

Nationalizations and the Development of Transport Systems: Cross-Country Evidence from Railroad Networks, 1860-1912

Dan Bogart¹
Department of Economics, UC Irvine
dbogart@uci.edu

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Abstract

Many states nationalized large portions of their railroad network between 1860 and 1912. This paper uses new cross-country data on the incidence and extent of nationalizations to examine which factors contributed to nationalizations and how nationalizations influenced network expansion. I find evidence that nationalizations were greater in countries with low constraints on the executive branch of government, with French and German civil law systems, and where neighboring countries had higher military capability. I also find evidence that countries experienced lower mileage growth after substantial nationalizations and that part of the decrease in mileage growth was caused by nationalizations. The results are consistent with the hypotheses that external military threats increased the necessity of nationalizations, while legal and political institutions limiting the power of the state raised the costs of nationalizations. They also suggest that nationalizations reduced the investment incentives of both private companies and the state.

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Railroad nationalizations are one of the most visible examples of government intervention in the economy during the 19th and early 20th centuries. Between 1860 and 1910 states in Russia, Sweden, Denmark, the Netherlands, Belgium, France, Switzerland, Italy, Austria, Hungary, Bulgaria, Serbia, Japan, Mexico, Costa Rica, Brazil, Argentina, Germany, India, Australia, and New Zealand nationalized more than 50,000 railroad miles, or around 10% of the miles constructed by 1910. In some cases, states expropriated the assets of several private companies through laws or decrees, and in other cases the state purchased individual railroads that were bankrupt or distressed.

Nationalizations were linked with a broader debate about whether the state should own and operate railroads and whether it should subsidize private railroads with land grants or guarantees on bonds and equity. Nationalizations were controversial because they represented an abrupt change in policy, and in some cases a violation of private property rights. They also touched upon deep political divisions within societies. In Japan, the nationalization bill of 1906 led to shouting and wrestling matches between supporters and opponents in the Parliament.² In Italy, the Minghetti government fell after the furor over the nationalization of the Upper Italy Railway Company in 1875.³

There are several hypotheses in the literature on which factors influenced the likelihood or extent of nationalizations. Many scholars have emphasized the role of military and fiscal factors, particularly in the European context. The argument is that nationalizations were desirable to states because they improved military effectiveness in times of war and it was easier to extract income directly from state-owned railroads rather than through regular taxation. Others have argued that nationalizations were also driven

² Ericson, *Sound of the Whistle*, p. 245.

³ Schram, *Railways and the Formation*, p. 45.

by the poor financial performance of private railroads, especially in Latin America. Poor financial performance has been linked with a variety of factors like ruinous competition, low demand, and high operating costs. Politics has figured prominently in the history of most railroad nationalizations, but the focus has been on individual leaders, like Otto von Bismarck in Prussia. The burgeoning literature on political institutions suggests that weak constraints on the power of the state could also contribute to nationalizations by making it easier to expropriate private property. The origin of the legal system (i.e. common law vs. civil law) could also influence expropriation, in this case through the ability of the state to intervene in judicial matters relating to nationalizations.

Another unresolved question in the literature is whether nationalizations slowed railroad network expansion. One possibility is that nationalizations slowed mileage growth by reducing the investment incentives of private companies. States may have also delayed their own railroad investments following nationalizations. Yet another possibility is that mileage growth would have been similar in the absence of nationalizations, and therefore they had no causal effect on network expansion.

In this paper, I examine these hypotheses using new data on the number of track miles owned by companies or the state in 35 countries or colonies between 1860 and 1912. The data reveal many aspects of railroad ownership, including the number of miles owned by companies or the state in each country and year. Here I use the data to identify the incidence and extent of nationalizations across more than 1200 country-year pairs. I also incorporate cross-country data, like constraints on the executive branch of government, the degree of democracy, legal origin, population density, real G.D.P. per capita, indicators for the military capability of neighboring countries, and a host of other

variables. The first part of the paper identifies which factors increased the incidence of nationalizations as well as their extent, measured by the fraction of miles nationalized. The main results are that nationalizations were more likely or extensive in countries with French and German civil law legal systems, with weak constraints on the executive branch, and where neighboring countries had high military capability. These findings are consistent with the hypotheses that external military threats increased the necessity of nationalizations, while legal and political institutions limiting the power of the state raised the costs of nationalizations.

The second part of the paper tests whether nationalizations reduced railroad mileage growth using a simple differences-in-differences procedure as well as two-stage least squares. The two-stage least squares model builds on the analysis of the previous part and assumes that the fraction of miles nationalized in each country is endogenous. The key exclusion restriction is that political and legal institutions influenced the cost of implementing nationalizations, but had no permanent effect on mileage growth after controlling for spillover channels like higher G.D.P. per capita. The differences-in-differences estimates reveal that countries had lower mileage growth relative to other countries in the 4 years following large nationalizations. The two-stage estimates show that greater nationalizations reduced mileage growth, suggesting that nationalizations did indeed slow network expansion.

The last part of the paper compares the results with the historiography on railroad nationalizations in several countries. The results are consistent with case-study evidence that some states nationalized for military reasons, some to perpetuate the operation of unprofitable railroads, and others in the hopes of extracting greater revenues. The case

study evidence also indicates that the process of nationalization was more protracted or difficult in countries where the executive had to convince the legislature or the electorate to support nationalizations. Finally, there is some evidence that courts in civil law countries were ineffective in preventing states from forcing companies to sell their shares at below market prices.

The findings relate to the literature examining state ownership and regulation of infrastructure.⁴ Most studies reach a similar conclusion that ownership and regulation policies affect the investment and pricing behavior of private companies. They also point to the multiplicity of factors which determined policies as well as the investment and pricing behavior of the state. This paper adds to the literature by quantitatively examining the determinants of nationalizations and addressing endogeneity concerns.

The findings also relate to the broader literature examining the role of political and legal institutions in economic development.⁵ This paper provides evidence that institutions which placed fewer limits on the powers of presidents, monarchs, or prime ministers indirectly slowed network expansion by lowering the costs of implementing nationalizations. As such, it suggests one mechanism by which institutions contributed to differences in infrastructure investment across countries.⁶

The paper is organized as follows. The next section discusses hypotheses about the determinants and consequences of nationalizations. The following section introduces the

⁴ See Millwad, *Public and Private*, Keefer, “Protection,” Wallsten, “Returning”, and the edited volume by Andersson-Skog and Krantz, *Institutions in the Transport*, for some recent examples of papers examining regulation and ownership in a comparative or institutional context.

⁵ See Acemoglu, Johnson, and Robinson, “Institutions” and La Porta, Lopez-de-Silanes, and Shleifer, “The Economic Consequences” for some recent papers analyzing this issue.

⁶ For related work on the effects of institutions on infrastructure see Henisz, “The Institutional Environment.”

data. The next three present the econometric results and discuss their connection with the case-study literature. The last section concludes by discussing the implications.

HYPOTHESES

The Determinants of Nationalizations

One of the main hypotheses in the literature is that military considerations affected the incidence or extent of nationalizations.⁷ This argument builds on the view that the primary concern of the nation state was to provide protection against the military aggression of its neighbors.⁸ Armies were much more effective if troops and supplies could be moved by rail rather than by wagons. In times of conflict, states could use their own railroads or they could enter into negotiations with private railroad companies. In most cases, it was more costly to negotiate with companies, and therefore, states had an incentive to nationalize railroads if they faced significant military threats from their neighbors or recently experienced war.

A second hypothesis argues that nationalizations were common in countries where private railroads experienced financial difficulties. In general, states might have an interest in buying bankrupt railroads and continuing their operation because their constituencies are dependant on railroad services. States might also operate unprofitable railroads because they believe it will generate spillovers and promote economic development.⁹ Low population density is one factor that contributes to poor financial

⁷ See Millwad, *Public and Private*, pp. 62-72, for a discussion of military considerations in European ownership policies.

⁸ See Charles Tilley, *Coercion*, for an analysis of military security in European history.

⁹ See Gerschenkron, *Economic Backwardness*, for a general argument that governments in less developed countries intervened in the economy because there were inadequate supplies of capital, skilled labor, entrepreneurship and technological capacity.

performance because the demand for railroad services is spread across a larger spatial area, while the operating costs are higher. High railroad miles per square mile can also contribute to poor financial performance because competition is likely to be greater between railroads in close proximity. These arguments imply that nationalizations should have been more common or extensive in countries with low population density and/or high railroad density.

A related argument is that low real G.D.P. per capita reduced the demand for railroad services and therefore decreased railroad profits. The state then found it necessary to nationalize unprofitable railroads to ensure their continued operation. The testable implication is that nationalizations should have been more common or extensive in countries with low real G.D.P. per capita.

The hypothesis that state's nationalized to extract greater revenues implies a potentially different relationship between G.D.P. per capita and nationalizations. Higher G.D.P. per capita meant a higher demand for railroad services, and given there was imperfect competition or restrictions on the supply of railroad services, higher demand would imply there were greater profits or rents that could be extracted by the state through direct ownership.¹⁰ Therefore, if extraction was the main motivation, then nationalizations may have been greater in rich countries where the state could earn more from railroad customers.

The effects of higher G.D.P. per capita might also depend on the level of railroad density. When railroad density is high, there are greater sunk investments in the network which can be expropriated. In such cases, greater G.D.P. per capita might increase

¹⁰ In most cases, the state should prefer to extract through state-ownership because income tax collection is particularly costly. See Schram, *Railways and the Formation*, p. 49 for a discussion of this issue in the Italian case.

nationalizations because the combination of higher demand for services and greater sunk investments would increase the profits that could be extracted through nationalizations.¹¹ On the other hand, when railroad density is low, greater G.D.P. per capita might decrease the necessity of nationalizations because the combination of higher demand and less competition improved the financial performance of companies.

The costs of implementing nationalizations suggest other determinants. There is a large literature arguing that states are less likely to expropriate private property if they are constrained by formal political institutions.¹² In the 19th century, several countries experienced constitutional changes that reduced the powers of the executive (i.e. the president, prime minister, emperor, or monarch) vis-à-vis the legislature.

Nationalizations may have been rare in such countries because the executive had to gain the consent of the legislature, which was costly in terms of time and resources. A related argument suggests that greater democracy may have reduced nationalizations because the executive and/or the legislature had to spend more time and resources convincing the electorate to accept nationalizations.

Legal systems may have also influenced the costs of nationalizing railroads. Legal systems are usually defined by their codes, modes of thought, and ideologies. A series of authors, including Rafael La Porta, Florencio Lopez-de-Silanes, Andrei Shleifer, and Paul Mahoney argue that countries with civil law legal systems tend to have greater government ownership and regulation compared to countries with common law

¹¹ Put differently, the state would like to wait until private companies build the network and demand becomes large before they start extracting income. If they were to nationalize a small network with low demand, then they would need to finance construction and wait for demand to increase.

¹² See North, *Structure and Change*, and Acemoglu, Johnson, and Robinson, "Institutions."

systems.¹³ The differences between civil and common law countries are sometimes attributed to differences in the capacity of the executive to interfere in judicial matters. This argument would imply that nationalizations were greater in civil law countries because the executive could manipulate judicial decisions which might otherwise slow-down or prevent nationalizations. La Porta, Lopez-de-Silanes, and Shleifer also argue that differences in laws, tools, and attitudes imply that governments in civil law countries are more likely to repress or replace the market system when challenges emerge.¹⁴ This argument suggests that civil law countries were more prone to nationalizations.

The Effects of Nationalizations on Network Expansion

In discussing the effects of nationalizations on network expansion, it is revealing to start with assumptions about the objectives of the state and how the private sector might respond. If the state nationalized railroads in order to extract greater revenues, then it would have an incentive to limit competition from private railroads. One way of limiting competition is to raise barriers-to-entry for private railroads, which should reduce network expansion. Network expansion might also be lower because the private sector believes there is a greater risk of expropriation. This concern will make companies more hesitant about starting new railroad projects because they anticipate there is some probability they will be forced to sell their assets at below market prices.¹⁵

Nationalizations can also change the incentives of a profit-maximizing state as it considers the expansion of its own network. The key issue is whether the state has greater monopoly power following railroad nationalizations. Knick Harley develops a

¹³ See La Porta, Lopez-de-Silanes, and Shleifer, "Government Ownership" and "The Economic Consequences" as well as Mahoney, "The Common Law."

¹⁴ La Porta, Lopez-de-Silanes, and Shleifer, "The Economic Consequences," p. 40

¹⁵ In *Regulations*, Levy and Spiller provide a general argument that private infrastructure investment will be low whenever there is a lack of commitment to protect property rights.

model of investment incentives for competitive and monopolistic railroads.¹⁶ He argues that a monopolist can earn higher rents by avoiding construction ahead of demand while under competition building ahead of demand is the only way to capture rents. Harley's model implies that if nationalization increased monopoly power then network expansion should proceed more slowly than if the market was competitive.

Network expansion could also decrease if the state nationalizes private railroads that were financially unsuccessful. The need to subsidize the operation of struggling railroads could limit the state's ability to finance additional construction of state-owned railroads, or to guarantee debt issued for new private construction. If the railroad network is over-developed relative to the income level of the country, then the state may try to rationalize the railroad sector by limiting the construction of additional lines. Notice that in this latter scenario nationalizations may have been socially beneficial, because the state was addressing the problem of over-investment by the private sector.

DATA

To test hypotheses about nationalizations, this paper makes use of new cross-country data on the number of railroad miles owned by the state and private companies between 1840 and 1912. Most of the data on ownership comes 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 of which are published by the Board of Trade in Great Britain.¹⁷ For some countries, *The Statistical Abstracts* do

¹⁶ Harley, "Oligopoly Agreement."

¹⁷ The latter publication was continued under the title, *Statistical Abstract for the Several British self-governing dominions, colonies, possessions, and protectorates*.

not distinguish between miles owned by companies and the state.¹⁸ I use several additional sources to identify railroad ownership in such cases.¹⁹ In most cases, it was straightforward to fill the gaps by identifying state-owned and operated lines and privately-owned and operated lines. When track miles were state-owned, but privately-operated, I chose to assign ownership to the state because it retained control over extensions to the network, and it was the ultimate residual claimant.²⁰

Figure 1 shows a weighted average of the fraction of miles owned by companies between 1840 and 1912 (the weights correspond to the size of the railroad network across countries). Private ownership was predominant up to the 1860s, but afterwards there was a gradual shift towards greater state ownership. By 1912, only 40 percent of all railroad miles were owned by companies as compared with over 70 percent before 1860.

The shift to greater state ownership was driven by construction of new state-owned railroads and the nationalization of private railroads. Unfortunately, *the Statistical Abstracts* do not provide information on the number of railroad miles that were nationalized in each country and in each year, but I can approximate the number of miles nationalized by the absolute reduction in railroad miles owned by private companies. Specifically, I assume that miles nationalized in year t equals $(\text{private miles}_{t-1} - \text{private miles}_t)$ if $\text{private miles}_{t-1} > \text{private miles}_t$ and 0 otherwise.

This measure of the number of miles nationalized is biased upwards in some cases because a decrease in private miles can be due to companies shutting down tracks. The

¹⁸ 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 state tracks through a lease contract, then it did not assign mileage to either companies or the state.

¹⁹ See the appendix for sources on the ownership status of each country or colony.

²⁰ My later conclusions are likely to be the same, if I were to adopt the opposite assumption that state-owned and privately operated lines were private. The Board of Trade Report, *State Railways* pp. 3-7, estimates that only 2.7% of the world's railway miles were state-owned and privately operated in 1910.

measure is also biased downwards in some cases because companies may have completed new miles between $t-1$ and t , which would reduce the observed decline in private miles. Despite these drawbacks, it is clear that nationalizations account for most of the reductions in private miles because they usually correspond with large increases in state-owned miles. For example, in 1894 Russia had 9480 private miles and 11,218 state miles for a total of 20,698 miles. In 1895, it had 8421 private miles and 13,527 state miles for a total of 21,948 miles. It is implausible that private companies shut down more than 1059 miles of track between 1894 and 1895, while the Russian state completed more than 2309 miles of track. Instead it is more likely that the state nationalized around 1059 miles and completed around 1250 new state-owned miles.

The measure of nationalizations can also be checked using secondary sources, like the Board of Trade report, *State Railways*. Table 1 lists all country-year pairs where the number of miles nationalized exceeds a threshold of 2 percent of the total number of railroad miles in that year. For several cases, I can document a correspondence between measured nationalizations and documented nationalizations. For example, the Board of Trade reports that the Belgian government purchased 19 private lines, and in 1897 it purchased three large lines, the Ghent Ecloo, the Belgian Great Central, and Plateaux de Herve. In 1898, I estimate that 453 miles of private railroads were nationalized in Belgium, which clearly reflects these purchases.

After identifying the number of miles nationalized in each year t , I construct three variables of interest. First, for each country and year, I calculate the cumulative number of miles nationalized in all previous years and divide it by the total number of miles in year t . I label this variable the fraction of railroad miles nationalized by year t . It

measures the extent of nationalizations.²¹ Second, I construct a nationalization dummy variable if the country had at least 2 percent of its railroad miles nationalized by 1910. The 2 percent threshold is useful because it separates countries with minor nationalizations from those with moderate or substantial nationalizations. Lastly, I calculate the annual percentage change in total railroad miles for each country. Railroad mileage comes from *the Statistical Abstracts* or *International Historical Statistics*.²²

The data on nationalizations and mileage growth is combined with information on the characteristics of countries or colonies, including real G.D.P. per capita, population, land area, government bond yields, exchange rates, consumer price indices, the price of railroad capital goods, an index for constraints-on-the-executive branch, an index for the degree of democracy, legal origin, the military capability of neighboring countries, and whether the country has gone to war. Most of the real G.D.P. per capita and population figures are from Angus Maddison's work.²³ Full details on the sources for bond yields, price indices, and exchange rates are provided in appendix 1.

The Polity IV data set provides institutional variables for many countries starting in 1800.²⁴ 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.

²¹ For instance, a value of 0.25 indicates that 25 percent of the railroad miles in country *i* were nationalized by year *t*. A value of 0 indicates that none of its miles were nationalized.

²² See Mitchell, *International Historical Statistics*.

²³ Maddison, *The World Economy*.

²⁴ See the Polity IV webpage for more details, <http://www.cidcm.umd.edu/inscr/polity/>. Polity IV classifies political institutions in some colonies but not all. There are no indicators for India before 1950, Egypt before 1922, or Australia before 1901. I drop these colonies for the cross-section analysis in 1910, but I do not drop them from the panel analysis. Instead I assume that constraints on the executive and democracy in Australia, India, and Egypt were constant from 1870 and 1912. The choice of the level of institutions has no effect on the later results because country fixed effects absorb all time-invariant unobservable characteristics.

after 1871). The “constraints-on-the-executive” variable 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). Many scholars have used the polity IV variables for democracy and constraints-on-the-executive as a measure of political checks and balances.²⁵ In most cases, they analyze the cross-sectional variation, but in the 1860 to 1912 period it is possible to exploit the variation over time because there was a shift towards higher constraints and higher democracy in some countries, but in others there was little change or even a reduction in constraints and democracy.

Most legal systems were transplanted (in part or whole) through colonization and the military conquests of Napoleon in the early nineteenth century. Therefore, legal origins are constant for most countries between 1860 and 1912. La Porta, Lopez-de-Silanes, and Schleifer distinguish between common law, French civil law, German civil law, and Scandinavian civil law.²⁶ I use their classifications to identify countries with common law and Scandinavian civil law systems.²⁷ I group together all the countries with French and German civil law classifications because the distinctions were not so sharp in the early 20th century.²⁸

²⁵ See Acemoglu, Johnson, and Robinson “Institutions” for a survey of the literature using these variables.

²⁶ La Porta, Lopez-de-Silanes, and Schleifer, “The Economic Consequences,” Figure 1.

²⁷ The common law countries in my data include the U.K., U.S., India, Canada, New Zealand, and Australia. The Scandinavian civil law countries include Finland, Norway, Sweden, and Denmark.

²⁸ The French and German civil law countries are Russia, Holland, Belgium, France, Portugal, Spain, Italy, Austria, Hungary, Egypt, Japan, Mexico, Chile, Brazil, Uruguay, Argentina, and Germany. See Sherman, *Roman Law*, for a discussion of French and German legal systems.

The Correlates of War database provides dates for inter-state wars, intra-state wars, and extra-state wars starting in 1815.²⁹ I use this data to code to a war dummy variable which identifies whether a country was in any type of war in each year. The Correlates of War database also provides military capability data for each country.³⁰ It includes an average of six indicators: military expenditure, military personnel, energy consumption, iron and steel production, urban population, and total population. Military capability has been used in international relations research to predict the onset of war.³¹ I build on this research and define the military capability of neighboring countries as the population-weighted average of the military capability index among contiguous countries.³²

THE DETERMINANTS OF NATIONALIZATIONS

There were 18 countries or colonies that experienced significant nationalizations between 1870 and 1912 (see Figure 2). Switzerland, Austria, and Japan had the highest fraction of miles nationalized, exceeding 0.5 by 1912. The state took over all miles in Switzerland and Japan after the passage of nationalization laws in 1898 and 1906 respectively. Italy, Belgium, Germany, Mexico, Hungary, and Russia also had a significant fraction of miles nationalized, exceeding 0.25 at some point between 1870 and 1912. Many of these countries experienced several nationalizations in this period. India, Denmark, Bulgaria, Brazil, and France are a third group with a fraction nationalized between 0.1 and 0.25. Holland, New Zealand, Austria, and Serbia are a fourth group

²⁹ Sarkees, "The Correlates of War Data."

³⁰ Singer, Bremer, and Stuckey, "Capability Distribution" and Singer, "Reconstructing."

³¹ For an example, see Schampel "Change in Material Capabilities."

³² There is no military capability data for Australia and New Zealand which were British colonies. This is problematic because they are the only neighbors to one another. They are dropped for the cross-sectional analysis in 1910. For the panel analysis, I assume their military capability was constant.

with a fraction nationalized between 0.02 and 0.1.³³ The countries or colonies with no (or very minor) nationalizations include Finland, Norway, Sweden, Portugal, Spain, Romania, Egypt, Greece, the United States, Chile, Uruguay, Argentina, China, the United Kingdom, and Canada.³⁴

What was different about countries with nationalizations? Table 2 addresses this question using cross-sectional variation in the incidence or extent of nationalization in 1910. Columns (1), (2), and (3) show estimates from a multivariate probit model where the dependent variable is 1 if the country had at least 2%, 1%, or 5% of their miles nationalized by 1910.³⁵ Summary statistics for all the variables are reported in appendix table 7. The results show that average military capability of neighboring countries between 1870 and 1910, the dummy variable for French/German civil law systems, and railroad miles per square mile in 1910 are all positively and significantly associated with the incidence of nationalizations. Average constraints-on-the-executive between 1870 and 1912 is negatively and significantly associated with the incidence of nationalizations. G.D.P. per capita in 1870 and average population density are negative and significant in some specifications. Average democracy and the average growth rate in G.D.P. per capita are not significantly related to nationalizations in any specification.

The estimated marginal effects for column (1) imply that French/German civil law countries were 65% more likely to have nationalizations than the omitted group which is common law or Scandinavian civil law countries. A one-unit increase in constraints-on-

³³ Costa Rica also had significant nationalizations, but it will not be used in the subsequent analysis because of missing variables for annual G.D.P. per capita.

³⁴ Sweden had less than 2% of its miles nationalized by 1910. Argentina had most of its nationalizations in the 1860s and had less than 1% of its miles nationalized by 1910.

³⁵ Australia, New Zealand are dropped from the cross-sectional analysis because there is no data on the military capability of neighboring countries. Egypt is also dropped because there is no data on constraints-on-the-executive.

the-executive reduces the probability of nationalization by 27%. A one-unit increase in the log military capability of neighboring countries, which is around a one-standard deviation increase, raises the probability by 67%. Lastly, a one-unit increase in log railroad miles per square mile increases the probability of nationalization by 89%.

The dependent variable in columns (4) and (5) is the fraction of miles nationalized by 1910. Least squares estimates show that average military capability is positively and significantly associated with the extent of nationalizations. French/German civil law countries have a greater extent of nationalizations than common law or Scandinavian civil law countries, but there is little difference between the latter two groups.

The extent of nationalizations can also be analyzed using panel data methods. Variation over time can reveal whether the fraction of miles nationalized increased in a country when the military capability of neighboring countries or railroad density increased. Similarly it can identify whether the fraction of miles nationalized decreased when constraints-on-the-executive, population density, or G.D.P. per capita increased.³⁶ The following regression model describes a linear relationship between the fraction of miles nationalized in country i by year t ($fracnat_{it}$) and several variables dated in $t-5$:

$$fracnat_{it} = \alpha_i + \delta_t + \beta_1 institutions_{it-5} + \beta_2 development_{it-5} + \beta_3 military_{it-5} + \varepsilon_{it} \quad (1).$$

α_i is a country fixed effect and δ_t are year dummies. They control for country-specific unobservable factors that do not change over time and year-specific factors that affect all countries. The main explanatory variables are set in year $t-5$ to avoid simultaneity and to allow for a lagged response to economic, political, and military changes.

³⁶ Unfortunately, Bulgaria, Serbia, Romania, Turkey, Greece, and China are dropped from the panel analysis because of missing variables, particularly G.D.P. per capita.

The vector $institutions_{it-5}$ includes indices for constraints-on-the-executive and democracy. Also included is a variable for the time trend (i.e. $t = 1865, 1866, \text{etc.}$), an interaction between the time trend and the dummy for French/German civil law systems, and an interaction between the time trend and the dummy for Scandinavian civil law systems.³⁷ The coefficient for the time trend captures the average annual increase or decrease in the fraction of miles nationalized in countries with common law systems. The interactions capture the differential average increase or decrease for countries with French/German civil law or Scandinavian civil law systems compared to countries with common law systems. These variables have a similar interpretation as country-specific time trends, except they apply to a group of countries with the same legal origin.³⁸

The vector $development_{it-5}$ includes the log of population density, the log of G.D.P. per capita, and the log of railroad miles per square mile. An interaction between the latter two variables is also included to capture the differential effect of higher railroad density in rich or poor countries and the differential effect of higher G.D.P. per capita in high or low railroad density countries. The vector $military_{it-5}$ includes the log military capability of neighboring countries and a dummy variable if the country was at war.

Overall the panel results are similar to the cross-sectional results and suggest several conclusions regarding the determinants of nationalizations (see table 3). First, the estimates show that the fraction of miles nationalized increased in a country when the military capability of neighboring countries increased. This finding suggests that external

³⁷ It is necessary to include an interaction between the legal origins dummies and the year because legal origins do not change over the sample period and thus they cannot be estimated with country fixed effects.

³⁸ See Wooldridge, *Econometric Analysis*, p. 315-317 for a discussion of fixed effects models with individual specific slopes, or specific slopes for program participants.

military threats raised the necessity of nationalizations.³⁹ Second, the results show that the fraction of miles nationalized decreased when constraints-on-the-executive or democracy increased. This suggests that it was more costly for presidents, prime ministers, or monarchs to nationalize railroads in countries where they had to gain the consent of an independent legislature or the electorate. Third, there was a higher average annual increase in the fraction of miles nationalized for countries with French/German civil law systems compared to common law systems. This suggests that nationalizations were more common in countries where the executive could manipulate judicial decisions or where laws, tools, and attitudes made countries more prone to state ownership.

With respect to the development variables, the results show that the fraction of miles nationalized decreased when population density increased. This finding is consistent with the view that nationalizations were less necessary when demand for railroad services became concentrated in a smaller spatial area. The results in columns (1) and (2) show that railroad density and G.D.P. per capita influenced nationalizations only in a specification where they are interacted. The results can be interpreted by predicting the fraction of miles nationalized after assigning each country-year pair with a one standard deviation increase or decrease in railroad density and G.D.P. per capita relative to the overall population mean, and then averaging over all countries in the sample (see table 4). The estimates imply that higher railroad density always increased the extent of nationalizations. However, higher G.D.P. per capita increased nationalizations when railroad density was high and decreased nationalizations when railroad density was low. The latter finding suggests that states nationalized more when high demand was combined with greater sunk investments in the network, and they nationalized less when

³⁹ The insignificance of the war dummy suggests that the incidence of war mattered less.

high demand was combined with lower competition between railroads. Later I discuss how this result is consistent with case-study evidence that some states nationalized profitable railroads to increase their own revenues, and others nationalized railroads that were experiencing financial difficulties.

As a robustness check, column 3 in Table 3 shows a specification which includes economic growth, population growth, differences in political institutions, and differences in military factors in t-3 and t-4 as additional controls. The estimates for the main variables are qualitatively similar. None of the added variables is statistically significant with the exception of differences in constraints-on-the-executive in t-4, which had a negative effect on nationalizations.

THE CONSEQUENCES OF NATIONALIZATIONS FOR NETWORK EXPANSION

Railroad mileage growth differed substantially across countries between 1860 and 1912. Mileage growth was generally higher in Australia, the U.S., Canada, and parts of Western Europe, while it was generally lower in Eastern Europe, Asia, and parts of Latin America. Mileage growth differed because of a variety of factors, like initial network size, economic performance, and the state of financial markets. Nationalizations may have also influenced mileage growth by reducing the investment incentives of both private companies and the state. One possibility is that the private sector was hesitant about investing in railroads following nationalizations because of fears that the state would expropriate their investments. Another is that the state limited network expansion following nationalizations to increase its profits from state-owned railroads, or to curtail railroad development until economic growth made greater expansion financially viable.

In this section, I test whether nationalizations reduced railroad mileage growth using a variety of techniques. First, a differences-in-differences approach is used to examine the change in mileage growth four years before and after nationalizations. Second, I build on the results from the previous section and use the institutional variables as instruments for the extent of nationalizations in a two-stage least squares regression.

Figure 3 plots the average mileage growth rate four years before and after a country experienced a nationalization of at least 2% of its railroad network. The surrounding band shows a 90% confidence interval for the mean growth rate. 0 on the x-axis corresponds to the year when nationalization occurred. The data show that the average growth rate was 0.92% lower for a country from year 0 to 4 compared to years -4 to -1. Mileage growth was especially low in year 0 and is statistically different from the growth rate in years -2, -3 and -4, but not year -1.

Figure 4 plots the average difference in mileage growth between countries that had nationalizations below the median size and all countries in the same year. Figure 5 plots the average difference between countries that had nationalizations above the median size and all countries in the same year (the differences are expressed on an inverted scale). Countries with nationalizations generally had a lower mileage growth rate than other countries, but the average difference in mileage growth appears to be similar before and after nationalizations below the median size. In the years -4, -3, -1, the difference in mileage growth ranges between -1.6% and -3.5% and in year 0 the difference is -2.9%. The differences are similar in years 1, 2, 3, and 4.

The patterns are different for nationalizations above the median size (see figure 5). The difference in mileage growth is around -1% in years -4, -3, and -2, but in year 0 it

increases to -4.6%. The difference-in-difference between year 0 and years -4, -3, or -2 is statistically significant. The difference in mileage growth in years 2, 3, and 4 is 0.8% lower than the difference in years -4, -3, and -2, although in this case it is not statistically significant.

Figures 4 and 5 reveal that mileage growth was generally lower following nationalizations that were substantial in terms of mileage. The data also show that mileage growth began to decrease one year before large nationalizations occurred. One explanation is that companies or the state anticipated nationalizations and began building fewer lines.⁴⁰ Another explanation is that large nationalizations were themselves a response to the factors which reduced mileage growth.

As the preceding remark suggests, it is not clear that nationalizations caused mileage growth to decrease, even though there was a decline in mileage growth following large nationalizations. The main problem is that the state chose to nationalize based on a variety of considerations, including its expectations about mileage growth.⁴¹ There are several ways to address this endogeneity problem. Here I follow a common approach in economics by estimating a two-stage least squares model. The second-stage equation for mileage growth in country i in year t is given by:

$$mileagegrowth_{it} = \eta_2 fracnat_{it} + \beta_2 x_{it-j} + \alpha_{2i} + \delta_{2t} + \varepsilon_{2it} \quad (2)$$

$fracnat_{it}$ is the fraction of miles that were nationalized by year t , x_{it-j} is a vector of control variables dated in $t-j$, α_{2i} is a country fixed effect, δ_{2t} is a year dummy, and ε_{2it}

⁴⁰ For instance, in Japan and Switzerland, nationalization bills underwent a lengthy debate years before they were passed. It is likely that companies and government officials could foresee these laws.

⁴¹ See Wooldridge, *Econometric Analysis*, p. 105 for a discussion of the bias from reverse causation, omitted variables, and measurement error in the standard regression model.

is an error term.⁴² The main hypothesis is that mileage growth should be lower when a country has a greater fraction of miles nationalized by year t .⁴³

The control variables capture several factors in years $t-3$, $t-4$, and $t-5$ that influence mileage growth in t . The time-lag reflects the fact that it often took several years to complete a railroad project.⁴⁴ The log of real G.D.P. per capita in $t-5$, the log of railroad miles per square mile in $t-5$, and an interaction between G.D.P. per capita and railroad density in $t-5$ are among the most important control variables. Higher G.D.P. per capita should increase mileage growth by raising the level of demand for railroad services. Higher railroad miles per square mile should reduce mileage growth because the returns to building new lines are lower when the network is already dense. The interaction term allows for the possibility that higher G.D.P. per capita increases mileage growth by more in low railroad density environments. I also include a dummy variable for war in $t-5$ because it could decrease the initiation of new railroad projects by disrupting markets.

Other important control variables are the growth rate of real G.D.P. per capita, the log of the real yield on British government bonds, the risk premium on government bonds, and the log difference in the exchange rate for the country in years $t-3$ and $t-4$. Higher real G.D.P. per capita growth should increase mileage growth because it signals greater demand for railroad services in the future. Higher real yields on British govt. bonds should reduce mileage growth because it proxies for real interest rates in the world

⁴² To avoid a direct correlation between the fraction of miles nationalized and new miles added in year t , I divide the number of miles nationalized by the number of miles in year $t-1$ instead of year t .

⁴³ Greater nationalizations imply that the state can extract greater income by raising barriers to entry or by delaying their own investments. Moreover, greater nationalizations might imply that the state is more fiscally constrained and cannot subsidize or pay for new construction, or that the state needs to curtail railroad development even more to rationalize the industry. Lastly, the private sector may believe that the risk of future expropriations are larger if the state nationalizes many miles.

⁴⁴ Evidence from *Estadística de los Ferrocarriles en Explotación* suggests it usually took 3 to 4 years to complete most railroad projects, although there were certainly cases where it took as little as 1 or 2 years or as many as 5 or 6 years.

economy. A higher risk premium on government bonds indicates that investors believe there are greater risks from investing in the country, and therefore, it should be negatively associated with mileage growth. An increase in the exchange rate reflects currency depreciation, which should reduce mileage growth because it signals that railroad revenues in the home currency have less value on international markets.⁴⁵

Several variables are excluded from the mileage growth equation and are used as instruments for the fraction of miles nationalized in the first-stage equation. In all specifications, the separate time trends for common law and civil law countries along with the level of constraints-on-the-executive and democracy in t-5 are excluded.⁴⁶ The key assumption is that legal origins and changes in constraints-on-the-executive or democracy influenced nationalizations, but did not have a *long-run* effect on mileage growth.⁴⁷ It is possible that greater democracy or constraints on the executive increased the security of all property rights in the economy, which might then have a positive spillover effect on the railroad sector. This is less of a concern in my model because I

⁴⁵ The other control variables dated in t-3 and t-4 include the log difference in railroad capital prices, dummies for entry/exit into war, the log difference in the military capability of neighboring countries, differences in the index for constraints-on-the-executive, and differences in the democracy index. Higher railroad capital prices should lower mileage growth by raising the cost of purchasing capital goods necessary for the construction and operation of railroads. Entry into war is likely to decrease the initiation of new railroad projects by disrupting markets. Changes in military threats from neighboring countries could increase mileage growth in the short-run by encouraging the government to build more railroads along its borders, or between military installations and major cities. Lastly, constitutional changes which increased constraints-on-the-executive and democracy may increase mileage growth in the short-run because they are linked with greater optimism about the economy. I also include population growth in t-5 and t-6. Population growth should increase mileage growth by increasing the number of railroad customers. The increase in customers will come at a later date and so I assume population growth influenced mileage growth at dates t-5 and t-6.

⁴⁶ In one specification I also include log of military capability of neighboring countries in t-5 and population density in t-7. Both of these variables affect nationalizations, but it is not obvious they influence mileage growth after including the other control variables discussed earlier.

⁴⁷ The second-stage equation includes differences in constraints-on-the-executive and differences in democracy in years t-3 and t-4. Thus it allows for short-term effects from political institutions.

control for many of the spillover channels from legal and political institutions, like government bond spreads and G.D.P. per capita.

Table 5 reports the key coefficient estimates for the mileage growth equation.⁴⁸ The main finding in column (1) is that the fraction of miles nationalized has a negative effect on mileage growth. The coefficient is statistically significant at the 10% confidence level, but it is more economically significant. The coefficient implies that a one-standard deviation increase in the fraction of miles nationalized in year t (0.13) would reduce mileage growth by approximately 1.3% in year t , which is equivalent to 22% of the standard deviation for mileage growth. The estimated effect is also similar to the average difference in relative mileage growth for countries that had nationalizations above the median (see figure 5).

The bottom of table 5 shows the results for an over-identification test.⁴⁹ The high p -value indicates that we cannot reject the hypothesis that constraints on the executive in $t-5$, democracy in $t-5$, and separate trends for common law and civil law countries are uncorrelated with the error term in the second stage after including all the other controls. Therefore, there is additional statistical evidence that legal and political institutions did not affect mileage growth outside of their influence on nationalizations.⁵⁰

⁴⁸ The first-stage estimates are not reported because they are very similar to results in table 3. They show that greater constraints on the executive, greater democracy, and common law systems lower nationalizations. Also nationalizations are higher in countries where neighbors have greater military capability; where the railroad network is dense, and where population density is low. Lastly, there is an interaction effect between G.D.P. per capita and railroad density.

⁴⁹ The over-identification test requires that at least one of the instruments be valid. Although it is not necessary to specify which, I would argue that the separate trends for common law and civil law countries are valid instruments because legal origin was determined prior to the mid-19th century and most of the spillover channels, like government bond spreads and G.D.P. per capita, are controlled for.

⁵⁰ The f -statistic for the joint significance of the instruments is also very large indicating that the instruments are not “weak” in the statistical sense.

Column 2 of Table 5 shows estimates when variables for the military capability of neighbors in t-5 and population density in t-7 are also excluded from the second stage. The estimated effect of nationalizations on mileage growth is slightly larger in this case (-0.108 vs. -0.098). Thus the results are similar if additional instruments are included.⁵¹

The estimates for the control variables are also of interest as they identify other factors influencing mileage growth. A table in the appendix reports the estimates for more variables. Most of the findings are consistent with standard theories. The coefficients for railroad density and its interaction with G.D.P. per capita imply that greater railroad density lowered mileage growth. This suggests there were lower returns to building railroads when the network was already large.⁵² Real G.D.P. per capita growth had a positive and significant effect on mileage growth. This implies that economic growth contributed to greater railroad development. Higher real yields on British government bonds and higher government bond spreads both have a negative and significant effect on mileage growth. This suggests that tightness in domestic and international financial markets slowed railroad development. The log difference in exchange rates has a negative and significant effect on mileage growth. This suggests that currency depreciations also slowed railroad development.⁵³

⁵¹ In some specifications, the estimated coefficient for the fraction of miles nationalized is lower if it is assumed to be exogenous. In a single equation specification that includes all the control variables in column 1, except for the instruments, the coefficient for the fraction of miles nationalized is -.009 with a standard error of .022. If I add the square of the fraction of miles nationalized, the results show that a higher fraction of miles nationalized significantly reduces mileage growth from 0 to 0.28, which covers most of the observations in the data. I would argue, however, that the two-stage estimate is more informative because it addresses the endogeneity of nationalization.

⁵² To estimate the effects of railroad density at different levels of G.D.P. per capita I predicted mileage growth for all observations after assigning a one-standard deviation increase or decrease in railroad density and G.D.P. per capita relative to the population mean and then averaged across all countries. The results show that greater density always reduced mileage growth. Interestingly they show that increasing density lowered mileage growth by more in rich countries than in poor countries.

⁵³ The difference in constraints-on-the executive in t-4 has a positive effect on mileage growth in t. This implies that greater constraints had a short-term effect on network expansion. This does not necessarily

CASE STUDY EVIDENCE

Cross-country regressions are useful in identifying the effects of factors that vary across countries, like institutions and external military threats, but it is important to check whether they are consistent with the case study evidence. Although it is impossible to provide a comprehensive discussion of each country here, it is worth making a few observations especially as they relate to the earlier results. Several case studies suggest that military threats were an important determinant of nationalizations. In Russia, Germany, and Austria-Hungary the prospects of a two-front war made nationalizations more attractive to the state, especially the military establishment.⁵⁴ France also faced threats from multiple neighbors, particularly Prussia, but it did not respond by nationalizing its eastern railroads. Instead it nationalized its western railroads because of their perceived military value.⁵⁵ Many scholars have also emphasized the importance of the Russian conflict in the Japanese nationalization of 1906-07. Steve Ericson points out that the army consistently advocated state ownership and was an important player in the nationalization movement.⁵⁶

The military factor was also present in the purchase of foreign-owned railroads. Foreign investment played an important role in many countries, and in some there was substantial foreign ownership. In Italy, Switzerland, Mexico, and Japan there were

imply a long-term effect on mileage growth. As I discuss in the next section, greater constraints had a long-term effect by raising the costs of nationalizations.

⁵⁴ Millward, "European Governments," p. 21.

⁵⁵ Doukas, *French Railroads*, p. 37.

⁵⁶ Ericson, *The Sound of the Whistle*, p. 261.

concerns that foreigners were extracting high profits, but the military implications were also widely expressed and seem to have contributed to railroad nationalizations.⁵⁷

With respect to the economic motivations of nationalization, several case-studies provide evidence that states purchased private railroads that were experiencing financial difficulties. For instance, in Mexico the state gained a controlling stake in the Mexican Central after its financial position became so weak that it could not repair its lines and in Brazil, the state of Sao Paulo purchased the Companhia Uniao Sorocabana in 1905 after it went bankrupt.⁵⁸ The financial problems of these and other private companies may have been associated with over-investment. In Latin America, Mexico and Brazil had substantial nationalizations while Argentina, Uruguay, and Chile did not. If these five countries are ranked by their ratio of railroad density to G.D.P. per capita in 1910, then Mexico is first, followed by Uruguay, and then Brazil. Thus the countries with nationalizations in Latin America generally had a denser railroad network relative to their G.D.P. per capita.

On the other hand, there is also evidence that states nationalized profitable railroads. For example, in Italy there were several private railroads operating in the early 1870s. The Upper Italy Railway Company was the first to be nationalized in 1875 and by most accounts it was the most profitable. Albert Schram has examined the motivations behind the purchase of the Upper Italy Railway Company.⁵⁹ He shows that the Upper Italy Railway Company was forced to pay substantially higher taxes in the three years before it

⁵⁷ Schram, *Railways and the Formation*, p. 39; Micheli, "State Purchase"; McNeely, "The Railways of Mexico"; Ericson, *The Sound of the Whistle*.

⁵⁸ McNeely, "Railways of Mexico," p. 17; Duncan, *Public and Private Operation*, p. 57. For additional evidence, see Ames, "A Century of Railroad Construction," p. 57 and Ericson, *Sound of the Whistle*, p. 153. Ames argues that the state purchased several bankrupt railroads in Russia in the 1880s. Ericson argues that in Japan, the crisis of the early 1890s prompted some railway investors to support nationalization in the hopes of receiving financial compensation from the government.

⁵⁹ Schram, *Railways and the Formation*, p. 49.

was nationalized, and argues that the rationale was to bring the company into financial trouble in order to take it over.

There are a number of other cases studies which suggest that states had fiscal motivations for nationalizing railroads. Prussia is the most famous example of a government that earned substantial profits. By most estimates, state-owned railroads contributed nearly 20% of all government revenue in Prussia and yielded a rate of return 2 to 3 percentage points higher than the interest rate on government bonds.⁶⁰ Other states appealed to the fiscal surpluses in Prussia when they were considering their own nationalizations. Communications ministers and various M.P.'s in Japan frequently pointed out that Prussia earned substantial profits from its state-owned railroads and that they expected similar results if Japan nationalized its railroads.⁶¹ The Netherlands is also an interesting case because state-owned (but privately operated) railroads competed vigorously with two privately owned and operated railroads in the 1880s: the Holland Iron Railway Company and the Dutch Rhenish Railway company. Few of the railroads were earning high returns and in 1890 the state purchased the Rhenish Railway Company. This purchase made the state the dominant owner of track mileage in the Netherlands and effectively increased its market power in railroad services.⁶² Lastly, there is evidence that Brazilian officials considered the fiscal benefits of nationalizations. One minister in particular argued that nationalization was desirable because private railroads were capturing external benefits that were generated by state-owned railroads.⁶³

⁶⁰ Fremdling, "Freight Rates."

⁶¹ Ericson, *The Sound of the Whistle*, p. 252, 302.

⁶² See Fremdling, "The Prussian and Dutch Railway," p. 85 and Veenendaal, "State Versus Private Enterprise," p. 191 for a discussion of the state purchase of the Dutch Rhenish Railway company.

⁶³ Duncan, *Public and Private Operation*, p. 41.

The econometric results suggest that nationalizations were more costly to implement if the president, prime minister, or monarch had to gain the approval of an independent legislature. The nationalization in Japan would seemingly go against this argument because it scores highly in terms of its constraints on the executive branch. However, an examination of the Japanese case shows how an independent legislature could make the process of nationalization lengthy, costly, and difficult. In 1891, the Masayoshi Cabinet introduced a nationalization bill in the House of Representatives, but it was rejected.⁶⁴ The second nationalization bill was initiated by the Saionji Cabinet in 1905. There was a contentious debate in the Lower House and the Cabinet was forced to use a wide range of carrots and sticks to convince Members to support the bill. The bill was then sent to the Upper House where again there was substantial debate. Finally, the two Houses had to agree on amendments amidst shouting matches between various supporters and opponents. Throughout this process it was not clear that the nationalization bill would pass, especially since an earlier nationalization bill failed.⁶⁵

The Italian case provides more evidence that legislatures could make it very difficult for ministers to nationalize railroads. The proposal to purchase the Upper Italy Railway Company was initiated by the Minghetti government. One of its proposals for buying the company implied in effect the nationalization of the whole Italian railroad network. The Italian Parliament then ‘revolted’ against this proposal and the Minghetti government eventually fell.⁶⁶ The Upper Italy Company was still nationalized but the rest of the network remained privately owned for several more years.

⁶⁴ Ericson, *Sound of the Whistle*, p. 159.

⁶⁵ See Ericson, *Sound of the Whistle*, Ch. 4 for a discussion of the Japanese nationalization.

⁶⁶ Schram, *Railways and the Formation*, p. 45.

Democracy is another factor that influenced nationalizations. Switzerland provides some insights on the effects of democracy because there were several referendums on whether to nationalize railroads.⁶⁷ In 1888, the executive body, known as the Federal Council, made its first attempt to nationalize a private railroad company, but it provoked substantial opposition and was subsequently dropped. In 1891, the Federal Council initiated another proposal to nationalize a private railroad company and was successful in gaining the approval of the legislature, the Federal Assembly. The issue did not end there because the opponents of nationalization were successful in requiring a referendum on the law as permitted by the Swiss Constitution. The subsequent vote went against nationalization and the law was nullified. In 1897, the Federal Council introduced a more ambitious plan to nationalize five major private railroads. The proposal passed through the Federal Assembly and was again challenged by a referendum. There was a vigorous debate which included public meetings and the publication of several pamphlets for and against nationalization. In the end, the law was ratified by a fairly large margin.⁶⁸

The Swiss case shows that the electorate sometimes supported nationalizations. However, it also shows that the state might have to engage in several campaigns to convince the electorate to support its policy. As a result, leaders in some democratic countries may have dropped their nationalization plans because it was too costly.

Legal institutions have received less attention in the literature on railroad nationalizations, but there are indications of their importance. The judiciary could play an important role in nationalizations if companies can sue the state when it tries to expropriate their railroad. In common law countries, courts have traditionally required

⁶⁷ See Micheli "State Purchase," for an extensive analysis of the Swiss nationalization.

⁶⁸ *Ibid.*, p. 362.

that expropriations satisfy a ‘public use’ and that owners receive ‘just compensation.’ The public use requirement might have made it more difficult for the state to nationalize railroads because they had to explain why state ownership satisfied a public benefit. Moreover, the just compensation clause might have prevented the state from imposing a low price on companies.

In civil law countries railroad companies could also appeal to courts, but they wouldn’t be as effective if the state could intervene and ensure that decisions went in their favor. The Swiss nationalization provides evidence that states in civil law countries sometimes intervened in judicial matters relating to nationalizations. The original concessions granted to private companies created a special board of arbitrators that would settle disagreements between companies and the state in the event of a proposed nationalization. The arbitrator was separate from the Federal court system, and presumably provided some assurance that decisions would be made independently. In 1896, one year before the nationalization law was passed, the Federal Council and Assembly passed a law nullifying the authority of arbitrators and requiring that disputes be settled in Federal courts. The law was controversial, but it was upheld through a referendum.⁶⁹

After the nationalization was approved, there are some indications that the Federal Council of Switzerland exploited its influence in the Federal Courts by offering a below-market price to the railroads. Horace Micheli shows that the Federal Council offered to pay an average of 406 francs per share for the 5 largest private railroads, but the average

⁶⁹ Micheli, “State Purchase,” p. 368.

market value of these shares was 445 francs just before the nationalization law was passed.⁷⁰

This brief review reveals that nationalizations could be quite controversial. Many contemporaries tried to assess the effects of nationalizations in order to condone or condemn them. Arthur Bohltingk, for example, argued that state railroad officials in Germany were not building enough railroads. He stated that:

“his Excellency Von Thielen has not once been able to provide sufficiently for the demands for rail transport, and although he has repeatedly declared that the railways had reached the limits of their capacity, he seems to have thought less than ever of making them equal to such demands by means of additions and improvements.”⁷¹

Ernest Dewsnap was perhaps the most vocal critic of nationalizations in the early 20th century. He argued that the Japanese nationalization produced few economic benefits. He also claimed that the expansion of the railroad network in Japan proceeded more slowly after nationalization because the state was unwilling to secure funds for subsidiary railroads that would likely produce little revenue.⁷²

What does the modern case-study literature reveal about the effects of nationalizations on railroad mileage growth? Most scholars have not addressed this question, probably because it is difficult to answer without making cross-country comparisons. One would have to identify whether some routes were constructed more slowly or not at all, and then compare the pattern of growth with similar countries that did not have nationalizations. The cross-country data analyzed here can provide a guide to such studies. Table 6 presents coefficients for interaction terms between country dummies and the fraction of miles nationalized in a single equation model for mileage

⁷⁰ *Ibid*, p. 388.

⁷¹ Quoted in Dewsnap “Review of Nationalizations,” p. 185

⁷² Dewsnap, “The Attitude of the State,” p. 851.

growth that includes country fixed effects, year dummies, and all the other variables listed in column 1 of table 5. These coefficients do not identify the causal effects of nationalizations in each country, but they do reveal where there was a large negative relationship between nationalizations and mileage growth after controlling for other factors. For example, there is evidence that in India, the Netherlands, and Belgium nationalizations were associated with a large decrease in mileage growth. Future research should investigate why nationalizations have a large negative relationship with mileage growth in these economies.

CONCLUSIONS

In the mid-nineteenth century most railroads were owned by private companies, but by 1913 governments owned more than half of the railroad miles in the world. State ownership increased in part because there were significant nationalizations of privately-owned railroad miles. This paper explores which factors influenced nationalizations and how nationalizations affected network expansion. I find evidence that nationalizations were greater in countries with French and German civil law legal systems, with lower constraints on the executive, with dense railroad networks, with low population density, and where neighboring countries had higher military capability. I also find evidence that railroad mileage growth was lower in countries that experienced greater nationalizations, and that nationalizations caused part of the decrease in mileage growth.

The results suggest that greater military threats, along with greater competition and diffuse demand, increased the necessity of nationalizations, while legal and political institutions limiting the power of the state raised the costs of nationalizing railroads. The

results also suggest that following nationalizations, the state limited expansion of the railroad network for fiscal reasons or to rationalize the industry, while private companies were hesitant about investing because of fears of expropriation.

As a final remark, it is important to recognize that social welfare was not necessarily reduced if nationalizations reduced the size of railroad networks. Their impact depends on the difference between the social rate of return on additional railroad mileage and the social rate of return on other investments. 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 estimates that the marginal social rate of return for Brazilian railroads may have been as high as 8 percent before 1913.⁷³ Findings such as this suggest that nationalizations lowered welfare in poor countries by reducing socially-valuable investments. In rich countries, the welfare implications are not so clear. The literature in the 1960s and 1970s argued that the social savings from railroads were relatively modest in the U.S., Britain, and Western Europe; however, more recent findings suggest that the social savings could be quite large when time savings are incorporated.⁷⁴ It is possible, therefore, that nationalizations also lowered welfare in rich countries when the broader effects of railroads are considered.

⁷³ Summerhill, "Big Social Savings," p. 87.

⁷⁴ See Fogel, *Railroads*; Fishlow, *American Railroads*; O'Brien, *Railways*; Leunig, "Time is Money."

APPENDIX 1: DATA SOURCES AND METHODS

Sources for Railroad data

Total Railroad Miles for each country are available in Mitchell, *International Historical Statistics*. Data on railroad miles owned by companies or the state 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*, and *Railways, Foreign Countries and British Possessions*. I also use other sources. For Italy, I consulted *Sviluppo delle ferrovie italiane dal 1839 al 31 dicembre 1926* published by the Direzione generale delle ferrovie dello Stato. For Chile, I used the *Anuario Estadístico de la Republica de Chile* published by Oficina Central de Estadística. For Brazil, I used *the Ministério da Indústria, Viação e Obras Públicas* (1893-1909) and *Viaçao E Obras Publicas* (1909-1914). For Argentina, I used *Estadística de los Ferrocarriles en Explotacion* published by the Ministerio de Obras Publicas. For China, I consulted Huenemann, *The Dragon and the Iron Horse*.

Sources and Methods for real G.D.P. per capita

Angus Maddison, *the World Economy*, provides real G.D.P. per capita 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 real G.D.P. and convert them into 1995 dollars using

Maddison's estimate from 1913. For example, I use Gregory, *Russian National Income*, Schulz, "Patterns of Growth," Yousef, "Egypt's growth," Braun et. al. "Economia Chilena," della Paolera and Taylor, *A New Economic History for Argentina*, and Koc, Filiztekin, Pamuk, "Sources of Long-term Growth."

Sources for Population

Whenever possible I used population data from Maddison. However, Maddison's figures did not always apply to boundaries in the 19th century. I supplemented Maddison's figures with Lahmeyer, the Populstat Website, 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 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 the real yield 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 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 difference in log of the 12-month average between year t and $t-1$.

APPENDIX 2: ADDITIONAL RESULTS

Table 7 reports summary statistics for the variables in the cross-sectional analysis of nationalizations in 1910. Table 8 reports summary statistics for the variables in the equations for the extent of nationalizations and mileage growth. Table 9 provides the coefficient estimates for the control variables in the mileage growth equation.

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Tables

Table 1: Major Nationalizations

Country	Year	Description
Russia	1889, 1891, 1893, 1894, 1895, 1901	State purchased Ekaterinenskaia, Trans-Caucasian, Moscow Brest, Vistula, Riga-Orel Samara-Zlatonst, SizranViazma, Northern Northwestern, and Southwestern
Sweden	1896	State purchased the West Coast Railway
Denmark	1878, 1879, 1880, 1882	Nationalizations followed plan to provide construction subsidies
Holland	1880, 1890	State purchased Netherland Rhenish Railway
Belgium	1871, 1875, 1878, 1880, 1898, 1908	State purchased 19 private lines. The biggest were the Bassina Houillers, Luxemburg, Dendre-Waes, Belgian Great Central and Western Flanders
France	1878, 1909	The state purchased lines that failed to amalgamate with Orleans company in 1878. State purchased the West Company in 1909
Switz.	1902, 1903, 1909	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	State purchased Upper Italian, Roman, and Calabrian-Sicilian lines before 1882. In 1905 the state purchased the Adriatic.
Austria	1884, 1888, 1892, 1906, 1908, 1909	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	
Bulgaria	1908	State purchased Vacarel-Bellovo, Belloost-Lubimetz, and Tyrnovo-Seemen-Jamboli lines as a consequence of Bulgarian declaration of Independence.
Serbia	1907	
Japan	1907, 1908	State purchased 17 companies by a law passed in 1906
Mexico	1903, 1906	State purchased Interoceanic, Mexican Central, and Ilidalgo & Northeastern,
Costa Rica	1901	
Brazil	1865, 1901, 1902, 1903, 1909	The state purchased the West of Minas Railway in 1903.
Argentina	1863	The state purchased the FC Oeste after it had difficulties raising private capital.
Germany	1879, 1880, 1882, 1883, 1884, 1890,	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	Nationalizations after 1879 coincided with a policy to have state-owned but privately operated railways. First large nationalization was the East India Railway company in 1879.
Australia	1872	
New Zealand	1886, 1900, 1908	

Sources: Board of Trade, *State Railways*. Thorner, "the Pattern," and Lewis, *British Railways*.

Table 2: The Determinants of Railroad Nationalizations: Cross-sectional Estimates in 1910

Variable	(1)	Probit (2)	(3)	Linear regression	
	Dep. var =1 if Fraction Nationalized >0.02	Dep. var =1 if Fraction Nationalized >0.01	Dep. var =1 if Fraction Nationalized >0.05	(4) Dep. var = Fraction Nationalized	(5) Dep. var. = Fraction Nationalized
	Coef. (std. err.)	Coef. (std. err.)	Coef. (std. err.)	Coef. (std. err.)	Coef. (std. err.)
Average Log Military Capability neighbor countries 1870-1910	1.68 (0.83)*	1.96 (0.91)*	2.10 (1.28)	0.05 (0.02)*	0.05 (0.02)*
Average Constraints on the executive 1870-1910	-0.68 (0.31)*	-0.63 (0.32)*	-0.94 (0.49)*	-0.02 (0.04)	-0.02 (0.04)
Average Index for Democracy 1870-1910	0.14 (0.11)	0.11 (0.12)	0.26 (0.18)	0.01 (0.01)	0.01 (0.16)
Dummy for French/German Civil Law	2.34 (1.01)*	1.78 (0.97)*	2.17 (1.09)*	0.16 (0.06)*	0.16 (0.11)
Dummy for Scandinavian Civil Law					0.00 (0.01)
Average Log Pop. Density 1870-1910	-1.31 (0.85)	-1.72 (0.89)*	-1.83 (1.19)	-0.01 (0.06)	-0.01 (0.05)
Average Growth rate, G.D.P. per capita 1870-1910	-2.09 (1.43)	-2.39 (1.46)	-3.93 (2.46)	0.025 (0.11)	0.03 (0.11)
Log of G.D.P. per capita 1870	-2.53 (1.79)	-3.16 (1.83)*	-4.59 (2.26)*	-0.02 (0.14)	-0.02 (0.13)
Log of RR Miles per Square Mile 1910	2.24 (1.09)*	2.68 (1.16)*	3.67 (1.62)*	0.05 (0.06)	0.05 (0.06)
Constant	30.85 (18.37)*	37.26 (18.9)*	53.46 (25.99)*	0.53 (1.20)	0.53 (1.22)
N	29	29	29	29	29
Pseudo R-Square/R-square	0.49	0.49	0.56	0.16	0.16
Log Likelihood	-10.21	-10.12	-8.82		

Notes: Robust standard errors are reported. * indicates statistical significance at the 90% level and above.

Table 3: The Determinants of the Extent of Nationalizations: Panel Estimates, 1860-1912

Variable	(1) Coeff. (Stand. Err.)	(2) Coeff. (Stand. Err.)	(3) Coeff. (Stand. Err.)
War Dummy t-5	.005 (.012)	.005 (.011)	.010 (.018)
Log of Neighbors Military Capability t-5	.033 (.015)*	.050 (.016)*	.075 (.021)*
Constraints-on-the-executive t-5	-.022 (.004)*	-.020 (.004)*	-.021 (.005)*
Polity2 Democracy Index t-5	-.005 (.001)*	-.004 (.001)*	-.003 (.001)*
Time Trend	.002 (.0008)*	.0003 (.0009)	.0007 (.001)
(Time Trend)* (French/German Civil Dummy)	.004 (.0005)*	.004 (.0005)*	.004 (.0006)*
(Time Trend)* (Scandinavian Civil Dummy)	.0007 (.0007)	.0004 (.0007)	-.00007 (.0008)
Log Pop Density t-5	-.107 (.030)*	-.150 (.032)*	-.171 (.036)*
Log of Real G.D.P. per capita t-5	-.027 (.023)	.092 (.039)*	.148 (.046)*
Log of RR Miles per Square Mile t-5	-.0001 (.006)	-.167 (.045)*	-.235 (.055)*
(Log of RR Miles per Square Mile t-5)* (Log of Real G.D.P. per capita t-5)	—	.025 (.006)*	.036 (.008)*
Country fixed effects	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes
Other controls included?	No	No	Yes
N	981	981	947
R-square	0.37	0.38	0.38

Notes: The dependent variables is the fraction of miles nationalized in country i in year t .
* indicates statistical significance at 90% and above. Other controls include Population growth, G.D.P. per capita growth, dummies for entry/exit into war, differences in neighbors' military capability, and differences in constraints and democracy in $t-3$ and $t-4$.

Table 4: Average Predicted Fraction of Miles Nationalized for a One-standard Increase or Decrease in G.D.P. per capita and Railroad Density

	One Standard deviation Decrease in Railroad Density from the Population Mean	One Standard deviation Increase in Railroad Density from the Population Mean
One-standard Deviation Decrease in G.D.P. Per capita from the Population Mean	0.10	0.12
One-standard Deviation Increase in G.D.P. Per capita from the Population Mean	0.01	0.15

Notes: The predicted fraction of miles nationalized for each country was calculated using a one standard deviation increase or decrease in the railroad density and G.D.P. per capita relative to the population mean. I then averaged the predicted fraction of miles nationalized across the sample.

Table 5: Nationalizations and Mileage Growth: Two-Stage Least Squares Estimates

Variable	(1) Coeff. (Stand. Err.)	(2) Coeff. (Stand. Err.)
Fraction of Miles Nationalized by t	-.098 (.058)*	-.108 (.058)*
War Dummy t-5	-.015 (.014)	-.019 (.013)
Log of RR Miles per Square Mile t-5	.041 (.039)	.040 (.036)
Log of Real G.D.P. per capita t-5	-.051 (.033)	-.046 (.031)
(Log of RR Miles per Square Mile t-5)* (Log of Real G.D.P. per capita t-5)	-.016 (.006)*	-.015 (.005)*
Log Neighbors' Military Capability t-5	.012 (.015)	—
Log Pop Density t-7	.028 (.026)	—
Country fixed effects	Yes	Yes
Year Dummies	Yes	Yes
Other Controls Included?	Yes	Yes
N	818	818
Over-identification test statistic (p-value)	0.24 (0.99)	3.19 (0.78)
Endogeneity test statistic (p-value)	1.67 (0.09)	1.86 (0.06)

notes: * indicates statistical significance at 90% and above. Controls include population growth in t-5 and t-6, G.D.P. per capita growth, real yields on British govt. bonds, bond spreads, the change in railroad capital prices, dummies for entry/exit into war, differences in neighbors' military capability, and differences in constraints and democracy in t-3 and t-4. The instruments in column (1) are constraints on the executive in t-5, democracy in t-5, a time trend, and separate trends for French and German civil law countries and Scandinavian civil law countries. The added instruments in column (2) are the log of neighbors' military capability in t-5 and the log of population density in t-7.

Table 6: Coefficient Estimates for an Interaction term between a country dummy and the Fraction of Miles Nationalized by year t

Country	Coefficient (standard error)
India	-.279 (.525)
Netherlands	-.161 (.239)
Belgium	-.160 (.071)
Mexico	-.063 (.103)
Germany	-.035 (.094)
Brazil	-.026 (.122)
Italy	-.016 (.070)
Japan	-.014 (.044)
Denmark	-.008 (.105)
New Zealand	-.001 (.645)
Switzerland	.019 (.044)
Austria	.063 (.057)
Russia	.179 (.208)
Hungary	.398 (1.49)
Country fixed effects	Yes
Year Dummies	Yes
Other Controls Included?	Yes
Instruments included?	No
N	818
R-square	0.41

Notes: The dependent variable is mileage growth in country i and year t. The estimates are obtained using a single-equation fixed effects model. For other controls see column (1) of table 5.

Table 7: Summary Statistics for the Cross-Sectional Analysis of Nationalizations in 1910

Variable	Mean	Stand. Dev.	Min	Max
Nationalization Dummy, 1910	0.55	0.50	0	1
Average Log Neighbors' Military Capability, 1870-1910	-3.00	1.17	-5.68	-1.87
Average Constraints-on-the-executive, 1870-1910	4.23	2.35	1	7
Average Democracy Index, 1870-1910	-0.62	5.85	-9.4	10
Dummy for French and German Civil	0.79	0.41	0	1
Dummy for Scandinavian Civil Law	0.10	0.32	0	1
Average Log Pop Density, 1870-1910	-2.81	1.69	-7.62	-0.62
Log of Real G.D.P. per capita 1870	7.18	0.49	6.27	8.06
Average Growth Rate G.D.P. per Capita, 1870-1910	1.33	0.58	0.09	2.71
Log of RR Miles per Square Mile 1910	-3.28	1.38	-6.64	-1.36
N	29			

Sources: see text

Table 8: Summary Statistics for analysis of Nationalizations and Mileage Growth

Variables	Mean	Standard Deviation	Min	Max
Mileage Growth	.038	.058	-.165	.568
Fraction of Miles Nationalized	0.091	.133	0	0.678
Log of Railroad Miles per square mile	-3.71	1.65	-8.54	-1.37
Population Growth	.012	.010	-.045	.075
Population Density	-2.99	2.01	-7.85	-.17
Real G.D.P. per capita Growth	.014	.047	-.171	.273
Log of Real G.D.P. per capita	7.60	.54	6.17	8.58
Log of Real Yield on British Govt. Bonds	.988	1.25	-9.21	2.36
Govt. Bond Spread	1.44	1.52	-.055	12.20
Log Difference in Exchange Rates	-.002	.126	-3.17	.494
Log Difference in Railroad Capital Prices	-.006	.140	-3.08	.416
Difference in War Dummy	-.003	.188	-1	1
War Dummy	.032	.175	0	1
Log difference in military cap. neighbors	-.0001	.053	-.241	.361
Log of military capability of neighbors	-2.83	1.45	-6.18	-1.47
Change in Democracy Index	.10	.789	-8	12
Democracy Index	1.19	5.61	-10	10
Change in Constraints on the Executive	.031	.329	-4	6
Constraints on the Executive Index (Log of RR Miles per Square Mile)	5.06	2.10	1	7
*(Log of Real G.D.P. per capita)	-27.87	11.89	-63.33	-11.31
N	818			

Sources: see the text.

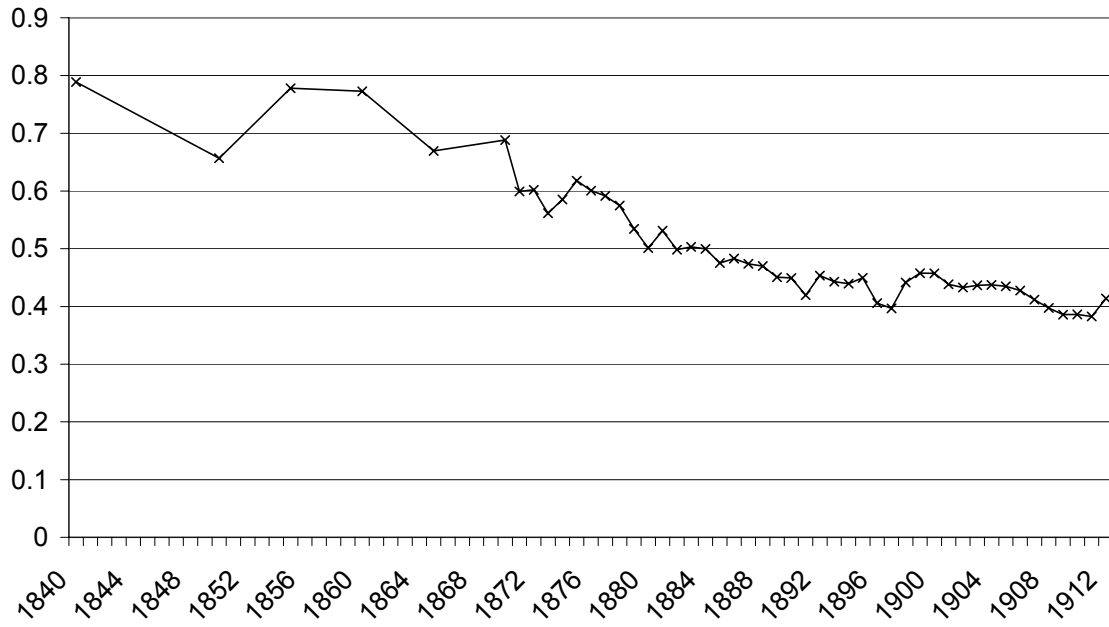
Table 9: Coefficient Estimates for other variables in Table 5

Variables	(1) Coeff. (st. er.)	(2) Coeff. (st. er.)
Population Growth in t-5	.106 (.271)	-.078 (.270)
Population Growth in t-6	.354 (.266)	.312 (.265)
Real G.D.P. per capita Growth in t-3	-.011 (.036)	-.011 (.036)
Real G.D.P. per capita Growth in t-4	.064 (.037)*	.064 (.037)*
Real Yield on British G. Bonds in t-3	-.004 (.002)	-.003 (.002)
Real Yield on British G. Bonds in t-4	-.008 (.002)*	-.008 (.002)*
Govt. Bond Spread in t-3	-.007 (.002)*	-.006 (.002)*
Govt. Bond Spread in t-4	.003 (.002)	.003 (.002)
Log Diff. Exchange Rates in t-3	-.089 (.028)*	-.090 (.028)*
Log Diff. Exchange Rates in t-4	-.017 (.028)	-.018 (.028)
Log Diff. in RR Cap. Prices in t-3	.065 (.027)*	.066 (.027)*
Log Diff. in RR Cap. Prices in t-4	.031 (.027)	.033 (.027)
Difference in War Dummy in t-3	-.009 (.010)	-.010 (.010)
Difference in War Dummy in t-4	-.009 (.012)	-.013 (.012)
Change neighbors' military cap. in t-3	.001 (.031)	-.003 (.031)
Change neighbors' military cap. in t-4	.011 (.032)	.004 (.031)
Change in Democracy Index in t-3	.002 (.002)	.001 (.002)
Change in Democracy Index in t-4	-.002 (.002)	-.002 (.002)
Change in Constraints on Exec. in t-3	.009 (.006)	.010 (.006)
Change in Constraints on Exec. in t-4	.024 (.007)*	.025 (.007)*
Year Fixed Effects	Yes	Yes
Country Fixed Effects	Yes	Yes
N	818	818

Notes: dependent variable is railroad mileage growth for country i in year t . Column (1) and (2) correspond to (1) and (2) in table 5. * indicates statistical significance at the 90% confidence level.

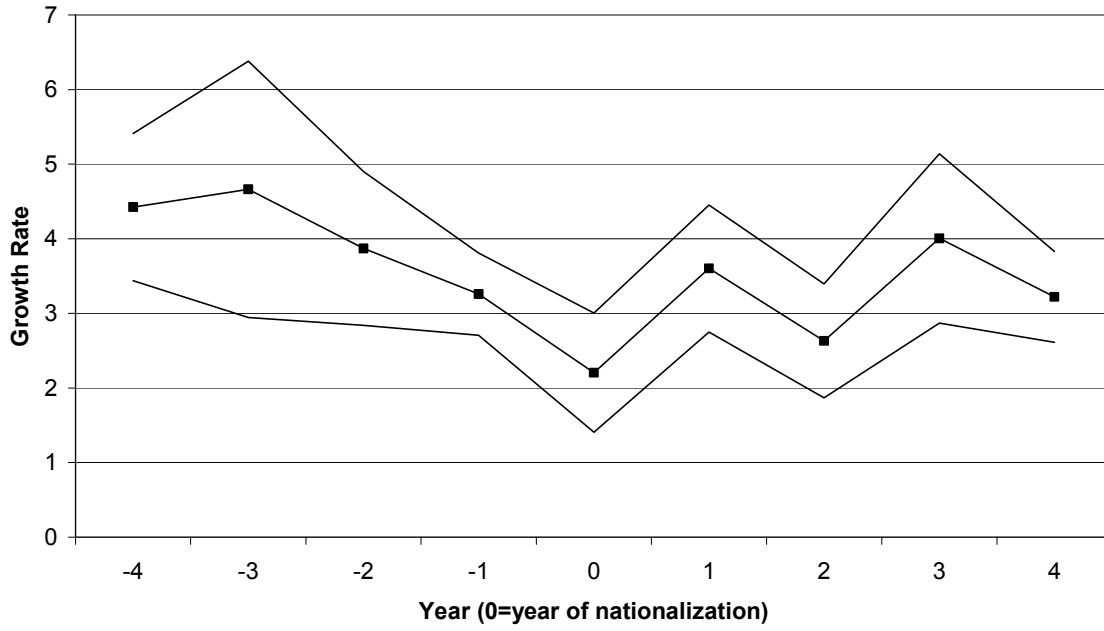
Figures

Figure 1: Estimated Fraction of World's Railroad Miles Owned by Companies, 1840-1912



Sources: see text.

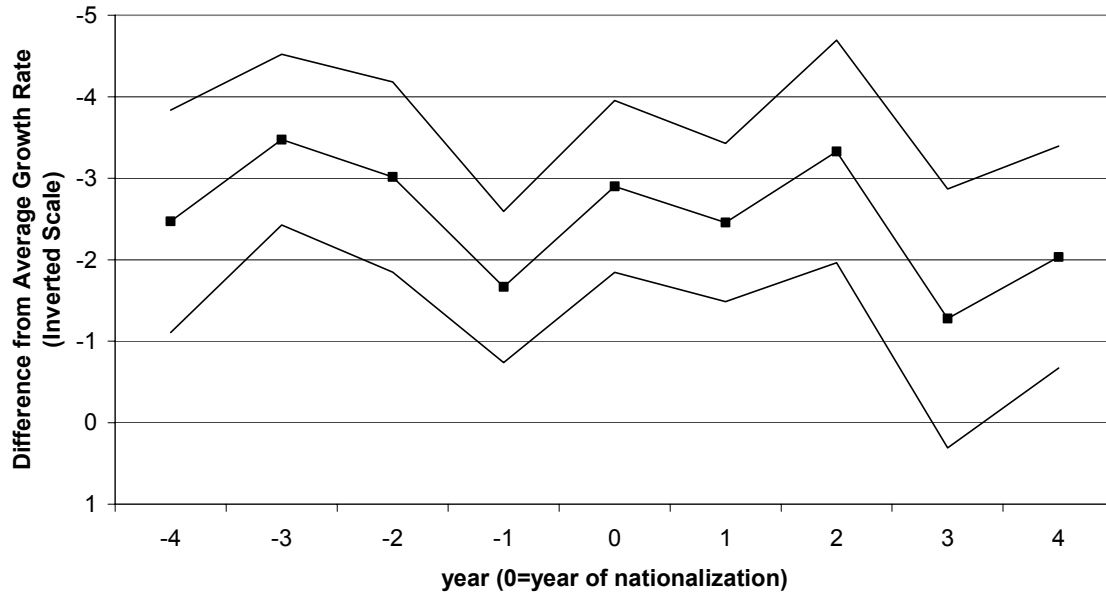
Figure 3: Average Mileage Growth Four years before and after a Country has a Nationalization



Sources: see text.

Notes: The bands represent a 90% confidence interval for the mean mileage growth

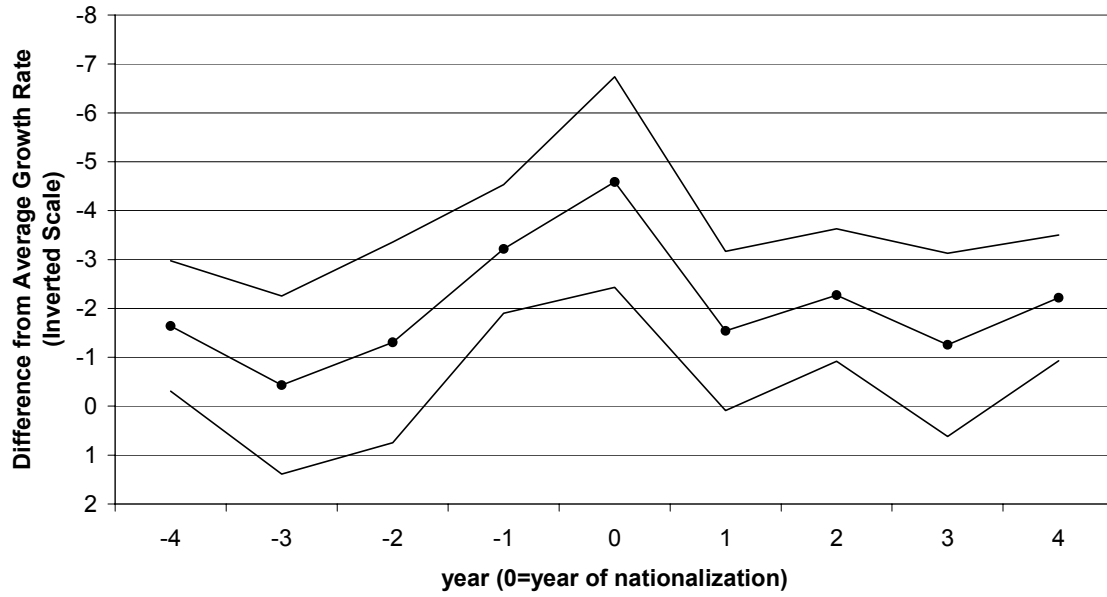
Figure 4: Average Difference in Mileage growth between countries that had nationalizations below the median size and all countries in the same year



Sources: see text.

Notes: The bands represent a 90% confidence interval for the mean difference in mileage growth between countries with nationalizations below the median size and all countries.

Figure 5: Average Difference in Mileage growth between countries that had nationalizations above the median size and all countries in the same year



Sources: see text.

Notes: The bands represent a 90% confidence interval for the mean difference in mileage growth between countries with nationalizations above the median size and all countries.