. Access to schooling equipped local workers with the skills needed to fill new non-agricultural jobs or to support factory production, reducing reliance on imported labor and making these locations more attractive to industrial investment. As Sugar (1963, 169) observes for Bosnia: “The pits and plants were situated in the regions in which a semi-skilled labor pool was available, and expansion of the work force could be handled partly by training and partly by recruiting among the peasantry in the immediate vicinity”.

State capacity also played an important role in conditioning the long-run effects of railway access in peripheral areas. Settlements located closer to armed forces benefited from stronger law enforcement and greater public safety. These areas were more likely to experience occupational change and to attract industrial activity – especially large-scale and capital-intensive factories – following railway construction. Greater security reduced risks associated with investments, fostered

trade, and made non-agricultural production more viable. By contrast, settlements beyond the effective reach of law enforcement were more vulnerable to banditry and political unrest, including nationalist upheavals such as the 1882 uprising in the Herzegovina (Ovčina et al., 2022).

These findings align with Hirschman’s notion of absorptive capacity, highlighting that railway investments generated sustained economic effects where complementary capabilities – such as human capital and effective law enforcement – enabled local economies to respond to new development opportunities.

8. Conclusion

Are railways always a harbinger of prosperity? Our analysis shows that the economic effects of railways in Bosnia–Herzegovina under Habsburg colonial rule were heterogeneous. Narrow-gauge railways generated short-run increases in non-agricultural employment, by attracting foreign workers and firms. These effects persisted only in settlements endowed with key development preconditions — access to elementary schooling and effective law enforcement. By contrast, access to the normal-gauge railway was associated with a contraction of local non-agricultural activity, as integration into the imperial market exposed local craftsmen to intensified competition from more productive manufacturers.

More broadly, our findings indicate that the integration of a pre-industrial colonial economy into an industrialized market had dual effects. Where human capital and rule of law were sufficiently developed, railway access supported more sustained non-agricultural employment growth. In less developed areas, railways primarily induced displacement of artisanal production without generating lasting local gains. These results caution against viewing transport infrastructure as a universal engine of development and highlight the importance of complementary local conditions. The mechanisms we document may be relevant for understanding the long-run effects of infrastructure investments in contemporary developing economies facing similar institutional and human-capital constraints.

CRedit authorship contribution statement

Magnus Neubert: Conceptualization, Methodology, Formal analysis, Investigation, Resources, Data Curation, Writing - Original Draft, Writing - Review and Editing, Visualization, Funding acquisition. **Stefan Nikolić:** Conceptualization, Methodology, Validation, Investigation, Resources, Data Curation, Writing - Original Draft, Writing - Review and Editing, Visualization, Funding acquisition.

Appendix A. Supplementary data

Supplementary material related to this article can be found online at <https://doi.org/10.1016/j.jdevco.2026.103747>.

Data availability

Replication files for this study are available on OPENICPSR: <https://doi.org/10.3886/E245011V1>.

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