THE IMPACT OF RAILWAY ON THE REGIONAL ECONOMIC DEVELOPMENT AND SOCIAL MOBILITY IN THE CONGRESS KINGDOM OF POLAND

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The Impact of Railway on the Regional Economic Development and Social Mobility in the Congress Kingdom of Poland

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Abstract: We estimate the impact of railway construction on local populations in Russian Poland in the 19th century. The initial wave of railway expansion outpaced economic demand. From the late 1860s onward, locations connected to the railway network experienced significantly higher population growth. The economic effects of the connection to the railway network increased over time. State-funded military railway lines generated a smaller impact than private-owned lines. We also study the impact of the railway connection on social mobility proxied through a number of notable people born in a given city. However, we do not identify any robust impact.

1. Introduction

The railway is a symbol of the industrial revolution. For contemporaries, it represented the power of technological progress and stood as a symbol of modernity and economic development. The construction of railways was the most significant capital investment of the 19th century, strongly backed by the state. New means of transportation reduced transport costs, which supported the expansion extraction of mineral resources and manufacturing. The substantial investment required to finance the development of the rail network played a key role in supporting the growth of financial markets, particularly the capital market. (Tilly, 1980; Berend 1998, 2003; Milward, 2004; Gwyn, 2023; Atack, 2024; Bogart, 2024).

However, the economic impact of railways has been a subject of huge controversy in economic history. Fogel (1964) in his seminal book "*Railroads and American Economic Growth*" offered a new methodology based on social savings and argued that the economic impact of the railway was significant on the local level, but the aggregate economic impact was small. Fogel's contribution generated huge debates and a new line of research in economic history in the subsequent decades (Fishlow, 1965; O'Brien, 1977, 1983). Recent research demonstrated that railway construction indeed provided aggregate economic benefits (Hornung, 2015; Donaldson & Hornbeck, 2016), and supported urbanization and structural transformation (Atack et al, 2010; Bogart & Chaudhary, 2013; Berger, 2019). It was also an important tool of state-building in the peripheral economies (Paik & Vechbanyongratana, 2024). The impact was heterogeneous over space and time, the growth-enhancing effects were greater in densely populated and more industrial areas (Braun & Franke, 2022; Esteban – Olivier, 2023). The development of the railway determined the location of economic activity and did not result in regional convergence (Jedwab et al., 2017; Berger & Enflo, 2017). Leuning (2010, 2011), Atack (2024) and Bogart (2024) discuss the rich literature on the economic effects of the railway.

In this paper, we investigate the economic impact of railway construction on the economic development of the Congress Kingdom of Poland. The first state-led attempts to industrialize the country between 1820 and 1840 failed, with the lack of transportation infrastructure being one of the major reasons for this failure (Jedlicki, 1964). Mineral resources and coal were available in the Dąbrowa Basin, located in the southwestern part of the country. However, prohibitive transportation costs rendered these resources economically unviable. The cost of transporting coal to Warsaw was three times higher than the extraction cost. Transportation was expensive in summer and entirely impossible during winter. Unfortunately, Warsaw was

missing its Bridgewater channel (so important for the development of Manchester as an industrial center). Rivers in Poland flow from south to north, while transportation from the west to the east was needed. The construction of the railway network started in the 1840s and only in the 1860s the Congress Kingdom was connected with the Russian imperial market.

Poland is an interesting country to study the economic effects of railway construction. While researchers invested significant effort in studying such investment in European colonies such as India (Donaldson, 2018), Java (Brata, 2021) or Kenya (Jedwab et al., 2017) and independent Asian countries such as Japan (Tang, 2014) or Thailand (Paik & Vechbanyongratana, 2024), the research on Eastern European peripheries is scarce. Despite, the depth of rapidly extending literature and great interest in the issue in the field of economic history our knowledge about the economic impact of railways ends in Prussia (Hornung, 2015) in the West and reappears only in China (Shuang, 2016) and Japan (Tang, 2014) in the east. Even in the case of Russia, a major world power often studied by economic historians, we are limited to a single, five-decade-old study on the value of social savings due to railway construction and the research on the impact of railway construction on the grain market integration in the western part of the country (Metzer, 1973, 1976).

Similarly, as in the colonial context, in the Congress Kingdom, the construction of a railway was possible only with the approval of a metropole. The Russian government constrained the development of private railway lines, while the public investments were focused on military needs with little regard for the economic impact. Railway lines funded by the state merged the fortresses and places of military deployment sometimes completely omitting larger cities. As we show, this strategy resulted in the misallocation of investment, at least from the perspective of the needs of the Polish economy.

We investigate the impact of the railway on the city population in the years 1825 – 1910. Similarly to other authors, we use the city population as the proxy for local economic development (e.g. Hornung, 2015; Berger & Enflo, 2017; Bukowski et al., 2019, Esteban – Olivier, 2023). We find that the effects of connecting cities to the railway network were heterogeneous, depending on the timing of construction and varying between public and private investments. The railway network in Poland predates the Industrial Revolution, therefore its economic effects did not become significant until the 1860s. Initially, the first railways served primarily administrative purposes and facilitated passenger travel to Western Europe, but these benefits were insufficient to generate substantial economic growth. By the 1860s, as industrialization began, the railway network started to yield more significant economic

advantages. Private investments focused on local economic needs had a stronger impact on population growth than public investment which prioritized the military needs of the empire. The effects of railway connections on the local population became insignificant in the early 20th century when further constructions took place in the economically laggard, eastern part of the country. However, the private lines continued to positively impact the local economic development.

We also examine the impact of railway construction on social mobility. Did improved transport infrastructure enable individuals born outside major cities to achieve greater success? To address this question, we rely on a dataset of digitized biographies from the Polish Biographical Dictionary and Who is Who, published in 1938 (Łoza, 1938). This dataset was previously used by Wroński & Minakowska (2024) to study social mobility. We measure the number of listed people born in a given city but do not identify any robust impact of railway connectivity on this proxy of social mobility. However, since our measure captures only the uppermost tier of social stratification, it remains possible that railway expansion facilitated social mobility in lower segments of the hierarchy.

In 1870, following the failed January Uprising, 336 out of 456 cities lost their urban rights. While the Tsarist decree served as a form of political punishment, our findings suggest that cities that lost their legal status had already been growing at a significantly slower pace for decades beforehand. The loss of city status did not immediately affect population growth in the short term, but it had negative effects in the medium term. However, cities eventually experienced a population catch-up in the long run, which offset much of the mid-term negative impact.

In the next section, we discuss the historical context Then, we review the literature on the economic effects of railway construction in Section Three. We present our data and method in Section Four. Results are discussed in Section Five. The last Section concludes and suggests the direction for future research.

2. Historical context

The Kingdom of Poland or Congress Kingdom was established as a result of the arrangements of the Congress of Vienna in 1815. It functioned as an independent state in personal union with Russia until 1831. After the November Uprising (the Polish-Russian War of 1830-31), it was annexed to Russia in 1832 retaining some elements of political and administrative autonomy until 1867. Then they were abolished, although legal separateness was

partially preserved. In particular, the Civil Code, based on the Napoleonic Code different from the regulations in the rest of Russia, including economic law, was retained. In the period 1815-1914, there were several administrative divisions of the Kingdom of Poland. In 1869, a division into 10 gubernias, often referred to as Privislenskiy Krai, was introduced.

In the first half of the 19th century, the lands of Russian Poland were one of the less developed regions of Europe. Only Warsaw stood out. In the second half of the century, there was a period of intensive industrialization. The development of industry, but also transport infrastructure in the Kingdom was quite poorly linked to the economic development of Russia. Due to the vastness of the country and the distance of each other regional economic centers of an insular nature, the local economy and infrastructure were formed quite independently in each of them. They were connected by a small skeletal network of roads, and only from the end of the century also by railroads.

In addition, the Kingdom's peculiar economic status, including a separate central bank, its own coinage (until 1842) and tax system, as well as a customs border between the Kingdom and Russia in effect until 1850, meant that the Kingdom's economic development proceeded independently of that of other Russian lands. The same was true of infrastructure development. State investments related to strategic needs were made in parallel with commercial investments, financed mainly through the issuance of shares. This was the case with railroads. In the western gubernias of the Kingdom of Poland: the Warsaw, Piotrków, Kalisz and Płock gubernias, the development of railroads was possible mainly thanks to the investments of the Polish bourgeoisie and was limited by its financial capabilities, as well as administrative permits. Most of the railroads in the area were of European gauge, unlike those built in the eastern governorates of the Kingdom and the rest of Russia (see Map 1).

The economy of the Kingdom in the first half of the 19th century developed slowly. It was still largely dominated by the pre-modern agricultural sector. The beginning of modern economic development did not happen until 1860-70. This development was very uneven and industrial civilization was earliest and most extensive in the heavily urbanized western governorates of the Kingdom, especially Warsaw and Piotrków. Data on economic development in the Kingdom are presented in Table 1.

Table 1. Regional GDP per capita in the Congress Kingdom GK 1990$.

Region	1900	1910
gubernia warszawska	2258	3380
gubernia piotrkowska	2287	2869
gubernia płocka	1065	1232
gubernia lubelska	925	1153
gubernia kaliska	897	1204
gubernia łomżyńska	921	1127
gubernia grodzieńska	883	1095
gubernia suwalska	844	1064
gubernia radomska	951	1031
gubernia siedlecka	779	1012
gubernia kielecka	802	861

Source: Bukowski et al. (2017)

The development of industry in the Congress Kingdom began, as the data indicate, only in the last decades of the 19th century (Puś 2013, Misztal 1970, Koryś, Tymiński 2022). Before that, the extent of industrial civilization in this part of the Polish lands was limited. The establishment of the first railroad in the Kingdom coincided with the formation of the first industrial cities and industrial basins (Warsaw, Łódź, Dąbrowa Basin). Earlier efforts made by the state to create industry that took place between 1820-1840 had very little effect (cf. Jedlicki) - perhaps due to the lack of a sufficiently developed transportation infrastructure. The industry that rapidly grew since the late 1860s benefited from the development of the rail network (access to raw materials and energy resources and easier access to markets).

Plans for railroad construction in the Congress Kingdom began relatively early, as early as 1835 - several years earlier than in German Silesia and they preceded period of rapid industrialization by several decades. The construction of the first railroad line, connecting Warsaw with the Austrian border and later (1859) also with the German border and, as a result, with the Austrian and German railroad systems, was a private undertaking. Finally, the Warsaw-Vienna line took a long time to be built and was opened in stages between 1845 and 1848. In 1866, a connection to Lodz was added to it and thus connected the main industrial centers of the Kingdom. Subsequent railroad investments were mostly public investments. In 1861-1867 the Warsaw-Bydgoszcz railroad was built, connecting the Congress Kingdom with the German railroad system via Greater Poland (German Provinz Posen). In the same period, the Warsaw-

Petersburg Railway connected Warsaw with the capital of the empire via Bialystok and Vilnius. In the second half of the 1860-1870 decade, the Warsaw-Terespol line was established, further giving a connection to Moscow via Minsk and Smolensk.

Another important railroad was established in the 1870s: the Vistula line connected Mława with Warsaw and further with Lublin, Chelm and the gubernias in the territories of today's Ukraine. This line made it possible to connect Warsaw with German Danzig (German Provinz West Preussen), and was also intended to serve a strategic function - it ran along a potential Russian-German front line on the Vistula, on the eastern side of the river. The next decade saw the construction of another line of great strategic importance: Ivangorod-Dabrowa. It connected Dąbrowa Górnicza with the Vistula line at Dęblin (Ivangorod) via Kielce and Radom. It also connected the Dąbrowa basin by the shortest route with Russia, which also made it economically important. This period also saw the construction of a line connecting Ostrowiec Swietokrzyski - a city with an extensive metallurgical and steel industry - with the Ivanogrod-Dabrowa line (at Skarżysko-Kamienna), the Warsaw-Vienna line and the Lodz line (at Koluszki). By the end of the decade, even smaller sections connecting existing lines, with military significance (Malkinia-Siedlce, Chelm-Brest-Litovsk) are built. In the 1890s, a railroad connection (via Malkinia and via Lapy) gained Ostroleka, as well as Suwalki and Augustow (via the Warsaw-Petersburg line) Several other sections were built, including the Ostroleka-Pilawa connection and the construction of narrow-gauge railroads around Warsaw began. In general, however, by the end of the century, the dynamics of railroad investment had slowed. In the first decade of the 20th century, the Warsaw-Kalisz railroad was built, connecting Kalisz and Sieradz (and further German lands) with Łódź and Warsaw, as well as a number of narrow gauge lines of local importance (including those around Warsaw and Włocławek). In 1911, the Kielce-Herby Nowe railway was established, connecting Kielce with Częstochowa and further to Germany.

The density of the railway network is shown in Table 2. On the eve of World War I, the railway density in the Congress Kingdom of Poland was lower than in the Prussian or Austrian partitions. In the Congress Kingdom, the density was 2.8 km of railway per 100 square kilometers of land and 0.27 km per 1,000 citizens. In the Province of Posen (Provinz Posen), the respective figures were 9.2 km and 1.27 km, while in Galicia, they were 5.2 km and 0.51 km. Compared to its population, the railway network in Lithuania and Belarus was denser than in the Congress Kingdom of Poland. In the most industrialized governorates of Warsaw and Łódź, there were 5/5.5 km of railway per 100 square kilometers of land and 0.32/0.33 km per

1,000 citizens. However, in the two remaining western governorates (Kalisz and Płock), where the construction of railways was prohibited by the tsarist government for military reasons, the density was lower than 1 km per 100 square kilometers of land and 0.10 km per 1,000 citizens. A comparison of railway density across the western governorates highlights how imperial restrictions on railway construction led to an uneven development of the network across regions of the country.

In the interwar period, when Poland regained independence several major railways were in the area of the former Congress Kingdom. This confirms that despite the Russian Empire providing the backbone of railway infrastructure for the Congress Kingdom, the demand for additional lines was relatively high. The slowdown in the development of the rail network after the 1880s, as well as significant investments of a primarily military nature, meant that the network did not fully meet the needs of businesses and that local railroads did not develop to enable the economic development of smaller centers, as well as to accelerate the processes of population agglomeration. Hence, the benefits of railroads were localized in a group of industrial districts already connected by the Warsaw-Vienna railroad and its branches, and the impact of railroads on the development of the eastern governorates was less - there the railroad appeared later, and business rationale determined its course to a limited extent. It should be emphasized that the relatively low density of the rail network was due to limited funds for railroad development throughout the empire and due to the tsars' planned policies. Administrative impediments slowed the development of the rail network - particularly lines of a commercial nature. Moreover, during the interwar years the economic growth in the former Congress Kingdom was higher than in the former Prussian and Austrian partition (Bukowski et al., 2025). This shows that before WW I, the Congress Kingdom was not able to benefit from its centrality.

Table 2. Density of railway network, c. 1910-1913.

Region	Population	Population density	Inhabitants of towns 10000+	Length of railway	Railway density	
	(thousands)	(per km2)	(share)	km	per 100 km2	per population (1000)
Congress Kingdom of Poland	13058	106	20.2	3394	2.8	0.27
western gubernias:						
warszawska	2669	158	46.9	836	5.0	0.33
piotrkowska	2268	188	43.4	660	5.5	0.32
kaliska	1317	118	13	81	0.7	0.06
płocka	706	76	8.5	48	0.5	0.07
Lithuania & Belarus	13033	43	11.1	6323	2.1	0.50
Galicia	8090	102	13.1	4120	5.2	0.51
Posen	2100	72	16.6	2666	9.2	1.27
Westpreußen	1703	67	24.6	2250	8.8	1.32
Eastpreußen	2064	53	11	2850	7.4	1.38
Silesia	5226	129	36.2	4627	11.5	0.89

Note: For Provinz East Preussen urban population data only for Allenstein.

Source: Krzyżanowski, Kumaniecki 1915; Statistical Yearbook of Prussia 1913, own calculations

3. Literature review

Railroads and economic development of the Congress Kingdom

The development of the rail network in the Congress Kingdom has been analyzed several times. A detailed analysis of the development of the rail network was presented by transport geographer Teofil Lijewski (1959), an updated version of which, written with Stanislaw Koziarski, was published in 1995. This study gives the dates on which rail lines were brought to most of the towns in Poland, which we used in our analysis. For the remaining towns we used the data from large database of all Polish current and historical railway stations created by Marek Potocki and Jarosław Woźny and supported by large community (Baza kolejowa 2025). The history of urban development in the Congress Kingdom has been described and analyzed since the 19th century. The most valuable analysis was presented by Maria Nietyksza (1986).

The issue of the economic development of the Congress Kingdom was taken up by economists, geographers and economic historians for a long time, starting with the studies of Rosa Luxemburg and Stanisław Koszutski. The issue of industrial localization was studied by Lijewski, Misztal (1970 and Pus (2013) among others. The question of the determinants of the development of industrial districts was analyzed by Jezierski, Pietrzak-Pawlowska, Missalowa and many others. In recent years, studies have appeared on the economic development of the Kingdom of Poland, including estimates of economic growth (cf. Koryś 2018, Koryś, Tymiński 2022, Bukowski et al. 2019). The preceding section presents the most important results of these studies.

The economic impact of railway

There are two main methods employed by researchers who study the economic benefits of the railway network. The first strand of literature focuses on the macroeconomic effects of railways, while the second strand is based on the more disaggregated approach based on the comparison of connected and unconnected locations across various economic dimensions (urbanization, industrialization, etc.)

Fogel (1964) proposed a "social saving" method, aimed at calculating aggregate economic benefits. This methodology compares the cost of transport by rail to the cost of transport by alternative means, which would have been used in a counterfactual scenario where the railway network was not constructed. He argued that in such a scenario, rivers and canals would have been used to transport freight and that this mode of transportation would have been only moderately more expensive. Fogel concluded that the total value of railroads in the USA did not exceed 4.7% of GNP in 1890. In his interpretation, this contribution was small enough to argue that railways were not decisive in generating sustained economic growth. Fogel's contribution resulted in the wave of research using his method, this method was also widely applied in the calculation of the benefits of technology. Leuning (2010, 2011) provides a great discussion of the pros and cons of the social saving method and reviews available estimates. He notes that the quality of the estimate is "*extremely heterogeneous*". The estimates available in the literature vary from 0.5% in China in 1933 to 38% in Brazil in 1913. He concludes that this line of research was rather disappointing because different assumptions used by authors made their estimates difficult to compare. Even scholars who agree that the method is correct can reach completely different results, e.g. Fogel (1964) vs. Fishlow (1965).

The biggest limitation of the social saving approach lies in the limited coverage of positive externalities caused by the railway construction. While the raw cost of transportation by

different means can be compared, the broader positive externalities are difficult to account for. Without the railway network, the congestion might significantly reduce the efficiency of road transport. It is doubtful that the large cities of the late 19th century could be supplied without the railway network. The construction of the railway greatly increased the demand for iron and steel, the key products of the Industrial Revolution. Positive externalities identified by scholars include also the development of accounting standards, financial market, and management techniques, an increase in the size of the business, the lower importance of weather shocks for the food supply, and better school quality (Chandler, 1979; Attack et al., 2014; Cermeño, 2022; Attack, 2024, Bogart, 2024)

Recently, a "market access" method has been applied by Donaldson (2018) to estimate the economic benefits of the railway in the US. He finds that removing all railroads in 1890 would have reduced the value of agricultural land by 60% and that alternative means of transportation have only limited potential to limit the losses. Scholars studying the macroeconomic effects of railroads have also applied conventional growth accounting techniques (Crafts, 2004; Herranz-Loncán, 2006; Bogart et al., 2024).

The second strand of literature examines the local economic impact of railways by comparing economic outcomes between locations connected to the railway network and those that are not. Population growth is frequently used as a proxy for economic development in these studies. This approach has been applied in various contexts, including the United States (Atack et al., 2010), Prussia (Hornung, 2015), and Sweden (Berger & Enflo, 2017). A central challenge in this literature is addressing endogeneity: while railways can stimulate population growth, faster-growing cities are also more likely to attract railway connections. To mitigate this issue, researchers often compare population growth in connected and unconnected cities prior to railway construction, estimate panel models with city-level fixed effects, or, where sufficient data exists, use propensity score matching to compare connected cities with similar unconnected counterparts. Many studies also focus on smaller cities that were arguably connected to the railway network randomly, as these cities were located along routes primarily designed to link larger urban centers. Bogart (2024) offers a comprehensive review of the economic history research on transportation.

Ivan Berend, a leading scholar on the economic development of 19th-century Central and Eastern Europe, offered a rather critical perspective on the economic benefits of railway networks in the region. He argued that the direct economic benefits of railway construction were limited due to the heavy reliance on imported industrial goods necessary for developing

the network. This reliance only began to decline in the final two decades of the century. Unlike Western Europe, much of the railway construction in Central and Eastern Europe was financed by foreign capital. While this approach enabled capital-poor peripheral regions to build rail networks, it also resulted in significant profit transfers abroad. By the century's end, railway density in the region was about half that of Western Europe. However, Berend contended that the network was overdeveloped relative to the region's economic capacity, leading to underutilization. Despite achieving half the railway density of Western Europe, the region's network transported only one-fifth of the cargo and one-tenth of the passengers compared to Western European railways. Berend concluded that, while the railway network was critical for agricultural development—enabling greater export volumes—and supportive of select industrial sectors, it delivered smaller aggregate economic benefits than in Western Europe (Berend, 1998, 2003).

Berend's assessment is not without controversy. Even if he is correct about the underutilization of capacity, Central and Eastern Europe may have had no viable alternative to constructing railways. Research on regions outside Europe demonstrates that railways can generate substantial economic benefits even in areas with significantly lower population densities than Western Europe (Leunig, 2010; Herranz-Loncán, 2014; Herranz-Loncán & Fourie, 2018; Bogart et al., 2024). Unfortunately, empirical studies focusing on Central and Eastern Europe remain scarce. Using the social savings method, Metzer (1976) estimated the economic benefits of Russian railways at 5.6% of GDP in 1907. By adjusting similar studies for the U.S., he concluded that the economic impact of railways in Russia was only half that of the United States. Metzer's findings align with broader patterns; for instance, the railway's impact on the Spanish and Italian economies was also smaller than in Western Europe's leading economies (Herranz-Loncán, 2006; Ciccarelli et al., 2021). Nevertheless, Sztern (2022) provides evidence that the development of the railway network significantly influenced the modernization of Russian society. She demonstrates that villages located closer to railway lines were more likely to transition from communal land ownership to private land ownership, highlighting the transformative social impact of railways.

4. Data and method

To evaluate the impact of railway construction on economic growth we assembled a dataset with local metrics of economic development. While the population is our key measure of interest, we also collected information on the position in the administrative division of the country (departments, capital of the departments vs. the rest), ethnic structure and the value of

insured property in the 1850s (at the onset of the industrialization) and share of industrial employment in the 1870s and 1897. Our data also includes information on the waterway access and the distance of a given location from Warsaw. We also collected the information on local taxation revenue and the value of industrial production in the late 1850s. As these data are highly correlated with the value of insured property and are missing for more locations, we decided to do not use them in estimated models.

The number of cities in the Kingdom of Poland has fluctuated over time, both due to the development of settlements with an urban character, and to the policy of Russia, which revoked the city rights of some such settlements not because they had lost their urban character, but because of the January Uprising (1863-4). In 1827, Franciszek Rodecki reported that there were 451 cities in the Kingdom, which included even very small settlements (35 had fewer than 500 residents, and only 9 had more than 5,000 residents). In 1859, there were 453 cities in the Kingdom. Between 1863 and 1869, as part of the post-Uprising repression, 336 cities were deprived of their city rights. By 1913, 2 more cities had gained and 3 lost city rights. Cities that lost their city rights were degraded to the category of urban settlements, which included both cities without city rights and urbanized rural settlements. By 1914, the number of urban settlements had reached 359, and consisted of both downgraded cities and upgraded rural settlements. Other than population figures, more detailed data on these settlements were not published. In addition, there was a group of industrial settlements that had not achieved settlement or city status by 1913 but had reached considerable size. They developed around large cities (i.e. Warsaw, Lodz) or large agglomerated areas and as independent poor worker settlements around factory locations (Zawiecie).

To estimate the economic benefits of the railway network we focus on its impact on the city population. We focus on the population because in the absence of local estimates of the GDP, it is a useful proxy of economic development. Cities need developed regional and local economies, which can support them. The urbanization rate was demonstrated to be a good proxy of the GDP in the 19th century (Bukowski et al, 2019).

Information on the population of cities is available for the years: 1825, 1857, 1868, 1890, 1897, 1910. In 1897, the source of information on the population and occupational structure is the first population census conducted in the Russian Empire (cf. database Stat1897 /2016/). As no censuses were conducted before or after, the population for other years is reconstructed based on the administrative data as well as partial censuses (1825) and the works

(in Russian *Trudy*) of the Warsaw Statistical Committee. Most of the data on the population of cities, with the exception of census data, comes from Jelonek's (1967) study, which contains collected statistical data on population of Polish cities in the 19th century. The census data includes information on the occupations performed by the active residents of the Kingdom, at a resolution at the level of counties (called uyezd) and 114 cities. We also used data contained in calendars that included statistical parts (Kalendarz 1860, 1867). In addition to information on the urban population, they contain information various additional data concerning eg. taxes, industrial production and buildings in towns. . The information of ethnic structure, the value of insured property were collected from Kalendarz (1860). The information on the share of industrial employment is available in Obzors (Statistical Reviews) of the Gubernia, usually published yearly by its Governors between 1870 and 1913. We used data collected from Obzors by authors of statistical review of Russian towns and cities (Russia 1906). The estimates of industrial employment based on Obzors and the 1897 census are not directly comparable due to the methodical differences but indicate the progress in the industrialization of Poland.

The descriptive statistics are provided in Table 3. Our sample includes 113 cities and 306 urban-type settlement with continuous population data. For an additional 7 cities and 52 urban-type settlements we have incomplete population data, most of them were funded in the late 19th century. The mean city population increased slowly between 1825 and 1867, thereafter the rate of growth increased significantly. In the years 1825 – 1857, the mean population increased by 1.1% annually. In the years 1857 – 1868, the population growth rate more than doubled and equaled 2.3% per year. The fast rate of demographic expansion was sustained in the 40 years, the annual rate of population increase in the years 1868 – 1910 equaled 2.3%. While rural areas were populated almost only by Poles, the share of Poles in the city population in 1859 averaged only 54%. The mean value of insured property in 1859 equaled 122 998 silver roubles. For cities, we have information on the share of industrial employment in the early 1870s and at the date of the first Imperial Census, in 1897. In 1873 the mean industry share in the city population stood at 1.62% (defined relative to the population in 1867, as the 1872 population is not available). The 1897 census recorded the mean industry share in the city employment at 27.98%. Although these estimates are not directly comparable due to the methodological differences, the difference is big enough to show how much the economy of the Kingdom transformed in less than 30 years. 36 of the cities in our sample had access to the waterways of varying quality, nine cities were regional administrative capitals.

The information on famous people was collected only for cities. We do not collect this information for urban-type settlements, because their naming in our data source varies. While cities are named in a consistent way, urban-type settlements are not. Moreover, the vast majority of urban-type settlements would have zero famous people born, the variation between zero and one may be random. The total number of famous people born in the cities varies from 639 in the years 1897 – 1909 and 1,891 in the years 1867-1889. The mean value of famous people born in a given city ranges from 3.01 in the years 1857 – 1868 and 15.76 in the years 1867 – 1889. Depending on the period, between 31% (1867–1889) and 52% (1897–1909) of cities had no notable individuals born there.

Table 3. Descriptive statistics.

Variable	Mean	Standard deviation
population_1825	1 772	6 001
population_1857	2 501	7 713
population_1868	3 206	1 2117
population_1890	4 963	22 022
population_1897	6 284	35 527
population_1910	8 478	46 365
famous_1825_56 (cities only)	5.89	40.32
famous_1857_67 (cities only)	3.01	21.61
famous_1868_89 (cities only)	15.76	108.02
famous_1890_96 (cities only)	6.5	45.86
famous_1897_1910 (cities only)	5.32	33.98
Poles_share_1859	53.98%	24.03%
Insured_property_1859 (silver roubles)	122 998	1 121 075
industry_share_1873 (cities only)	1.62%	4.28%
industry_share_1897 (cities only)	27.47%	12.21%
	Number	
Cities	(up to) 120	
Urban-type settlements	(up to) 358	
waterway_access (cities only)	38	
regional_capital (cities only)	9	

Source: own estimation.

The statistical information on the development of the railway system in the Congress Kingdom of Poland is reported in Table 4. We separately report the number of connected and unconnected: urban settlements (population higher than 5000), cities and urban-type settlements. Cities had municipal rights, so they were distinguished by regulation, not by size or real urban nature. As mentioned above, cities that were deprived of city rights by the Russian administration, as well as settlements that were acquiring urban character but that had not yet acquired city rights, were called urban-type settlements. Separately, we distinguish urbanized areas with relatively high populations, i.e. urban settlements (both cities and urban-type

settlements). On the territory of the Kingdom of Poland, there were also settlements with the formal status of villages, which grew to thousands or tens of thousands of inhabitants. Unfortunately, they were not distinguished in statistics

In 1857 only 6 cities and 3 urban-type settlements were connected to the railway network. The number of connected locations gradually increased to 57 cities and 71 urban-type settlements in 1910. In 1857, already 48% of the urban citizens lived in the urban locations connected to the railway. However, this high share was mainly produced by the limited number of cities over 5000 people. In 1910, the railway network was accessible at the place of residence for 77% of the urban citizens. In 1910, two of the 20 biggest cities (respectively 12th and 18th) remained unconnected to the network, mostly due to military concerns.

Table 4. Railway development in the Congress Kingdom of Poland.

Year	Urban settlements population > 5000		Cities		Urban-type settlements		Share of population	
	Railway	**No railway**	**Railway**	**No railway**	**Railway**	**No railway**	**Cities**	**Urban >5k**
1857	4	24	6	107	3	316	28.74%	48.20%
1868	10	38	16	97	5	331	41.74%	51.33%
1890	35	63	39	74	19	312	64.61%	65.92%
1897	40	57	44	76	20	312	71.97%	73.81%
1910	61	86	57	56	39	314	81.60%	77.20%

Note: the number of urban settlements increase over time due to the population growth. The number of cities and urban-type settlements also changes over time.

Source: own estimation.

The main concern in the literature on the impact of railways on economic development is endogeneity. The railway can not only increase the population growth but also be built to connect the cities which are growing faster. Therefore, we begin by comparing the population growth in unconnected and newly connected cities. Then, we compare the population increase in connected and unconnected cities.

The main stage of our investigation begins with the estimation of the cross-sectional OLS model. We begin with the estimation of the model for a whole sample of cities and urban-type

settlements. Firstly, we estimate the effects of railway access, then we separately estimate the effects of military and non-military lines financed by the private capital. We also estimate separate models only for cities, for which a higher number of controls is available.

A popular method to obtain the causal effect of railways on population growth is based on the exploitation of the deviation of railways from the straight-line corridors (Hornung, 2015) or least-cost paths (Bogart, 2022). This method can not be currently applied in our case due to data limitations and the limited role of economic factors in the construction of military lines. To better understand the impact of railways on the city development we estimate a panel model. We estimate panel models with city- and year-fixed effects. We estimate two models, the first one measures the effects of new railway connections, the next one estimates the effects of all existing connections. Locations were connected to the railway for a varying number of periods. Therefore, to better understand the economic effects of railways, we separately estimate the effects of the duration of the connection on the city's growth. Finally, we limit our sample to non-urban locations with less than 5,000 inhabitants. These locations were connected to the railway system not due to their administrative/economic importance but were situated near the planned railways. These estimates have an easier causal interpretation.

5. Results

The first step of our investigation involves comparing population growth in cities connected to the railway network during a given period with those that remained unconnected. The results of this comparison are presented in Table 5. During the periods 1825–1857 and 1857–1868, when railway construction began, the mean population growth in newly connected cities and unconnected cities was not statistically different. However, in the period 1868–1890, cities newly connected to railroads experienced faster population growth than their unconnected counterparts. A similar and statistically significant difference is observed for the years 1890–1910.

These findings should be interpreted with caution. On one hand, the results might suggest that railways were strategically planned to connect economically important cities, making their location endogenous to population growth. On the other hand, the length of these periods is sufficient to potentially capture the developmental effects of railways constructed during them. Unfortunately, reducing the timeframe for measuring population growth is challenging due to the lack of complete population statistics for the 1870s and 1880s. At present, we are unaware of any source that includes comprehensive data for all cities in our study. Russian governors' reports (obzory) from this time were not standardized, thus the available

information varies across the governorates. Even in the case of a given governorate, not all locations (or even not all cities) are reported each year.

Table 5. Difference in population growth: locations recently connected to the railway network in a given period vs. unconnected locations.

Era	Unconnected (1)	New connection (2)	Difference (2 - 1)
1825 – 1857	1.4777	1.4813	0.0036
	(0.0648)	(0.1681)	(0.1801)
1857 – 1868	1.2121	1.2830	0.0709
	(0.0105)	(0.0613)	(0.0622)
1868 – 1890	1.4409	1.6288	0.1879**
	(0.0292)	(0.0762)	(0.0816)
1890 – 1910	1.3936	1.5861	0.1925*
	(0.0294)	(0.0963)	(0.1007)

Note: Population growth is defined as the population in year 2/the population in year 1.The difference is calculated using a two-sided test. Standard errors are reported in parentheses, asterisk indicates the statistical significance.

Source: own estimation.

In Table 6 we compare the population growth for the cities connected and unconnected to the railway. According to this comparison until 1868, the railway system in Poland did not support the economic development of the country. After 1868, the cities connected to the railway were growing faster than cities without railway connections. However, this is only a difference in the mean between both groups. Faster growth of cities connected to the railway might be caused by other factors than the railway itself.

Table 6. Difference in population growth: locations connected to the railway network vs. unconnected.

Era	Unconnected (1)	Railway access (2)	Difference (2 - 1)
1810 – 1825	1.4042	.	.
	(0.0226)		
1825 – 1857	1.4777	1.4813	0.0036
	(0.0637)	(0.1681)	(0.1801)
1857 – 1868	1.2121	1.3503	0.1382*
	(0.0105)	(0.0471)	(0.0483)
	1.4409	1.6896	0.2487***
1868 – 1890	(0.0292)	(0.0661)	(0.0723)
	1.3936	1.8640	0.4704***
1890 – 1910	(0.0292)	(0.1453)	(0.1482)

Note: Population growth is defined as the population in year 2/the population in year 1. The difference is calculated using a two-sided test. Standard errors are reported in parentheses, asterisk indicates the statistical significance.

Source: own estimation.

The results of the cross-sectional model estimated on the full sample of observed locations are reported in Table 7. Before 1868, the estimated impact of railway connections on population growth is not statistically significant. This finding is unsurprising, as the first railway line was opened only in the later decades of this period. Additionally, as discussed earlier, railway construction often preceded economic growth. We observe positive and statistically significant effects of railway connection for the period 1868 – 1890 and 1890 – 1897. The economic benefits of the railway network increased with the onset of industrialization and the integration of the Congress Kingdom into the Russian imperial market. Industrialization began in the 1860s, and rail connections to the Russian market significantly boosted Polish industrial exports.

Between 1897 and 1910, the effects of railway connections on city development were once again not statistically significant. In our interpretation, the positive economic impact of railways diminished in the first decade of the 20th century because the final stages of network expansion primarily connected locations of lesser economic importance. Additionally, medium-sized cities near the borders with Prussia and Austria remained unconnected due to security concerns, further limiting the railway network's overall economic impact during this period. Thus, the effects of railways is accounted for in the 1897 population, which is also included in our model.

Table 7. The impact of railway access on regional economic development.

VARIABLES	(1) ln_pop1857	(2) ln_pop1868	(3) ln_pop1890	(4) ln_pop1897	(5) ln_pop1910
ln_pop1825	0.533***				
	(0.0641)				
ln_pop1857		0.797***			
		(0.0605)			
ln_pop1868			0.803***		
			(0.0483)		
ln_pop1890				0.709***	
				(0.0751)	
ln_pop1897					0.863***
					(0.0401)
railway_access	-0.105	0.0503	0.159***	0.179***	0.0107
	(0.120)	(0.0470)	(0.0446)	(0.0460)	(0.0340)
dep_capital	-0.0468	0.143**	0.140*	-0.0981	0.251*
	(0.117)	(0.0705)	(0.0787)	(0.174)	(0.152)
lost_city_rights	-0.0863**	-0.0438	-0.0282	-0.217***	0.155***
	(0.0385)	(0.0267)	(0.0481)	(0.0534)	(0.0411)
Poles_share_1859	-0.273***	-0.0753	-0.0781	-0.0150	-0.112*
	(0.0544)	(0.0521)	(0.0676)	(0.0812)	(0.0598)
ln_property_1859	0.323***	0.156***	0.101***	0.217***	0.116***
	(0.0574)	(0.0436)	(0.0325)	(0.0559)	(0.0366)
ln_Warsaw_distance	-0.0260	-0.00539	-0.0458	-0.0349	0.0412
	(0.0263)	(0.0258)	(0.0323)	(0.0396)	(0.0289)
gov_kielce	0.0964*	0.0346	0.188***	0.134**	-0.0151
	(0.0526)	(0.0422)	(0.0484)	(0.0635)	(0.0461)
gov_lublin	0.102**	0.0649**	0.173***	0.132**	0.0283
	(0.0491)	(0.0292)	(0.0486)	(0.0613)	(0.0522)
gov_piotrków	0.247***	0.00466	0.163**	0.148*	0.107**
	(0.0645)	(0.0343)	(0.0641)	(0.0769)	(0.0483)
gov_plocka	0.0567	0.0495	0.0867	0.125	-0.0917
	(0.0531)	(0.0408)	(0.0611)	(0.0845)	(0.0742)
gov_radoms	0.0927*	0.0366	0.0823	0.141**	0.0201
	(0.0513)	(0.0340)	(0.0502)	(0.0580)	(0.0429)
gov_siedlce	0.0225	0.0255	0.0502	0.127**	-0.0182
	(0.0522)	(0.0384)	(0.0611)	(0.0579)	(0.0440)
gov_suwalki	0.173*	-0.0366	-0.283***	0.0248	-0.278***
	(0.0963)	(0.0618)	(0.0988)	(0.0881)	(0.0729)
gov_warszawa	-0.0520	-0.00249	0.0204	0.0366	-0.0973*
	(0.0476)	(0.0357)	(0.0586)	(0.0638)	(0.0526)
gov_łomza	0.134**	0.136***	0.0906	0.179**	-0.157***
	(0.0557)	(0.0432)	(0.0599)	(0.0732)	(0.0564)
Constant	0.465	0.0941	0.939***	0.207	-0.0685
	(0.321)	(0.216)	(0.349)	(0.369)	(0.311)
Observations	417	425	425	423	439
R-squared	0.902	0.947	0.887	0.896	0.927

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: own estimation.

In the years 1897 – 1910 20 cities and 11 urban-type settlements were connected to the network. However, the list of connected cities includes minor cities close to Łódź, which even before the connection were close to the railway system. Entirely new railways were constructed only in eastern regions of the Congress Kingdom, which were much less economically developed than in western parts of the country. According to the indicative regional estimates

of the GDP in the industrialized governorates of Warsaw and Piotrków, the GDP per capita stood at 150% of the national average. In the eastern governorates of Suwałki, Łomża, and Siedlce, when new railways were built in the 1890s and 1900s the GDP per capita stood at 60 – 70% of the national average (Bukowski et al, 2015; Wroński, 2023). It is also possible that new railways constructed in the 1900s did not have enough time to yield economic benefits before World War I.

Our control variables include binary indicators for governorates (relative to the western Kalisz governorate), a binary variable for cities that served as regional administrative capitals, a variable for locations that lost their city rights in 1870 as a consequence of the failed January Uprising, local ethnic structure (share of Poles) and the value of insured property in 1859. While the loss of administrative status is often regarded in Polish historiography as an unjust punishment, our findings suggest that cities losing their rights were already experiencing slower development at least as early as the 1820s. The loss of city rights was indeed a form of punishment, but our results suggest that this punishment was at least well-targeted. In the short term, this change in administrative status did not significantly affect the former cities. During the period 1868–1890, the effects on city populations were not statistically significant. However, in the mid-term (1890–1897), we observe negative and statistically significant impacts. Interestingly, by the first decade of the 20th century, these former cities appeared to rebound, experiencing faster population growth compared to the rest of the country. We find that the population of nine administrative capitals for most of the 19th century was growing faster than the rest of the country. Until 1868, the increase in the population was relatively evenly distributed across the governorates. In the late 19th century western and central governorates developed faster than the eastern regions. The value of insured property at the onset of industrialization has a positive and statistically significant impact on the city population. The impact of the share of the Polish population is negative, although not always statistically significant.

Military and non-military lines served distinct purposes and differed significantly in their development. Non-military lines were constructed to link major economic hubs of the Congress Kingdom with the expectation of generating future profits. They were financed by private capital. In contrast, military lines were developed primarily for military purposes, often with little consideration for their economic impact. To compare the economic effects of military and non-military lines, we re-estimate the model, including an interaction term between railway access and a variable indicating the type of line. The full results of the model are reported in

the Appendix Table A1. As the estimated coefficients for the remaining variables are similar, in Table 8 we present only estimates for private versus public railway lines.

Table 8. The impact of railway access on regional economic development: public vs. private railway lines.

VARIABLES	(1) ln_pop1857	(2) ln_pop1868	(3) ln_pop1890	(4) ln_pop1897	(5) ln_pop1910
public railway	-0.348***	0.0676	0.112**	0.136***	-0.0176
	(0.158)	(0.0711)	(0.0461)	(0.0427)	(0.0345)
private railway	0.0025	0.0944	0.403***	0.460***	0.176***
	(0.133)	(0.0591)	(0.106)	(0.158)	(0.0607)
Observations	417	425	425	423	439
R-squared	0.902	0.947	0.890	0.898	0.928

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: own estimation.

The estimated coefficients are consistently higher for private railway lines compared to public ones. The effects of private lines are statistically significant from the 1868 through 1910, whereas the effects of public lines are significant only from the 1868 to 11897. These results align with our intuition that private lines were better suited to the country's economic needs, while the smaller economic impact of public lines reflects their primary focus on military objectives rather than economic considerations.

Railway lines were constructed to connect major cities, with smaller towns often gaining connections incidentally due to their location between the starting and ending points of the lines. To better assess the impact of railway connections and address endogeneity concerns, we re-estimate our model using a subsample of locations with populations below 5,000. In this case, we also observe positive and statistically significant effects of railway connectivity on the population growth in the years 1868 – 1897. The estimated effects are however smaller than in the full sample. The results confirm the positive impact of railway connection on the local economic development during the three first decades of the Industrial Revolution in Poland. Similarly, as in the full sample, the effects turn out to be not statistically significant in the last period, when mainly the military lines in the laggard eastern Poland were constructed.

Table 9. The impact of railway access on regional economic development: only nonurban (population less than 5000) locations.

VARIABLES	(1) ln_pop1857	(2) ln_pop1868	(3) ln_pop1890	(4) ln_pop1897	(5) ln_pop1910
ln_pop1825	0.541***				
	(0.0662)				
ln_pop1857		0.800***			
		(0.0632)			
ln_pop1868			0.783***		
			(0.0476)		
ln_pop1890				0.655***	
				(0.0710)	
ln_pop1897					0.902***
					(0.0456)
railway_access	-0.0635	0.0600	0.101**	0.104*	-0.00642
	(0.155)	(0.0630)	(0.0493)	(0.0567)	(0.0432)
dep_capital	-0.0109	0.306***			
	(0.170)	(0.0753)			
lost_city_rights	-0.0825**	-0.0418	-0.0518	-0.139**	0.0979*
	(0.0382)	(0.0272)	(0.0467)	(0.0644)	(0.0517)
Poles_share_1859	-0.272***	-0.0812	-0.106	-0.0836	-0.0892
	(0.0549)	(0.0537)	(0.0684)	(0.0856)	(0.0686)
ln_property_1859	0.322***	0.156***	0.0943***	0.229***	0.100**
	(0.0589)	(0.0454)	(0.0347)	(0.0586)	(0.0395)
ln_Warsaw_distance	-0.0263	-0.00296	-0.0530	-0.0658**	0.0274
	(0.0265)	(0.0268)	(0.0337)	(0.0316)	(0.0318)
gov_kielce	0.0923*	0.0221	0.198***	0.213***	-0.0251
	(0.0535)	(0.0437)	(0.0533)	(0.0696)	(0.0478)
gov_lublin	0.102**	0.0569*	0.166***	0.170**	0.0567
	(0.0503)	(0.0305)	(0.0550)	(0.0658)	(0.0607)
gov_piotrków	0.240***	-0.0113	0.113	0.139*	0.0604
	(0.0667)	(0.0361)	(0.0712)	(0.0825)	(0.0521)
gov_plocka	0.0512	0.0366	0.0697	0.146**	-0.116
	(0.0546)	(0.0426)	(0.0689)	(0.0724)	(0.0773)
gov_radoms	0.0900*	0.0305	0.0828	0.149**	0.0235
	(0.0528)	(0.0357)	(0.0545)	(0.0625)	(0.0466)
gov_siedlce	0.0199	0.0249	0.0599	0.170***	-0.0252
	(0.0528)	(0.0415)	(0.0663)	(0.0585)	(0.0499)
gov_suwalki	0.165*	-0.0607	-0.304***	-0.00451	-0.252***
	(0.0956)	(0.0727)	(0.116)	(0.0918)	(0.0806)
gov_warszawa	-0.0499	-0.000857	0.0150	0.0521	-0.111*
	(0.0478)	(0.0386)	(0.0627)	(0.0638)	(0.0583)
gov_łomza	0.130**	0.121***	0.116*	0.202***	-0.148**
	(0.0577)	(0.0451)	(0.0697)	(0.0736)	(0.0642)
Constant	0.421	0.0635	1.236***	0.591*	-0.0774
	(0.327)	(0.230)	(0.343)	(0.353)	(0.365)
Observations	412	398	378	328	347
R-squared	0.894	0.927	0.823	0.797	0.838

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: own estimation.

In Table 10, we present the results of the cross-sectional model estimated on the subsample of cities. This subsample also includes two urban-type settlements that lost city rights in 1870, but remained the administrative capital of the county. The limitation of the sample allows us to control for the waterway access and the share of industrial employment

starting from the 1870s. Moreover, the limited sample is composed of the units more comparable to each other.

Table 10. The impact of railway access on regional economic development: only locations with city rights.

VARIABLES	(1) ln_pop1857	(2) ln_pop1868	(3) ln_pop1890	(4) ln_pop1890	(5) ln_pop1897	(6) ln_pop1910
ln_pop1825	0.274**					
	(0.120)					
ln_pop1857		0.929***				
		(0.0498)				
ln_pop1868			0.956***	0.833***		
			(0.117)	(0.0830)		
ln_pop1890					0.962***	
					(0.117)	
ln_pop1897						0.793***
						(0.0792)
railway_access	-0.0175	0.0652	0.145**	0.234***	0.207**	0.00394
	(0.164)	(0.0498)	(0.0609)	(0.0473)	(0.0816)	(0.0484)
dep_capital	0.0767	0.151*	0.0252	0.149	-0.176	0.373**
	(0.127)	(0.0829)	(0.141)	(0.104)	(0.191)	(0.151)
waterway_access	-0.0359	-0.0137	0.0253	-0.0141	-0.0885	-0.0683
	(0.0499)	(0.0323)	(0.0523)	(0.0464)	(0.0744)	(0.0452)
Poles_share_1859	-0.608***	0.0735	0.166	-0.0795	0.184	0.0129
	(0.131)	(0.0802)	(0.181)	(0.147)	(0.194)	(0.121)
ln_property_1859	0.401***	0.0647*	0.0310	0.0526	0.0879	0.149*
	(0.107)	(0.0361)	(0.0612)	(0.0538)	(0.0846)	(0.0763)
ln_Warsaw_distance	0.0464	-0.0660*	-0.00150	0.0421	-0.118	0.123**
	(0.0524)	(0.0367)	(0.0554)	(0.0594)	(0.0938)	(0.0494)
industry_share_1873				2.725***		
				(0.688)		
industry_share_1897					-0.0665	0.678***
					(0.400)	(0.236)
gov_kielce	-0.154	0.0542	0.235**	0.174*	-0.0975	0.0437
	(0.0944)	(0.0649)	(0.0907)	(0.0949)	(0.129)	(0.113)
gov_lublin	-0.0263	-0.00691	0.154**	0.268***	0.126	-0.0740
	(0.106)	(0.0520)	(0.0761)	(0.0732)	(0.123)	(0.0929)
gov_piotrków	0.303**	0.0161	0.329***	0.206***	0.203	0.228*
	(0.123)	(0.0513)	(0.109)	(0.0754)	(0.163)	(0.122)
gov_plocka	-0.0132	0.0281	0.145	0.215**	-0.0304	0.0555
	(0.108)	(0.0730)	(0.0907)	(0.0943)	(0.213)	(0.152)
gov_radoms	-0.0133	-0.00816	0.0600	0.0450	0.0566	0.0475
	(0.0927)	(0.0532)	(0.0764)	(0.0827)	(0.123)	(0.0833)
gov_siedlce	-0.0997	-0.0945*	0.124	0.236**	-0.0227	0.0638
	(0.0901)	(0.0534)	(0.109)	(0.102)	(0.142)	(0.0980)
gov_suwalki	0.0355	0.00370	-0.0866	-0.0580	0.0974	-0.398***
	(0.243)	(0.0649)	(0.0965)	(0.0774)	(0.194)	(0.117)
gov_warszawa	-0.0783	-0.0359	0.0468	0.102	0.00538	0.0389
	(0.0797)	(0.0626)	(0.0997)	(0.109)	(0.145)	(0.0984)
gov_łomza	0.0107	0.137**	0.0209	0.215**	0.0500	-0.0462
	(0.105)	(0.0634)	(0.0921)	(0.0953)	(0.162)	(0.104)
Constant	1.448**	0.337	0.115	0.731	-0.0832	-0.514
	(0.673)	(0.371)	(0.836)	(0.751)	(1.007)	(0.633)
Observations	111	111	111	95	110	110
R-squared	0.798	0.946	0.870	0.921	0.832	0.930

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: own estimation.

The outcomes for the cities are similar as in the whole sample. The effects of the initial wave of construction on the local population are not statistically significant. Railway connectivity has positive and statistically significant effects in the years 1868 – 1897. .

However, the effects also become not statistically significant in the early 20ᵗʰ century. Waterway access does not have a statistically significant impact on the population growth. In the US or in Western Europe rivers and channels are often seen as a counterfactual means of transportation if the railway network was not developed. However, in Poland, their importance for trade was limited. While Polish freight moved from west to the east, the rivers flowed from south to the north. The country also did not have access to the Baltic sea, which reduced the importance of Vistula compared to the pre-partition period. We demonstrate the positive impact on the industrial employment share of the population growth.

The results of the panel model are reported in Table 11. All columns include year and location-specific fixed effects. In the first column, we present the results of the connection to the railway network on the population increase. In the second column, we report the estimated effect of new connections (gaining the connection in the given period. The third specification reports the effect of how long the city is connected to the network. The fourth specification is also nonliner, but limited to nonurban locations.

Table 11. The impact of railway access on regional economic development: panel model

	(1)	(2)	(3)	(4)
VARIABLES	FE	FE	non-linear	non-linear nonurban
has_railway	0.401***			
	(0.0603)			
has_railway_new		0.0786**		
		(0.0352)		
has_railway_one_period			0.210***	0.106**
			(0.0369)	(0.0426)
has_railway_two_periods			0.372***	0.132*
			(0.0613)	(0.0768)
has_railway_three_periods			0.531***	0.206**
			(0.0929)	(0.104)
has_railway_four_periods			0.906***	0.161
			(0.182)	(0.151)
has_railway_five_periods			1.004***	0.485***
Constant	6.764***	6.764***	6.764***	6.497***
	(0.0183)	(0.0192)	(0.0182)	(0.0177)
Observations	3,097	3,097	3,097	2,085
R-squared	0.748	0.730	0.757	0.753
Number of Name_encode	473	473	473	318

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: own estimation.

The results of the estimated panel model confirm that the connection to the railway network was beneficial for the regional economic development. We find positive and

statistically significant effects of both existing and new railway connections on the city population. The estimated effect of the new connection is smaller, but still statistically significant. The nonlinear specifications show that the effects of the connection are increasing over time. Limiting the sample to locations with less than 5000 citizens in 1910 reduces the impact of the railway network on the population increase. The impact, however, remains significant. The positive effects in the subsample of locations connected to the network at random show that the impact in the whole sample is not driven by the endogeneity. The results of the panel model provide additional insight into the causes of the neutralization of the economic benefits of railways in the first decade of the 20th century. The locations connected later to the network were on average smaller and less urbanized and thus less sensitive to the impact of the rails. They were connected only for a short time and the new transport infrastructure did not have enough time to affect the population growth.

Appendix Figures A1 – A4 present the population growth in the connected and unconnected locations for locations with railway connections in 1857, 1868, 1890 and 1897. The comparison of the figures confirm the increase in the effects of railway connections over time and the limited benefits of the last wave (post-1897) of the railway construction.

6. The impact on social mobility: the place of birth of people listed in Polish Biographical Dictionary and 1938 "Who is Who"?

In Table 12 we present the cross-sectional regression of railway access on the number of notable people born in a given city in a period before the railway construction. We use the same set of control variables as in the model of city population with the addition on the number of notable people born two period before. An alternative specification, in which we regress the railway access on the number of notable people born in the period after the connection yields similar results and is not reported here for brevity.

We do not observe any consistent effects of railway access on the number of notable people born in a given location. Only for 1890, we observe positive and statistically significant effects of railway connection on the number of notable people born in the previous period (in this case in the years 1868 – 1889). We observe that more notable people tend to be born in cities where: more people live, more notable people were born in the past, Poles represent a higher share of total population and in richer cities. We also observe, that contrary to models of local population presented before, the effects of railway connection in this model are sensitive to the set of controls.

Overall, our results show that railway tracks alone are not sufficient to disrupt preexisting social structures. At least in the case of top-tier social mobility, preexisting social ties connecting people appear to be more influential than newly built physical infrastructure connecting regions. Since our focus is on the uppermost levels of social stratification, we cannot rule out the possibility that railway connectivity affected social mobility in lower segments of society. However, we are not aware of any other dataset that records precise local birthplaces and social outcomes in the 19th century.

Table 12. The impact of railway connection on the social mobility (proxied through a number of notable people born in a given city).

VARIABLES	(1) 1857	(2) 1868	(3) 1890	(4) 1897	(5) 1910
Notable_people (previous period)		0.325***	1.846***	0.459**	0.992***
		(0.0865)	(0.601)	(0.184)	(0.137)
ln_population (previous period)	2.104**	0.906	6.154***	3.795	0.797
	(0.834)	(0.744)	(2.336)	(2.820)	(0.714)
railway_access	-3.266	0.0417	3.184**	-0.367	0.215
	(2.878)	(0.521)	(1.238)	(0.889)	(0.514)
dep_capital	7.366**	2.117	4.136	-9.859	-4.082
	(3.264)	(1.606)	(7.680)	(7.201)	(2.469)
waterway_access	0.731	0.208	0.108	1.691	-0.338
	(0.573)	(0.348)	(1.239)	(1.146)	(0.685)
Poles_share_1859	3.406***	-0.418	9.403***	-0.751	0.670
	(1.229)	(1.010)	(3.092)	(2.215)	(1.518)
ln_property_1859	2.392***	-0.193	2.120	-1.376	0.889
	(0.639)	(0.357)	(1.528)	(1.350)	(0.824)
ln_Warsaw_distance	0.0297	-0.156	-1.555	0.155	-0.533
	(0.467)	(0.425)	(1.333)	(1.010)	(0.830)
gov_kielce	1.472	-0.0306	1.931	1.425	0.685
	(1.276)	(0.575)	(2.141)	(1.359)	(1.022)
gov_lublin	-0.414	0.638	-1.731	0.764	0.461
	(1.264)	(0.970)	(1.547)	(1.262)	(0.972)
gov_piotrków	0.696	-0.244	0.0922	3.257	-1.691
	(1.181)	(0.567)	(3.184)	(2.516)	(1.665)
gov_plocka	1.038	0.780	0.770	-1.280	-0.126
	(1.536)	(0.593)	(2.609)	(1.729)	(1.012)
gov_radoms	1.558	-0.432	0.844	1.793	-2.070
	(1.332)	(0.614)	(2.615)	(1.385)	(1.596)
gov_siedlce	0.734	-0.246	-0.320	0.664	-0.567
	(1.145)	(0.618)	(2.259)	(1.579)	(1.179)
gov_suwalki	-3.017	-0.808	-1.112	2.391	0.558
	(2.097)	(1.451)	(4.100)	(2.324)	(1.115)
gov_warszawa	1.046	0.178	-1.067	1.523	-0.690
	(1.171)	(0.553)	(1.993)	(2.059)	(1.576)
gov_kielce	-1.339	0.984	-5.261**	0.582	0.631
	(1.669)	(0.695)	(2.165)	(1.411)	(0.997)
					(0.514)
Constant	-45.11***	-4.252	-70.72***	-18.83	-14.73
	(8.655)	(4.758)	(18.65)	(18.54)	(10.75)
Observations	110	110	110	110	117
R-squared	0.705	0.648	0.770	0.602	0.867

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: own estimation.

7. Conclusions

In this paper, we estimate the impact of the railway network on regional economic development in the Congress Kingdom of Poland, using population as a proxy for local economic progress. We also study the impact of transport infrastructure on social mobility. Our dataset includes over a hundred cities and over three hundreds urban-type settlements. We estimate the effects of railways separately for the full sample, a subsample of non-urban locations (with populations under 5,000), and a subsample of cities (some of which also have populations below 5,000 and may not meet common urban definitions). We separately investigate the effects of private and public lines. Additionally, we estimate panel models to further limit the endogeneity concerns.

Our findings indicate that the development of the railway network positively influenced regional economic development, but the effects were heterogeneous across time and space. The initial phase of railway construction did not yield significant economic benefits, likely because it preceded the industrial revolution and outpaced the demands of the pre-modern economy. Significant economic benefits emerged starting in the 1860s, coinciding with industrialization. The effects of the railway network on the local population diminished in the early 20th century. During the last wave of railway construction, new railway lines were predominantly constructed in the less-developed eastern regions of the country, where their economic impact was less pronounced. The results of the nonlinear panel model suggest that the benefits of railway connections increase over time; however, in these less-developed areas, there may not have been sufficient time for spin-off effects to materialize fully.

We find that private railway lines generated higher economic benefits than public railway lines. The private lines continued to generate economic benefits until 1910. While private lines were built with a clear focus on the economic needs of the country, public lines mainly served the military needs of the Russian Empire. This result confirms that the public Russian investment did not fully support the economic development of the Congress Kingdom.

We study the impact of railway access on social mobility proxied through the number of people listed in *Polish Biographical Dictionary* and 1938 "*Who is Who*?" (Łoza 1938) born in a given city. We do not identify any robust effects of railway connectivity on the number of notable people born, we also observe that the results are sensitive to the choice of controls This suggests that newly built transport infrastructure connecting regions was not sufficient to

override the influence of preexisting social ties connecting individuals. As we focus on the top of the social stratification, we cannot exclude that positive impact on social mobility may be observed in the lower segments of the stratification.

In this paper, we estimate the railway impact on the regional level. The investigation of the aggregate macroeconomic impact, either by social saving method or by growth-accounting techniques remains a promising direction for future research. Additionally, comparing the economic consequences of railway development across the Prussian, Austrian, and Russian partitions offers significant potential. In the Congress Kingdom of Poland, railway construction was hindered by tsarist rule and military considerations, which imposed constraints not present in the Prussian and Austrian partitions. A comparative analysis would provide valuable insights into how differing institutional frameworks influenced the economic impact of railway networks, shedding light on the broader relationship between governance and infrastructure-driven development

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