

Private Ownership and the Development of Transport Systems: Cross-Country Evidence
from the Diffusion of Railroads in the 19th Century

By Dan Bogart
Department of Economics, UC Irvine
dbogart@uci.edu

October 2006

Preliminary Version
Please do not quote without author's Permission

Abstract

Railroads played a key role in 19th century economic growth, particularly in middle to low income countries. Despite their high benefits, there were large differences in railroad diffusion across countries. This paper investigates whether the degree of private ownership can explain the cross-country differences in railroad diffusion and investment. It uses a new dataset on the number of track miles owned by private companies in over 40 countries, provinces, or colonies between 1840 and 1912. The initial results show that shifts towards greater private ownership increased railroad mileage after controlling for population growth, GDP per capita growth, political institutions, as well as country and year fixed effects. The findings address the historical and contemporary debate about the merits of public versus private ownership. Most countries in the 19th century faced a choice between direct funding through public ownership or indirect funding through private ownership with government subsidies. My findings suggest that countries which had greater private sector participation tended to have higher railroad diffusion and investment.

Ownership determines who has the legal right to claim income from an asset. There is a long tradition in economics which argues that different ownership arrangements affect investment and how efficiently assets are used.¹ Ownership is especially important in transportation infrastructure. Some argue that private ownership leads to greater transport investment because firms are better in identifying projects that are both privately profitable and socially beneficial. Governments, on the other hand, tend to invest in projects which reward political constituents. Some also argue that private firms are better in obtaining external financing, especially when government debt carries a high risk premium.²

An alternative view is that private firms tend to under-invest in infrastructure because they don't internalize the social benefits, such as the promotion of industrialization and economic growth. In such cases, governments may invest more because they can capture part of the social benefits through higher tax revenues. Governments may also increase investment to serve military objectives or to address regional inequities. Lastly, in cases where the government has a well developed tax system, they may have an easier time obtaining external financing than private firms.

The debate over private versus public ownership goes back to the nineteenth century and the railroad. Railroads were a key factor in 19th century economic growth especially in low to middle income countries (see O'Brien, 1983, Summerhill, 2003). Governments and private interest groups throughout the world were keen to develop their railroad networks. The need to obtain external financing was an issue of particular importance (Eichengreen, 1994). In many countries domestic savings were scarce, and

¹ There are many references on the effects of ownership. The original contributions are from by Coase (1937) and Williamson (1985). More recent contributions are Hart (1990) and Schleifer (1988).

² There is a large literature focusing on the benefits of privatization. See Smith (1999) for an overview.

therefore it was difficult for private firms to borrow the necessary funds for investment. Many railroads were also built in developing economies, and thus the social benefits were likely to be large, whereas the private benefits could be small, especially in the initial years of operation. State ownership provided one solution to the problem of scarce capital and low private returns. The government could issue bonds backed by its own reputation, and then build and operate railroads. Alternatively, governments could provide subsidies to private railroad companies, who would then issue their own bonds or shares. The subsidies included interest guarantees, dividend guarantees, land grants, or direct payments for miles constructed.

There was a great diversity in ownership policies across European countries before World War I. In the United Kingdom private companies financed and owned the entire railroad network without the aid of government subsidies. Initially many continental countries also relied on private ownership, but they tended to offer guarantees to investors or bondholders. Belgium, Italy, and Switzerland shifted to government ownership later in the nineteenth century, while others continued to rely on private ownership up to 1913.

Ownership policies also varied outside of Europe as well. State ownership was common in Australia and New Zealand from the outset, but it was rare in Canada. Private ownership was also common in the United States and Mexico, and was again associated with government subsidies like land grants or interest guarantees. In South America government ownership was common at the early stages of network expansion, but waned as time progressed. In Japan state ownership was prevalent in the 1870s and

early 1900s, but not in between. In China, the government constructed and owned most of the initial lines, but over time private ownership became increasingly common.

Ownership was not the only differentiating factor across countries. Economic growth was higher in some places, and presumably increased the amount of railroad investment. Political conditions were varied as well. Democracy and ‘the rule of law’ were spreading in some countries, while autocracy and arbitrary rule became more entrenched in others. The incentives of ruling groups under different political conditions may have influenced the spread of railroads more than private ownership.

In this paper, I examine whether state or private ownership affected railroad diffusion and investment. I also investigate whether higher economic growth and political factors mattered as well. The paper uses a new data set on the number of track miles owned by companies or the state in over 40 countries, provinces, or colonies between 1840 and 1912. The data is drawn from *the Statistical Abstract for the Principal and Other Foreign Countries* and *the Statistical Abstract for the Several Colonial and other Possessions of the United Kingdom*, both published by the British Board of Trade. The ownership data is combined with information on population, estimates of G.D.P. per capita, and various measures of institutional quality, such as the degree of democracy or constraints on the executive.

I analyze the effects of ownership on railroad diffusion and investment by using panel data techniques. My initial results show that countries which experienced a shift towards greater private ownership had a higher growth in railroad mileage. However, the effects of private ownership were limited compared to other factors like population growth and political changes. This suggests that countries which relied on private

ownership with government subsidies had moderately higher railroad diffusion than countries which used state ownership as its main mechanism for implementing railroads. My results also show that population growth had a large effect on railroad diffusion, whereas per capita GDP growth had less impact. Finally, I find that countries which shifted towards greater autocracy or lower constraints on the executive tended to have a higher growth in railroad miles. Put differently, greater democracy and the expansion of constitutional limits were not a boon to railroad diffusion.

The findings address the historical literature on ownership and infrastructure industries. Robert Millward (2005) argues that private ownership had little influence on railroad diffusion in 19th century Europe. The findings here show that private ownership had some effect on railroad mileage and investment. The differences may be due to the extended time-period covered (i.e. 1840 to 1913) or the inclusion of countries outside of Europe.

The findings also relate to ownership and regulation in 19th century telecommunications. Scott Wallsten (2005) argues that telephones diffused more slowly in countries where the government had a monopoly or where companies faced unfavorable regulation by the state. My findings suggest a similar conclusion with respect to the government ownership of railroads. The result that greater democracy and greater constraints on the executive reduces railway diffusion appears to be at odds with Wallsten's findings on regulation. However, countries which Wallsten characterizes as having a harsh regulatory environment, like the U.K., also tend to be highly ranked in terms of institutional quality. Thus the results suggest that institutional indices may not capture variation in infrastructure regulation in the 19th century.

The paper is organized as follows. Section 1 discusses the data. Section 2 illustrates the trends in railroad diffusion, investment, and ownership. Section 3 discusses the estimation methodology. Section 4 presents the results. Section 5 concludes.

1. Data

Railroads were a large source of foreign investment during the 19th century. Many European governments or other entities collected information on railroads and published their findings in readily available sources. The *International Historical Statistics* series provides information on railroad miles in most countries for every year between 1825 and 1913 (see Mitchell, 1992, 1995, 2003). I use this data to measure changes in total track mileage over this period. I also draw on population estimates for various countries in Mitchell and other sources.³

There is less information on railroad investment across countries. The *Dictionary of Statistics* (Mulhall, 1892; Webb, 1911) reports total investment figures for some countries at benchmark dates like 1840, 1850, etc. I supplemented this data with information from country studies.⁴ I use this information to track total railroad investment over this period.

Information on railroad ownership is available in *the Statistical Abstract for the Principal and Other Foreign Countries*, which was published annually between 1860 and 1913, and *the Statistical Abstract for the Several Colonial and other Possessions of the*

³ Additional population data come from Maddison (1995) and Lahmeyer (2005).

⁴ For example, I use Lewis (1983) for information on Argentine railway investment between 1885 and 1900.

United Kingdom, also published annually between 1850 and 1913.⁵ Both report the number of railroad miles owned by companies and the number owned by the state. Reported company mileage plus state mileage generally equals the total number of railroad miles reported in the *International Historical Statistics*.⁶ I measure the degree of private ownership by calculating the fraction of total miles owned by companies in each country in each year. For some countries the ownership data is missing in various years. Whenever possible, I use secondary sources to fill the gaps.⁷

The Statistical Abstract for Foreign Countries and *the Statistical Abstract for Colonies* are useful sources on ownership because they were compiled by the same organization, the British Board of Trade. The Board of Trade used analogous definitions of ownership when making international comparisons. The published ownership data is aggregated, however, and thus there is no information on the concentration of ownership across companies, or different levels of government.

I combine the figures on track mileage, population, and the fraction of miles owned by companies with other variables, like estimates of G.D.P. per capita and the quality of institutions. Most of the G.D.P. per capita figures come from Maddison (1995), and are expressed in 1990 dollars. Unfortunately, Maddison does not estimate G.D.P. per capita for many of the country-year pairs in my data set. To fill the gaps I use other sources on G.D.P. per capita and convert them into 1990 dollars.⁸

⁵ The latter publication was continued under the title, *Statistical Abstract for the Several British self-governing dominions, colonies, possessions, and protectorates*.

⁶ I use the number of railroad miles in the *Statistical Abstract* whenever there were discrepancies with the *Historical Statistics*.

⁷ For example, I use Duncan's (1932) work on Brazil to fill the gaps in the data.

⁸ For example, I use Braun (2000) for G.D.P. per capita estimates in Chile, Good and Ma (1999) for eastern European countries, Yousef (2002) for Egypt, Contador and Haddad (1975) for Brazil, della Paolera and Taylor (2003) for Argentina, and Gregory (1982) for Russia.

The political and institutional variables are taken from the Polity IV data set.⁹ The “polity2” variable is an index for the degree of democracy versus autocracy. The lowest value of -10 corresponds to complete autocracy (i.e. Russia before 1904). Values around 0 correspond to a middle ground between democracy and autocracy (i.e. Italy between 1900 and 1920, or Japan after 1868). Finally, a 10 corresponds to the greatest degree of democracy (i.e. the U.S. after 1871, or New Zealand after 1893).

I also use the variable “Constraints on the Executive.” The lowest value of 1 implies there are no limits on the power of the monarch, emperor, or president (i.e. China before 1910). The highest value of 7 implies that the ruler is strongly limited by a well-functioning constitution (i.e. the UK throughout or Japan after 1868). Constraints-on-the-Executive is a popular measure for the quality of institutions, and it has proven to be a powerful predictor of G.D.P. per capita in cross-country studies (see Acemoglu, Johnson, and Robinson, 2005).

2. Trends in Railroad Diffusion, Investment, and Ownership

The first steam locomotive was introduced in Britain in 1825. Thereafter steam powered railroads spread throughout Europe, Oceania, Asia, and North and South America. Figures 1-4 show the trends in railroad miles per 1000 persons across regions and continents between 1840 and 1912. The patterns show a high variance in diffusion rates across different parts of the world. The United Kingdom, Belgium, and France were the early leaders in adopting railroads within northwestern Europe (see figure 1). Between 1860 and 1880 there was a substantial growth in railroad mileage in Switzerland, Sweden, Norway, Spain and Germany. After 1880 the number of railroad

⁹ See the Polity IV webpage for more details, <http://www.cidcm.umd.edu/inscr/polity/>.

miles per capita stabilized in most northwestern European countries, reflecting the mature status of their networks. Sweden is the one country that continued to increase its railroad mileage by more than its population. In 1912 Sweden had more than twice as many railroad miles per capita as any other country in Scandinavia or northwestern Europe.

The degree of railroad diffusion was more mixed in central and eastern Europe (see figure 2). Most of these countries had few railroads before the 1860s. Austria and Hungary had a rapid growth in railroad miles during the 1870s and 1880s and approached the diffusion levels of northwestern Europe. Russia, Romania, Italy, Greece, and Bulgaria also experienced a growth in railroad mileage per capita during the 1870s and 1880s, but not as much as Austria and Hungary. Egypt and Turkey experienced relatively slow growth in railroads compared to their neighbors. In 1912 Egypt had one-fourth as many railroad miles per capita as Austria and Hungary. Turkey had around one-fifth as many railroad miles per capita as these two countries.

Australia, New Zealand, and countries in North and South America had the highest rates of diffusion in the world (see figure 3). In the 1850s, the U.S. already had a high number of railroads relative to its population. Its network continued to expand up to 1890 and was the fourth largest in per capita terms by 1912. Canada and Argentina also experienced a rapid growth in mileage, particularly in the 1870s and 1880s. By 1912 Canada and Argentina had the second and third largest penetration levels. In 1870 Australia had 0.5 railroad miles per 1000 persons, which was similar to most western European countries. By 1912 Australia had around 4 railroad miles per 1000 persons, which was six times the average in western Europe. New Zealand was similar to Australia, but the growth in mileage failed to keep up with population growth after 1890.

Railroad mileage grew rapidly in Uruguay, Chile, Mexico, Peru, and Costa Rica during the 1870s and 1880s (figure 3). By 1912 the number of railroad miles per capita was similar in Uruguay, Chile, Mexico, Peru, and Costa Rica compared with most western European countries. However, their growth in railroad mileage failed to keep pace with Argentina, the U.S. and Canada.

Railroads were adopted more slowly in Asia. India had the highest adoption rate among Asian countries, especially after 1870. Japan had a similar growth, particularly in the 1880s and 1890s. Despite these achievements, both India and Japan had around one-fifth as many railroad miles per capita as most western European countries in 1912 and far less than the U.S., Argentina, Australia, Canada, and New Zealand. Railroad diffusion was extremely slow in China before 1900, but there was some growth in mileage in the early part of the twentieth century.

The number of railroad miles provides a proxy for the amount of railroad investment, but it may not capture differences in investment per mile. Table 1 reports total railroad investment per 100,000 persons across several countries between 1840 and 1905. The investment figures are translated into 1900 constant prices using the capital goods price index from Feinstein and Pollard (1988, p. 470-71). The table orders countries according to investment per capita in 1888. In general, the countries which had high investment per capita also had high railroad miles per capita. For example, the U.S., Australia, and Canada are in the top 3 in terms of railroad investment per capita and mileage per capita. There were some countries though that had lower investment per capita relative to miles per capita. Sweden, for example, had lower investment per capita

than the U.K., but it had significantly higher mileage. This was due to the large difference in construction costs per-mile across the two countries.

The spread of the railroad typically coincided with economic development. The most rapidly growing economies during the late nineteenth century were the U.S., Argentina, Australia, Canada, and New Zealand. They also had the most rapid growth in railroad miles per capita. More generally, there was a correlation between economic development and railroad diffusion during this period. Figure 5 shows a scatter plot of the natural log of railroad miles per 1000 persons against the log of G.D.P. per capita in constant 1990 dollars. The positive correlation is exactly what one would expect: countries with high G.D.P. per capita also had high railroad miles per person. Not surprisingly, there is a similar relationship between infrastructure capital per person and G.D.P. per capita in 1990 (Banister and Berechman, 2000).

There were two main types of railroad ownership during the nineteenth century: private ownership, through companies, and state ownership, usually under the national government. Table 2 shows the diversity in private ownership by listing the fraction of total railroad miles owned by companies at various benchmark dates. I grouped countries according to six ownership typologies to clarify the patterns. Countries under the label “private” had complete or nearly complete private ownership up to 1910. They include the U.K., Spain, the U.S., France, Mexico, Uruguay, Turkey, Greece, and Costa Rica. In the U.K. private companies obtained authority to build railroads through private acts of Parliament. The acts gave companies rights of way, set maximum freight rates, and determined capitalization, but they did not provide subsidies. A similar procedure was used in the U.S. during the mid-nineteenth century, except that state governments gave

private companies authorization to build railroads. Some U.S. States also granted subsidies to the private railroads or guaranteed interest on their bonds. Later the federal government gave land grants to transcontinental railroads, like the Union Pacific. Turkey was another country with an entirely private railroad network. German and French investors were particularly active in financing Turkish railways, including the famed Orient Express, which ran between Constantinople and Paris starting in 1883.

Countries under the “public or mixed” label had higher levels of state ownership from the beginning of their railroad construction up to 1910. The most extreme case was Egypt, which apparently never had a privately owned railroad. Finland, Bulgaria, and Serbia had some private ownership, but the vast majority of miles were state-owned from the outset. Australia is also a case where state ownership predominated from the beginning. Its ownership policy was quite different from Canada, which shared a similar cultural background as well as a similar economic environment. Chile was unique in that it had a mixed system of ownership. Around half of all Chilean railroads were owned by the state between 1875 and 1910. Private ownership predominated in the north near the mining industry, while state ownership was common in the south where agriculture was the dominant sector (Splawn, 1928).

Some countries moved to state ownership after an initial period where private companies owned most of their railways. I label this group “private then public.” Switzerland, for example, had a privately owned railroad network until 1903 when approximately 1400 miles were taken over by the state. Hungary is another example of a country that switched to greater state ownership. In this case, greater state ownership

occurred through the construction of new railroads rather than nationalization of existing private lines.

China is one of the few countries that began with a public system of ownership and then switched to greater private ownership. The state owned most lines prior to the first war with Japan in 1894-95. In the next decade, the Chinese government entered into agreements with Russian, French, German, and British investors who built over 1000 miles of privately owned railroads (Splawn, 1928). The result was mixed system of ownership whereby companies owned 43% of the miles in 1910.

Several countries switched ownership regimes several times. One group went from private to public and then back to private. In Sweden, private companies built more than 50% of the mileage in the 1850s and early 1860s. In the late 1860s, the trend changed as the Swedish government built most of the new lines. In the 1870s the trend changed once again as companies built a greater proportion of the new mileage. In Brazil there was a similar pattern where private ownership was replaced by state ownership in the early 1870s. This was followed by a move to greater private ownership during the 1880s and 1890s (Duncan, 1932).

Another group of countries switched from public ownership to private ownership and then back to public ownership. The state built a substantial portion of the early railways in Belgium, but by the 1860s, private companies financed most of the new lines, and actually competed with state-owned railroads. After 1870, state ownership increased in Belgium and by 1912 it had one of the largest state-owned railroad networks in the world (Splawn, 1928).

Japan is another case where there was a move from public to private ownership and then back to public ownership. The first lines constructed in the 1870s and early 1880s were entirely financed by the state. Starting in the late 1880s, the Japanese government began offering interest guarantees to foreign bondholders of between 4 and 8 percent. In 1906, the Japanese government nationalized most private railroads, and began constructing more state-owned railroads. Within a few years it had the second largest state-owned railroad network in the world (Splawn, 1982).

3. Methodology

In this section, I develop a methodology to address whether private ownership affected railroad diffusion and investment. The following equation describes the growth of railroad mileage in a dynamic setting:

$$rr_{it} - rr_{it-1} = \alpha + \beta_1(rr_{it-1} - rr_{it-2}) + \beta_2(private_{it} - private_{it-1}) + \beta_3x_{it} + u_i + d_t + \varepsilon_{it} \quad (1)$$

rr_{it} is the natural log of railroad miles in country i in year t . $private_{it}$ is the fraction of mileage owned by companies in country i in year t . x_{it} is a vector of control variables, like the level of railroad miles per capita in country i in year $t-1$, the growth rate of population between t and $t-1$, the growth rate of real G.D.P. per capita between t and $t-1$, and indices for democracy and constraints on the executive. Finally, u_i is a country fixed effect, d_t is a year dummy, and ε_{it} is the error term.

Equation (1) captures several features of a standard investment model. The change in railroad mileage in the current year is assumed to be a function of the change in

mileage in the previous period as well as the level of railroad miles per capita in the previous year. Cyclicity implies that a higher growth in mileage last year may be associated with higher or lower growth in the current year. Diminishing returns imply that a greater level of railroad miles per capita in the previous year may lower the growth in mileage in the current year. The growth of population and G.D.P. per capita are hypothesized to increase railroad mileage by raising the demand for railroad services. Finally, investment will be influenced by unobservable factors, which are partly captured by the country fixed effects and the year dummies.

Equation (1) also includes variables that are not in the typical investment model. $private_{it}$ is the fraction of miles owned by companies. It measures the degree of private or public ownership in the railroad network. An increase in the fraction of miles owned by companies reflects new mileage constructed by private companies, or the privatization of existing lines. In either case, it captures a move towards greater private ownership. A decrease in the fraction of miles owned by companies reflects new mileage constructed by the state or nationalization of existing lines. This would reflect a move towards greater public ownership.

The regression coefficient on $private_{it} - private_{it-1}$ has implications for the substitutability of private and public ownership. If the coefficient equals 0 then public and private ownership are essentially substitutes for one another. If the coefficient is positive, then private ownership is associated with greater railroad diffusion. Finally, if it is negative then public ownership is associated with greater railroad diffusion.

The other non-standard variables in equation (1) are the indexes for democracy and constraints on the executive. The degree of democracy can affect the amount of

public funding devoted to railroads, either through the budget for new construction or subsidies to companies. Democracy can also influence regulations, which affect profitability for private investors. Similarly, if the king, president, or dictator has greater power then there may be changes in public funding or investors' perceptions of railroad profitability.

The inclusion of country and year fixed effects has several implications. First, time-invariant variables, like land area or access to the coast are necessarily dropped. This represents the standard tradeoff between controlling for unobserved heterogeneity and the ability to measure country characteristics. Second, country-fixed effects can be correlated with the error term ε_{it} . In other words, the county dummies can be related to factors like a general propensity to have private or publicly-owned railroads. Similarly, the year dummies can be correlated with unobserved shocks that are common to all countries in a given year.

Estimating equation (1) is complicated by missing values. Mileage and ownership data are generally available on an annual basis after 1875, but G.D.P. data is only available in select years. Therefore, I estimate the model for all years after 1875 where I can calculate first differences of all variables. I also consider a sub-sample of the years 1840, 1850, 1860, 1870, 1880, 1890, 1900, and 1910, where G.D.P. estimates are often available. In this case, I calculate the differences in variables over a ten-year horizon.¹⁰

¹⁰ Potential correlations between that growth in railroad mileage in year t and $t+1$ introduces another complication. I examined this issue by allowing for AR(1) disturbances, in which $\varepsilon_{it} = \rho\varepsilon_{it-1} + \eta_{it}$. However, the Baltagi-Wu (1999) test statistic for the parameter ρ is not statistically different from zero in the main specifications. Thus auto-correlation is not a significant problem in this particular case.

4. Results

In this section, I analyze whether private ownership, economic growth, or changes in the political environment affected railroad diffusion. I begin by analyzing the annual data on railroad mileage between 1875 and 1912. Table 3 reports summary statistics. The average log difference in railroad miles between years was 0.038, which implies that the average annual growth in railroad mileage was around 3.8%. The standard deviation for the log difference in railroad miles is much higher at 0.11. This is to be expected given the divergence in railroad diffusion across countries. The mean for the fraction of private miles was 0.49. This shows there was an even distribution of private and public ownership throughout the period between 1875 and 1912. The mean and standard deviation for the difference in the fraction of private miles is -0.0017 and 0.053 respectively. Thus with a few exceptions, the typically country gradually changed its ownership structure from year to year. Finally, this period experienced high population and GDP per capita growth. The average for annual population growth was 1.2% and the average for annual GDP per capita growth was 1.5%.

Table 4 shows various estimates of equation (1) using annual data on railroad mileage after 1875. Column (1) reports results for a specification that includes the lagged growth of mileage, the log of railroad miles per capita in the previous year, population growth, and GDP per capita growth. It does not include ownership changes or country and year fixed effects. The estimates show that higher mileage in the previous year encouraged further growth in the current period. In other words, the growth in mileage exhibited expansions or slowdowns lasting several years. The estimates also show that the growth in mileage decreased as the level of railroad miles per capita increased. This

is to be expected because there was a large initial growth in railroad mileage followed by slower growth as the network matured.

The demand variables are also significant in column (1). Higher population growth and GDP per capita growth increased railroad mileage. The estimates imply that a 1% increase in population growth would lead to a 0.8% increase in railroad mileage. Similarly, a 1% increase in the growth of GDP per capita would lead to a 0.1% increase in mileage. This finding accords with the experiences of the U.S., Australia, Argentina, Canada, and New Zealand, where substantial immigration flows and high economic growth coincided with a substantial expansion in railroad mileage.

Column (2) shows estimates for the same regression after including changes in the fraction of railroad miles owned by companies. The results show that increases in private ownership were associated with higher growth in railroad miles. The coefficient implies that a one-standard deviation increase in the fraction of private railroad miles would result in a 1.1% increase in the annual growth of railroad mileage. The effect is not insignificant considering that the standard deviation for the annual growth rate of railroad miles was 11%.

The preceding results are based on specifications that do not control for unobserved heterogeneity. Column (3) shows the results when country fixed effects are included and column (4) shows the results when country and year fixed effects are included together. As expected, the R-square rises significantly because country and year fixed effects capture unobservable differences across countries, like land area, as well as unobservable differences across years, like land financial crises. The inclusion of country and year fixed effects reduces the significance of several variables. For example, the

coefficient on private ownership falls to 0.111 when country fixed effects are included and 0.092 when country and year fixed effects are included. These estimates are less than half of the same coefficients in column (2). However, the effects of private ownership are still economically significant. The coefficient in column (4) implies that a one-standard deviation increase in the fraction of private railroad miles would result in a 0.5% increase in the annual growth of railroad mileage. By way of comparison, a one standard deviation increase in population would result in a 0.9% increase in the annual growth of railroad mileage. Thus a typical change in ownership can explain approximately half as much as a typical change in population growth.

Country and year fixed effects change the coefficients on other variables as well. The effect of railroad miles per capita in the previous year is much larger, suggesting that countries differed substantially in their temporal rates of diffusion. Lagged changes in the growth of railroad miles no longer have any effect on the current growth in mileage. In other words, there is no evidence of annual cyclicity in the growth of railroad mileage. The effect of GDP per capita growth falls substantially, and the variable is no longer statistically significant. However, income growth still has a noticeable impact. In particular, a one standard deviation increase the growth of GDP per capita would result in a 0.4% increase in the growth of railroad mileage.

The last two columns of table 4 incorporate changes in the political environment. The results from column (5) show that changes in the degree of democracy had no effect on the growth in railroad mileage. This finding needs to be qualified by the fact that few sample countries experienced changes in democracy over the period between 1875 and

1912. In a moment, we will see that a longer time-span changes the results on democracy.

The results from column (6) show that higher constraints on the executive reduced the growth of railroad mileage. In particular a one-standard deviation increase in the index for constraints-on-the-executive of 2.38 would result in a 5% decrease in the annual growth rate of railroad mileage. Several European countries experienced a 1 or 2 point increase in their constraints index between 1875 and 1912. European countries also tended to have slower growth in railroad mileage after 1875. Perhaps the negative coefficient on the constraints variable is capturing this association.

The preceding estimates are based on the period between 1875 and 1912 where annual data are available. I now incorporate information from the 1840 to 1875 period by examining ten-year differences starting in 1840 and ending in 1910. Table 5 reports summary statistics for the decennial data. The average for the log difference in railroad miles between decades is 0.64 and the standard deviation is 0.72. The average change in the fraction of private miles owned by companies was -0.032 but the standard deviation was much larger at 0.211. Finally, the decadal average for population growth and GDP per capita growth was 11% and 13% respectively.

Table 6 reports regression estimates for different specifications of equation (1) using the decennial data. The right-hand side variable is the log difference of railroad miles between year t and year $t-10$, while the left-hand side variables are also differences over ten-year spans. Column (1) shows there is a weak relationship between shifts towards greater private ownership and the growth of railroad mileage. However, in columns (2) and (3) the effect of private ownership becomes larger when the polity2 and

constraints-on-the-executive variables are also included. The estimates from (2) imply that one-standard deviation increase in private ownership would lead to a 5.9 % increase in the decadal growth rate of railroad mileage, which is around one-tenth of the standard deviation for decadal mileage growth.

Some of the estimates in table 6 are qualitatively similar to those for the annual data. For example, greater railroad miles per capita in the previous year leads to lower growth in railroad mileage during the current year, while higher population growth increases the growth in railroad mileage. As before, the estimates show a surprisingly weak relationship between the growth of GDP per capita and increases in railroad mileage. This puzzle could be explained by measurement error in GDP per capita estimates before 1870.

The decennial data are particularly useful in identifying the effects of political changes because many countries experienced constitutional changes in the mid-nineteenth century. The results in table 6 show that shifts towards greater democracy reduced the growth of railroad mileage. The estimates imply that a one standard deviation decrease in polity2, or equivalently a typical reduction in democracy, would increase the decadal growth of railroad mileage by around 25%. They also imply that a shift from complete democracy to autocracy (10 to -10) would result in more than a 75% increase in the decadal growth of railroad mileage. To put these figures in perspective, Mexico had a polity2 score of -9 and approximately 1 railroad mile per 1000 persons in 1910. Japan had a polity2 score of 7 and 0.10 railroad miles per capita. Among other factors, it is possible that differences in democracy can explain why these two countries had such different railroad densities.

The results also show that increases in constraints-on-the-executive tend to reduce the growth of railroad mileage. They imply that a one-standard deviation increase in constraints-on-the executive reduces the decadal growth in railroad mileage by around 50%. Alternatively a shift from the highest value for restraints on the executive (7) to the lowest value (1) would increase the growth in railroad mileage by over 100%.

As a final exercise, I investigate whether private ownership had different effects across political or economic contexts. Private ownership may have had a larger effect in democratic countries with effective limits on the powers of the executive, or in countries that were initially poor. Table 7 shows estimates for interactions between changes in private ownership and the polity2 or constraints-on-the-executive variables. It also reports estimates for the interaction between private ownership and the level of GDP per capita in 1870. The results are based on the annual data between 1875 and 1912. The estimates for other variables are similar to columns (5) and (6) of table 4 and are not reported to save space.

The main finding is that the effects of private ownership are not any different in countries with greater democracy or greater constraints on the executive. It appears that autocratic governments or those with powerful kings, presidents, and dictators were more active in promoting the growth of their railroad networks, regardless of the ownership structure. The other main finding is that private ownership was relatively more effective in poor countries. The negative interaction term in column (3) implies that in countries with a higher GDP per capita in 1870, there was a smaller increase in the growth of railroad mileage after a shift towards private ownership. This suggests that ownership policies had different effects in poor countries, compared to rich countries.

5. Conclusions

Economists and policy makers debated the relative merits of private versus public ownership of transportation infrastructure during the nineteenth century much like they do today. In the midst of this debate, governments faced an important practical problem: they needed to obtain external financing to pay for railroad investment. Some countries opted for a system where the state owned and financed railroads by issuing government bonds. Others relied on a system of private ownership with government subsidies, like interest guarantees, land grants, and cash payments. Which of these systems led to more beneficial outcomes?

This paper shows that railroad diffusion was greater in countries with more private ownership of railroads. Whether this was more beneficial depends on the optimal level of railroad investment in each country. Recent studies have found evidence of high social returns from railroads in low to middle income countries before World War I. For many countries, therefore, increasing railroad mileage or railroad investment contributed to economic growth. This implies that private ownership with government subsidies may have been beneficial to economies during the 19th century. Cases studies of particular countries, like Brazil, generally point to this conclusion as well (Summerhill, 1998, 2003).

It is an open question why some countries opted for state ownership over private ownership. Perhaps state ownership was more likely in countries with greater military spending or with new political regimes. Another possibility is that countries with low interest rates on government bonds were more likely to rely on state ownership because

they could more easily finance railroad investment. Identifying what factors led to changes in ownership is one of the main goals for future research. It will also help in further identifying the effects of private ownership on railroad diffusion and investment.

The result that lower constraints-on-the-executive increased railroad growth is somewhat surprising given that much of the development literature finds that greater constraints on the executive encourages economic growth by increasing the security of property rights (see Acemoglu et. Al., 2005). It is possible that greater constraints-on-the-executive does not capture greater security of property rights towards infrastructure in the 19th century. Scott Wallsten (2006) found that the telecommunications sector in the U.K. and France suffered from “capricious” regulations. Ironically, these two countries had the highest value of the index in the late nineteenth century. Therefore, constraints-on-the-executive probably reflects some other political changes.

One explanation is that powerful kings, presidents, or dictators promoted railroads because they earned greater military and political benefits. Therefore as some countries shifted towards greater centralized power, the state spent more tax revenues on railroads, or it offered greater guarantees to private investors. By the same logic, as power became more decentralized in some countries, new constituents used tax revenues for other purposes, such as social welfare programs (see Lindert, 2004).

Finally, the results shed light on the broader debate about infrastructure privatization. There is currently a movement towards private sector participation in infrastructure throughout the developed and developing world (Harris, 2003). The evidence from the nineteenth century shows that ownership matters for infrastructure diffusion and investment. It would be naïve to conclude that privatization will have the

beneficial effects in the twenty-first century, yet it seems likely that private sector involvement can help in providing necessary infrastructure investment.

References

- Acemoglu, Daron, Simon Johnson, and James Robinson. "Institutions as the Fundamental Cause of Long-term Growth" in Philippe Aghion and Stephen Durlauf, eds., *Handbook of Economic Growth*, North Holland, 2005.
- Baltagi Badi and Wu Ping. "Unequally Spaced Panel Data Regressions with AR(1) Disturbances," *Econometric Theory* 15(1999).
- Banister, David and Joseph Berechman. *Transport Investment and Economic Development*. London: UCL Press, 2000.
- Braun, Juan, Ignacio Briones, José Díaz, Rolf Luders, and Gert Wagner. "Economía Chilena 1810-1995: Estadísticas Históricas," *P. Universidad Católica de Chile, Departamento de Economía, Documento de Trabajo # 187*, January 2000.
- Coase, Ronald. "The Nature of the Firm," *Economia* 4 (1937).
- Contador, Claudio and Haddad, Claudio. "Produto Real, Moeda e Precos: A Experiencia Brasileira no periodo 1861-1970." *Revista Brasileira de Estatística* 36 no. 143 (1975).
- Della Paolera, Gerardo and Alan M. Taylor (eds.). *A New Economic History of Argentina*. Cambridge: Cambridge University Press, 2003.
- Duncan, Julian Smith. *Public and Private Operation of Railways in Brazil*. New York: AMS Press, 1932.
- Eichengreen, Barry. "Financing Infrastructure in Developing Countries: Lessons from the

- Railway Age,” Mimeo, 1994.
- Feinstein, Charles and Sidney Pollard. *Studies in Capital Formation in the United Kingdom, 1750-1920*. Oxford: Oxford University Press, 1988.
- Good, David and Ma Tongshu, “The Economic Growth of Central and Eastern Europe in Comparative Perspective, 1870-1989.” *European Review of Economic History* 2 (1999).
- Great Britain, Board of Trade. *Statistical Abstract for the Principal and other Foreign Countries in each Year*, London: HM Stationary, Various years.
- Great Britain, Board of Trade. *the Statistical Abstract for the Several Colonial and other Possessions of the United Kingdom*, London: HM Stationary, Various years.
- Gregory, Paul. *Russian National Income, 1885-1913*. Cambridge: Cambridge University Press, 1982.
- Gurr, Ted Robert, Monty G. Marshall, and Keith Jagers, The PolityIV Project, <http://www.cidcm.umd.edu/inscr/polity/>, assessed on 10/6/2006.
- Hart, Oliver. “Property Rights and the Nature of the Firm” *Journal of Political Economy* 98 (1990).
- Harris, Clive. *Private Participation in Infrastructure in Developing Countries: Trends, Impacts, and Policy Lessons*. Washington D.C.: World Bank, 2003.
- Lahmeyer, Jan. “Populstat Website” <http://www.library.uu.nl/wesp/populstat/populhome>.
- Lewis, Colin. *British Railways in Argentina 1857-1914: A case Study in Foreign Investment*. London: Athlone, 1983.
- Lindert, Peter. *Growing Public: Social Spending and Economic Growth since the Eighteenth Century*. Cambridge: Cambridge University Press, 2004

- Maddison, Angus. *Monitoring the World Economy: 1820-1992*. Paris: OECD, 1995.
- Mitchell, B.R. *International Historical Statistics: Africa, Asia, & Oceania, 1750-1988*.
New York: MacMillan, 1995.
- Mitchell, B.R. *International Historical Statistics: The Americas, 1750-2000*. New York:
Palgrave MacMillan, 2003.
- Mitchell, B.R. *International Historical Statistics: Europe, 1750-1988*. New York,
MacMillan, 1992.
- Millward, Robert. *Private and Public Enterprise in Europe: Energy,
Telecommunications, and Transport, 1830-1990*. Cambridge: Cambridge
University Press, 2005.
- Mulhall, Michael, *The Dictionary of Statistics*. London: George Routledge and Sons,
1892.
- O'Brien, Patrick (eds.), *Railways and the Economic Development of Western Europe,
1830-1914*. MacMillan, St. Anthony's College Oxford, 1983.
- Shleifer, Andre. "State versus Private Ownership," *Journal of Economic Perspectives* 12
(Fall 1998).
- Smith, A. J. *Privatized Infrastructure: the Role of Government*. London: Thomas Telford,
1999.
- Summerhill, Bill. *Order Against Progress: Government, Foreign Investment, and
Railroads in Brazil, 1854-1913*, Stanford: Stanford University Press, 2003.
- Summerhill, Bill. "Market Intervention in a Backward Economy: Railroad Subsidy in
Brazil, 1854-1913," *Economic History Review* (August, 1998).
- Splawn, Walter. *Government Ownership and Operation of Railroads*. New York:

- MacMillan, 1928.
- Wallsten, Scott. "Returning to Victorian Competition, Ownership, and Regulation: an Empirical Study of European Telecommunications at the Turn of the Twentieth Century" *Journal of Economic History* 65 (September 2005).
- Webb, Augustus. *The New Dictionary of Statistics*. London George Routledge and Sons, 1911.
- Williamson, Oliver. *Economic Institutions of Capitalism*. New York: Free Press, 1985.
- Yousef, Tarik. "Egypt's Growth Performance Under Economic Liberalism: A Reassessment with New GDP estimates, 1886-1945." *Review of Income and Wealth* 48 (December 2002).

Table 1: Total Real Railroad Investment per 100,000 Persons (in constant 1900 pounds)

| Country | 1840 | 1850 | 1860 | 1870 | 1880 | 1888 | c1905 |
|-------------|--------|--------|--------|--------|--------|--------|---------|
| U.S. | 0.0013 | 0.0032 | 0.0083 | 0.0128 | 0.0254 | 0.0390 | |
| Australia | | | 0.0019 | 0.0077 | 0.0237 | 0.0380 | 0.0350 |
| Canada | | 0.0005 | 0.0086 | 0.0083 | 0.0196 | 0.0372 | 0.04705 |
| UK | 0.0013 | 0.0109 | 0.0131 | 0.0180 | 0.0230 | 0.0298 | 0.0334 |
| France | 0.0003 | 0.0019 | 0.0050 | 0.0078 | 0.0107 | 0.0169 | 0.0186 |
| Austria | | 0.0014 | 0.0034 | 0.0061 | 0.0117 | 0.0156 | |
| Switzerland | | | 0.0056 | 0.0070 | 0.0115 | 0.0150 | 0.0177 |
| Argentina | | | | 0.0027 | 0.0054 | 0.0149 | 0.0255 |
| Belgium | 0.0014 | 0.0036 | 0.0060 | 0.0087 | 0.0107 | 0.0140 | |
| Germany | | | | 0.0051 | 0.0096 | 0.0122 | 0.0130 |
| Holland | | 0.0008 | 0.0013 | 0.0037 | 0.0063 | 0.0093 | |
| Sweden | | | 0.0005 | 0.0017 | 0.0051 | 0.0070 | 0.0107 |
| Spain | | 0.0 | 0.0013 | 0.0031 | 0.0044 | 0.0063 | |
| Italy | | 0.0002 | 0.0011 | 0.0029 | 0.0037 | 0.0052 | |
| Denmark | | | 0.0006 | 0.0022 | 0.0034 | 0.0052 | |
| Norway | | | | 0.0011 | 0.0021 | 0.0042 | 0.0058 |
| Portugal | | | | 0.0016 | 0.0027 | 0.0044 | |
| Russia | | 0.0001 | 0.0003 | 0.0018 | 0.0032 | 0.0040 | 0.0055 |
| Egypt | | | 0.0007 | 0.0013 | 0.0021 | 0.0025 | |
| Japan | | | | | 0.0000 | 0.0003 | 0.0010 |

Table 2: The Fraction of Total Railroad Miles Owned by Companies

| Country | Fraction of Miles Owned by Companies | | | | | | |
|---|--------------------------------------|------|------|------|-------|-------|------|
| | 1855 | 1860 | 1870 | 1875 | c1890 | c1900 | 1910 |
| “Private” | | | | | | | |
| UK | 1.00 | | 1.00 | | 1.00 | | 1.00 |
| Spain | 1.00 | | 1.00 | | 1.00 | | 1.00 |
| U.S. | 1.00 | | 1.00 | | 1.00 | | 1.00 |
| France | 1.00 | | 1.00 | | 0.93 | | 0.82 |
| Mexico | | | | 1.00 | 1.00 | 1.00 | 1.00 |
| Uruguay | | | | 1.00 | 1.00 | 1.00 | 1.00 |
| Turkey | | | 1.00 | | 1.00 | | 1.00 |
| Greece | | 1.00 | 1.00 | | 1.00 | | 1.00 |
| Costa Rica | | | | | | 0.85 | 0.82 |
| Canada | | | | | | 0.91 | 0.93 |
| “Public or Mixed” | | | | | | | |
| Egypt | | 0.00 | 0.00 | | 0.00 | | 0.00 |
| Finland | | | | | | 0.10 | 0.09 |
| Serbia | | | | | | 0.00 | 0.00 |
| Chile | | | | 0.50 | | 0.53 | 0.53 |
| Bulgaria | | | | | | 0.21 | 0.0 |
| Australia | | | | | | 0.05 | 0.09 |
| New Zealand | | | | | | 0.03 | 0.01 |
| “Private Then Public” | | | | | | | |
| Switzerland | 1.00 | | 1.00 | | 1.00 | | 0.42 |
| Holland | 1.00 | | 0.44 | | 0.46 | | 0.47 |
| Norway | 1.00 | | 0.18 | | 0.04 | | 0.16 |
| Germany | | | 0.53 | | 0.09 | | 0.06 |
| Hungary | 0.95 | 1.00 | 0.90 | 0.83 | 0.49 | 0.55 | 0.60 |
| Italy | 1.0 | 1.0 | 0.87 | 0.80 | 0.35 | | 0.21 |
| Russia | | | 0.90 | 0.96 | 0.71 | 0.40 | 0.38 |
| Romania | | | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 |
| “Public then Private” | | | | | | | |
| China | | | | | 0.00 | 0.00 | 0.43 |
| Argentina | | | | 0.51 | 0.92 | 0.88 | 1.00 |
| “Private then Public then back to Private” | | | | | | | |
| Portugal | 1.00 | | 1.00 | | 0.39 | | 0.51 |
| Sweden | 1.00 | | 0.36 | | 0.68 | | 0.68 |
| Denmark | 1.00 | | 0.42 | | 0.21 | | 0.43 |
| Brazil | 1.00 | 1.00 | 0.39 | 0.70 | 0.75 | | 0.85 |
| “Public then Private then back to Public” | | | | | | | |
| Belgium | 0.50 | 0.57 | 0.70 | 0.42 | 0.28 | 0.12 | 0.07 |
| Japan | | | | 0.00 | 0.51 | 0.75 | 0.09 |
| Austria | 0.67 | 0.99 | 0.99 | 0.99 | 0.67 | 0.57 | 0.17 |

Source: *the Statistical Abstract for the Principal and Other Foreign Countries and the Statistical Abstract for the Several Colonial and other Possessions of the United Kingdom*, Various Years.

Table 3: Summary Statistics for Annual Data, 1875-1912

| Variable | Mean | Stan. Dev. | Min | Max | Obs. |
|--|---------|------------|---------|--------|------|
| Log difference in Railroad miles between year t and t-1 | 0.038 | 0.118 | -0.467 | 2.390 | 1113 |
| Fraction of Private RR miles | 0.493 | 0.392 | 0 | 1 | 1297 |
| Change in Fraction of Private RR Miles between t and t-1 | -0.0017 | 0.0532 | -0.3139 | 0.9704 | 990 |
| Log of Rail Miles per capita in t-1 | -1.137 | 1.708 | -11.040 | 1.386 | 989 |
| Population Growth between t and t-1 | 0.0128 | 0.0119 | -0.0898 | 0.1118 | 788 |
| Real GDP per capita growth between t and t-1 | 0.0152 | 0.0483 | -0.2928 | 0.2739 | 650 |
| Polity Score in year t | -1.185 | 6.215 | -10 | 10 | 2244 |
| Constraints on the Executive in year t | 4.007 | 2.387 | 1 | 7 | 2167 |

Sources: see text.

Table 4: The Effects of Private Ownership on Railroad Diffusion: Estimates for Annual Data, 1875-1912

| Variable | Dependent Variable: Log difference in Railroad Miles between year t and t-1 | | | | | |
|--|---|-------------------|--------------------|--------------------|-------------------|--------------------|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Change in Fraction of Private RR Miles between t and t-1 | — | 0.212 (0.072)* | 0.111 (0.064)* | 0.092 (0.068) | 0.092 (0.068) | 0.105 (0.069) |
| Lagged log difference in RR miles | 0.301 (0.036)* | 0.243 (0.036)* | 0.010 (0.036) | 0.015 (0.038) | 0.014 (.039) | .069 (0.039) |
| Log of Rail Miles per capita in t-1 | -0.015 (0.002)* | -.018 (.002)* | -0.108 (0.008)* | -0.117 (0.010)* | -0.117 (.010)* | -0.116 (0.010)* |
| Population Growth between t and t-1 | 0.799 (0.250)* | 1.047 (0.279)* | 0.806 (0.373)* | 0.730 (0.392)* | 0.719 (0.397)* | 0.773 (0.404)* |
| Real GDP per capita growth between t and t-1 | 0.109 (0.055)* | 0.158 (.060)* | 0.093 (0.054)* | 0.077 (0.058) | 0.074 (.059) | 0.077 (0.061) |
| Polity Score in year t | — | — | — | — | 0.0004 (0.001) | — |
| Constraints on the Executive in year t | — | — | — | — | — | -.022 (0.008)* |
| Constant | 0.003 (.004) | .00008 (.0047) | -0.029 (.006) | -0.028 (0.019) | -0.029 (0.019) | 0.094 (0.048) |
| Country Fixed Effect | No | No | Yes | Yes | Yes | Yes |
| Year Fixed Effects | No | No | No | Yes | Yes | Yes |
| N | 481 | 461 | 461 | 461 | 451 | 431 |
| R square | 0.24 | 0.26 | 0.34 | 0.38 | 0.38 | 0.40 |

Notes: Standard Errors are in parentheses. * indicates statistical significance at the 90% level and above.

Table 5: Summary Statistics for Decennial Data, 1840-1910

| Variable | Mean | Stan. Dev. | Min | Max | Obs. |
|--|--------|------------|---------|-------|------|
| Log difference in Railroad miles between year t and t-10 | 0.64 | 0.72 | 0 | 4.25 | 172 |
| Change in Fraction of Private RR Miles between t and t-1 | -0.032 | 0.211 | -0.812 | 0.875 | 162 |
| Log of Rail Miles per capita in t-1 | -1.66 | 1.653 | -8.465 | 1.263 | 182 |
| Population Growth between t and t-1 | 0.111 | 0.0781 | -0.0971 | 0.435 | 201 |
| Real GDP per capita growth between t and t-1 | 0.130 | 0.131 | -0.4126 | 0.722 | 119 |

Sources: see text.

Table 6: The Effects of Private Ownership on Railroad Diffusion: Fixed Effects Estimates for Decennial Data, 1840-1910

| Variable | Dependent Variable: Log difference in Railroad Miles between year t and t-10 | | |
|---|--|--------------------|--------------------|
| | (1) | (2) | (3) |
| Change in Fraction of Private RR Miles between t and t-10 | 0.157 (0.181) | 0.278 (0.175) | 0.234 (0.162) |
| Log of Rail Miles per capita in t-10 | -0.568 (0.059)* | -0.547 (0.056)* | -0.438 (0.058)* |
| Population Growth between t and t-10 | 1.932 (1.014) | 2.163 (0.957)* | 2.234 (0.909)* |
| Real GDP per capita growth between t and t-10 | 0.132 (0.312) | 0.144 (.2938) | 0.237 (0.275) |
| Polity Score in year t | — | -0.046 (.014)* | — |
| Constraints on the Executive in year t | — | — | -0.244 (0.048)* |
| Constant | -0.381 (0.429) | -0.452 (0.404) | 1.186 (0.490)* |
| Country Fixed Effect | Yes | Yes | Yes |
| Year Fixed Effects | Yes | Yes | Yes |
| N | 105 | 105 | 100 |
| R square | 0.76 | 0.79 | 0.82 |

Notes: Standard Errors are in parentheses. * indicates statistical significance at the 90% level and above.

Table 7: The Effects of Private Ownership on Railroad Diffusion: Interaction Estimates using Annual Data, 1875-1912.

| Variable | Dependent Variable: Log difference in Railroad Miles between year t and t-1 | | |
|--|---|-------------------|-------------------------|
| | (1) | (2) | (3) |
| Change in Fraction of Private RR Miles between t and t-1 | 0.094 (0.069) | 0.094 (0.178) | 0.255 (0.064)* |
| Polity Score in year t | 0.0004 (0.001) | — | — |
| Constraints on the Executive in year t (Polity Score in year t)* | — | -0.022 (.008)* | — |
| Change in Fraction of Private RR Miles between t and t-1 (Constraints in year t)* | -0.0043 (.0182) | — | — |
| Change in Fraction of Private RR Miles between t and t-1 (Real GDP per capita in 1870)* | — | 0.002 (.032) | — |
| Change in Fraction of Private RR Miles between t and t-1 | | | -7.70e-06 (5.21e-06) |
| Country Fixed Effect | No | No | Yes |
| Year Fixed Effects | No | No | No |
| N | 451 | 431 | 331 |
| R square | 0.38 | 0.40 | 0.49 |

Notes: Standard Errors are in parentheses. * indicates statistical significance at the 90% level and above.

Figure 2: Railroad Miles Per Capita: Central and Eastern Europe, Egypt, and Turkey

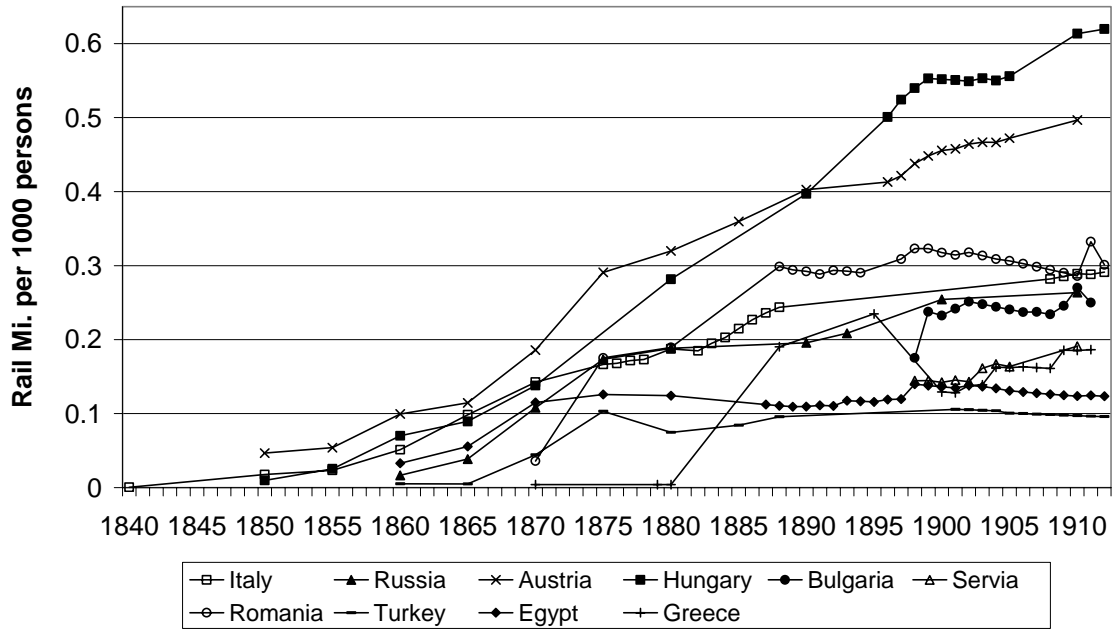


Figure 3: Railroad Miles Per Capita: North and South America, Australia, and New Zealand

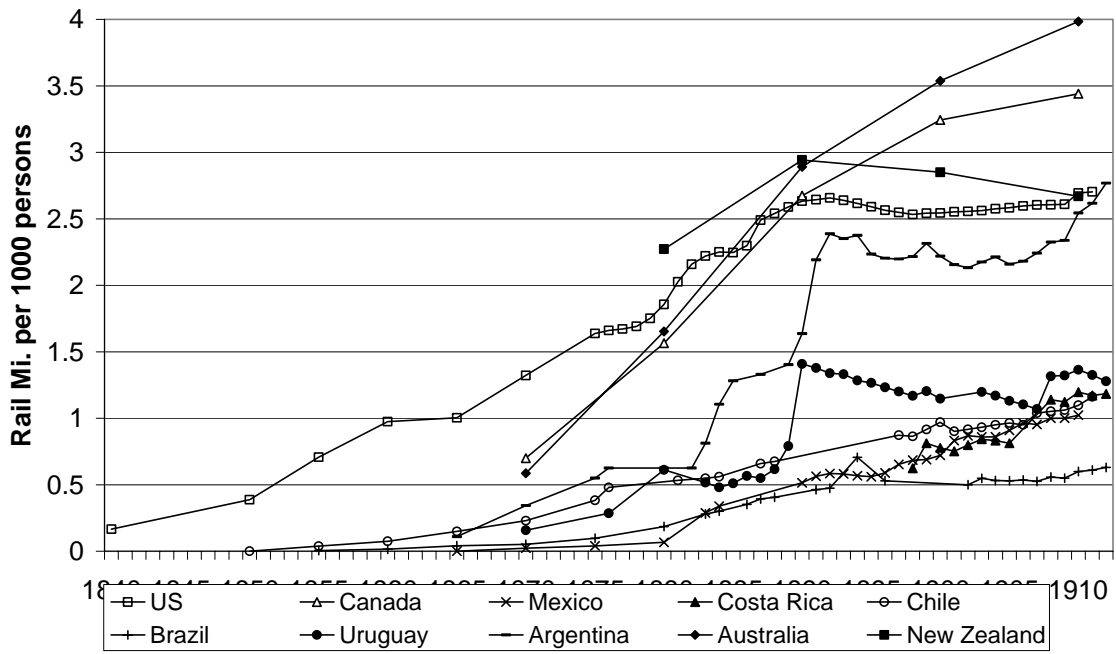


Figure 4: Railroad Miles per Capita, Asia

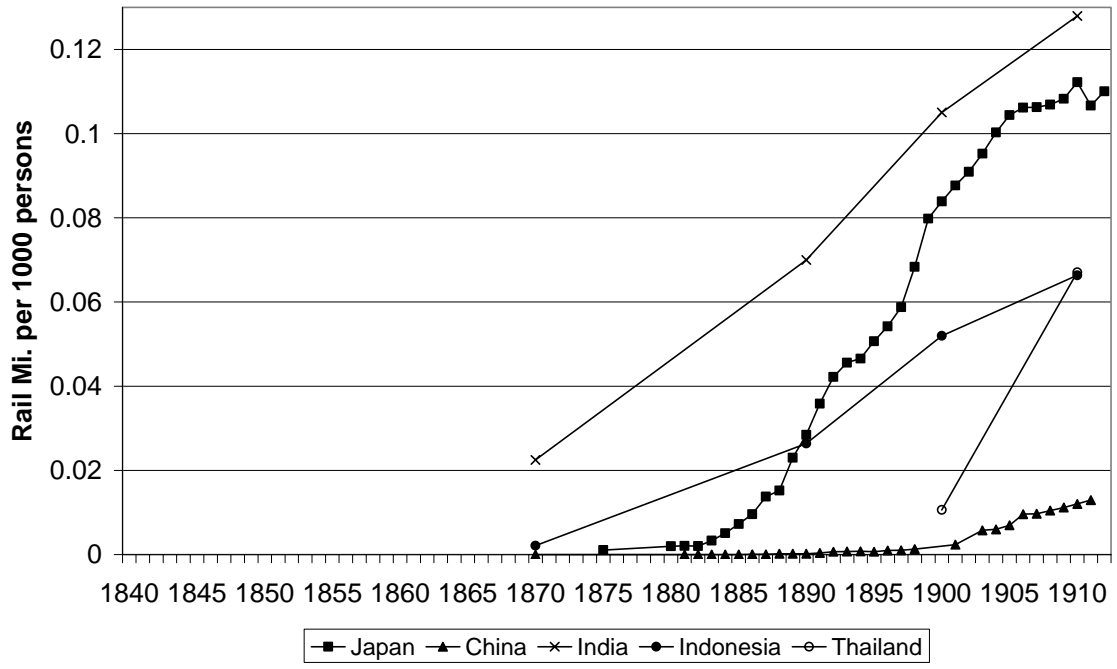


Figure 5: The Correlation Between the Log of Railroad Miles per Capita and the Log of Real GDP per Capita

