Private Ownership, Nationalization, and the Development of Transport Systems:
Cross-Country Evidence from the Growth of Railroad Networks, 1860-1913

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June 2007

Abstract

By 1913 there were large differences in the size of railroad networks across countries. This paper tests whether differences in the degree of private versus government ownership influenced the growth of railroad networks between 1860 and 1913. It uses new data on the number of track miles owned by private companies or governments in 35 countries and colonies. The main findings are that nationalizations of existing private miles reduced railroad mileage growth, while greater private ownership over new projects increased mileage growth. I also find that nationalizations reduced mileage growth in poor countries and outside of Europe, but had little effect in rich countries or in Europe. Lastly, there is evidence that greater private ownership increased mileage growth in rich countries, but not in poor countries.

Transportation infrastructure can be owned by private companies or governments. The degree to which a society relies on private versus government ownership can affect efficiency through a variety of channels, including investment, operational costs, prices, and quality of services. Like today, ownership was a major policy issue in the railroad sector during the 19th century and was known among contemporaries as 'the railway question.' Leaders in every country had to decide whether private or government ownership would best serve the needs of their citizens and the state. In some countries, private companies financed, constructed, and operated most railroad tracks and equipment, while in others local and central governments fulfilled this role. There were also cases where governments subsidized private companies with interest and dividend guarantees, land grants, or direct payments. The subsidies were aimed to attract domestic and foreign investment, particularly from Great Britain (Eichengreen, 1995).

Ownership policies varied substantially across countries and over time. Overall there was a shift to greater government ownership particularly between 1870 and 1900. The shift was partly due to new construction of government-owned railroads, like in Australia and New Zealand, but in many countries there were significant nationalizations of existing private lines, as in Russia, Belgium, Switzerland, and Mexico. There were some countries, like Britain and Spain, where private ownership was predominant throughout the period before 1913. There were also cases where private ownership increased through privatizations, as in Argentina and China.

This paper examines the link between ownership and railroad mileage growth using new data on the number of track miles owned by companies or governments in 35 countries or colonies between 1860 and 1912. The data contains over 1200 observations

on total railroad miles, and miles owned by companies and governments. I use the cross-country data to test whether mileage growth in country i was influenced by ownership changes in country i. The baseline regression analysis shows a positive relationship between mileage growth and increases in the fraction of miles owned by companies in year t, even after controlling for the level of railroad development, country fixed effects, and year fixed effects. Thus there is evidence that greater private ownership increased mileage growth and greater government ownership decreased mileage growth.

I also decompose ownership changes into three types: (1) transfers of privately-owned miles to the government (i.e. nationalizations), (2) transfers of government-owned miles to companies (i.e. privatizations), and (3) new track miles completed by companies versus governments. In this case, the regression analysis shows a positive relationship between mileage growth and greater miles completed by companies as opposed to governments in year t. It also reveals a negative relationship between mileage growth and nationalizations in year t, as well as a positive relationship with privatizations in t.

The finding that mileage growth was higher when greater miles were completed by companies can be explained in several ways. It may be that companies had higher investment incentives than governments due to differences in ownership structure, subsidies, or competition. Alternatively, it could be that private companies simply owned projects with greater investment potential, or they owned more projects when economic conditions were favorable.

The finding that nationalizations were associated with lower mileage growth is consistent with several explanations as well. Nationalizations may have deterred companies from starting new railroad projects by raising concerns about future

expropriations. Nationalizations may have also changed the incentives of governments by increasing their ownership presence in the railroad sector. Specifically, governments might have inhibited the construction of new private lines or delayed their own investments in order to increase profits. An alternative view suggests that nationalizations did not directly reduce mileage growth because they were correlated with other factors, like worsening economic conditions. According to this explanation, recessions or lower expectations of profitability ultimately reduced mileage growth and made nationalizations necessary.

It is difficult to estimate the causal effects of nationalizations and greater private ownership, but I argue that one can still determine whether they increased or decreased mileage growth by studying lagged ownership changes and by including control variables. Many railroad projects took 2 to 4 years to complete, and therefore, real G.D.P. growth, population growth, and real interest rates in year *t-2, t-3,* and *t-4* should influence mileage growth in year *t*. After controlling for these factors, a significant relationship between mileage growth in year *t* and ownership changes in *t-2, t-3*, and *t-4* suggests that ownership changes affected the initiation of new railroad projects that would have been completed by year *t*.

The regression analysis shows that mileage growth was indeed lower when there were significant nationalizations four years earlier, even after controlling for G.D.P. growth, population growth, and real interest rates. This finding suggests that nationalizations likely reduced mileage growth by deterring the initiation of new railroad projects. The regression analysis also reveals that mileage growth in year *t* was higher when greater miles were completed by companies than governments in year *t-2*. This

finding suggests that greater private ownership also contributed to the initiation of new projects. Lastly, mileage growth is positively associated with privatizations in year *t,* but not in *t-2, t-3*, or *t-4*. This casts some doubt on the argument that privatizations increased mileage growth.

I also investigate whether the effects of ownership differed in rich versus poor countries as well as in European versus non-European countries. The results show that nationalizations reduced mileage growth in poor countries and outside of Europe, and that greater private ownership contributed to higher mileage growth in rich countries, but not in poor countries. These findings are related to a number of comparative studies on ownership and infrastructure development before 1913. Robert Millward (2005) argues that ownership did not have a large effect on infrastructure development in Europe before 1913. My results also show that ownership changes had little effect on railroad mileage growth in European countries. 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. The findings here suggest a similar conclusion that nationalizations deterred infrastructure development, especially in poor countries.

The results are also related to the literature that studies the relationship between government ownership and the fiscal interests of the state. Rainer Fremdling (1980) argues that government railroads contributed to a substantial proportion of tax revenues in Prussia following their nationalization in the 1880s. Albert Schram (1997) discusses how the Italian state sought to control the most profitable portion of the railroad network by nationalizing the Upper Italy Railway Company in 1875. These studies suggest that nationalizations were driven in part by desires to expand government tax revenues. They

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are also consistent with the view that nationalizations deterred mileage growth by raising concerns over expropriation or by raising barriers to entry in the railroad sector.

Lastly, the results are related to the seminal work of Alexander Gerschenkron (1962) who argued that free markets and private ownership were less efficacious in 'backward' countries because they had inadequate supplies of capital, skilled labor, entrepreneurship and technological capacity. Gerschenkron went on to suggest that government ownership could encourage development by providing a substitute for private ownership. The results here are consistent with Gerschenkron's argument because they show private ownership was less effective in promoting railroad mileage growth in poor countries compared to rich countries. However, it is not so clear that government ownership contributed to greater railroad construction in poor countries, and it appears that nationalizations deterred mileage growth in poor countries.

The paper is organized as follows. Section 1 briefly discusses some theories on ownership and investment. Section 2 discuses the data. Section 3 examines the link between ownership and mileage growth across the full sample of countries and colonies. Section 4 carries out the same analysis for sub-samples. Section 5 concludes.

1. Theoretical perspectives on Ownership and Railroad Investment

This section discusses the theory on ownership and investment, which is the vehicle underlying railroad network growth. The first part examines the link between ownership and investment when contracts are incomplete. The second examines investment incentives of companies and governments after nationalizations.

1.A   Ownership and Investment incentives under Incomplete Contracts

The theory of incomplete contracts focuses on projects where owners and employees make non-contractible, relationship-specific investments (see Grossman and Hart 1986; Hart and Moore 1990). In the standard model, ownership gives an individual the right to claim the surplus from the project in the event that all parties are unable to negotiate a division of the surplus after investments are made. In other words, ownership makes an individual the residual claimant over the profits from a project. The theory suggests that the joint surplus of all investors is greater when the project is owned by the individual whose investments are most 'crucial' for its success. The reason is that ownership gives crucial individuals the ability to appropriate more of the benefits once the project is completed.

Besley and Ghatak (2001) modify the incomplete contracting framework to study the link between ownership and investment incentives when projects are public goods (see also Hart, Shleifer, and Vishny, 1997; Shleifer, 1998). Besley and Ghatak define ownership over the public good as the right to complete the project in the event of a bargaining failure between all parties involved (i.e. residual control rights). They show that investment incentives are greater when the project is owned by the individual who values the public good the most, even if their investments are not the most crucial. In this case, ownership gives the higher valuing individual greater incentive to invest because they enjoy the public good benefits more. However, ownership does not necessarily give the most crucial person higher incentives to invest, because they cannot exclusively appropriate the public good benefits.

The theory of incomplete contracts suggests that ownership could influence railroad investment in at least two ways. First, ownership matters because it determines

whether crucial individuals are the residual claimant. The historical literature suggests that construction managers and financiers were often crucial for the implementation of railroads. Construction managers had to figure out how to build railroads in difficult terrain and keep construction costs to a minimum. Financiers had to convince investors to purchase new railroad bonds or shares. Moreover, it is likely that many of the tasks performed by construction managers and financiers were difficult to contract upon, as they entailed unobservable effort. They were also specific to each railroad because of the variety across projects. Under these circumstances, it is possible that railroad investment was greater when construction managers and financiers owned the railroad, compared to cases where the government owned the railroad and hired managers and finance ministers to complete the project.

Second, ownership matters for investment because it determines whether groups with a high-valuation for the public benefits of railroads have residual control rights. The literature suggests that many railroads contributed to political unification and greater military capability, and that governments placed a high value on these public benefits (see Millward 2005). Political unification clearly benefited the central government because it strengthened their power vis-à-vis localities. Greater military capability also benefited central governments because they could better defend their territory against aggressive neighbors. Considering these factors in the context of the Besley and Ghatak framework suggests that railroad investment may have been greater under government ownership in cases where the public benefits were relatively large. The reason is that governments placed a higher value on political unification and greater military capability than private investors.

The theory of incomplete contracts yields a prediction on the empirical relationship between ownership and railroad investment, contingent upon observing the public and private benefits. Suppose there is a new railroad project which has a ratio of public to private benefits of r and that investment incentives are greater under government ownership if and only if r exceeds some threshold r^*. The theory predicts that private ownership will yield higher investment if the ratio of public to private benefits is below r^*; otherwise government ownership will yield higher investment. Unfortunately it is difficult to determine the ratio of public to private benefits across countries, and therefore it is difficult to test the predictions from incomplete contracts using cross-country data. Nonetheless the theory provides a basis for interpreting the empirical relationship between ownership and mileage growth.

1.B   Nationalizations and Investment Incentives

Nationalizations are transfers of ownership from companies to the government. As we shall see later, nationalizations were very common in the railroad sector before 1913. Nationalizations can influence railroad investment in a variety of ways. One possibility is that nationalizations changed the investment incentives of companies by raising the risk of expropriation. When nationalizations occurred, companies were usually compensated for their assets, but the purchase price may have been below the market value. For example, some companies received government bonds in exchange for their railroad assets. In some cases, the total value of the bonds was set so that the interest payments were equal to the average profits of the railroad over the previous 3 to 5 years. Even if the profits were accurately calculated, this transfer could have resulted in a partial expropriation of the company if the yield on government bonds started to fall or

if there was a default. Moreover, railroad profits likely increased with time, so compensation based on lagged profits could represent a below-market valuation.

If nationalizations did entail some form of expropriation, then they might discourage companies from investing in new railroad projects because they feared their assets would also be expropriated. This argument can be formalized by considering the investment decision for a private railroad company. Suppose there is a project that yields a net present value NPV for company A. If the NPV is greater than zero then company A considers investing in the project, and otherwise it will not. Now imagine that the government nationalizes some other company called B. As a result, company A now believes that with probability p its project will be nationalized, in which case it receives a net present value NPV', which is less than NPV. Now the company will only invest if $pNPV'+(1-p)NPV$ is greater than zero. Since the nationalization has reduced the expected net present value, company A is less likely to invest in the railroad project.

A nationalization can also change the investment incentives of governments, particularly if it substantially increases their ownership presence in the railroad sector. Railroads could be quite profitable before 1913 and in some cases the surplus contributed to a substantial portion of government tax revenues (see Fremdling, 1980). Under these circumstances, governments may want to limit new miles by private companies because it would restrict competition and thus increase their profits from operating railroads.

Governments may also delay their own railroad investments if nationalizations significantly increased their ownership presence. To see why consider the model of investment behavior under competition and monopoly developed by Harley (1982). Harley argues that a competitive railroad will invest when the net present value (NPV) is

just above zero to prevent their competitors from undertaking the project and reducing

their profits. By contrast, he argues that it is optimal for a monopolist railroad to delay

their investment until the NPV is maximized. If instead the monopolist invested when

the NPV is just above zero, they would preclude themselves from investing later when

profits are higher. Harley uses this model to explain the surge in U.S. mileage

construction during the 1880s when collusion broke down. However, it could also

explain why the government might delay investments after nationalizations give them

greater market power.

To summarize, theory suggests that nationalizations can reduce railroad

investment by changing the incentives of companies and governments. The opposite

argument can be applied to privatizations suggesting they increase railroad investment.

Later I test the consistency of these theories by looking at the link between mileage

growth and nationalizations or privatizations, but first it is necessary to provide an

overview of the data on ownership and the growth of railroad networks across countries.

2.   Data on Railroad Networks and Ownership

International Historical Statistics provides data on the length of railroad networks

in most countries or colonies (see Mitchell, 1992, 1995, 2003). Figures 1-4 show the

trends in railroad miles per 1000 persons between 1840 and 1912.[2] The patterns show a

high variance in miles per capita across and within regions. Britain, Belgium, and France

were the early leaders in adopting railroads within Western Europe (see figure 1).

Switzerland, Sweden, Norway, Spain and Germany experienced substantial growth in

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[2] There are many ways to compare network size across countries. For the moment, I focus on railroad
miles per capita. Later I analyze railroad mileage growth.

miles per capita between 1860 and 1880. Mileage per capita stabilized in most northwestern European countries after 1880, with the exception of Sweden which had twice the miles per capita of any other European country in 1912.

Railroad mileage per capita was generally lower in central and eastern Europe before the 1860s (see figure 2). Some of these countries experienced rapid growth during the 1880s and 1890s. Austria and Hungary approached the mileage per capita of countries in Western Europe, while Russia, Romania, Italy, Greece, and Bulgaria experienced slower growth. Egypt and Turkey experienced even slower growth compared to Western Europe or 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.

The U.S., Canada, Australia, Argentina, and New Zealand had the highest mileage per capita in the world (see figure 3). The U.S. network continued to expand up to 1890 and was the fourth largest in per capita terms by 1912. Canada and Argentina experienced very rapid mileage growth in the 1870s and 1880s. By 1912 Canada and Argentina had the second and third largest level of miles per capita. 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 Western European average. New Zealand was similar to Australia, but mileage growth failed to outpace population after 1890.

Railroad mileage also grew rapidly in Uruguay, Chile, Mexico, Peru, and Costa Rica during the 1870s and 1880s. By 1912 the number of railroad miles per capita in these five countries was similar to most Western European countries. However, their mileage growth failed to keep pace with the U.S. and Canada.

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Railroads were adopted more slowly in Asia (see figure 4). The Indian railroad network grew rapidly in the 1870s and 1880s and Japan experienced a similar growth in the 1880s and 1890s. Nevertheless, 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 growth was very slow in China given its population size, even after 1900.

Total investment in railroads is an alternative measure of network growth, but unfortunately there is less information on railroad investment across countries. Table 1 reports total railroad construction costs per 100,000 persons across several countries between 1840 and 1888 using data from *The Dictionary of Statistics* (Mulhall, 1892). The investment figures are translated into constant 1900 prices using the British 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, countries which had high investment per capita in 1888 also had high railroad miles per capita in 1890. The correlation coefficient between the two series is 0.83. There were some outliers, however. Sweden and Argentina, for example, had lower investment per capita than Britain, but both had significantly higher mileage. This was likely due to the large differences in wages and land prices across the three countries.

2.A   Railroad Ownership

Various sources from the 19th century list the number of miles owned by companies or the government. The British Board of trade published *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*, which report the

number of railroad miles owned by companies and the government in several countries and British colonies between 1860 and 1913.[3] For some countries, the *Statistical Abstracts* do not distinguish between miles owned by companies and the government.[4] I use several additional sources to identify the ownership of railroads in such cases. For example, *the Estadistca de los Ferrocarriles en Explotacion* reports ownership data for all railroads in Argentina before 1913.[5] In many cases, it was straightforward to fill the gaps by identifying government-owned and operated lines and privately-owned and operated lines. When track miles were government-owned, but privately-operated, I chose to assign the mileage to the government because it retained control over extensions to the network, and it was the ultimate residual claimant.

Figure 5 shows an estimate of the fraction of world railroad miles owned by private companies between 1840 and 1912. The estimate comes from a weighted average of the fraction of miles owned by companies in each year (the weights correspond to the size of the railroad network). The graph shows that private ownership was predominant up to the 1860s, but afterwards there was a gradual shift towards greater government ownership. By 1912, only 40 percent of all railroad miles were owned by companies as compared with over 70 percent before 1860.

Table 2 shows the diversity in private ownership by listing the fraction of total railroad miles owned by companies at benchmark dates. I grouped countries into six ownership categories to clarify the patterns. Countries under the label "private" had

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

[4] In some cases, it appears that the Board of Trade simply lacked information on ownership, but in others there was ambiguity about the distinction between ownership and operation. The Board of Trade assigned mileage to companies when they owned and operated the track, but if companies operated government tracks through a lease contract, then it did not assign mileage to either companies or the government.

[5] See the appendix for sources on the ownership status of each country or colony.

nearly complete private ownership up to 1912. They include Britain, Spain, the U.S., France, Uruguay, Turkey, Greece, and Canada. In Britain, private companies obtained the authority to build railroads through acts of Parliament. The acts gave companies rights of way, set maximum freight rates, and determined capitalization. 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 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. Foreign investors were particularly active in financing Turkish railways, including the famed Orient Express, which ran between Constantinople and Paris starting in 1883 (Spawn, 1928).

Countries under the "government or mixed" label had high levels of government ownership from the beginning of their railroad construction up to 1912. The most extreme case was Egypt, which never had a privately owned railroad. Serbia had some private ownership in the early 1900s, but the vast majority of miles were government-owned from the beginning. Australia and New Zealand were also cases where government ownership predominated from the beginning. Interestingly, the policies of Australia and New Zealand were different from Canada, which shared a similar colonial status and economic environment. Chile was unique in that around half of all railroads were owned by the government between 1875 and 1912. Private ownership was predominant in the north near the mining industry, while government ownership was common in the south where agriculture was the dominant sector (Splawn, 1928).

Some countries moved to government ownership after an initial period of private ownership. I label this group "private then government." Most countries in this category shifted to government ownership through nationalizations. Switzerland, for example, had a privately owned railroad network until 1903 when approximately 1400 miles were taken over by the government. Russia and Mexico are also examples of countries that experienced large-scale nationalizations.

China is one of the few countries that began with complete government ownership and then switched to greater private ownership. The Chinese government 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 a mixed system, whereby companies owned 43 percent of the miles in 1910.

Several countries switched ownership regimes several times. One group went from private to government and then back to private. In Sweden, private companies built more than 50 percent 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 Argentina there was a similar pattern where private ownership was replaced by government ownership in the 1880s. This was followed by a move to greater private ownership during the 1890s, which included several privatizations (Lewis, 1983).

Japan is one of the few countries that moved from government to private ownership and then back to government ownership. The first lines constructed in the 1870s and early 1880s were government-owned. Starting in the late 1880s, private

ownership increased when the Japanese government began offering guarantees to foreign

bondholders. In 1906, the state nationalized most private railroads, and began

constructing more government-owned railroads. Within a few years Japan had one of the

largest government-owned railroad networks in the world (Splawn, 1928).

3.   An Empirical Analysis of Mileage Growth and Ownership

This section uses several econometric models to study ownership and mileage growth.

The first section analyzes the relationship between mileage growth and contemporaneous

ownership changes. The second analyzes lagged ownership changes and incorporates

control variables, like real G.D.P. growth, population growth, and real interest rates.

3.A   Baseline results

The fraction of miles owned by companies in year t (i.e. total $private_{it}$/total$_{it}$) provides an

overall measure of the degree of private ownership in country i. It reflects all ownership

choices made prior to and including year t. Table 3 presents summary statistics for the

fraction of miles owned by companies and other ownership variables defined below. The

average fraction of miles owned by companies is 0.58 with a standard deviation of 0.37.

The table also reports that the average log difference in railroad miles is 0.053. This

implies an average annual mileage growth rate of 5.3 percent across countries.

Figure 6 shows a scatter plot of mileage growth against the fraction of miles

owned by companies for all country-year pairs in the data. There is no clear relationship

between mileage growth and the fraction of miles owned by companies. This finding is

confirmed in the first column of table 4 which reports a regression of mileage growth in

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year *t* on the fraction of miles owned by companies in year *t* and a constant. The coefficient on the fraction owned by companies is positive, but statistically insignificant.

Ownership changes can also influence mileage growth. The change in the fraction of miles owned by companies (i.e. total private$_{it}$/total$_{it}$ – total private$_{it-1}$/total$_{it-1}$) provides an overall measure of ownership changes in year *t*. A positive value indicates that a country shifted to greater private ownership in *t*. A negative value implies that a country shifted to greater government ownership in *t*. Figure 7 shows a scatter plot of mileage growth in year *t* against changes in the fraction of miles owned by companies in year *t* across all country-year pairs in the data. In this case, there is some evidence that mileage growth was higher when countries shifted to greater private ownership and lower when they shifted to greater government ownership. This finding is confirmed in column (2) of table 4 which reports a regression of mileage growth in year *t* on changes in the fraction of miles owned by companies in year *t* and a constant. The coefficient on changes in the fraction of miles owned by companies is both positive and significant.

The preceding regression does not incorporate the level of railroad development as well as other differences across countries and over time. Equation (1) includes some of these factors in a model describing the growth of railroad miles in country *i* in year *t*.

$$mileagegrowth_{it} = \lambda mileage_{it-1} + \delta fracprivate\_change_{it} + \alpha_i + \delta_t + \varepsilon_{it} \qquad (1)$$

The first term on the right-hand side is the log of railroad miles for country *i* in year *t-1*. The second term is the change in the fraction of miles owned by companies for country *i* between year *t* and *t-1*. α_i is a country fixed effect, δ_t is a year fixed effect, and ε_{it} is an

error term. The log of railroad miles is included because there was a limit to the number of miles that can be built in each country, and therefore, growth should decrease as the level of miles increases in *t-1*. The country fixed effects capture time-invariant unobservable factors that influence the trend growth in railroad miles for each country, like terrain or land mass. Year dummies are also included because there were shocks that influenced mileage growth for all countries in specific years.

The results are reported in column (3) of table 4. The main finding is that changes in the fraction of miles owned by companies continues to be positively and significantly related with mileage growth. This result implies that shifts to greater private ownership increased mileage growth after controlling for country specific factors, year specific factors, and the level of railroad mileage. It also implies that shifts to greater government ownership reduced mileage growth after controlling for the same factors.

The preceding estimates show a strong relationship between ownership changes and mileage growth, but it is not clear what types of ownership changes are driving this result. A change in the fraction of miles owned by companies partly reflects new miles completed by companies or the government. It also reflects privatizations and nationalizations of existing miles in year *t*. To separate these effects, I decompose changes in the fraction of miles owned by companies in year *t* into changes due to privatizations in *t*, changes due to nationalizations in *t*, and changes due to new miles completed by companies versus governments in *t*.

There is no source identifying the number of miles nationalized or privatized in every country and year, but many nationalizations and privatizations can still be identified using information on the absolute change in privately-owned miles and

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government-owned miles. I exploit the fact that a large absolute decline in private miles between year *t-1* and *t* implies there must have been a nationalization of existing private lines in year *t*. To see why consider an example from Russia. In 1894, Russia had 9480 private miles and 11,218 govt. miles for a total of 20,698 miles. In 1895, it had 8421 private miles and 13,527 govt. miles for a total of 21,948 miles. It is implausible that private companies shut down more than 1000 miles of track between 1894 and 1895, while the Russian government completed more than 2000 miles of track. Instead the reduction in private miles must have been due to nationalizations in 1895.

Following a similar logic, I argue that a large absolute decline in government miles between year *t-1* and *t* implies there was a privatization of existing government lines in year *t*. I use these assumptions to create two variables for each country called 'changes due to privatizations' and 'changes due to nationalizations.'

changes due to nationalizations in t = (total private$_{it-1}$ – total private$_{it}$)/(total$_{it-1}$)
if total private$_{it-1}$ > total private$_{it}$ and 0 otherwise.   *(2)*

changes due to privatizations in t = (total govt$_{it-1}$ – total govt$_{it}$)/(total$_{it-1}$)
     if total govt$_{it-1}$ > total govt$_{it}$ and 0 otherwise.   *(3)*

I use changes due to nationalizations to identify the effect on mileage growth when governments took over existing private lines. Similarly, I use changes due to privatizations to identify the effect on mileage growth when private companies took over existing government lines. It should be pointed out that the absolute reduction in private miles between *t-1* and *t* is a lower bound for nationalizations because some new private miles may have been completed between *t-1* and *t*, which would reduce the absolute

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decline in private miles. This implies that changes due to nationalizations will under-

state the true amount of nationalizations whenever new private miles are created.[6]

Table 5 lists all countries where 'changes due to nationalizations' exceeds 0.02. It

also provides a description of nationalizations using secondary sources, like the Board of

Trade report, *State Railways*. In general there is a close correspondence between changes

due to nationalizations and documented nationalizations. For example, the Board of

Trade reports that the Belgian government purchased 19 private lines after the 1871, and

in 1897, it purchased three large lines, the Ghent Ecloo, the Belgian Great Central, and

Plateaux de Herve. In 1898, the change due to nationalizations is 0.16 which clearly

reflects these purchases.

Table 6 lists all countries where 'changes due to privatizations' exceeds 0.02 as

well as descriptive information in some cases. It is immediately clear that privatizations

were less common than nationalizations. The privatizations in Argentina in the late

1880s are particularly notable because they resulted in a large shift from provincial

government ownership to greater private/foreign ownership.

I also use the nationalization and privatization variables to identify new miles

completed by companies versus governments. If there were nationalizations in year *t*,

then adding the change due to nationalizations and the change in the fraction of miles

owned by companies yields an approximation of ownership changes due to new miles

constructed by companies vs. governments in *t*.   For example, in Russia, the change due

to nationalizations was 0.053 in 1895 and the change in the fraction owned by companies

was -0.077. These figures imply that out of the -0.077 change in the fraction owned by

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[6] This type of systematic error presents a problem when correlating mileage growth in year *t* with
ownership changes due to nationalizations in *t*, but it is less of a concern when analyzing the lagged effects
of nationalizations in *t-1, t-2, t-3,* or *t-4*, which is the focus of the next section.

companies, -0.023 (=0.053-0.077) was due to more new miles constructed by governments than companies, and the rest was due to nationalizations. Similarly if there was a privatization in year *t* then subtracting the change due to privatizations from the change in the fraction of miles owned by companies yields an approximation of ownership changes due to new miles constructed by companies vs. governments in *t*. For each country, I define ownership changes due to new miles constructed by companies versus governments using the following expression:

change due to new miles completed by companies vs. governments in t =
*   (change in the fraction owned by companies in t) –*
*   (changes due to privatizations in t) +*
*   (changes due to nationalizations in t)   (4)*

The mean for changes due to new miles completed by companies vs. governments is 0.0014 (see table 3). Its minimum value is -0.299, and corresponds to a large increase in new miles completed by governments. Its maximum is 0.352, which corresponds to a large increase in new miles completed by companies.

The fourth column of table 4 reports estimates from a regression that includes changes due to new miles completed by companies versus governments in *t*, changes due to privatizations in *t,* and changes due to nationalizations in *t*. It also includes the log of railroad miles in *t-1* along with country and year fixed effects. The estimates show a positive and significant relationship between mileage growth and changes due to new miles completed by companies vs. governments. They also show a positive and significant relationship between mileage growth and privatizations as well as a negative and significant relationship between mileage growth and nationalizations.

The negative effect from nationalizations can be interpreted in several ways. First, companies may have built fewer lines because nationalizations raised concerns about expropriation. Nationalizations may have also encouraged governments to raise barriers to entry which would inhibit the construction of new lines. The same arguments could be applied to the effects of privatizations as they may increase competition and reduce concerns about expropriation. An alternative view suggests that nationalizations did not directly reduce mileage growth, and privatizations did not directly increase mileage growth. According to this argument, nationalizations were driven by worsening economic conditions, which reduced mileage growth by lowering expected profits.

The result that mileage growth was higher when more new miles were completed by companies than governments has several interpretations as well. One possibility is that companies built more miles because crucial actors, like financiers and construction managers, had greater incentives to invest under private ownership. A higher number of miles completed by companies could also signify greater competition which could encourage additional investment. An alternative view is that companies owned more new projects when economic conditions were positive, and governments owned more projects when economic conditions were negative. This type of selection may produce a spurious correlation between higher mileage growth and more new lines being completed by companies than governments.

It is difficult to distinguish between these explanations and identity the causal effects of nationalizations and greater private ownership without using an instrumental variables approach. In the followings section, I take a different approach and try to determine whether nationalizations and greater private ownership increased or decreased

mileage growth by studying lagged ownership changes and by adding variables that control for changes in the economic and political environment.

3.B   Analysis of Lagged Ownership Changes with Control Variables

Theory suggests nationalizations might deter the initiation of new railroad projects by raising expropriation risks or barriers to entry. To investigate this possibility, I examine the relationship between mileage growth in year t and nationalizations in year $t, t-1, t-2, t-3$, and $t-4$. Many railroad projects took 2 to 4 years to complete, and therefore, projects initiated in year $t-2, t-3$, and $t-4$ are generally completed in year t. A negative relationship between mileage growth in t and nationalizations in year $t-2, t-3$, and $t-4$ suggests that nationalizations deterred new projects that would have been completed by year t. If, on the other hand, mileage growth in t is only influenced by nationalizations in t or $t-1$, then this would suggest that nationalizations did not directly decrease mileage growth and may reflect some other factor, like worsening economic conditions.   Similarly, if there is a positive and significant relationship between mileage growth and privatizations in year $t-2, t-3$, or $t-4$, then this would suggest that privatizations encouraged companies or governments to start new projects. Otherwise, it is more likely that privatizations were correlated with other factors.

I also investigate the relationship between mileage growth in year t and changes due to miles completed by companies vs. governments in year $t, t-1, t-2, t-3$, and $t-4$. A positive relationship between mileage growth in t and changes due to new miles completed by companies vs. governments in year $t-2, t-3$, and $t-4$ would suggest that greater private ownership encouraged the initiation of new projects by increasing competition or through some other type of spillover effect. If there is no effect from

changes due to new miles completed by companies vs. governments in *t-2, t-3*, and *t-4*, then it is not clear whether greater private ownership over new projects had an influence.

In addition to lagged ownership changes, I also incorporate other economic and political factors. Mileage growth arises from new investments in the railroad network, and therefore, it should be influenced by economic growth, changes in interest rates, and relative prices of capital goods in a particular country. I measure these factors using real G.D.P. growth, population growth, the real yield on British govt. bonds, the difference between domestic bond yields and British govt. bond yields, the change in exchange rates, and the change in relative prices of railroad capital goods. Most of the real G.D.P. and population figures are taken from Angus Maddision (2003). Bond yields, price indices, and exchange rates are all taken from the Global Financial Database (GFD).[7] The price of railroad capital goods comes from Feinstein and Pollard's (1987) estimate of British railroad capital prices. Full details on all variables are provided in the appendix.

Higher real G.D.P. growth and population growth are included because they raise the demand for new railroad investment. The real yield on British govt. bonds and the difference between bond yields in country *i* and British govt. bonds are proxies for real interest rates in the world economy and the risk premium for country *i*. Railroad mileage growth should decrease when the real yield on British govt. bonds increases or when the bond spread increases for country *i*. Exchange rates are measured by the domestic currency relative to the British pound. Large depreciations in the domestic currency were particularly costly for private railroads because their rates and fares were often fixed. Therefore an increase in the domestic currency required to purchase 1 British pound should reduce railroad mileage growth. A higher relative price of railroad capital goods

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[7] For more information on the Global Financial Database see http://www.globalfinancialdata.com/.

should lower mileage growth by making it more expensive to import locomotives and other capital goods which are needed for the operation or construction of railroads.

G.D.P. growth, the real yield on British govt. bonds, the bond spread, the log difference in the exchange rates, and the log difference in relative prices of railroad capital goods are all included in year *t-2*, *t-3* and *t-4* because they control for economic conditions in year *t-2*, *t-3* and *t-4*. Population growth was lagged to *t-4*, *t-5* and *t-6* because higher births and immigration should influence mileage growth more slowly.

I also include lagged changes in political institutions, warfare, and the military capability of neighboring countries as additional control variables in the mileage growth regression. Political institutions, like greater limitations on the authority of the ruler or greater democracy, could affect railroad mileage growth by changing expectations about future economic growth. The Polity IV data set provides institutional variables for many countries starting in 1800.[8] 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), and the highest value of 10 corresponds to the greatest degree of democracy (i.e. the U.S. after 1871). The polity IV variable "constraints on the executive" quantifies whether a country has effective checks on the authority of the executive, such as the monarch, emperor, or president. The lowest value of 1 implies there are no checks on the executive (i.e. China before 1910). The highest value of 7 implies that the ruler is strongly limited by a well-functioning constitution (i.e. Japan after 1868).[9]

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[8] See the Polity IV webpage for more details, http://www.cidcm.umd.edu/inscr/polity/.
[9] Constraints on the executive is a popular measure for the security of property rights, and it is a powerful predictor of G.D.P. per capita in cross-country regressions (see Acemoglu, Johnson, and Robinson, 2005).

Warfare could stimulate network growth because governments devote more resources to railroads, or by illustrating the benefits of the new technology. On the other hand, warfare could also slow network growth by disrupting markets. The Correlates of War database provides dates for inter-state wars, intra-state wars, and extra-state wars starting in 1815 (see Sarkees (2000)). I use this data to code to a war dummy which identifies whether a country was in any type of war in each year between 1850 and 1912.

The threat of warfare may have also encouraged mileage growth. To capture this effect, I include changes in the military capability of neighboring countries, which is defined as the weighted average of the natural log of the military capability index among contiguous countries. The military capability index comes from the Correlates of War database (see Singer, Bremer, and Stuckey, 1972; Singer, 1987).

The first column of table 7 reports the main estimates. The regression includes the log of railroad miles in *t-1*, contemporary and lagged ownership changes, country fixed effects, year fixed effects, and all the control variables just discussed. The sample size is smaller than before because the control variables are not available for all countries and years. For comparison, the second column in table 7 reports the same regression after dropping all the control variables, but restricting the sample to the country-year pairs with observations on all the control variables.

The estimates with controls show an overall positive relationship between mileage growth in *t* and more miles completed by companies vs. governments in *t, t-1, t-2, t-3*, and *t-4*. The sum of the coefficients for changes due to new miles completed by companies vs. governments is large and significant. More importantly, they show a positive relationship between mileage growth in year *t* and more miles being completed

by companies than governments in *t-2*. This result is important because it provides some evidence that greater private ownership over new projects increased future mileage growth, perhaps by encouraging greater competition or through some spillover effect.

The estimates in table 7 also show an overall negative relationship between mileage growth in *t* and nationalizations in *t, t-1, t-2, t-3*, and *t-4*. The sum of the coefficients on changes due to nationalizations is large and significant. Of most importance is the finding that mileage growth was significantly lower 4 years after nationalizations. It suggests that nationalizations deterred the initiation of new projects that would have been completed 4 years later. This result is unlikely to be due to lagged effects from a worsening economic environment because the regression controls for any changes in G.D.P. growth, interest rates, exchanges rates, and other factors. Instead it suggests that nationalizations changed the investment incentives of companies and governments.

Finally, the estimates show a positive and significant relationship between mileage growth in *t* and privatizations in *t-1*, but not in *t, t-2, t-3*, and *t-4*. Overall privatizations are positively associated with mileage growth, but the timing of the effects does not provide strong evidence that privatizations increased mileage growth by encouraging the initiation of new railroad projects.

Comparing the R-square in columns 1 and 2 suggests that adding control variables improves the overall fit of the model. The inclusion of controls also reinforces the conclusion that nationalizations reduced mileage growth and greater private ownership over new projects increased mileage growth. Table 8 reports a summary of the estimates for the control variables. Each was included in *t-2, t-3*, and *t-4* with the exception of

population growth which is included in *t-4, t-5*, and *t-6*. The rows report the sum of the

coefficients for the variables across all dates. The outlined variables are those where the

p-value indicates that the sum of the coefficients was statistically different from zero.

Most of the signs on the economic variables are consistent with theory. Higher

population growth and higher Real G.D.P. growth raised mileage growth, although

population appears to have a much larger effect. Higher real yields on British govt.

bonds and higher bond spreads both significantly reduced mileage growth. Greater

currency depreciation and railroad capital prices reduced mileage growth.

The estimates also reveal some interesting results regarding the effects warfare

and institutional changes. Warfare and shifts to greater democracy reduced mileage

growth, while higher military capability of neighboring countries and greater constraints

on the executive increased mileage growth.

4. Results for Sub-samples

The literature often suggests that ownership had different effects across economic

and geographic environments. In this section, I investigate these possibilities by splitting

the sample into rich and poor countries in 1870 as well as European and non-European

countries.

In a seminal work, Gerschenkron (1962) argued that private ownership was less

effective in poor countries, and that government ownership provided a more effective

substitute. I investigate this claim by dividing the sample of countries according to

whether they had a G.D.P. per capita below the median in 1870 or above the median in

1870. Table 9 reports estimates for both sub-samples after including contemporaneous

and lagged ownership changes along with all the control variables. The results reveal that ownership changes had very different effects in rich and poor countries. First, there is no relationship between mileage growth and changes due to new miles completed by companies vs. governments in poor countries. By contrast, there is a strong positive relationship in rich countries. Specifically, the estimates show that in rich countries mileage growth was higher when more miles were completed by companies than governments in year t and t-2. The lagged effect is particularly important because it suggests that shifts to greater private ownership increased investment in new projects.

Another striking result is that nationalizations reduced mileage growth in poor countries, but not in rich countries. In poor countries, there is a negative and significant relationship between mileage growth in year t and nationalizations in t-1, t-3, and t-4. In rich countries, there was a negative and significant effect from nationalizations in t and t-2, but a positive and significant effect in t-1. These results suggest that nationalizations were a greater deterrent to new projects in poor countries. One possibility is that expropriation risks were perceived to be greater in poor countries. Another possibility is that governments in poor countries used railroads as a revenue source, and erected higher barriers to entry once they assumed a larger ownership stake. In rich countries, nationalizations did not deter new railroad projects, perhaps because they were driven by temporary shocks or military considerations.

A final result is that a higher level of private ownership was associated with higher mileage growth in rich countries, but not in poor countries. The last bolded row in table 9 shows that mileage growth was higher when companies owned a higher fraction of miles in rich countries. This suggests that greater private ownership had a positive

long-run effect on mileage growth in rich countries. The coefficient suggests that a one standard deviation increase in the fraction owned by companies could increase mileage growth by as much as 1.8%, which is not small considering that average mileage growth was around 3.8% in rich countries.

Aside from differences between rich and poor countries, the literature also emphasizes the unique factors underlying ownership changes in Europe as opposed to elsewhere. Robert Millward (2003), for example, argues that military considerations contributed to nationalizations and greater government ownership in Europe. To investigate whether ownership changes had a different effect in Europe, I re-estimate the model after dividing the sample into European and non-European countries. The results are reported in table 10. In non-European countries, there is an overall negative relationship between mileage growth and changes due to new miles completed by companies vs. governments, but it is not significant. In European countries, there is some evidence of a positive relationship between mileage growth in *t* and greater miles completed by companies in *t-2*, but it is relatively weak as well.

The most striking result in table 10 is that nationalizations had a large negative effect on mileage growth in non-European countries, but they have no effect in European countries. In non-European countries, there is a negative and significant relationship between mileage growth in *t* and nationalizations in *t-1* and *t-4*. In European countries, mileage growth is negatively related to nationalizations in *t*, but positively related to nationalizations in *t-1*. These findings are consistent with the argument that nationalizations were driven by military considerations in Europe, and therefore, may not have deterred new railroad investments. On the other hand, the large negative effect of

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nationalizations in non-European countries suggests that nationalizations did deter new investment elsewhere.

Lastly, the results show a large positive relationship between mileage growth and privatizations in non-European countries, but not in European countries. It is difficult, however, to place a lot of weight on these results because there were few privatizations in either sample.

5. Conclusions

Before 1913 leaders in every country vigorously debated the merits of private versus government ownership of railroads. Some countries opted for a mixed system, with many railroads owned and financed by the government. Others choose private ownership, in some cases with government subsidies, like interest guarantees and land grants. Which of these policies regimes led to greater growth of the railroad network? Did it matter how countries implemented ownership changes?

This paper explores these questions using cross-country data on mileage growth and ownership between 1865 and 1912. Across the entire sample of countries and colonies, the results show that mileage growth was higher when there was greater private ownership over new projects, and it was lower when there were nationalizations. These results are reinforced by additional analysis which shows that mileage growth was higher when there was a shift to greater private ownership two years earlier and mileage growth was lower when there were significant nationalizations four years earlier.

These results do not imply specific mechanisms, but they are consistent with several hypotheses about the relationship between ownership and infrastructure

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development. First, they suggest that nationalizations can deter companies from initiating or completing new projects because of fears of expropriation. The findings also suggest that governments may restrict infrastructure investment once they take a larger ownership stake through nationalizations.

The results also suggest that greater private ownership increased mileage growth in rich countries, but not in poor countries. This may be due to differences in the public-good aspects of infrastructure across rich and poor countries. It could also be that private individuals were able to appropriate more of the returns from their investments in rich countries with well developed markets and legal systems.

Finally, this paper focuses on mileage growth, but of course it is not necessarily better for a country to have more railroad miles. The social benefits of a larger railroad network depend on the difference between the social rate of return on additional railroad mileage in each country and the social rate of return on other investments. Recent studies on low to middle income countries have found evidence of high social returns from railroads in the 19th and early 20th century. For example, Bill Summerhill (2003) estimates that the social rate of return for Brazilian railroads may have been as high as 8 percent before 1913.[10] This literature has some interesting implications regarding the effects of private versus government ownership in poor countries. If nationalizations reduced network growth, then greater government ownership may have slowed economic growth by reducing socially-valuable investments. On the other hand, since greater government ownership over new projects did not reduce mileage growth in poor countries, it would not necessarily slow economic growth. In fact, government

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[10] See O'Brien (1983) for a review of the estimated social savings from railroads in European countries. Also see Canning and Bennathan (2000) for contemporary estimates on the return from infrastructure.

ownership might enhance growth if it was the only ownership structure that could

implement 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.

Argentina, Ministerio de Obras Publicas. *Estadistica de los Ferrocarriles en Explotacio.*
Buenos Aires, 1916.

Besley, Timothy and Maitreesh Ghatak. "Government versus Private Ownership of
Public Goods," *The Quarterly Journal of Economics* (Nov. 2001).

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.

Brazil. *Ministério da Indústria, Viação e Obras Públicas*. Sao Paulo (1893-1909).

Brazil. *Viacao E Obras Publicas*. Sao Paulo (1909-1914).

Canning, David and Esra Bennathan. "The Social Rate of Return on Infrastructure
Investments, *World Bank Policy Research Working Paper 2390*, 2000.

Chile, Oficina Central de Estadistica. *Annuario Estadistico de la Republica de Chile,*
Santiago: Soc. Imprenta Y Litografia Universo., 1912

Della Paolera, Gerardo and Alan M. Taylor. *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," *World Bank Research Observer* (February 1995).

Feinstein, Charles and Sidney Pollard. *Studies in Capital Formation in the United Kingdom, 1750-1920.* Oxford: Oxford University Press, 1988.

Fremdling, Rainer, "Freight Rates and State Budget: the Role of the National Prussian Railways, 1880-1913," *Journal of European Economic History* (1980).

Gerschenkron, Alexander. *Economic Backwardness in Historical Perspective*. Cambridge: Belknap Press, 1962.

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.

Great Britain, Board of Trade. *the Statistical Abstract for British India*, London: HM Stationary, Various years.

Great Britain, Board of Trade. *Report on State Railways (British Possessions and Foreign Countries)*, London: HM Stationary, 1913.

Great Britain, Board of Trade. *Railways (Foreign Countries and British Possessions)*, London: HM Stationary, 1907.

Gregory, Paul. *Russian National Income, 1885-1913*. Cambridge: Cambridge University Press, 1982.

Grossman, Sanford and Oliver Hart. "The Costs and Benefits of Ownership: A theory of Vertical and Lateral Integration," *Journal of Political Economy* (1986).

Gurr, Ted Robert, Monty G. Marshall, and Keith Jaggers, The PolityIV Project, http://www.cidcm.umd.edu/inscr/polity/, assessed on 10/6/2006.

Hart, Oliver and John Moore. "Property Rights and the Theory of the Firm" *Journal of*

Political Economy 98 (1990).

Hart, Oliver, Andrei Shleifer, and Robert Vishny. "The Proper Scope of Government:

Theory and an Application to Prisons," *Quarterly Journal of Economics* (1997).

Huenemann, Ralph W. *The Dragon and the Iron Horse: The Economics of Railroads in China, 1876-1937*. Cambridge MA: Harvard University Press.

Ichiro, Kakizaki, *Laying the Tracks: the Thai Economy and its Railways, 1885-1935*. Kyoto University Press, 2005.

Italy. Direzione generale delle ferrovie dello Stato. *Sviluppo delle ferrovie italiane dal 1839 al 31 dicembre 1926*, Roma, Tipografia ditta L. Cecchini, 1927.

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.

Maddison, Angus. *The world economy: historical statistics*. Paris: Development Centre, OECD, 2003.

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.

Sarkees, Meredith Reid. "The Correlates of War Data on War: An Update to 1997," *Conflict Management and Peace Science*, (2000).

Schram, Albert. *Railways and the Formation of the Italian State in the Nineteenth Century*. Cambridge: Cambridge University Press, 1997

Shleifer, Andre. "State versus Private Ownership," *Journal of Economic Perspectives* 12 (Fall 1998).

Schulz, Max-Stephan. "Patterns of Growth and Stagnation in the Late 19th Century Hapsburg Economy," *European Review of Economic History* (2000).

Singer, J. David. "Reconstructing the Correlates of War Dataset on Material Capabilities of States, 1816-1985" *International Interactions* (1987).

Singer, J. David, Stuart Bremer, and John Stuckey. "Capability Distribution, Uncertainty, and Major Power War, 1820-1965." in Bruce Russett (ed) *Peace, War, and Numbers*, Beverly Hills: Sage, 1972.

Summerhill, Bill. *Order Against Progress: Government, Foreign Investment, and Railroads in Brazil, 1854-1913,* Stanford: Stanford University Press, 2003.

Splawn, Walter. *Government Ownership and Operation of Railroads*. New York: MacMillan, 1928.

Stinnett, Douglas M., Jaroslav Tir, Philip Schafer, Paul F. Diehl, and Charles Gochman.

"The Correlates of War Project Direct Contiguity Data, Version 3." *Conflict Mangagement and Peace Science* (2002).

Thorner, David. "The Pattern of Railway Development in India," *Far Eastern Quarterley* 14 (1955).

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).

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).

Data Appendix

Sources for Railroad data: Total Railroad Miles for each country are available in International Historical Statistics (Mitchell 1992, 1995, 2003). Data on railroad miles owned by companies and the government comes from several sources. I use several reports published by the British Board of Trade. They include *The Statistical Abstract for the Principal and Other Foreign Countries* (various years), *The Statistical Abstract for the Several Colonial and other Possessions of the United Kingdom* (various years), *The Statistical Abstract for British India* (various years), *Report on State Railways, British Possessions and Foreign Countries* (1913), and *Railways, Foreign Countries and British Possessions* (1913). I used other sources to fill gaps. For Italy, I consulted *Sviluppo delle ferrovie italiane dal 1839 al 31 dicembre 1926* (1927) published by the Direzione generale delle ferrovie dello Stato. For Chile, I used additional information from the *Annuario Estadistico de la Republica de Chile* (1912) published by Oficina Central de Estadistica. For Brazil, I used additional information from *the Ministério da Indústria, Viação e Obras Públicas* (1893-1909) and *Viacao E Obras Publicas* (1909-1914). For Argentina, I used additional information from *Estadistica de los Ferrocarriles en Explotacion* (1913) published by the Ministerio de Obras Publicas. For China, I used additional information Huenemann (1984).

Sources and Methods for real G.D.P.: Angus Maddison (2003) provides real G.D.P. estimates in constant 1995 dollars for several countries and British colonies in 1820, 1850, 1860, and every year after 1870. Whenever possible I use Maddison's estimates. In some cases, however, Maddison provides real G.D.P. for 1870, 1890, and 1913 only.

To fill the gaps, I use other sources for annual G.D.P. and convert them into 1995 dollars using Maddison's estimate from 1913. For example, I use Gregory (1992) for Russia, Schulz (2000) for Hungary, Yousef (2002) for Egypt, Braun et. al. (2000) for Chile, and della Paolera and Taylor (2003) for Argentina.

Sources for Population: Whenever possible I used population data from Maddison (2003). However, Maddison's figures did not always apply to boundaries in the 19th century. I supplemented Maddison's figures with Lahmeyer (n.d.) and *the Statistical Abstracts* published by the Board of Trade.

Sources and Methods for railroad capital prices: As the British were one of the main exporters of capital goods for the railroad sector, I use Feinstein and Pollard's (1987) series on British railroad capital prices as my estimate of railroad capital prices throughout the world. I then convert the British price into a domestic price for each country using exchange rates from the Global Financial Database (GFD). Finally, I deflate the domestic capital price using a consumer price index for the country again taken from GFD.

Sources and Methods for Bond yields, Bond Spreads, and exchange rates: All bond yield and exchange rate data come from GFD. To calculate real on British govt. bonds in year t, I subtract the average of the percentage change in the British consumer price index in year t, $t+1$, and $t+2$ from the bond yield in year t. Government bond spreads equal to the yield on government bonds in country i minus the yield on British government bonds. To

measure the change in exchange rates, I first calculate the average monthly exchange rate

and then calculate the log difference in log of the average between year t and t-1.

Table 1: Total Railroad Construction Costs per 100,000 Persons
(in 1900 British pounds)

Country	1840	1850	1860	1870	1880	1888	Railroad Miles per 1000 persons in 1890
U.S.	0.0013	0.0032	0.0083	0.0128	0.0254	0.0390	2.63
Australia			0.0019	0.0077	0.0237	0.0380	3.06
Canada		0.0005	0.0086	0.0083	0.0196	0.0372	2.70
UK	0.0013	0.0109	0.0131	0.0180	0.0230	0.0298	0.57
France	0.0003	0.0019	0.0050	0.0078	0.0107	0.0169	0.57
Austria		0.0014	0.0034	0.0061	0.0117	0.0156	0.40
Switzerland			0.0056	0.0070	0.0115	0.0150	0.68
Argentina				0.0027	0.0054	0.0149	2.23
Belgium	0.0014	0.0036	0.0060	0.0087	0.0107	0.0140	0.46
Germany				0.0051	0.0096	0.0122	0.54
Holland		0.0008	0.0013	0.0037	0.0063	0.0093	0.36
Sweden			0.0005	0.0017	0.0051	0.0070	1.05
Spain		0.0	0.0013	0.0031	0.0044	0.0063	0.35
Italy		0.0002	0.0011	0.0029	0.0037	0.0052	0.25
Denmark			0.0006	0.0022	0.0034	0.0052	0.53
Norway				0.0011	0.0021	0.0042	0.49
Portugal				0.0016	0.0027	0.0044	0.25
Russia		0.0001	0.0003	0.0018	0.0032	0.0040	0.20
Egypt			0.0007	0.0013	0.0021	0.0025	0.12
Japan					0.0000	0.0003	0.03

Source: Construction costs come from *The Dictionary of Statistics* (Mulhall, 1892). The price deflator comes from the British capital goods prices series of Feinstein and Pollard (1988, p. 470-71). Railroad miles per capita come from the sources described in the text and appendix.

Table 2: The Fraction of Total Railroad Miles Owned by Companies: 1860-1910

Country	Fraction of Miles Owned by Companies					
	1860	1870	1880	1890	1900	1910
"Private"						
UK	1.00	1.00	1.00	1.00	1.00	1.00
Spain	1.00	1.00	1.00	1.00	1.00	1.00
France	1.00	1.00	1.00	0.93	0.94	0.82
U.S.		1.00	1.00	1.00	1.00	1.00
Uruguay		1.00	1.00	1.00	1.00	1.00
Turkey		1.00	1.00	1.00	1.00	1.00
Greece		1.00	1.00	1.00	1.00	1.00
Canada			0.84	0.90	0.91	0.93
"Government or Mixed"						
Egypt	0.00	0.00	0.00	0.00	0.00	0.00
Australia		0.03	0.06	0.05	0.06	0.11
New Zealand			0.00	0.06	0.03	0.01
Chile			0.47	0.61	0.52	0.52
Serbia				0.00	0.00	0.00
Finland					0.10	0.09
"Private Then Government"						
Switzerland	1.00	1.00	1.00	1.00	1.00	0.42
Holland	1.00	0.43	0.42	0.46	0.42	0.47
Norway	1.00	0.19	0.06	0.04	0.09	0.16
Italy	1.00	0.87	0.55	0.34	0.32	0.21
Brazil	1.00	0.69	0.71	0.76	0.77	0.52
India	1.00	0.98	0.49	0.24	0.12	0.12
Belgium	0.65	0.54	0.32	0.12	0.12	0.07
Austria	0.99	0.99	0.92	0.67	0.57	0.17
Germany		0.56	0.35	0.10	0.08	0.06
Russia		0.90	0.96	0.71	0.40	0.38
Romania		1.00	0.33	0.00	0.00	0.00
Bulgaria		1.00	1.00	1.00	0.21	0.00
Mexico			1.00	1.00	1.00	0.64
"Government then Private"						
China			0.00	0.00	0.00	0.43
Costa Rica			0	0	0.85	0.80
"Private then Government then back to Private"						
Argentina	1.00	0.76	0.51	0.86	0.80	0.88
Portugal	1.00	1.00	0.48	0.39	0.61	0.58
Hungary	1.00	1.00	0.63	0.49	0.55	0.61
Sweden	0.50	0.36	0.67	0.68	0.66	0.68
Denmark	1.00	0.35	0.21	0.21	0.39	0.43
"Government then Private then back to Government"						
Japan			0.00	0.51	0.76	0.09

Sources: See text.

Table 3: Summary Statistics for Main Variables across Countries, 1840-1912

Variable	Mean	Stan. Dev.	Min	Max	Obs.
Log of Railroad Miles	7.86	1.78	1.79	12.44	1409
Log difference in Railroad miles	0.059	0.133	-.165	2.39	1265
Fraction of Miles owned by Companies	0.577	0.369	0	1	1398
Change in fraction of miles owned by Companies	-0.002	.051	-.639	.675	1260
Change due to new miles completed by companies and governments	0.0014	.026	-.299	.352	1254
Change due to Nationalizations	0.0059	0.031	0	0.531	1254
Change due to Privatizations	0.0015	0.022	0	0.624	1279

Sources: see text.

Table 4: Baseline Results: Effects of Contemporaneous Ownership Changes

Dependent Variable: log difference in railroad miles for country i between t and $t-1$

Variables	(1) Coeff. (St. Error)	(2) Coeff. (St. Error)	(3) Coeff. (St. Error)	(4) Coeff. (St. Error)
Fraction of Miles owned by Companies, t	.011 (.010)			
Change in fraction of miles owned by Companies, t		0.337 (.072)*	.300 (.062)*	
Change due to new miles completed by companies vs. governments, t				.490 (.125)*
Change due to Privatizations, t				.241 (.138)*
Change due to Nationalizations, t				-.179 (.105)*
Log of Railroad Miles, t -1			-.052 (.006)*	-.051 (.006)*
Country Fixed Effects	No	No	Yes	Yes
Year Fixed Effects	No	No	Yes	Yes
N	1259	1257	1257	1251
R-square	0.001	0.02	0.31	0.31

Notes: * indicates statistical significance at 90% and above.

Table 5: Major Nationalizations

Country	Year	Changes due to Nationalizations	Description
Russia	1889, 1891, 1893, 1894, 1895, 1901	0.08, 0.07, 0.02, 0.09, 0.05, 0.02	State purchased Ekaterinenskaia, Trans-Caucasian, Moscow Brest, Vistula, Riga-Orel Samara-Zlatonst, SizranViazma, Northern Northwestern, and Southwestern
Sweden	1896	0.03	State purchased the West Coast Railway
Denmark	1878, 1879, 1880, 1882	0.08, 0.02, 0.04, 0.10	Nationalizations followed a plan to provide construction subsidies
Holland	1880, 1890	0.02, 0.06	State purchased Netherland Rhenish Railway
Belgium	1875, 1877, 1880, 1898, 1908	0.05, 0.06, 0.03, 0.16, 0.04	State purchased 19 private lines. The biggest were the Bassina Houillers, Luxemburg, Dendre-Waes, Belgian Great Central and Western Flanders
France	1878, 1909	0.02, 0.12	The state purchased the feeder lines that failed to amalgamate with the Orleans company in 1878. State purchased the West Company in 1909
Switz.	1902, 1903, 1909	0.36, 0.21, 0.03	Nationalization was approved by a referendum in 1898. The state purchased the Swiss Central, North Eastern, Swiss Union, Jura Simplon, and St. Gothard
Italy	1876, 1882, 1905	0.24, 0.19, 0.13	State purchased the Upper Italian, Roman, and Calabrian-Sicilian lines before 1882. In 1905 the state purchased the Adriatic.
Austria	1884, 1888, 1892, 1906, 1908, 1909	0.14, 0.02, 0.06, 0.04, 0.24, 0.15	State purchased 32 private lines. The biggest were Kaiserin Elisabeth-Bahn, Kronprinz Rudolf-Bahn, Gahzische Karl Ludwig-Bahn, Kaiser Ferdinands Nord Bahn, Oesterreich-Unger-Statsbahn
Hungary	1877, 1880, 1884, 1890, 1891	0.07, 0.09, 0.04, 0.08, 0.08	
Bulgaria	1908	0.24	State purchased Vacarel-Bellovo, Belloost-Lubimetz, and Tyrnovo-Seemen-Jamboli lines
Japan	1907, 1908	0.31, 0.25	State purchased 17 companies by a law passed in 1906
Mexico	1903, 1906	0.13, 0.21	State purchased Interoceanic, Mexican Central, and Ilidalgo & Northeastern,
Costa Rica	1901	0.10	
Brazil	1865, 1901, 1902, 1903, 1909	0.22, 0.02, 0.02, 0.14, 0.04	The state purchased the West of Minas Railway in 1903.
Argentina	1863, 1877	0.53, 0.20	
Germany	1879, 1880, 1882, 1883, 1884, 1890,	0.10, 0.04, 0.07, 0.10, 0.04, 0.02	State railways of Prussia-Hesse purchased 8400 miles between 1879 and 1885. Saxony purchased over 780 miles between 1871 and 1907
India	1873, 1880, 1886, 1889, 1892, 1900, 1908	0.02, 0.17, 0.07, 0.04, 0.08, 0.05, 0.03	Nationalizations after 1879 coincided with a policy to have state-owned but privately operated railways. First major nationalization was the East India Railway company in 1879.
Australia	1872	0.04	No information
New Zealand	1886, 1900, 1908	0.03, 0.03, 0.04	No information

Sources: Descriptive information comes from the British Board of Trade, *State Railways* and Thorner (1955).

Table 6: Major Privatizations

Country	Year	Changes due to Privatizations	Description
Holland	1886, 1892, 1898	0.03, 0.02, 0.04	
France	1883	0.07	State ceded lines to companies as part of the Railway Convention of 1883 forming 10 large companies
Portugal	1892	0.28	
China	1903	0.40	
Austria	1901	0.02	
Costa Rica	1899	0.62	
Brazil	1890	0.04	
Argentina	1887, 1889, 1890, 1901	0.03, 0.08, 0.13, 0.08	Provincial railways in Buenos Aires, Entre Rios, and Santa Fe were sold to foreign investors who set private companies

Sources: Descriptive information comes from the British Board of Trade, *State Railways* and Lewis (1983).

Table 7: The Effects of Lagged Ownership Changes with and without Control Variables

Variables	(1) Coeff. (St. Error)	(2) Coeff. (St. Error)
Log of Railroad Miles in year t -1	-.085 (.008)*	-.091 (.008)*
Change due to new miles completed by companies vs. governments, t	.362 (.111)*	.293 (.109)*
Change due to new miles completed by companies vs. governments, t -1	-.038 (.081)	-.071 (.081)
Change due to new miles completed by companies vs. governments, t -2	.162 (.077)*	.122 (.078)
Change due to new miles completed by companies vs. governments, t -3	-.059 (.075)	-.072 (.076)
Change due to new miles completed by companies vs. governments, t -4	-.003 (.074)	-.008 (.075)
Sum of Coefficients for Change due to new miles completed by companies vs govts., t and t-5 (p-value)	**0.42 (0.04)***	**0.26 (0.20)**
Change due to Privatizations, t	-.347 (.218)	-.330 (.217)
Change due to Privatizations, t-1	1.017 (.220)*	1.009 (.217)*
Change due to Privatizations, t-2	.204 (.133)	.161 (.125)
Change due to Privatizations, t-3	.151 (.138)	-.010 (.124)
Change due to Privatizations, t-4	.156 (.135)	-.026 (.124)
Sum of Coefficients for Changes due to Privatizations, t and t-5 (p-value)	**1.18 (0.00)***	**0.80 (0.02)***
Change due to Nationalizations, t	-.112 (.052)*	-.132 (.052)*
Change due to Nationalizations, t-1	-.001 (.051)	.011 (.052)
Change due to Nationalizations, t-2	-.077 (.051)	-.074 (.052)
Change due to Nationalizations, t-3	-.034 (.049)	-.032 (.050)
Change due to Nationalizations, t-4	-.104 (.049)*	-.088 (.050)*
Sum of Coefficients for Changes due to Nationalizations, t and t-5 (p-value)	**-0.33 (0.00)***	**-0.32 (0.00)***
Fraction of Miles owned by Companies, t-5 (p-value)	**.018 (0.35)**	**.012 (0.52)**
All Control Variables Included	Yes	No
Country Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
N	740	740
R-square	0.50	0.44

Notes: * indicates statistical significance at 90% and above.

Table 8: Coefficients for Control Variables

Variables	Sum of Coefficients. (P-value)
$\Sigma_{t-4, t-5, t-6}$ Coefficients for Population Growth	1.112 (0.00)*
$\Sigma_{t-2, t-3, t-4}$ Coefficients for Real G.D.P. Growth	0.076 (0.30)
$\Sigma_{t-2, t-3, t-4}$ Coefficients for Real Yield on British Govt. Bonds	-0.018 (0.00)*
$\Sigma_{t-2, t-3, t-4}$ Coefficients for Govt. Bond Spread	-0.006 (0.00)*
$\Sigma_{t-2, t-3, t-4}$ Coefficients for Log Difference in Exchange Rates	-0.014 (0.76)
$\Sigma_{t-2, t-3, t-4}$ Coefficients for Log Difference in Relative Capital Prices	-0.024 (.061)
$\Sigma_{t-2, t-3, t-4}$ Coefficients for War Dummy	-0.040 (0.00)*
$\Sigma_{t-2, t-3, t-4}$ Coefficients for Change in Military Capability of Neighboring countries	0.012 (0.85)
$\Sigma_{t-2, t-3, t-4}$ Coefficients for Change in Democracy Index	-0.006 (.14)
$\Sigma_{t-2, t-3, t-4}$ Coefficients for Change in Constraints on the Executive	0.021 (.11)
Year Fixed Effects	Yes
Country Fixed Effects	Yes
R-square	0.50
N	740

Notes: * indicates statistical significance at 90% and above.

Table 9: Separate Estimates for Countries with Below or Above Median G.D.P., 1870

Variables	Coefficients for Countries with Below Median G.D.P., 1870	Coefficients for Countries with Above Median G.D.P., 1870
Log of Railroad Miles in year t -1	-.089	-.090
	(.014)*	(.016)*
Change due to new miles completed by companies vs. governments, t	.307	.397
	(.162)*	(.185)*
Change due to new miles completed by companies vs. governments, t -1	-.201	.145
	(.119)*	(.135)
Change due to new miles completed by companies vs. governments, t -2	.014	.375
	(.112)	(.132)*
Change due to new miles completed by companies vs. governments, t -3	-.093	.008
	(.109)	(.124)
Change due to new miles completed by companies vs. governments, t -4	.011	-.066
	(.109)	(.123)
Sum of Coefficients for Change due to new miles completed by companies vs govts., t and t-5 (p-value)	**0.04**	**0.86**
	(0.90)	**(0.00)***
Change due to Privatizations, t	-.063	-.241
	(.291)	(.423)
Change due to Privatizations, t-1	1.136	.740
	(.296)*	(.425)*
Change due to Privatizations, t-2	.193	.126
	(.162)	(.418)
Change due to Privatizations, t-3	.056	.004
	(.172)	(.419)
Change due to Privatizations, t-4	.095	-.345
	(.165)	(.419)
Sum of Coefficients for Changes due to Privatizations, t and t-5 (p-value)	**1.42**	**0.28**
	(0.00)*	**(0.79)**
Change due to Nationalizations, t	-.011	-.188
	(.084)	(.068)*
Change due to Nationalizations, t-1	-.270	.213
	(.082)*	(.069)*
Change due to Nationalizations, t-2	-.045	-.141
	(.081)	(.069)*
Change due to Nationalizations, t-3	-.153	.040
	(.074)*	(.069)
Change due to Nationalizations, t-4	-.156	-.091
	(.075)*	(.069)
Sum of Coefficients for Changes due to Nationalizations, t and t-5 (p-value)	**-0.64**	**-0.17**
	(0.00)*	**(0.23)**
Fraction of Miles owned by Companies, t-5	**.011**	**.050**
(p-value)	**(0.73)**	**(0.06)***
All Control Variables Included	Yes	Yes
Country Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
N	331	408
R-square	0.60	0.57

Notes: * indicates statistical significance at 90% and above. The countries or colonies with below median G.D.P. per capita in 1870 include Russia, Finland, Norway, Portugal, Spain, Italy, Hungary, Japan, Egypt, Mexico, Chile, Brazil, Argentina, and India. The countries with above median G.D.P. per capita include Sweden, Denmark, Holland, Belgium, France, Switzerland, Austria, U.S., Uruguay, United Kingdom, Germany, Australia, New Zealand, and Canada.

Table 10: Separate Estimates for European and Non-European Countries

Variables	Non-European Countries	European Countries
Log of Railroad Miles in year t -1	-.115	-.076
	(.016)*	(.016)*
Change due to new miles completed by companies vs. governments, t	.302	.223
	(.188)	(.154)
Change due to new miles completed by companies vs. governments, t -1	-.210	.082
	(.138)	(.114)
Change due to new miles completed by companies vs. governments, t -2	.055	.199
	(.133)	(.113)
Change due to new miles completed by companies vs. governments, t -3	-.262	-.150
	(.125)*	(.111)
Change due to new miles completed by companies vs. governments, t -4	-.099	-.155
	(.127)	(.109)
Sum of Coefficients for Change due to new miles completed by companies vs govts., t and t-5 (p-value)	**-0.21**	**0.20**
	(0.62)	**(0.44)**
Change due to Privatizations, t	-.697	-.365
	(.321)*	(.374)
Change due to Privatizations, t-1	1.037	.704
	(.319)*	(.375)*
Change due to Privatizations, t-2	.449	-.091
	(.326)	(.156)
Change due to Privatizations, t-3	.325	-.127
	(.356)	(.168)
Change due to Privatizations, t-4	.341	.010
	(.351)	(.158)
Sum of Coefficients for Changes due to Privatizations, t and t-5 (p-value)	**1.45**	**0.13**
	(0.04)*	**(0.84)**
Change due to Nationalizations, t	-.159	-.133
	(.111)	(.053)*
Change due to Nationalizations, t-1	-.266	.124
	(.109)*	(.053)*
Change due to Nationalizations, t-2	-.024	-.051
	(.109)	(.053)
Change due to Nationalizations, t-3	-.145	-.001
	(.097)	(.052)
Change due to Nationalizations, t-4	-.214	.002
	(.098)*	(.053)
Sum of Coefficients for Changes due to Nationalizations, t and t-5 (p-value)	**-0.80**	**-0.06**
	(0.00)*	**(0.63)**
Fraction of Miles owned by Companies, t-5 (p-value)	**-.006**	**-.015**
	(0.91)	**(0.44)**
All Control Variables Included	Yes	Yes
Country Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
N	323	417
R-square	0.64	0.54

Notes: * indicates statistical significance at 90% and above. European countries include Russia, Norway, Denmark, Portugal, Italy, Austria, Hungary, Germany, Sweden, Holland, Belgium, France, Switzerland,

Spain, and the United Kingdom. Non European countries include Mexico, Chile, Brazil, Uruguay, Argentina, India, Japan, Egypt, U.S., Australia, New Zealand, and Canada.
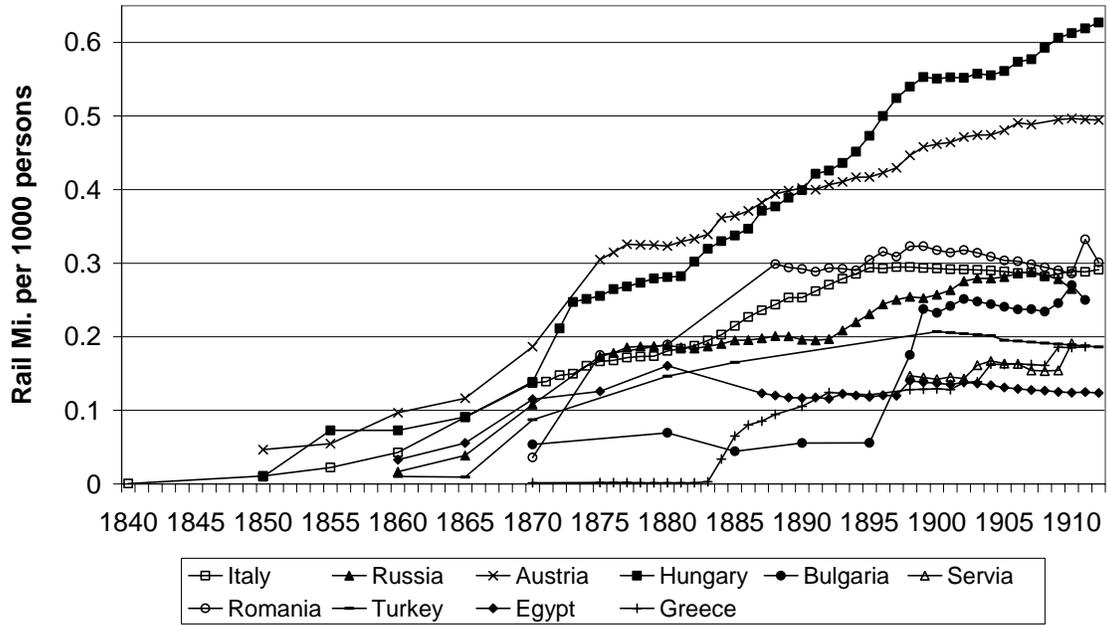
Figures

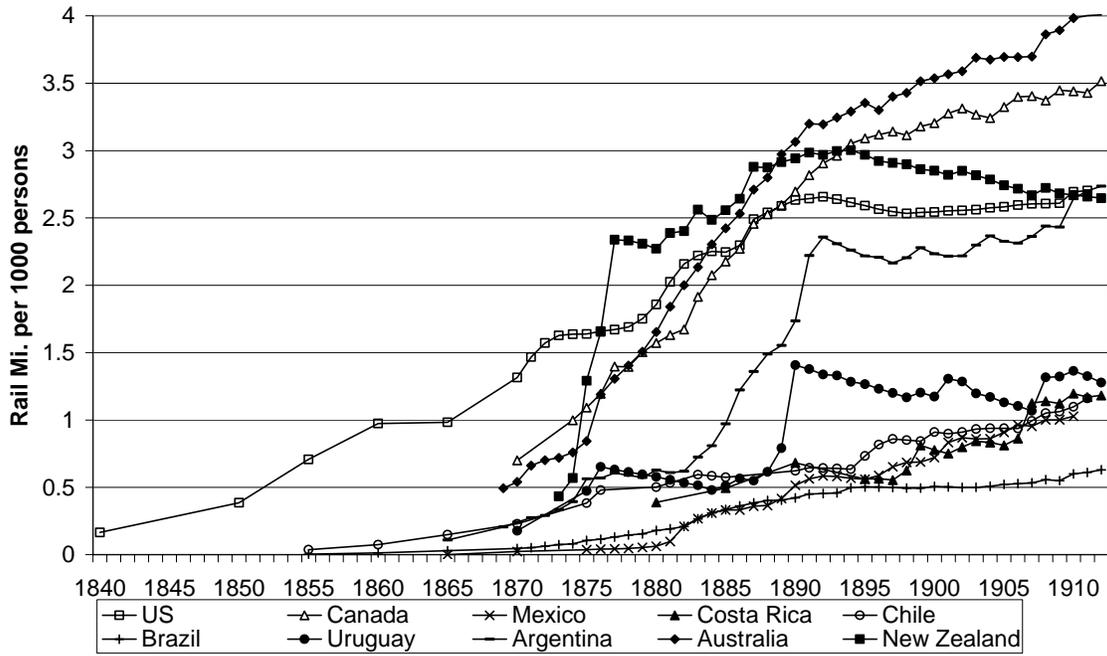**Figure 1: Railroad Miles Per Capita: Western Europe**
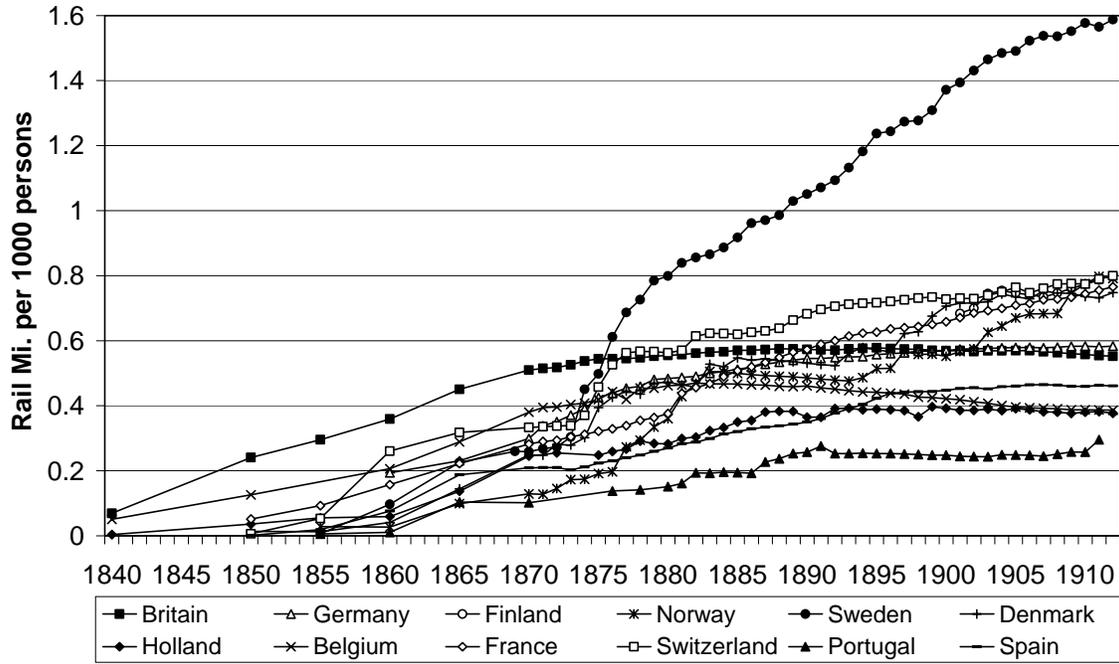
source: see text.

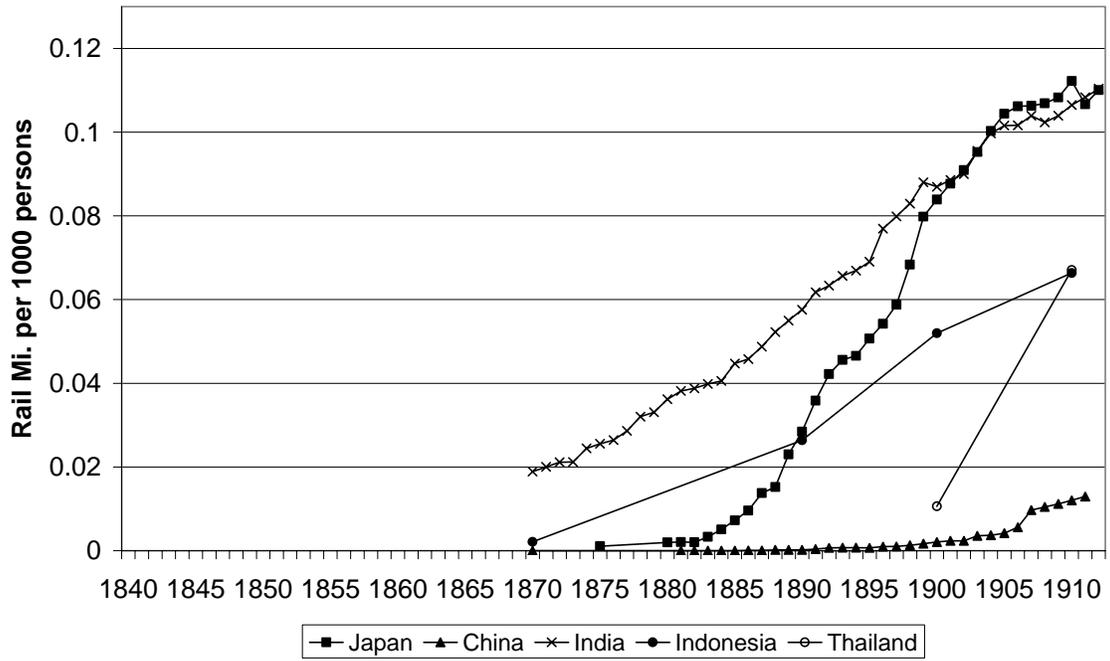**Figure 2: Railroad Miles Per Capita: Central and Eastern Europe, Egypt, and Turkey**

source: see text.

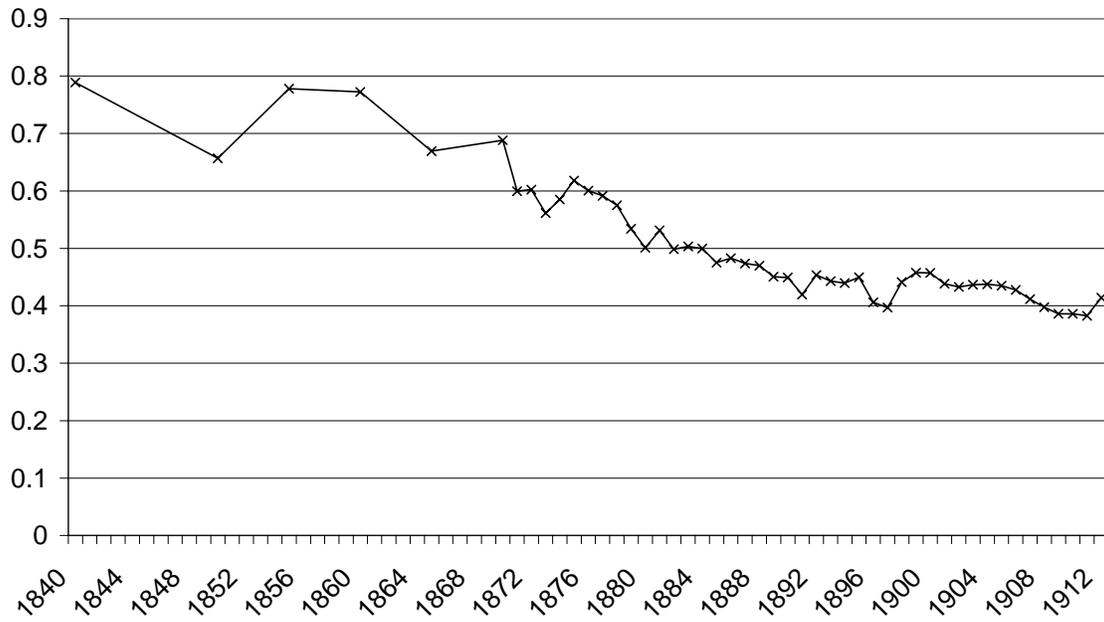**Figure 3: Railroad Miles Per Capita: North and South America, Australia, and New Zealand**

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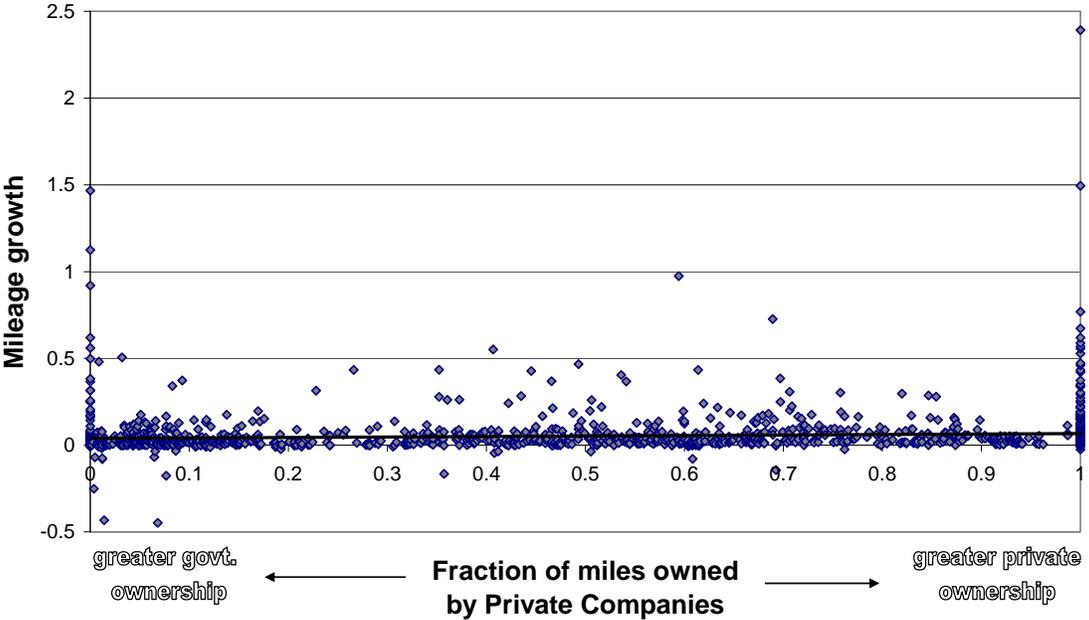
Figure 4: Railroad Miles per Capita: Asia

source: see text.

Figure 5: Estimated Fraction of World Railroad Miles Owned by Companies, 1840-1912
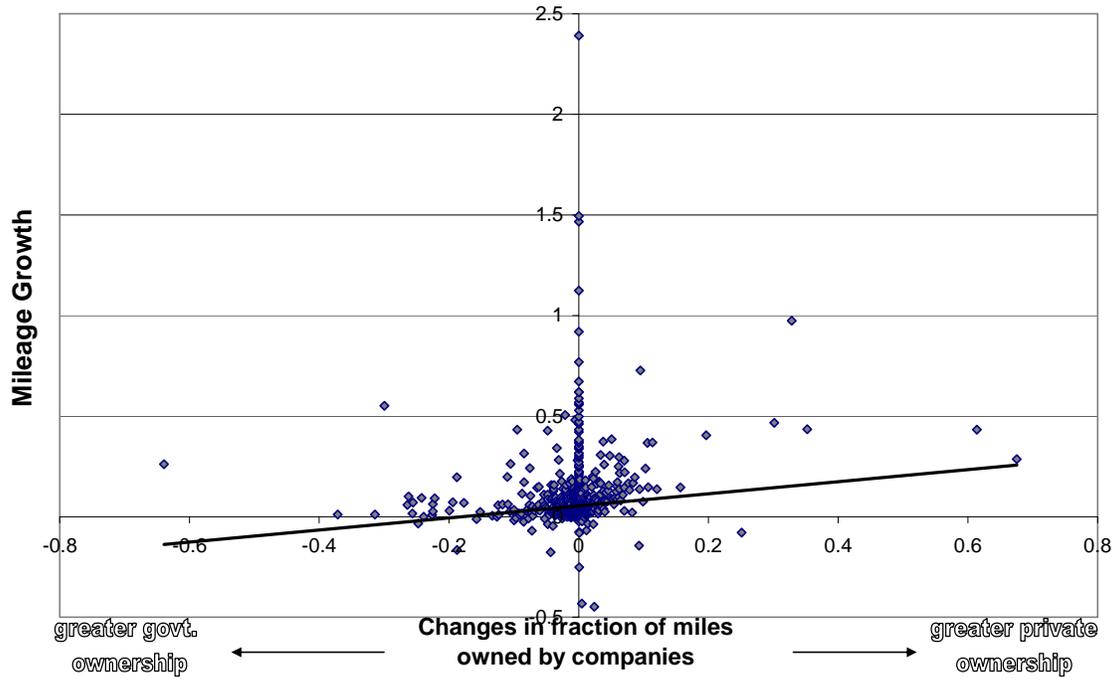

source: see text.

Figure 6: Scatter Plot of the Fraction of Miles Owned by Companies Vs. Mileage Growth

sources: see text.

Figure 7: Scatter Plot of Changes in the Fraction Owned by Companies vs. Mileage Growth

sources: see text.