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

Dan Bogart[1]
Department of Economics, UC Irvine
dbogart@uci.edu

November 2007

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 railroad mileage growth. I find evidence that nationalizations were greater in countries with less democracy or 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.

[1] I would like to thank Jean-Laurent Rosenthal, Gary Richardson, Jun Ishii, Barry Eichengreen, Chris Meissner, Aldo Musacchio, Alessandro Tuzza, Eric Hilt, Robert Millward, Stergios Skepardas, Jan Bruekner, Alfonso Herranz, Marianne Bitler, David Neumark, David Jacks, Dror Goldberg, and Jared Rubin for helpful comments. I also thank seminar participants at UC Berkeley, UC Irvine, Eindhoven Technical University, Harvard, Cal State Fullerton, the NSF/NBER/CEPR workshop on the Evolution of the Global Economy in Lund the Economic History Society Meetings in Exeter, the all-UC economic History Meetings at UC Davis, and Social Science History Association Meetings. Finally I would like to thank Joaquin Artes, Sarah Chiu, Cindy Tran, and Sa Le for valuable research assistance.

Railroad nationalizations are one of the most dramatic 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, which represented around 10% of the miles constructed by 1910. In some cases, states expropriated the assets of several private railroads 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 government 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 has been 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. Many have argued that nationalizations were also

[2] Ericson, *Sound of the Whistle*, p. 245.
[3] Schram, *Railways and the Formation*, p. 45.

driven 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.

The literature has also focused on whether nationalizations influenced the performance of the railroad sector. One of the unresolved questions is whether nationalizations reduced network expansion. One hypothesis posits that nationalizations slowed railroad mileage growth by reducing the investment incentives of private companies. A related view argues that nationalizations also encouraged states to delay network investments to increase profits from state-owned railroads or to rationalize an overly-developed railroad sector. An alternative hypothesis argues that in the absence of nationalizations mileage growth would have been similar, and therefore it 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, such as the fraction of miles owned by companies versus 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, with less democracy, 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 along with mileage growth. The key exclusion restriction is based on the assumption that political and legal institutions affected the costs of nationalizing railroads, but had no permanent effect on mileage growth after controlling for spillover channels like 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 significant nationalizations. The two-stage estimates show that greater nationalizations reduced mileage growth, suggesting that nationalizations did indeed slow network expansion in

some countries. They also suggest that legal and political institutions had an indirect effect on network expansion by changing the costs of implementing nationalizations.

The last part of the paper compares the results with the historiography on railroad nationalizations in several countries. The results are consistent with the case study literature which provides evidence that some states nationalized for military reasons or to perpetuate the operation of unprofitable railroads, while others nationalized 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 not as effective in preventing states from forcing companies to sell their shares at below market prices.

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

There are several hypotheses about which factors influenced the incidence or extent of nationalizations. The first is that military considerations affected nationalizations. 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.[4] Armies were much

[4] See Charles Tilley, *Coercion*, for an analysis of military security in European history. In *Public and Private*, Robert Millward has also emphasized the importance of military factors in railroad nationalization.

more effective if troops and supplies could be moved by rail rather than by wagons. In times of conflict, states could either use their own railroads or they could enter into negotiations with private railroad companies. In most cases, it was less costly for the state to use its own railroads rather than negotiate, and therefore they had an incentive to own more railroads if war was likely. This argument suggests that nationalizations should have been greater in countries that faced significant military threats from their neighbors or that recently experienced war.

A second hypothesis argues that nationalizations were common in countries where private railroads experienced financial difficulties. The state might have an interest in buying bankrupt railroads and continuing their operation because their constituencies are dependant on railroad services. The state might also operate unprofitable railroads because they believe it will generate spillovers and promote economic development.[5] Low population density is one factor that contributes to poor financial 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. The result might be that railroads charge fees below average costs, eventually leading to bankruptcy, and the need for some type of policy intervention like nationalization. These arguments imply that nationalizations may have been more common or extensive in countries with low population density and/or high railroad density.

[5] 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.

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 taxation or directly through ownership. In most cases, the state should prefer to own railroads because it is difficult to detect private profits and tax collection is costly. Therefore, if fiscal extraction was the main motivation, then nationalizations may have been greater in rich countries where the state could extract more from railroad customers.

The preceding arguments suggest that the effects of G.D.P. per capita may 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 nationalizations because the combination of higher demand for services and greater sunk investments increased the profits that could be extracted by the state through nationalizations.[6] On the other hand, when railroad density is low, greater G.D.P. per capita might decrease the necessity of nationalizations because

[6] 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.

the combination of higher demand and less competition improved the financial performance of companies.

All the preceding arguments focus on the 'demand' for nationalization, but the costs mattered as well. There is a large literature arguing that states are less likely to expropriate private property if they are constrained by formal political institutions.[7] 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 their time and resources. A related argument suggests that greater democracy reduced nationalizations because the executive and 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 systems.[8] 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

[7] See North, *Structure and Change*, and Acemoglu, Johnson, and Robinson, "Institutions."
[8] See La Porta, Lopez-de-Silanes, and Shleifer, "Government Ownership" and "The Economic Consequences" as well as Mahoney, "The Common Law."

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.[9] This argument suggests that civil law countries were more prone to nationalize railroads as financial crises afflicted the industry or as military threats emerged.

The Effects of Nationalizations on Network Expansion

In discussing the potential 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 slower 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 shares at below market prices.[10]

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 model of investment incentives for competitive and monopolistic railroads.[11] 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

[9] La Porta, Lopez-de-Silanes, and Shleifer, "The Economic Consequences," p. 40
[10] In *Regulations*, Levy and Spiller provide a general argument that private infrastructure investment will be low whenever there is a lack of regulatory commitment. Keefer has explored this hypothesis for Spanish railroads in the 19th century in "Protection," and Wallsten for telecommunications in "Returning."
[11] Harley, "Oligopoly Agreement."

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 also try to rationalize the railroad sector by limiting the construction of additional lines. Notice that in this latter scenario nationalizations may have been beneficial, as 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.[12] For some countries, *The Statistical Abstracts* do not distinguish between miles owned by companies and the state.[13] I use several additional sources to identify railroad ownership in such cases. For example, *the Estadistca de los Ferrocarriles en Explotacion* reports ownership data for all railroads in

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

[13] 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.

Argentina before 1913.[14] In many 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.

Figure 1 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 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. *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 (private $miles_{t-1}$ – private $miles_t$) if private $miles_{t-1}$ > 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 measure is also biased downwards in some cases because companies may have completed new miles between t-1 and t, which would reduce the absolute decline in private miles.

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

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.

I also check my measure of nationalizations 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, we 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 two 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. 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. Second, I construct a nationalization dummy variable if the country had at least 2% of its railroad miles nationalized by 1910. The 2% threshold is useful because it separates countries with relatively minor nationalizations from those with moderate or substantial nationalizations.

The percentage increase or decrease in railroad miles between year t and t-1 is another key variable in the analysis. Railroad mileage growth for each country comes from the same sources that document the total number of miles owned by companies and the state. I also supplement with mileage data from *International Historical Statistics*.

I also have information on the characteristics of countries. The data include 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.[15] Bond yields, price indices, and exchange rates are all taken from the Global Financial Database.[16] Full details on these variables are provided in appendix 1.

The Polity IV data set provides institutional variables for many countries starting in 1800.[17] 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.

[15] Maddison, *The World Economy*.
[16] For more information on the Global Financial Database see http://www.globalfinancialdata.com/.
[17] 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 or Australia before 1901. Rather than drop these colonies, I assumed that Australia's political institutions were constant from 1870 to 1901 and that India's institutions were constant between 1870 and 1912. The choice of the level of institutions has no effect on the later results because of country fixed effects which control for time-invariant unobservable characteristics.

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). It is important to note that the indices for constraints-on-the-executive and democracy vary within countries. In some there was a shift towards higher constraints and higher democracy, 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 Napolean 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, noting that French civil law and German civil law are more derivative of Roman law.[18] I use their classifications to identify countries with common law and Scandinavian civil law systems.[19] There are some problems in using their classifications of French and German civil law countries in the early 20th century because the distinctions were not so sharp.[20] Therefore, I group together all French and German civil law countries.[21]

The Correlates of War database provides dates for inter-state wars, intra-state wars, and extra-state wars starting in 1815.[22] I use this data to code to a war dummy variable

[18] La Porta, Lopez-de-Silanes, and Schleifer, "The Economic Consequences," Figure 1.
[19] 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.
[20] See Sherman, *Roman Law*, for a discussion of French and German legal systems.
[21] The French and German civil law countries are Russia, Holland, Belgium, France, Portugal, Spain, Italy, Austria, Hungary, Egypt, Japan, Egypt, Mexico, Chile, Brazil, Uruguay, Argentina, and Germany.
[22] Sarkees, "The Correlates of War Data."

which identifies whether a country was in any type of war in each year. The military capability data also comes from the Correlates of War database.[23] It includes an average of six indicators: military expenditure, military personnel, energy consumption, iron and steel production, urban population, and total population. I define the military capability of neighboring countries as the population-weighted average of the military capability index among contiguous countries. Contiguity is also defined using the Correlates of War database.[24]

RESULTS ON THE DETERMINANTS OF NATIONALIZATIONS

There were 21 countries that experienced significant nationalizations between 1870 and 1912. Figure 2 shows the fraction of miles nationalized for 18 of these countries.[25] Some, like Switzerland, Japan, Mexico, and France, experienced all of their nationalizations in one or two years. The nationalizations in Switzerland and Japan were substantial and covered over half of their railroad networks. Most other countries had multiple nationalizations, which covered a smaller portion of their railroad network. For example, there were several nationalizations in Germany in the late 1870s and early 1880s, each of which affected less than 10 percent of their network.

What was different about the countries with significant nationalizations? Table 2 compares the mean for several variables between countries with at least 2% of their miles

[23] Singer, Bremer, and Stuckey, "Capability Distribution" and Singer, "Reconstructing."
[24] 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. I assumed that the military capability was constant for both countries.
[25] Sweden is not presented because its nationalizations were relatively minor. Argentina is not presented because it had most of its nationalizations in the 1860s. Lastly, Costa Rica will not be used in the subsequent analysis because of missing variables for annual G.D.P. per capita.

nationalized by 1910 versus those with none or less than 2% nationalized.[26] The mean military capability of neighboring countries, the mean population density, and the mean railroad density were all higher in countries with substantial nationalizations. The mean of the index for constraints-on-the-executive and the mean of the index for democracy are lower in countries with substantial nationalizations. Countries with French and German civil law legal systems are more likely to have nationalizations than not, while countries with Scandinavian civil law legal systems and common law legal systems are less likely to have nationalizations. Lastly the mean for G.D.P. per capita is the same in countries with and without substantial nationalizations. Most of these differences are consistent with the hypotheses discussed earlier except for the population density variable. It is difficult, however, to draw conclusions about population density, because we would like to know whether nationalizations increased when the demand for services became more diffuse while holding the density of the network constant.

To get at the conditional relationships, I now examine a multivariate probit model where the dependent variable is 1 if the country had at least 2% of their miles nationalized by 1910. The estimation results are presented in table 3 and the summary statistics are reported in appendix table 8. Column (1) shows that the military capability of neighboring countries and railroad density are positively and significantly associated with nationalizations after controlling for other factors. This suggests that external military threats along with greater competition among proximate railroads made nationalizations more necessary. The coefficients on other variables also yield the expected signs. Greater constraints-on-the-executive, greater democracy, greater population density, and greater G.D.P. per capita are negatively associated with

[26] The results are similar if I use a threshold of 1% or 3% when coding nationalizations.

nationalizations, while French and German civil law systems are positively associated with nationalization. However the coefficients on all these variables are statistically insignificant.

The insignificance of constraints-on-the-executive could be due to its positive correlation with democracy ($\rho = 0.84$), which is also negatively correlated with nationalizations. Column (2) shows that if democracy is dropped then constraints-on-the executive is negative and significant at the 10 percent level. This provides some initial evidence that either greater constraints and/or greater democracy made nationalizations less likely.

The preceding analysis focuses on the incidence of nationalizations using cross-section data. I now address whether the conclusions are similar after examining the extent of nationalizations using panel data.[27] 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:

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

The regression includes a country fixed effect α_i and a dummy variable for each year δ_t. They control for country-specific unobservable factors that do not change over time and year-specific factors that affect all countries. The vector $institutions_{t-5}$ includes an index for constraints-on-the-executive and an index for the degree of democracy. It also includes a time trend (i.e. the year) along with a separate time trend for French and German civil law countries and another separate time trend for Scandinavian civil law

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

countries.[28] The hypotheses are that the fraction of miles nationalized should decrease when constraints-on-the-executive or democracy increases in a country because the costs of nationalization rise for the state. One version of the legal origins theory argues that the state was more likely to repress or replace the market system when challenges emerged in civil law countries.[29] This suggests that civil law countries might experience greater nationalizations over time compared to the omitted group which is common law countries.

The vector $development_{t-5}$ includes the log of population density, the log of G.D.P. per capita, the log of railroad miles per square mile, and an interaction between the latter two variables. The hypotheses are that countries should have a higher fraction of miles nationalized when population density decreases and when railroad density increases. The effect of higher or lower G.D.P. per capita could be ambiguous, or it may depend on railroad density.

The vector $military_{t-5}$ includes the log military capability of neighboring countries and a dummy variable if the country was at war. A country should have a higher fraction of miles nationalized when their neighbors have higher military capability, or when they were recently at war.

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. The assumption is that countries experience shocks to their economic, political, and military environment which then have a persistent effect on nationalizations in the years that follow. In one

[28] 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; therefore I cannot estimate a legal origins dummy variable with country fixed effects.
[29] La Porta, Lopez-de-Silanes, and Shleifer, "The Economic Consequences," p. 40

specification, I also allow for short-run effects from economic growth, population growth, differences in political institutions, and differences in military factors in t-3 and t-4.

The estimates for the main explanatory variables are reported in table 4. There is a strong positive relationship between nationalizations and increases in the military capability of neighboring countries, and a weaker relationship between nationalizations and the war dummy. This suggests that greater military threats raised the necessity of nationalizations, although not necessarily the incidence of war. The results also show that greater constraints-on-the-executive and democracy reduced the fraction of miles nationalized, while French and German civil law countries have greater nationalizations over time than common law countries. Scandinavian civil law countries also have greater nationalizations over time, but the difference with common law countries is not significant. Together these latter findings suggest that greater constitutional constraints on the executive, greater democracy, and common law legal systems all raised the costs of nationalizations.

With respect to the development variables, the results show that the fraction of miles nationalized decreases when population density increases. This finding is consistent with the view that nationalizations were more necessary when demand for railroad services was spread across a larger spatial area. The results in columns (1) and (2) show that railroad density and G.D.P. per capita affect the fraction of miles nationalized 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

population mean, and then averaging over all countries in the sample (see table 5). The calculations imply that greater railroad density raises the extent of nationalizations when G.D.P. per capita is both small and large. They also show that greater G.D.P. per capita increases nationalizations when railroad density is high and decreases nationalizations when railroad density is low. These findings suggest that the combination of high demand for railroad services and less competition reduced the necessity of nationalizations, while high demand combined with greater sunk investments in the network encouraged nationalizations by increasing the revenues that could be extracted by the state. Later I discuss some case-study evidence which supports these arguments.

Column 3 in table 4 shows that the estimation results are similar when economic growth, population growth, differences in political institutions, and differences in military factors in t-3 and t-4 are included. None of these additional variables was significant with the exception of differences in constraints-on-the-executive in t-4, which had a negative effect on nationalizations. These findings suggest that it was a lower level of population density, a lower level democracy, and a higher level of military capability in neighboring countries which contributed to a greater fraction of miles nationalized.

RESULTS ON 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 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 nationalizations made the private sector hesitant about investing in railroads 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 possibly 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, I use a differences-in-differences approach 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 institutional variables as instruments to examine the causal effects of nationalizations on mileage growth.

Figure 3 plots the average mileage growth rate four years before and after a country experienced a nationalization of at least 2 percent of its railroad network. 0 on the x-axis corresponds to the year when the state took over the railroad; I refer to it as 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 when the nationalization occurred.

Figure 4 plots the average difference between the growth rate for a country that nationalized in year 0 and the average growth rate for all countries in the same year on an inverted scale. It also plots the average difference in mileage growth four years before and after the nationalization. The data show that countries which nationalized tended to have a lower growth rate than the average country. They also show that the difference in their growth rate decreases by 1.5% in the year of the nationalization compared to the

previous four years. However, it is not obvious that the difference in mileage growth permanently decreases following the nationalization.

The comparisons in figure 4 assume the effects of nationalizations are the same, regardless of the miles nationalized above the 2% threshold. However, there are reasons to expect that mileage growth decreased by more when nationalizations were extensive.[30] I investigate this possibility by restricting the sample of nationalizations to those in which the fraction of miles nationalized was above the median. Figure 5 plots the average difference between the growth rate for a country that experienced a large nationalization and the average growth rate for all countries in the same year on an inverted scale. Mileage growth is close to the country-wide average two to four years before a large nationalization, but in year -1 the difference in mileage growth declines to -3.2%, and in the year the nationalization occurred it declines further to -4.6%. More significantly, the average difference in mileage growth in years 2, 3, and 4 is 0.8% lower than the average difference in years -4, -3, and -2.

Figures 4 and 5 reveal some interesting results about mileage growth before and after nationalizations. First, it appears that mileage growth was lower following nationalizations that were more substantial in terms of mileage. Second, the data also show that mileage growth began to decrease one year before the nationalization occurred. One explanation is that companies or the state anticipated nationalizations and began building fewer lines. Another is that nationalizations were partly a response to the factors which reduced mileage growth.

[30] 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 more railroads.

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 substantial nationalizations. The main problem is that the state chose to nationalize based on a variety of considerations, including its expectations about mileage growth. As a result, comparisons of mileage growth before and after nationalizations may yield biased conclusions, even when control variables are introduced through regression analysis.[31] There are several ways to address this identification problem. Here I follow a common approach in economics by estimating a two-stage least squares model, where the fraction of miles nationalized in country i and year t is assumed to be endogenous along with mileage growth. In order to identify the effects of nationalizations, I need at least one instrumental variable that is correlated with nationalizations, but not with mileage growth after controlling for other factors. The main exclusion restriction is that greater constraints-on-the-executive and democracy in t-5 influence the extent of nationalizations in year t but they do not permanently affect mileage growth after controlling for other factors. In a moment, I discuss this assumption in greater detail.

The first-stage equation for the fraction of miles nationalized in country i and year t builds on the analysis from the previous section and is similar to equation (1). The determinants include constraints-on-the-executive in t-5, the level of democracy in t-5, a time trend, separate time trends for French/German civil law countries and Scandinavian civil law countries, the log of G.D.P. per capita in t-5, the log of railroad miles per square mile in t-5, an interaction between G.D.P. per capita and railroad density in t-5, a dummy if the country was at war in t-5, and the average military capability of neighboring

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

countries in t-5. I also include country fixed-effects, year dummies, population density, and a set of additional control variables that primarily determine mileage growth but could also affect nationalizations.

Equation (2) is the second-stage equation for mileage growth in country i in year t.

$$mileagegrowth_{it} = \eta_2 \, fracnat_{it} + \sum_{j=3}^{7} \beta_{2j} x_{it-j} + \alpha_{2i} + \delta_{2t} + \varepsilon_{2it} \qquad (2)$$

$fracnat_{it}$ 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 fixed effect for country i, δ_{2t} is a dummy variable for the year t, and ε_{2it} is an error term.[32] The main hypothesis is that mileage growth should be lower if a country has a greater fraction of miles nationalized by year t because a greater extent of nationalizations reduced the investment incentives for governments and private investors.

The control variables dated in t-3 and t-4 include real G.D.P. per capita growth, the log of the real yield on British government bonds, the risk premium on government bonds, the log difference in the exchange rate, 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 real G.D.P. per capita growth in year t-3 and t-4 should increase mileage growth in year t because it signals greater demand for railroad services in the future. The time-lag reflects the fact that it usually took 3 to 4 years to complete a railroad project. Higher real yields on British govt. bonds in t-3 and t-4 should reduce mileage growth because it proxies for real interest rates in the world

[32] 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.

economy. A higher risk premium on government bonds indicates that investors believe there are greater risks from investing in country i, and therefore, it should be negatively associated with mileage growth in country i. 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. 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.

In addition to these variables 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 when newborns become children and adults. I assume that population growth has its largest effect on mileage growth at dates t-5 and t-6.[33]

As mentioned above, a key issue is whether separate trends for civil law countries and the level of constraints-on-the-executive, democracy, real G.D.P. per capita, railroad density, warfare, and military capability of neighboring countries in t-5 should be included as determinants of mileage growth. Recall that several of these variables were

[33] It is very likely that population growth positively affects mileage growth, but the timing is not clear. Alternative specifications show that population growth in t-3 and t-4 has little effect on mileage growth, but population growth in t-5 and t-6 does, so I included the latter variables.

strong determinants of the extent of nationalizations. I argue their inclusion depends on whether institutions, economic development, and the security environment had short-run effects and/or persistent effects on mileage growth. The specification above allows for short-run effects by including differences in constraints-on-the-executive in years t-3 and t-4, differences in democracy in years t-3 and t-4, the growth of real G.D.P. per capita in t-3 and t-4, population growth in t-5 and t-6, dummies for entry/exit into war in t-3 and t-4, and the log difference in military capability in t-3 and t-4. One could argue that the level of real G.D.P. per capita in t-5 should also influence mileage growth because higher income reduces the cost of funding railroads by increasing national savings. Similarly, high railroad density may influence mileage growth because the returns to new railroad projects are lower.

In my main specification, the log of real G.D.P. per capita in t-5, the log of railroad miles per square mile in t-5, an interaction between G.D.P. per capita and railroad density in t-5, a war dummy in t-5, the military capability of neighboring countries in t-5, and population density in t-7 are all included in the second-stage mileage growth equation, but constraints on the executive in t-5, democracy in t-5, and separate trends for civil law countries are excluded. The idea is that weaker constraints on the executive, less democracy, and French/German civil law systems lowered the legal and political costs of nationalization for the state, but they did not permanently affect mileage growth. Of course, greater democracy or constraints on the executive may have 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 control for many of the spillover channels from legal and political institutions, like government bond

spreads and G.D.P. per capita growth. Therefore, the level of constraints-on-the-executive in t-5, democracy in t-5, and separate trends for civil law countries are likely to be independent of mileage growth in year t after including such controls.

Table 6 reports the key coefficient estimates for the mileage growth equation.[34] Column 1 shows the specification where only constraints-on-the-executive in t-5, democracy in t-5, and separate trends for civil law countries are excluded. The main finding is that the fraction of miles nationalized has a negative and significant effect on mileage growth. The coefficient (-.098) 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 percent in year t. This is similar to the average difference in relative mileage growth for countries that had nationalizations above the median (see figure 5).

I also use an over-identification test to investigate whether constraints on the executive in t-5, democracy in t-5, and separate trends for civil law countries are uncorrelated with the error term in the second stage after including all the other controls. The 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. The over-identification statistic is reported near the bottom of table 6. It implies that we cannot reject the hypothesis that the instruments are uncorrelated with the error term after including the other control variables. Therefore,

[34] The first-stage estimates are not reported because they are very similar to results in table 4. 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.

there is additional statistical evidence that greater constraints-on-the-executive and democracy did not permanently affect mileage growth outside of their influence on nationalizations.[35]

It is worth noting that 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. In other specifications, the coefficient on nationalizations is negative and significant, but generally lower in magnitude than the two-stage estimate.[36] I would argue, however, that the two-stage least squares estimate is more reliable because it addresses the endogeneity of nationalization. It also shows how political and legal institutions indirectly slowed network expansion by changing the costs of nationalization.

Columns 2 and 3 check the robustness of the results when additional exclusion restrictions are made. The estimated effect of nationalizations on mileage growth is slightly larger when neighbors' military capability and population density are excluded from the mileage growth equation. The over-identification test implies once again that we cannot reject the hypothesis that the instruments are uncorrelated with the error term after including the other control variables. The effect of nationalizations becomes even larger when the log of G.D.P. per capita and its interaction with railroad density are also excluded. However, in this case the over-identification statistic implies that we can reject the hypothesis that the instruments are orthogonal to the error term. This finding

[35] 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.

[36] For example, 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.

makes sense because G.D.P. per capita is likely to have a direct effect on mileage growth other than through nationalizations. Moreover, higher G.D.P. per capita is one of the main spillover effects of greater constraints-on-the-executive and democracy.

Overall the estimates suggest that greater nationalizations caused mileage growth to decrease in some countries. One explanation is that nationalizations reduced the investment incentives of states because they were trying to increase their profits from railroads or they were trying to rationalize an over-developed railroad sector. Another explanation is that the investment incentives of the private sector were reduced because of fears of future expropriations. Of course, these are not the only interpretations of the results as other mechanisms may have been at work. In the following section, I discussion how future research might examine the effects of nationalizations in individual countries.

The estimates for the control variables are also of interest as they identify some other factors influencing mileage growth. A table in the appendix reports the estimates for all three specifications in table 6. Most of the findings are consistent with standard investment theories. Population growth and real G.D.P. per capita growth both have a positive and significant effect on mileage growth. This implies that intensive and extensive 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 slowed railroad development. Lastly, changes

in constraints-on-the executive has a positive effect on mileage growth. This implies that institutional changes had short-term effects on network expansion perhaps by raising optimism about future growth.

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. First, 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.[37] 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.[38] 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.[39]

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, concerns about

[37] Millward, "European Governments," p. 21.
[38] Doukas, *French Railroads*, p. 37.
[39] Ericson, *The Sound of the Whistle*, p. 261.

foreign ownership seem to have contributed to railroad nationalizations.[40] Part of the angst about foreign ownership was related to concerns that foreigners were extracting high profits, but the military implications were also widely expressed.

Second, several case-studies provide evidence that states sometimes nationalized 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 had become so weak that it could not repair its lines, and in Brazil, the state of Sao Paulo purchased the Compahnhia Uniao Sorocabana in 1905 after it went bankrupt.[41] The financial problems of these and other private companies may have been associated with over-investment.[42] 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. In this case, it is clear that the Italian state wanted to extract greater income from the railroad. Albert Schram shows that the Upper Italy Railway Company was forced to pay substantially higher taxes in the three years before it

[40] Schram, Railways and the Formation," p. 39; Micheli, "State Purchase"; McNeely, "The Railways of Mexico"; Ericson, *The Sound of the Whistle.*
[41] McNeely, "Railways of Mexico," p. 17; Duncan, *Public and Private Operation,* p. 57.
[42] 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.

was nationalized, and that the rationale was to bring the company into financial trouble in order to take it over.[43]

There is evidence that several 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.[44] 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.[45] The Netherlands is also an interesting case because state-owned railroads competed vigorously with private railroads in the 1880s.[46] After earning significantly lower profits, the Dutch state decided to purchase the Rhenish railroad in 1890, increasing its market share. There is also evidence that ministers in Brazil wanted to nationalize because private railroads were capturing external benefits that were generated by state-owned railroads.[47]

Overall then it appears that some states nationalized to capture greater revenue from the railroad sector, while others did so to perpetuate the operation of unprofitable railroads. The varying motives may explain why G.D.P. per capita had mixed effects on nationalizations. Low G.D.P. per capita should make private railroads less profitable, which will encourage nationalizations if the state is primarily concerned with long-term

[43] Schram, *Railways and the Formation,* p. 49.
[44] Fremdling, "Freight Rates."
[45] Ericson, *The Sound of the Whistle,* p. 252, 302.
[46] Veenendaal, "State Versus Private Enterprise," p. 191.
[47] Duncan, *Public and Private Operation,* p. 41.

economic development. However, low G.D.P. per capita would discourage nationalizations if the state was more interested in extracting rents.

Above I argued 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 had substantial 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. The nationalization was initiated by the Saionji Cabinet who submitted a nationalization bill to the House of Representatives in 1905. There was a contentious debate in the 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 proposal failed in the 1890s.[48]

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.[49] The Upper Italy Company was still nationalized but the rest of the network remained privately owned, at least for the next few years.

[48] See Ericson, *Sound of the Whistle*, Ch. 4 for a discussion of the Japanese nationalization.
[49] 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. 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 including public meetings and the publication of several pamphlets for and against nationalization. In the end, the law was ratified by a fairly large margin.[50]

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. Many argue that the capacity for the executive to intervene in judicial matters is the main difference between common law and civil law legal systems. The judiciary could play an important role in nationalizations if companies can sue the state when it tries to expropriate their railroad.

[50] Micheli "State Purchase," p. 362.

In common law countries, courts have traditionally required 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 the 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.[51]

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

[51] Micheli, "State Purchase," p. 368.

market value of these shares was 445 francs just before the nationalization law was passed.[52]

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 states 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."[53]

Ernest Dewsnup 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.[54]

What does the modern case-study literature reveal about the effects of nationalizations on railroad mileage growth? Most studies 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 7 presents coefficients for interaction terms between country dummies and the fraction of miles nationalized in a single equation model for mileage

[52] *Ibid*, p. 388.
[53] Quoted in Dewsnup "Review of Nationalizations," p. 185
[54] Dewsnup, "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 6. 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 nationalizations were associated with a large decrease in mileage growth. Future research should compare India with other colonies, like Australia, where nationalizations did not have the same relationship.

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. Government ownership increased because some states nationalized railroads through expropriations or the purchase of bankrupt private lines. This paper explores which factors influenced nationalizations and how nationalizations affected mileage growth. I find evidence that nationalizations were greater in countries with French and German civil law legal systems, with weak constraints on the power of the state, 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 influenced the cost 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 a country had a smaller railroad network. The change in welfare 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.[55] Findings such as this suggest that nationalizations may have 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.[56] It is possible, therefore, that nationalizations also lowered welfare in rich countries when the broader effects of railroads are considered.

[55] Summerhill, "Big Social Savings," p. 87.
[56] 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 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*, 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 additional information from the *Annuario Estadistico de la Republica de Chile* 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* published by the Ministerio de Obras Publicas. For China, I used additional information 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 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," for Hungary, 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," for Turkey.

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 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.

APPENDIX 2: ADDITIONAL RESULTS

Table 8 reports summary statistics for the variables in the probit analysis of nationalization in 1910. Table 9 reports summary statistics for the variables in the equations for the extent of nationalizations and mileage growth. Table 10 provides the coefficient estimates for the control variables in the mileage growth equation.

References

Acemoglu, Daron, Simon Johnson, and James Robinson. "Institutions as the Fundamental Cause of Long-term Growth." In *Handbook of Economic Growth* , edited by Philippe Aghion and Stephen Durlauf, 385-472, New York: North Holland, 2005.

Ames, Edward. "A Century of Railroad Construction: 1837-1936." *American Slavic and East European Review* 6 (Dec., 1947): 57-746.

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

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*, Chile, 2000.

Brazil. *Ministério da Indústria, Viação e Obras Públicas*, annual series, 1893-1909, Sao Paulo: Brazil.

Brazil. *Viacao E Obras Publicas*. annual series, 1909-1914, Sao Paulo: Brazil.

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.

Dewsnup, Ernest. “The Attitude of the State Towards Railways: A Discussion of the Question of Nationalization.” *American Economic Review* 1 (Apr., 1911): 175 187.

Dewsnup, Ernest. “Review of Nationalizations of Railways in Japan by Toshiharu Watarai.” *American Economic Review* 5 (Dec. 1915): 850-852.

Doukas, K. *French Railroads and the State*. New York: Columbia, 1945.

Ericson, Steven J. *The Sound of the Whistle: Railroads and the State in Meiji Japan.* Cambridge: Harvard University Press, 1996.

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

Fishlow, Albert. *American Railroads and the Transformation of the Antebellum Economy*. Cambridge: Harvard University Press, 1965.

Fremdling, Rainer, “Freight Rates and State Budget: the Role of the National Prussian Railways, 1880-1913,” *Journal of European Economic History* 9 (1980): 21-39.

Fogel, Robert. *Railroads and American Economic Growth: Essays in Econometric History.* Baltimore: John Hopkins, 1964.

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*, annual series, London: HM Stationary.

Great Britain, Board of Trade. *the Statistical Abstract for the Several Colonial and other Possessions of the United Kingdom,* annual series, London: HM Stationary.

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

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.

Gurr, Ted Robert, Monty G. Marshall, and Keith Jaggers, The PolityIV Project, available online at http://www.cidcm.umd.edu/inscr/polity/.

Harley, C. Knick. "Oligopoly Agreement and the Timing of American Railroad Construction." *Journal of Economic History* 42 (1982): 797-823.

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

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

Keefer, Philip. "Protection Against a Capricious State: French Investment and Spanish Railroads, 1845-1875." *Journal of Economic History* 56 (Mar., 1996): 170-192.

Koc, Sumru Altug, Alpay Filiztekin, and Sevket Pamuk. "Sources of Long-term Economic Growth for Turkey, 1880-2005." Working Paper, 2006.

Lahmeyer, Jan. "Populstat Website," available online at http://www.library.uu.nl/wesp/populstat/populhome.

La Porta, Rafael, Florencio Lopez-de-Silanes, and Andrei Shleifer. "Government Ownership of Banks." *Journal of Finance* 57 (2002): 265-301.

La Porta, Rafael, Florencio Lopez-de-Silanes, and Andrei Shleifer. "The Economic Consequences of Legal Origins." Working Paper, 2007.

Levy, Brian and Pablo Spiller. *Regulations, Institutions, and Commitment: Comparative Studies of Telecommunications.* Cambridge MA: Cambridge University Press, 1996.

Leunig, Tim. "Time is Money: A Re-Assessment of the Passenger Social Savings from Victorian British Railways." *Journal of Economic History* 66 (2006): 635-673.

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.

Mahoney, Paul G. "The Common Law and Economic Growth: Hayek Might be Right." *The Journal of Legal Studies* 30 (June 2001): 503-525.

McNeely, John H. "The Railways of Mexico: A study in Nationalization." *Southwestern Studies* 2 (1964): 1-56.

Micheli, Horace. "State Purchase of Railways in Switzerland." *Economic Studies* 3 (1898): 356-420.

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. "European Governments and the Infrastructure Industries, c1840 1914." European Review of Economic History 8 (2004): 3-28.

Millward, Robert. *Private and Public Enterprise in Europe: Energy, Telecommunications, and Transport, 1830-1990.* Cambridge: Cambridge University Press, 2005.

North, Douglass. *Structure and Change in Economic History*. New York: Norton, 1981.

O'Brien, Patrick. *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,* 18 (2000): 123-144.

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

Schulz, Max-Stephan. "Patterns of Growth and Stagnation in the Late 19th Century Hapsburg Economy," *European Review of Economic History* 4 (2000).

Sherman, Charles Phineas. *Roman Law in the Modern World*. New Haven: New Haven Law Book Company, 1922.

Singer, J. David. "Reconstructing the Correlates of War Dataset on Material Capabilities of States, 1816-1985" *International Interactions* 14 (1987): 115-132.

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

Summerhill, Bill. “Big Social savings in a Small Laggard Economy: Railroad-Led Growth in Brazil.” *Journal of Economic History* 65 (March 2005): 72-102.

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* 19 (2002): 58-66.

Thorner, David. “The Pattern of Railway Development in India,” *Far Eastern Quarterly* 14 (1955): 201-216.

Tilley, Charles. *Coercion, Capital and European States: A. D. 990-1992*. New York: Blackwell, 1993.

Veenendaal, Augustus J. “State versus Private Enterprise in Railway Building in the Netherlands, 1838-1938.” *Business and Economic History* 24 (Fall 1995): 186 193.

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): 693-722.

Wooldridge, Jeffrey. *Econometric Analysis of Cross Section and Panel Data*. Cambridge: M.I.T. Press, 2002.

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): 561-579.

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 major 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: Mean Differences Between countries that had significant Nationalizations by 1910 versus those that did not

Variable	Mean for Countries with at least 2% of its miles nationalized by 1910	Mean for Countries with less than 2% of its miles nationalized by 1910
Log of Neighbors Military Capability, 1910	*-2.6*	*-3.4*
Constraints-on-the-executive, 1910	4.7	5.7
Polity2 Democracy Index, 1910	1.4	4.2
Dummy for French and German Civil Law	0.8	0.6
Dummy for Scandinavian Civil Law	0.05	0.2
Dummy for Common Law	0.15	0.20
Log of Pop Density, 1910	-2.5	-3.1
Log of Real G.D.P. per capita, 1910	7.7	7.7
Log of RR Miles per Square Mile, 1910	-3.1	-3.7

Notes: Italics indicates that the mean differences are statistically different at the 90% level. Countries or colonies without substantial nationalizations include Finland, Norway, Sweden, Portugal, Spain, Romania, Egypt, Greece, the United States, Chile, Uruguay, Argentina, China, the United Kingdom, and Canada. Countries with nationalizations are listed in table 1 with the exception of Sweden and Argentina, which had less than 2% of their network nationalized in 1910, and Costa Rica where data was not available.

Table 3: The Determinants of the Incidence of Nationalizations by 1910: Probit Estimates

Variable	(1) Coeff. (Stand. Err.)	(2) Coeff. (Stand. Err.)
Log of Neighbors' Military Capability, 1910	.877 (.459)*	.908 (.445)*
Constraints-on-the-executive, 1910	-.261 (.247)	-.305 (.176)*
Polity2 Democracy Index, 1910	-.025 (.098)	—
Dummy for French and German Civil Law	1.435 (1.243)	1.539 (1.187)
Dummy for Scandinavian Civil Law	-.181 (1.334)	-.136 (1.323)
Log Pop Density, 1910	-.680 (.575)	-.696 (.573)
Log of Real G.D.P. per capita 1910	-1.455 (1.161)	-1.510 (1.145)
Log of RR Miles per Square Mile 1910	1.326 (.746)*	1.346 (.744)*
N	31	31
Log Likelihood	-12.74	-12.77
Pseudo R-square	0.40	0.40

Notes: The dependent variable is 1 if the country had a nationalization by 1910. The coefficients are estimated using a probit model. * indicates statistical significance at 90% and above.

Table 4: Determinants of Extent of Nationalizations: Panel Estimates

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 (year)	.002 (.0008)*	.0003 (.0009)	.0007 (.001)
Trend for French and German Civil	.004 (.0005)*	.0042 (.0005)*	.004 (.0006)*
Trend for Scandinavian Civil Law	.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: * 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 5: 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 Mean	One Standard deviation Increase in Railroad Density from the Mean
One-standard Deviation Decrease in G.D.P. Per capita from the Mean	0.10	0.12
One-standard Deviation Increase in G.D.P. Per capita from the 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 6: Nationalizations and Mileage Growth: Two-Stage Least Squares Estimates

Variable	(1) Coeff. (Stand. Err.)	(2) Coeff. (Stand. Err.)	(3) Coeff. (Stand. Err.)
Fraction of Miles Nationalized by t	-.098 (.058)*	-.108 (.058)*	-.122 (.056)*
War Dummy t-5	-.015 (.014)	-.019 (.013)	-.022 (.013)
Log of RR Miles per Square Mile t-5	.041 (.039)	.040 (.036)	-.062 (.004)*
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	Yes
Year Dummies	Yes	Yes	Yes
Other Controls Included?	Yes	Yes	Yes
N	818	818	818
Over-identification Statistic	0.24	3.19	14.23
(p-value)	(0.99)	(0.78)	(0.08)
Endogeneity test statistic	1.67	1.86	
(p-value)	(0.09)	(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. The added instruments in column (3) are the log of G.D.P. per capita in t-5 and an interaction between the log of G.D.P. per capita and railroad density in t-5.

Table 7: 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 6.

Table 8: Summary Statistics for the Analysis of Nationalizations in 1910

Variable	Mean	Standard Deviation	Min	Max
Nationalization Dummy, 1910	0.57	0.50	0	1
Log of Neighbors' Military Capability, 1910	-2.96	1.14	-5.66	-1.49
Constraints-on-the-executive, 1910	5.11	2.21	1	7
Polity2 Democracy Index, 1910	2.53	5.93	-9	10
Dummy for French and German Civil	0.71	.46	0	1
Dummy for Scandinavian Civil Law	0.11	0.32	0	1
Log Pop Density, 1910	-2.74	1.74	-7.26	-.12
Log of Real G.D.P. per capita 1910	7.69	.62	6.31	8.58
Log of RR Miles per Square Mile 1910	-3.29	1.51	-6.73	1.34
N	31			

Sources: see text

Table 9: 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	5.06	2.10	1	7
(Log of RR Miles per Square Mile) *(Log of Real G.D.P. per capita)	-27.87	11.89	-63.33	-11.31
N	818			

Sources: see the text.

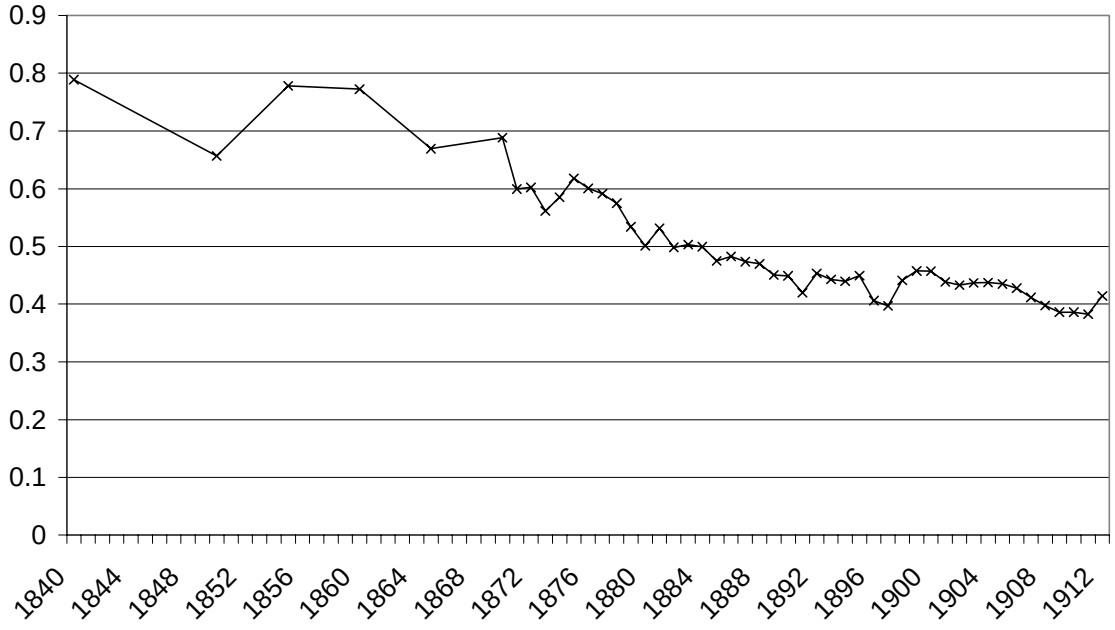
Table 10: Coefficient Estimates for other variables in Table 6

Variables	(1) Coeff. (st. er.)	(2) Coeff. (st. er.)	(3) Coeff. (st. er.)
Population Growth in t-5	.106 (.271)	-.078 (.270)	.277 (.265)
Population Growth in t-6	.354 (.266)	.312 (.265)	.448 (.264)*
Real G.D.P. per capita Growth in t-3	-.011 (.036)	-.011 (.036)	-.019 (.035)
Real G.D.P. per capita Growth in t-4	.064 (.037)*	.064 (.037)*	.055 (.036)
Real Yield on British G. Bonds in t-3	-.004 (.002)	-.003 (.002)	-.004 (.003)
Real Yield on British G. Bonds in t-4	-.008 (.002)*	-.008 (.002)*	-.008 (.002)*
Govt. Bond Spread in t-3	-.007 (.002)*	-.006 (.002)*	-.006 (.003)*
Govt. Bond Spread in t-4	.003 (.002)	.003 (.002)	.003 (.002)
Log Diff. Exchange Rates in t-3	-.089 (.028)*	-.090 (.028)*	-.087 (.028)*
Log Diff. Exchange Rates in t-4	-.017 (.028)	-.018 (.028)	-.015 (.028)
Log Diff. in RR Cap. Prices in t-3	.065 (.027)*	.066 (.027)*	.067 (.027)*
Log Diff. in RR Cap. Prices in t-4	.031 (.027)	.033 (.027)	.029 (.027)
Difference in War Dummy in t-3	-.009 (.010)	-.010 (.010)	-.012 (.010)
Difference in War Dummy in t-4	-.009 (.012)	-.013 (.012)	-.015 (.012)
Change neighbors' military cap. in t-3	.001 (.031)	-.003 (.031)	-.003 (.031)
Change neighbors' military cap. in t-4	.011 (.032)	.004 (.031)	.005 (.031)
Change in Democracy Index in t-3	.002 (.002)	.001 (.002)	.001(.002)
Change in Democracy Index in t-4	-.002 (.002)	-.002 (.002)	-.003 (.002)
Change in Constraints on Exec. in t-3	.009 (.006)	.010 (.006)	.009 (.006)
Change in Constraints on Exec. in t-4	.024 (.007)*	.025 (.007)*	.024 (.007)*
Year Fixed Effects	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes
N	818	818	818

Notes: dependent variable is railroad mileage growth for country i in year t. Column (1) corresponds to (1) in table 6. The same for columns (2) and (3). * indicates statistical significance at the 90% confidence level.

Figures

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



Sources: see text.

Figure 2: Fraction of Miles Nationalized for Countries with Nationalizations, 1870-1912

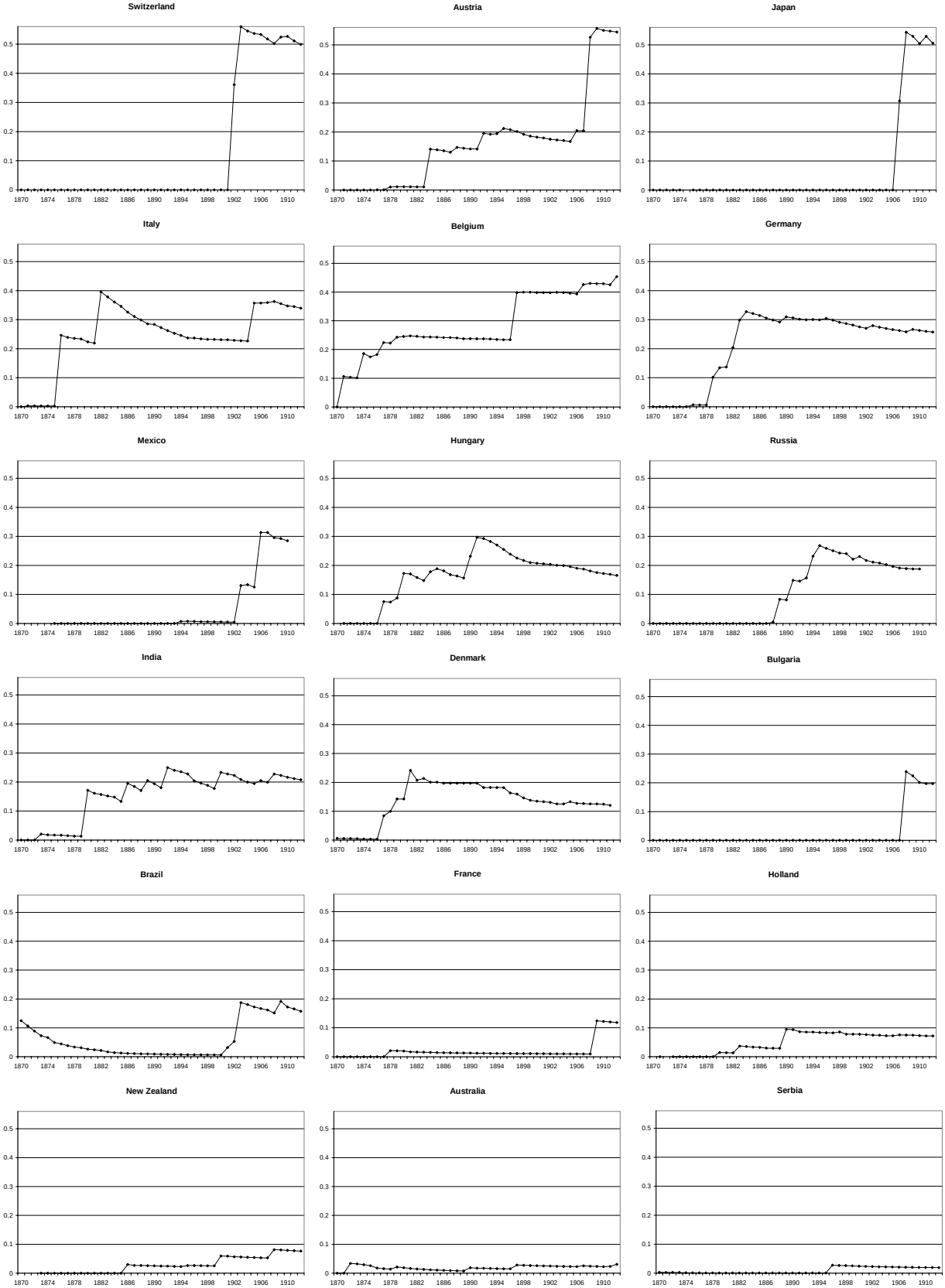
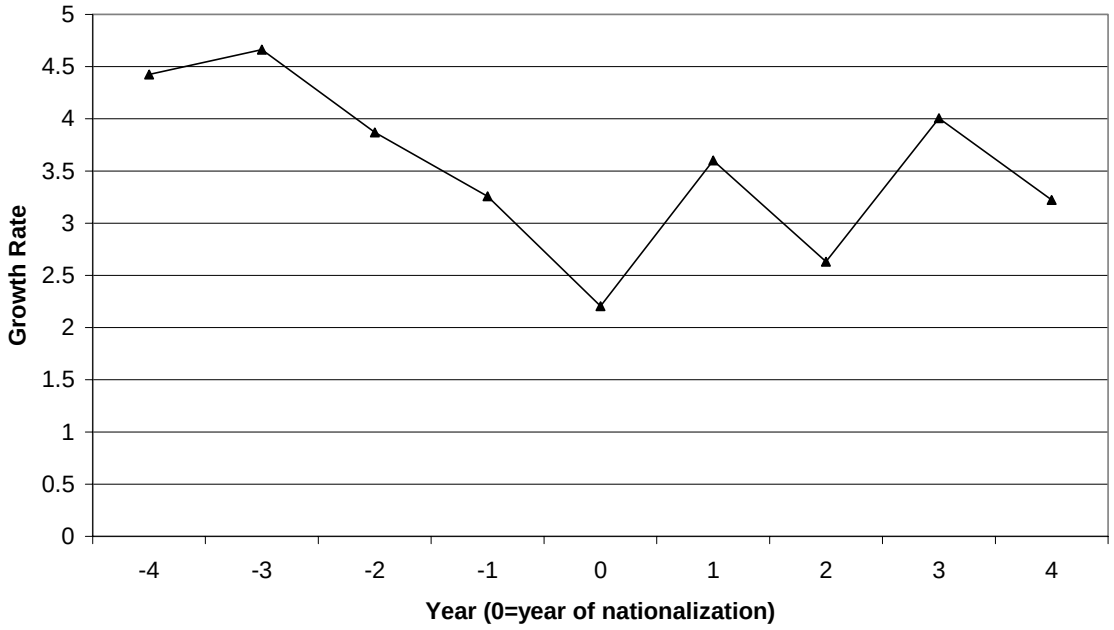
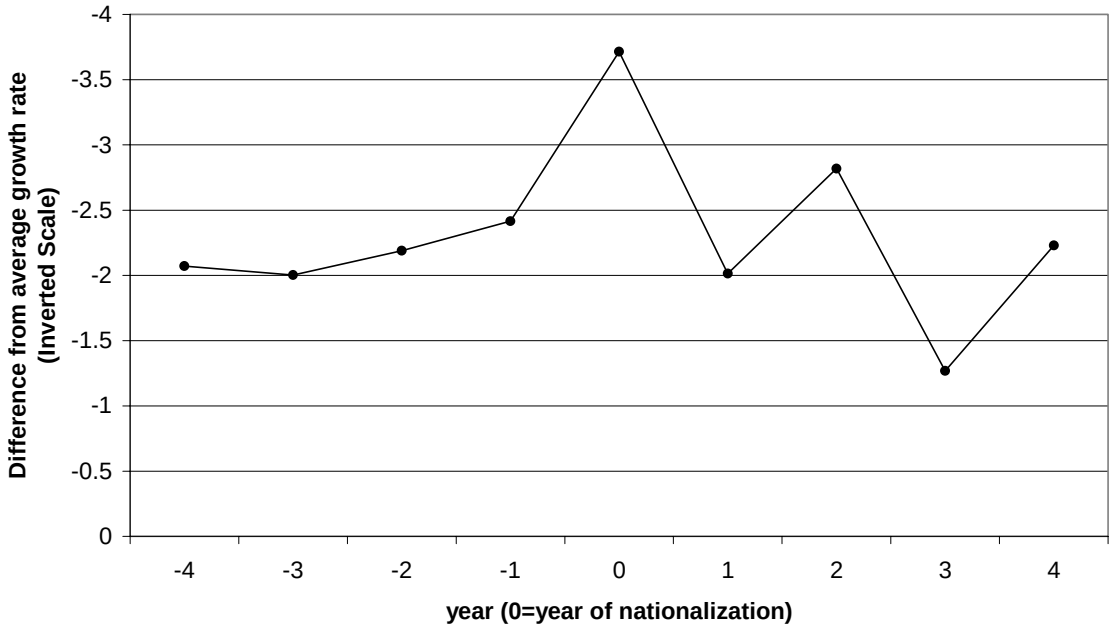


Figure 3: Average Mileage Growth Four years before and after Nationalizations



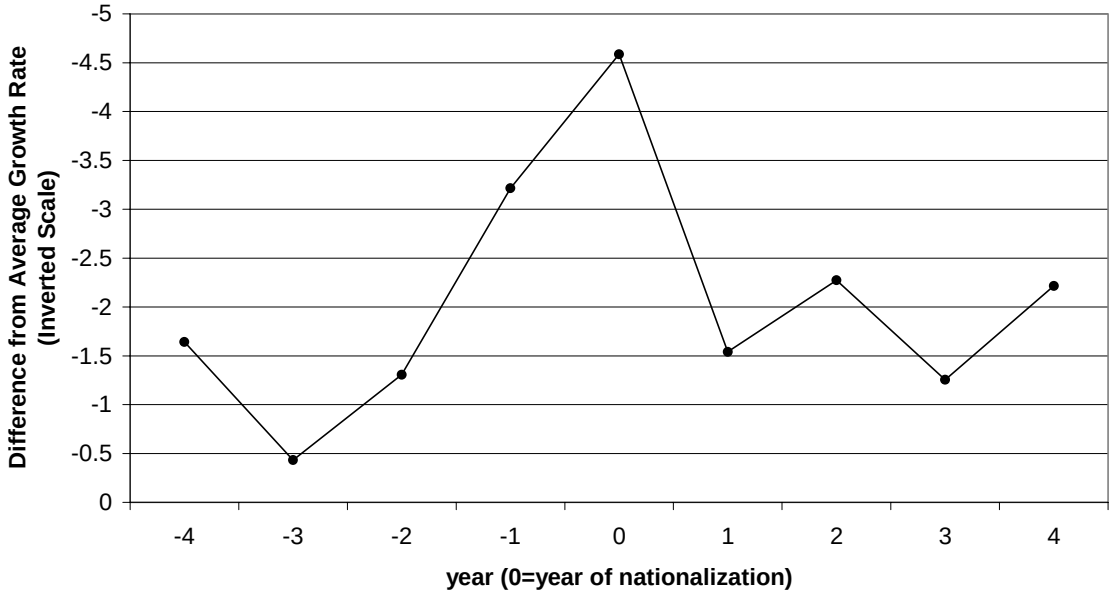
Sources: see text.

Figure 4: Average Difference in mileage growth in year t between countries that had nationalizations and all countries



Sources: see text.

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



Sources: see text.