

**Imperialists and Private Companies:
New Evidence on the Efficiency of Indian Railways, 1882-1912**

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Abstract

Using a new dataset on Indian railway companies, we study the effects of ownership structure on performance between 1882 and 1912. Over this period, new public-private partnerships came to dominate the scene as former private companies were bought out by the State but were allowed to retain operations in most cases. Moreover, any new companies created in these decades often managed the operation of State owned lines. By exploiting the switch from private ownership and operation to state ownership and private operation within the same railway line, we find state ownership and private operation lead to significant efficiency gains. This shift contributed to India's success in developing one of the most efficient railway networks in the world by the early 20th century.

1. Introduction

Infrastructure innovations and improvements are of critical importance to economic development across the world. In particular the advent of railways in different countries dramatically reduced transportation costs, led to greater commercialization and increased economic growth in both developed and developing countries. However, differences in the performance of railways in terms of productivity and cost efficiency may have significantly affected the degree of benefits associated with railway development. State policies were often a key determinant of performance because state agencies influenced the construction and maintenance of tracks, electricity transmission lines, and sanitation facilities by regulating the entry and fares charged by private railway companies. Moreover, states also directly built and operated lines in several countries.

Despite the public goods nature of railways, many scholars argue that private ownership yields greater efficiency, lower prices, larger networks, and higher quality services (Shirley and Walsh 2001.) The underlying studies, however, often rely on cross-country comparisons of privately owned versus nationalized railways and focus on relatively short time periods. Even the within country studies frequently fail to control for unobservable factors that may affect both the type of ownership (public or private) and performance. In this paper, we study the effects of ownership structure on performance in colonial India by comparing working expenses within the same railway system before and after it changed ownership between 1882 and 1912. Using railway system fixed effects, we more effectively address problems of unobservable heterogeneity that have plagued cross sectional studies.

The Indian context is particularly unique because different ownerships structures dominated the railway scene in our sample period. Beginning in 1853, the first railway lines

were constructed in India by private British companies relying on capital raised in England with a 5 percent guarantee backed by the Government of India. Until 1869 the ‘guaranteed private’ companies were the only players in the field of railways, but in the early 1870’s the Government of India also began to construct and operate lines. Over time other public entities such as provincial governments and princely states also set up their own railway lines.¹ In this early phase, the public lines were not profitable and the private companies relied almost exclusively on the state guarantee to pay off their shareholders.

After 1880, the Government of India began to buy out private companies and in many instances allowed them to manage operations creating interesting public-private partnerships whereby the state owned the lines and private companies handled the working subject to state control and supervision. Surplus profits were divided between the state and private companies with the latter receiving less than a quarter of the net profits on average. Growing public dissatisfaction in India with private British companies finally lead to Indian railways being gradually nationalized from the 1920’s.

To identify the effects of ownership, we focus on the key period between 1882 and 1912 when many of the private guaranteed companies switched to state ownership and private operation, and when new state owned and privately operated lines were established. For the econometric analysis, we collected detailed data on the operation of railways from *Annual Reports on the Administration of Indian Railways* that report mileage, passenger and goods traffic, fares and rates, fuel consumption, working expenses and capital outlay among many other variables. The data allow us to precisely identify the ownership status of each railway

¹ The Native States, also known as the Princely States, comprised one third of the territories of the Indian sub-continent and were controlled by many different native kings that deferred to the British with regard to defense and foreign policy. In return, these Native States were allowed to autonomously manage their own local affairs.

line including when the state took over ownership of a private line or when the state outsourced the working of a line to a private company.

The preliminary results suggest that a switch to state ownership and private operation conferred significant efficiency gains for Indian railways. Working expenses are 6 percent lower on average for state owned and privately operated railways controlling for input costs, network density, railway and year fixed effects and railway specific time trends. The findings are robust to alternate specifications and methods of organizing the lines. Most of the gains are driven by changes in ownership of the old guaranteed companies that came under more stringent state control and supervision after they were taken over by the Government of India. Stronger state incentives for efficiency may have also contributed to the decrease in costs.

Our paper contributes to the Indian economic history literature, which has largely analyzed the impact of railways on social savings and trade issues such as expansion of markets, price and wage convergence and increase in commercialization (McAlpin 1974, Hurd 1975, Adams and West 1979, Andrabi and Kuehlwein 2008, Donaldson 2008). By focusing on efficiency and exploiting changes in ownership, our results complement the existing literature and highlight how the transition from private ownership and operations in the 19th century to state ownership and private operation contributed to India's transformation from a relatively inefficient to an efficient railway network by the early 20th century (Bogart 2009).

The findings also have implications for the transport economics literature and the broader literature on state versus private ownership of public services. While economists generally argue in favor of private provision (Shleifer 1995), the experience of Indian railways suggests that creating the 'correct incentives' for the parties involved is the critical issue. In India private companies bore limited downside risk, were free to increase capital costs and

consequently were inefficient at operating railways. Once the incentives for private extravagance at public cost were reduced with state ownership, costs decreased and Indian railways became more efficient.

The rest of the paper is organized as follows: we set up a simple theoretical framework to motivate our analysis in section 2; section 3 describes our institutional environment; the data are discussed in section 4; the empirical strategy is outlined in section 5; we present the results in section 6 and section 7 concludes.

2. Theoretical Framework

Privately owned enterprises are generally believed to be more efficient than state-owned enterprises because the former encourages competition and provides stronger incentives for investment and innovation than the latter (Shleifer 1995). It is unclear, however, whether private ownership contributes to efficiency in the context of railways. One reason is because railway services are subject to network externalities. For example, the value of providing a service between two destinations A and B depends on the network links associated with A and B. If private companies operate each link then they may be less effective at coordinating services than a centralized state. A state-owned railway may control more links or may just be more effective in forcing neighboring railways to provide complementary services. The effects of better coordination under state ownership may ultimately lower the cost of operating services.

Private ownership may also be less efficient in contexts where regulators are unable to commit to protect the rights of private companies. If companies anticipate they may be expropriated or their profits may be deliberately diminished by policies adopted by the regulator, they may forgo undertaking efficiency enhancing investments. In such contexts state ownership and operation may be preferable from an efficiency point of view because governments are less

likely to expropriate from themselves (Levy and Spiller 1995, Keefer 1995).

In the mid-19th century private ownership of railways predominated throughout the world despite their theoretical drawbacks. In Britain private companies through acts issued by Parliament built the first railways. The acts provided rights of way and regulated maximum fares and freight charges, but they provided no subsidies and little coordination. Other countries experimented with this form of ‘pure’ private ownership in the 1830’s and 1840’s but relatively quickly it became the norm for governments to provide construction subsidies or interest and dividend guarantees. Throughout the world investors demanded public support before building and operating railways and most received it.

There were a few countries, like Belgium, that deviated from the norm by having state-owned and operated railways as early as the 1840’s. State ownership remained relatively uncommon until after the 1870’s when some government authorities started to nationalize private railway companies. Governments also constructed their own railways increasingly after 1870. From 1870 to 1910 the fraction of the world’s railway miles owned by companies decreased from over 90 percent to just over 70 percent with the corresponding share of state owned railway miles rising commensurately (Bogart 2009). The shift to state ownership usually coincided with state operation of railways. India, as we shall see below, was an exception over this period because most of the Government of India owned railways were either privately operated or switched to private operations.

From a theoretical point of view, the rise of state ownership after 1870 could have contributed to greater or lower inefficiency. State takeovers of private companies may have created disruptions in operation, which may have raised costs. Governments may have also operated railways to achieve non-commercial i.e. military or political objectives. For example,

excessive numbers of services may have been provided to reward constituents. Wages for government railway workers may have been increased above the market wage. On the other hand, the shift to state ownership may have contributed to greater efficiency by improving the coordination of services. The elimination of interest or dividend guarantees could have also sharpened the incentives to cut costs. Greater state supervision combined with no public guarantee may thus have operated to increase efficiency. Moreover, if private companies faced a harsh regulatory environment then the shift to state ownership may actually have increased the incentives for investment.

Within the Indian context, national and official opinion concurred on the perceived extravagance of private guaranteed companies and there were several calls for state management.

Viceroy Lord Ripon writing in 1887 had the following to say about private ownership:

“The ideal of private enterprise in Indian railways in the view of the Government of India was that a company would require nothing more than a free grant of land; but they were not prepared to start the creation of companies which would have a very limited interest in the concern from which they took their name, which would contribute only a small portion of the capital at an unnecessarily high rate of interest...and which for the rest of their capital would have to take from the Government Treasury...” (1887)

Indian nationalists writing in the early 20th century also called for more state ownership (for example Gopal Krishna Gokhale) of Indian railways. The anecdotal evidence notwithstanding, it is an empirical question whether state ownership conferred any cost savings to Indian railways. Many factors such as placement of lines, geography and input costs influence the performance of railways and a simple comparison of state and private railways is likely to be biased because of unobservable factors affecting ownership and working expenses. We thus exploit the Indian experiment of changing ownership to assess whether private or state ownership is preferable.

3. Development of Indian Railways

The arrival of railways in India fundamentally transformed the communication network

and broader economy. Before railways, the transportation infrastructure was weak. Roads were few, poorly developed and often inaccessible during the monsoon season. High transportation costs lead to small regional markets in most products except for high value to weight luxury goods (Hurd 1982, Studer 2008). Recognizing the economic and political benefits conferred by railways, the East India Company began to encourage railway construction in the mid-19th century with the initial push coming from railway promoters representing the interests of English merchant houses (Thorner 1951). By lowering transportation costs, railways could cheaply bring raw material such as cotton from India to Great Britain and also open up Indian markets to British finished products.

In the beginning railway promoters and British officials alike favored private provision of railways. Two private British companies, the East Indian Railway Company and Great Indian Peninsula Railway Company, were incorporated in the 1840's to construct small experimental lines in Bengal and Bombay respectively. After a slow start in the early 1850's, the subsequent construction of railways was very rapid especially between 1890 and 1910. The first line totaling 20 miles was opened in 1853 connecting the port of Bombay city to Thana. Subsequent lines connecting the ports of Calcutta and Madras to interior districts were opened in 1854 and 1856 respectively. Open mileage grew to 838 miles in 1860, 9,162 miles in 1880, 24,752 miles in 1900 and before Indian independence mileage stood at 40,509 miles in 1945 (Government of India 1955). The density of the network also expanded rapidly from 35 route kilometers in 1880 to 159 route kilometers per 10,000 square kilometers by Independence. By the early 1900's, India had grown to the fourth largest rail network in the world (see the attached maps).

Indian railway development was characterized by a complex ownership and operation structure spanning four distinct phases. In the first phase between 1853 and 1868, private

guaranteed companies constructed and managed lines subject to supervisory control by the Government of India. During the second phase extending from 1869 to 1882, the state began to directly build new lines alongside private guaranteed companies. Besides the Government of India, lower level bodies such as provincial governments and district boards and Native Rulers for example the Nizam, also built some lines. Beginning in 1882, the third phase of development ushered in a complex public-private partnership whereby the former private guaranteed companies were taken over by the state but retained operation of the lines. New private companies such as the Southern Mahratta, Bengal Nagpur and Indian Midland were also formed in the 1880's period but under different guarantee schemes more favorable to the state. Public-private partnerships dominated the scene until the beginning of phase four in 1924 involving gradual nationalization per the recommendations of the 1921 Acworth Committee Report.

To illustrate the change in organization structure, figure 1 plots the fraction of total miles weighted by train miles for our analysis period from 1882 to 1912. In the beginning of the 1880's, state owned and privately operated lines comprised less than 20 percent of Indian railways but they grew to almost 90 percent by 1912. Most of the increase came at the expense of old guaranteed companies such as Great Indian Peninsula and South Indian that switched to state ownership and private operation over these decades. Moreover, new assisted companies created in the 1880's are also classified as state owned and privately operated because the state owned the lines while the companies managed operations. By the early 1900's 'pure' private ownership disappeared from the Indian landscape.

Railway construction under the Raj was thus a complicated affair of public and private provision. The interests of private companies were often at odds with those of the state, but even in the public sphere different groups clashed with each other. British officials working in India

(i.e. the Government of India) were more in tune with Indian interests and strongly advocated for greater efficiency and accountability in private provision. The Secretary of State housed in London, in contrast, was more influenced by the demands of private British companies. In each phase of construction, the interaction between the competing interests of private companies, the Government of India and Secretary of State (East India Company directors before 1858) lead to different outcomes.

Private companies incorporated in Britain constructed and managed the early lines under a guarantee system up to 1868 (phase one). Ten companies were sanctioned between 1849 and 1864 under the following general terms.² Capital was raised in Britain but the Government of India provided free land and a 4.5 to 5 percent guarantee on capital at a fixed exchange rate.³ To recuperate interest payments made in unprofitable years, the Government of India was entitled to receive half of all surplus profits and company shareholders received the other half. After the interest payments were paid off, the company would receive all profits. The government retained control over route placement, gauge and materials, and also had authority over any alterations. Railways were leased to private companies for 99 years but the government retained the right to purchase the railways after 25 or 50 years at market value.

Guarantees were common in other countries without well-developed capital markets for example, Brazil. British railway promoters negotiating with the directors of the East India Company also emphasized the difficulty of raising British capital for a potentially risky Indian infrastructure project without an explicit guarantee.⁴ Unfortunately, the early lines were

² East Indian (1849), Great Indian Peninsula (1849), Madras (1852), Bombay, Baroda and Central India (1855), Sind, Punjab and Delhi (1855), Eastern Bengal (1858), Great Southern of India (1858), Calcutta and South Eastern (1859), Oudh (1862) and Carnatic (1864). Year of sanction and contract in brackets from Sanyal (1930). All the lines were built on a broad gauge – 5 feet 6 inches.

³ The exchange rate was fixed at 1s. 10d to the rupee.

⁴ The East India Company was opposed to the public guarantee in the beginning but came around after the English depression in 1847-49.

unprofitable for several years (i.e. earned less than 5 percent) and the Indian government incurred substantial losses because of interest payments to British shareholders. By 1900, the payouts totaled 50 million pounds. The rising exchange rate further contributed to the losses because the contracts stipulated a fixed exchange rate. Although the Government supervised private companies, they were ineffectual at controlling costs because state engineers “were not experienced enough in railway construction and the fear of causing delay to the progress of work often led them to overlook the negligence of companies (Sanyal 1930, pg. 63).” Private companies may have also been more extravagant because of the guarantee—ornate railway stations with luxury cabins testify to private extravagance on a public purse. High capital outlays coupled with poor returns plagued the guaranteed companies over the first phase of railway construction and ushered in a wave of public provision.

Two events marked the second phase between 1869 and 1882. First, contracts between the state and guaranteed companies were renegotiated in 1869 leading to strong differences between the Secretary of State and the Government of India on account of the contractual terms. Company debts due to the guarantee were cleared in exchange for sharing half of all surplus net profits with the Government of India from that point forward. Other than the East Indian, the other guaranteed companies accepted the offer and in a few cases (Great Indian Peninsula, Madras and Bombay, Baroda and Central India Railways) the private companies also negotiated for extended private ownership beyond the first 25 years that was coming up for most of them in the 1870’s. The Government of India opposed the renegotiation because it forgave interest debts just as private companies were beginning to earn profits above 5 percent. But the Secretary of State despite their reservation renegotiated the contracts.

Second, the direction of railway construction changed because of the continued

unprofitability of the guaranteed lines. Worried about paying interest guarantees into the indefinite future, official opinion in India turned against private provision and in favor of public provision. Sir John Lawrence, viceroy from 1864 to 1869, made the following statement about private provision in 1869 and set the stage for public provision (phase two):

“The Government of India has for several years been striving to induce capitalists to undertake construction of railways in India at their own risk, and on their responsibility with a minimum of Government interference. But the attempt has entirely failed, and it has become obvious that no capital can be obtained for such undertakings otherwise than under a guarantee of interest, fully equal to that which the Government would have to pay if it borrowed on its own account.”

Between 1869 and 1882, the Government of India constructed and operated railway lines. No new contracts were signed with private companies although the old guaranteed companies constructed a few extensions. Private companies owned and operated trunk lines, while the state owned and operated auxiliary lines many of which broke from the standard gauge to a smaller metre gauge (3 feet 3/8 inches). Although government lines were built more cheaply, the economic depression in the 1870's coupled with the war in Afghanistan increased the government's borrowing costs turning the tide against state provision. Famines in 1877 and annual constraints on government borrowing also contributed to the problem because the subsequent Famine Commission recommended a rapid extension of railways, which the state could not achieve. Advocates of private provision capitalized on the Government's economic woes and won their battle in 1879 when the Secretary of State called for an end to the era of state owned and operated railways leading to phase three.

Beginning in 1882, a new hybrid public-private partnership appeared and dominated the scene up to the 1920's. As the contracts of the former guaranteed companies expired, the Government of India bought the companies in exchange for annuity payments to the majority shareholders. A minority of the shareholders formed a new company to manage operations but

generally the new company held less than 20 percent of the capital. They were not allowed to make capital investments without state approval and shared surplus profits with the Government of India in proportion to their respective capital shares. On average, the private companies received less than a quarter of surplus profits in this period and were also under more stringent supervision by the state.

East Indian Railways was the first guaranteed company to be purchased by the state in 1879 because they rejected the earlier government offer to split profits in 1869 and hence the state decided to purchase them at the end of their 25-year contract in 1879. The lines were subsequently worked by the newly formed East Indian company, which retained one fifth of the capital now guaranteed at 4 percent and also received one fifth of surplus profits for working the lines. Similar terms more favorable to the state were negotiated with the other guaranteed companies when their contracts came due. Although the Government of India offered a lower guarantee (3 to 3.5 percent) in these modified state-private contracts, the railways began to earn higher returns post 1880 and guarantees were thus a moot point.

New companies were also set up in the early 1880's but the Government again negotiated more favorable terms as compared to the first generation of contracts signed in the 1850's and 1860's. For example, Bengal Central Railway Company was formed in London in 1881 receiving free land and a 3.5 percent interest guarantee for 5 years. The Government also received three quarters of the net earnings after deducting the guarantee payments and had the option to purchase the line after 20 years or every 10 years thereafter. Another company, Southern Mahratta incorporated in 1882 became the prototype for subsequent public-private arrangements. The Government owned the lines while the company constructed and worked the lines under public supervision. The company raised the capital guaranteed at 4 percent for the

first 7 years and 3 percent thereafter, and received a quarter of net earnings to manage operations (proportional to their capital share).

The Government thus made a big push toward state ownership of lines in this period. Private companies were created to manage state owned lines, and the older guaranteed companies switched to publicly owned and privately operated organizations. The Government outsourced the working of many state lines to private companies but retained the operation of military lines and small auxiliary lines. State owned and privately operated railways were the norm until the 1920's when a perceived inefficiency of private management and changing public opinion lead to complete nationalization.⁵

Over time the Government of India thus secured better terms in their dealings with private companies and in so doing better aligned state incentives to achieve greater efficiency among state owned railways. In the first set of contracts, the state offset the downside risk for private companies via the guarantee but received no share of the profits. Moreover, state engineers were unable to constrain private costs due to their inexperience in the field of railways. In the modifications of 1869, the state secured fifty percent of all surplus profits but in exchange had to give up their past interest payments made on account of the guarantee and the unprofitability of railways in the 1850's and 1860's. When the state took ownership of private lines, however, it negotiated for a larger slice of surplus profits (in proportion to their capital share, which was more than 75 percent on average) and greater supervision over operations. Since they received bulk of the surplus profits, it was thus in the state's interest to force companies to reduce costs and improve efficiency. We assess whether costs decreased following these ownership changes in the following sections.

⁵ Public opinion turned against private operation of high rates, mistreatment of Indian passengers and discrimination against Indian employees.

4. Data

We created a new data set of Indian Railway systems from 1882 to 1912 for the analysis using *Administration Reports on the Railway in India*, *Statistical Abstracts* and *History of Indian Railways* (1947). Most of the data is from the official *Administrative Reports* for 1882 to 1912 published annually from 1882 onwards. They contain a wealth of information on the progress and operation of railways in each year. Individual chapters cover “works in progress”, detailed revenue transactions including working expenses and gross earnings, unit mileage (number of passengers carried one mile and number of tons carried one mile), train miles, fares, accidents, etc. Although official reports were published before 1882, they do not report information on fuel costs, unit mileage and cost of train staff that are essential for our regressions. We therefore begin the analysis in 1882 and end in 1912 just before the beginning of World War 1—a thirty-year period during which state ownership and private operation became the dominant organizational form.

Our data are extracted primarily from the tables titled “General Results of Working of the Principal Indian Railways” reported annually before 1900 and for each half year after 1900. The tables include capital outlay, passenger and goods earnings, gross earnings, working expenses, train miles, cost of train staff, unit mileage, and average cost and sum received for carrying either one passenger or one ton of goods one mile. For the post-1900 variables, we either aggregate or average the variables over the two half years to construct an annual observation.⁶ In a few cases of missing observations, we do a linear interpolation using the nearest years of available data.⁷

⁶ We construct capital outlay in the post-1900 years using the ratio of net earnings to capital outlay adjusted for steamboat earnings and expenses to be consistent with the measure of capital outlay reported in the pre-1900 years.

⁷ Avg. fuel costs in 1882 are the same as 1883 because the 1882 volume does not report fuel costs. Cost of train staff for Rohilkhand and Kumaon railways in the early 1890’s is also interpolated.

Ideally, we would like to follow each individual railway line for the entire period even after it merges with another line. We are unfortunately unable to code individual lines because of two reporting problems. First, if there is a merger between two lines, we only have data on the new merged line. Second and more importantly, there is a significant reporting change in 1900: the pre-1900 reports provide information on the “principal standard and metre gauge lines” but after 1900 they report information on the “principal railway system” aggregating the main company or state line with any other secondary lines worked by the same company or state. Although the pre-1900 reports occasionally include secondary lines with primary lines, data on secondary lines are reported separately for several cases.

To illustrate the problem, let’s consider the case of the East Indian Railways, a private guaranteed company among the first to switch to state ownership and private operation in 1879. For the 1880’s and 1890’s, East Indian includes the main East Indian line and three small state owned lines worked by the East Indian (Patna-Gaya, Sindia and Dildarnagar-Ghazipur). In the same period, East Indian also manages the operations (i.e. working) of three private assisted company lines (Tarakesur from 1885, Delhi-Umballa-Kalka from 1891 and South Behar from 1899). Data on the latter are reported separately before 1900, but beginning in 1900 East Indian is only reported as one system including the state lines and the assisted company lines.

We address the pre and post 1900 difference by creating a consistent series of the “principal railway system” from 1882 to 1912. Since data on the secondary lines is reported separately in other tables of the pre 1900 reports, we merge their information to the primary

system managing their operation.⁸ Appendix table 1 describes the principal railway systems and the secondary lines included in the system. To handle mergers, we follow the “principal railway system” and drop secondary lines in the years before the merger. We thus end up dropping Tirhoot State Railways, Bengal Central, East Coast State and Indian Midland Railways before they merge with their principal systems.⁹ We can also leave these lines in the panel as individual observations before they merge and we present results for both panels to ensure our results are not driven by the merger strategy.

Indian railways have many ownership structures in this period such as state owned and operated, state owned and privately operated, native state owned, etc. We construct broad ownership categories based on information reported in the appendix tables of the *Administrative Reports*. If the *Reports* are unclear, we also refer to the *History of Indian Railways* (1947). Since railway systems manage many types of lines, we code the system according to the organization of majority of the lines within the system. Although the reports distinguish between Imperial versus Provincial state railways for some years, we code all public railways as state owned. In later years, the official reports also forgo the distinction between different state entities confirming our prior that state railways at all levels had the support of the Government of India.

Under private ownership and operation, we only code the old guaranteed companies formed in the 1850’s to 1860’s while most of the private assisted companies formed in the 1880’s are coded as state owned and privately operated. The two exceptions are Bengal and Northwestern before they take over the operations of the Tirhoot State Railways in 1890 and

⁸ Cost of train staff per mile even in the pre-1900 documents is reported for the “principal system” but other variables such as working expenses, gross earnings, unit mileage, etc. are not. Fuel costs are only reported for the principal railway lines and we assume they are equal to the costs faced by the system.

⁹ We also drop a few other smaller lines before they merge for e.g. Calcutta and South Eastern, etc.

Bengal Central Railway between 1897 and 1905 when it manages its own private lines.¹⁰

Finally, we exclude the four main Native State owned lines from the analysis because of the complicated relationship between Native States, the Government of India and private companies, and the resulting ambiguity in their organizational form.¹¹

Given our observations are defined for the “principal railway system”, we code ownership in two ways. First, we use the organization of the dominant railway line within a system to code the entire system. Dominant railways lines represent majority of the system mileage on average so any measurement error from this approximation should be small. Second, we also code the fraction of miles of each type within the system such as the fraction of privately owned miles, of state owned miles, of state owned and privately operated, etc. Our main results focus on the former organizational variable but we present results using the fraction mileage variable as an additional robustness check.

To capture input costs across railways, we use the average price of coal per ton, cost of train staff per mile and capital outlay per mile. Data on train staff is unreported in the 1880’s and we interpolate this variable for 1882 to 1889 using the 1890 cost of train staff and the trend in real wages for skilled labor over the 1880’s. In future work, we hope to precisely measure labor costs faced by each railway using skilled and unskilled wages reported in official volumes for different Indian districts based on the annual location of each railway system.

Table 1 displays the summary statistics by year and organization type. Average mileage increased in both state owned and operated, and state owned and privately operated systems from 1885 to 1910. Privately owned and operated lines had lower working expenses on average than

¹⁰ See section 3 for more detail about the Bengal Central railway.

¹¹ We thus exclude the Nizam’s Guaranteed State Railway, Jodhpore-Bikaner, Udaipur-Chittoor, Bhavnagar-Gondal-Junagarh-Porbander. The only exception is Mysore state railways, which begins the period as a Native State railway but is merged with the Southern Mahratta Railway Company in 1887.

state-state and state-private lines, but their systems were also smaller on average (803 miles versus 1,357 for state-private and 1,560 for state-state). State owned and privately operated lines enjoyed lower fuel and capital costs, but their labor costs were comparable to privately owned lines. Although these mean differences across ownership types are informative, it is difficult to disentangle the factors contributing to differences in costs. In fact, if we look at average passenger and freight costs by ownership type (figures 2 and 3), state-state lines begin the period with the highest costs but then converge to state-private and private-private costs. We turn therefore to regression analysis to quantify the effect of ownerships structure on performance by comparing the same railway system before and after it changes ownership.

5. Empirical Strategy

Regression analysis is a useful tool for analyzing the effects of contractual arrangements in the Indian railways sector. Our approach is to specify a cost function relating the operating expenses of railways with variables for scale, density, and input prices. The cost function is then augmented by railway line fixed effects, year fixed effects, and dummies for state ownership-state operation, private ownership-private operation, and state ownership-private operation.

Our baseline specification is based on the Cobb-Douglas cost function taking the following form:

$$\ln c_{it} = \sum_{k=1}^K \beta^k \ln q_{it}^k + \sum_{j=1}^J \gamma^j \ln p_{it}^j + \delta_t + \alpha_i + pp_{it} + ss_{it} + \varepsilon_{it} \quad (1)$$

$\ln c_{it}$ is the natural log of working expenses for railway system i in year t , $\ln q_{it}^k$ is the log of ton-miles, passenger-miles, and rail miles for system i in year t , $\ln p_{it}^j$ is the log of the price of labor, fuel, and construction costs per mile for system i in year t , δ_t are year fixed effects, α_i are railway system fixed effects, and ε_{it} is the error term. Our main variables of interest are sp_{it} and

ss_{it} where sp_{it} is a dummy variable taking the value 1 in years when the railway system is state owned and privately operated and 0 otherwise, and ss_{it} is a dummy variable taking the value 1 in years when the system is state owned and operated and 0 otherwise. In all our specifications the omitted category is private ownership and private operation.

As the specification includes railway system fixed effects, we identify the effects of ownership from changes in the ownership-operation within railway systems. Several private guaranteed railway companies shifted from private ownership and operation to state ownership and private operation in our sample period.¹² In addition, three state owned and operated railways also switched to state ownership and private operation. If this ownership change lowered operating costs then the coefficient on sp_{it} should be negative and statistically significant. Several railways also shifted from private ownership and operation to state ownership and state operation.¹³ If this ownership and operational change lowered costs then the coefficients on ss_{it} should also be negative and statistically significant.

By including railway system fixed effects, we effectively control for any time-invariant unobserved heterogeneity at the railway level. Geography and railway gauges are two important sources of heterogeneity that could bias the results. For example, constructing and operating railway lines in mountainous terrain prone to land slides is perhaps more expensive than operating railways over a flat dessert terrain. The type of railway gauge is also relevant because narrow gauges (metre or smaller) are believed to have had lower costs than standard gauge

¹² Five private companies switched to state ownership and private operation: South Indian in 1891; Great Indian Peninsula in 1900; Bombay, Baroda and Central India in 1908; Madras in 1908; and Bengal and Northwestern in 1890. Bengal and Northwestern was an assisted company formed in 1884 that took over the working of Tirhoot Railways (state owned and operated line) in 1890 and thus became a state owned and privately operated system. We do not code the transfer of Sind, Punjab and Delhi (a private guaranteed company) as a switch because the company came under state control and was merged with the Punjab Northern and Indus Valley system in 1886 but the mileage of Punjab Northern and Indus Valley was much higher than SPD. The fraction mileage variable, however, does take into account the change in private mileage of the merged Northwestern Railway system.

¹³ Eastern Bengal (1884) and Oudh and Rohilkhand (1889) switch from private-private to state-state.

railways (5 feet 6 inches in India). We also include year fixed effects in the specifications to control for time-varying shocks common to all railways. For example, depreciation in the value of the rupee would be one factor affecting costs for all railways in a particular year.

Railway system and year fixed effects address a variety of identification problems, but there still could be railway specific time varying unobserved heterogeneity correlated with working expenses and a switch to state ownership. If the Imperial government was more likely to take ownership of private lines when costs were declining, then ownership changes would be endogenous to working expenses. To address endogeneity concerns, we include railway system specific time trends that control for any unobservables trending up or down at the railway level. We also change our dummy variables for ownership and operation to one, two and three years before the change actually occurred. If the switch in ownership is endogenous to costs, we may expect to see cost changes even before any actual change in ownership. There could however also be anticipatory effects once the state announced its decision to take over a private company. On average, the Indian government announced decisions one to two years before the expiration of contracts so the anticipatory effects should not exceed three years. Finally, we graph the residuals for costs from specifications that omit our organizational variables and we examine trends in working expenses several years before and after a switch occurs. These approaches are commonly used in the policy evaluation literature and we hope alleviate the main concerns regarding the robustness of our findings.

6. Results

Table 2a presents our first set of results on log working expenses as the dependent variable for the railway system panel excluding data on secondary lines before they merge into a system. All the specifications include controls for capital costs (capital outlay per mile), labor

and fuel costs, the scale of output (ton miles, passenger miles), and the density of the railway system (total mileage). Higher capital, labor, and fuel costs should contribute to higher working expenses as in a conventional cost function framework. Higher ton miles and passenger miles should also contribute to higher costs, but note that the sum of the coefficients on ton miles and passenger miles should be less than one because railways are subject to economies of scale. The number of rail miles should also raise working expenses because density diminishes. The coefficient on rail miles gives the effect of increasing network size while holding ton miles and passenger miles constant. If there are economies of density then working expenses should rise as a result. The coefficients on density and input costs point to both economics of scale and density.

Privately owned and operated lines are the omitted category in all the specifications. Specification 1 is our most parsimonious regression where we only control for input costs and network density. While state owned and operated railways appear to have no advantage to privately owned and operated railways in this specification, state owned and privately operated systems have a clear cost advantage relative to privately owned and operated systems. Working expenses are 8 percent lower for state-private lines as compared to private-private lines.

In specification 2, we add year dummies to control for temporal patterns affecting all Indian railways in the same manner. The coefficient on state-private decreases to 5.4 percent but is still statistically significant. State ownership thus appears to be correlated with lower costs but it is unclear how to interpret the results from these cross-sectional regressions because of unobservable heterogeneity across railways. For example, if private companies were forced to construct lines in high cost geographic regions than these regressions would falsely attribute the effects of geography to private ownership. To address such concerns, we include railway system fixed effects in specifications 3 to 8 and thus control for unobservable time invariant railroad

characteristics such as geography, etc. We identify the effects of ownership via changes within railroad systems in the fixed effects regressions.

Specification 3 documents the negative and statistically significant effect of state ownership and private operation on working expenses even after controlling for railroad and year fixed effects. Interestingly, state owned and operated lines also have lower costs than private-private lines in the fixed effects specifications. We are hesitant however to assign too much weight on these findings because there are only two switches to state ownership and operation in our sample period as compared to eight switches to state ownership and private operation. Since there could be time varying unobservable factors affecting working expenses and ownership, we also control for railroad specific trends in specification 4. By including such trends, the estimates on ownership and operation are now identified from trend breaks in working expenses within railways after they change ownership. Our findings are robust to trends and suggest that switching to state-private ownership reduced costs by 6 percent.

Specifications 5 and 6 present the results using the fraction mileage variable for ownership as compared to the dummy variable. The fraction of state owned miles captures both the state and native state lines within a railway system but our results are robust to controlling for native state mileage separately.¹⁴ The fraction mileage variables confirm the findings on the dummy variables although the magnitude of the effects is slightly larger—increasing the fraction of state owned and privately operated lines by 100 percent lowers expenses by 7.4 percent. The coefficient is not as precisely estimated when we include railroad specific trends (specification 6) but is still significant at the 12 percent level. Given the time series nature of our data, serial correlation is an important concern so we estimate fixed effects models controlling for an AR (1)

¹⁴ This only refers to a few Native State lines constructed and managed by private companies or the Government of India, and that are reported along with the data for a primary line. For example, GIPR manages the Amraoti and Khamgaon lines (14 miles total) owned by the Berar State and GIPR data always includes these lines.

disturbance in specifications 7 and 8.¹⁵ The findings on state ownership and private operation are robust however the fraction mileage variable is not as precisely estimated again. Table 2b estimates the same set of regressions on our complete railway system panel including secondary lines, which exit the system after they merge to a primary line. The effects on the coefficient for state-private are very similar to those in table 2a—negative and statistically significant.

By comparing railways before and after they change ownership, we thus find strong effects of state ownership and private operation on working expenses even when we control for railroad specific trends. There may however be an endogeneity concern regarding the timing of the switch if the state was more likely to take over private railroads as their costs were declining. On average, the state announced its decision to take over private companies one to two years before their contracts actually expired so there could also be short term anticipatory effects just prior to the change.¹⁶ We explore this timing issue in table 3a where we change the timing of ownership to one, two and three years before the change actually occurs. Barring short run anticipatory effects, in principle there should be no effect of the organization variables on performance especially three years before a change.

We find strong negative effects on state ownership and private operation one year before the switch but no effects two and three years before the change. Given the state generally gave notice of their intentions one year in advance, the results on state-private provide some evidence of anticipatory effects. Unlike state-private, there are strong pre trends in working expenses among railways that switched to state-state operations. Even three years before a change to state-state, working expenses are lower for these railways. Most of this effect is coming from the Oudh and Rohilkhand Railways, an old guaranteed company that switched to state ownership

¹⁵ Our results are also robust if we include lagged working expenses as an independent variable.

¹⁶ Add dates from reports on when the state gave notice to the companies.

and operation in 1889 as compared to Eastern Bengal the other private company taken over by the state in 1884. Given the pre trend in working expenses, the Government of India's decision to take over ownership and management of Oudh and Rohilkhand Railways may have been endogenous to cost considerations. The lack of comparable findings on state-private two and three years prior to an actual change is thus reassuring that the timing of the change is less endogenous.

To illustrate this further, we plot residuals from regressions of log working expenses on input costs, railroad density, year dummies and railway system fixed effects against the number of years since a system changed organization (figure 4). For systems that did not change ownership between 1882 and 1912, we use 1896, the mean year of change for our switchers, as the 'change year' for the non-switchers. Working expenses (net of controls) for railroads that switch to state ownership and private operation have increasing costs four to five year before they switch and then show a marked decline the first year after the switch. In comparison, the residuals for non-switchers show no trend.

The evidence is even starker if we focus on a few key railroads namely Great Indian Peninsula, Madras, South Indian, and Bombay, Baroda and Central India (BB&CI). They are among the old guaranteed companies formed in the 1850's and 1860's with public guarantees and were taken over by the Government of India in the 1890's and 1900's. Working expenses were higher on average for all of them in the years before state ownership (figure 5), but costs fell sharply following the switch to state ownership and operation. How did this change in ownership structure lower costs even though operations were privately managed?

With a change in ownership from private to public, the state owned the lion's share of the capital and accordingly received most of the surplus profits in proportion to their capital share.

The state thus had stronger incentives to better supervise private companies and the new contracts also afforded them the opportunity with wider control over company operations. For example, no capital expenditures could be sanctioned without state approval. In the past railway engineers were not as experienced and perhaps hesitant to rein in company personnel, but after 20 plus years of managing and operating state railways, they were perhaps more experienced at effectively supervising private companies and bringing down costs.

A simple before and after comparison of the composition of the Great Indian Peninsula's working expenses shows a sharp reduction in maintenance, carriage and wagon, and miscellaneous expenses in the first year following the switch to state ownership. Miscellaneous expenses appears to be a slippery category and the company probably reduced some extraneous spending after coming under greater public scrutiny in 1900 when the state took over ownership. The fall in maintenance and carriage expenses, however, is more difficult to interpret. The change may have prompted companies to reduce their annual maintenance costs below the economically optimal level, a short run gain at the expense of replacing the equipment sooner (long run cost). Alternately, the companies under private ownership may have been repairing and replacing their stock more often than necessary (inefficient) on account of the public guarantee on capital. We will analyze the detailed working expenses for more railway systems over a longer time period, which will better address this issue. Broadly, the GIPR case does indicate that important categories of costs were reduced after the state took ownership of the company. In future work, we hope to disentangle whether the cost reductions were achieved by an improving state bureaucracy and efficient monitoring or by better aligning state incentives toward efficiency in the public-private contracts, which gave the state a larger share of the profits.

7. Conclusion

In this paper, we estimate the efficiency gains achieved by Indian railways when they switched to state ownership and operation in the late 19th and early 20th century. Using a novel data set on the principal Indian railway systems and comparing changes within systems, we find a change to state-private organization reduced working expenses by 6 percent controlling for input costs, density and railway specific time trends. Moreover, the timing of the switch to state-private does not appear to be endogenous to costs. A more qualified state bureaucracy combined with more efficiency aligned contractual terms probably contributed to the observed efficiency gains. In the late 19th century India had a very low rank vis-à-vis railway efficiency relative to other countries in the world but by the early 20th century India was ranked second behind Belgium but ahead of Britain at rank 11 (Bogart 2009). We believe the transition of majority of the privately owned and operated mileage to state owned and privately operated over the 1890's to 1910's contributed to this transition.

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Railways Map - 1909

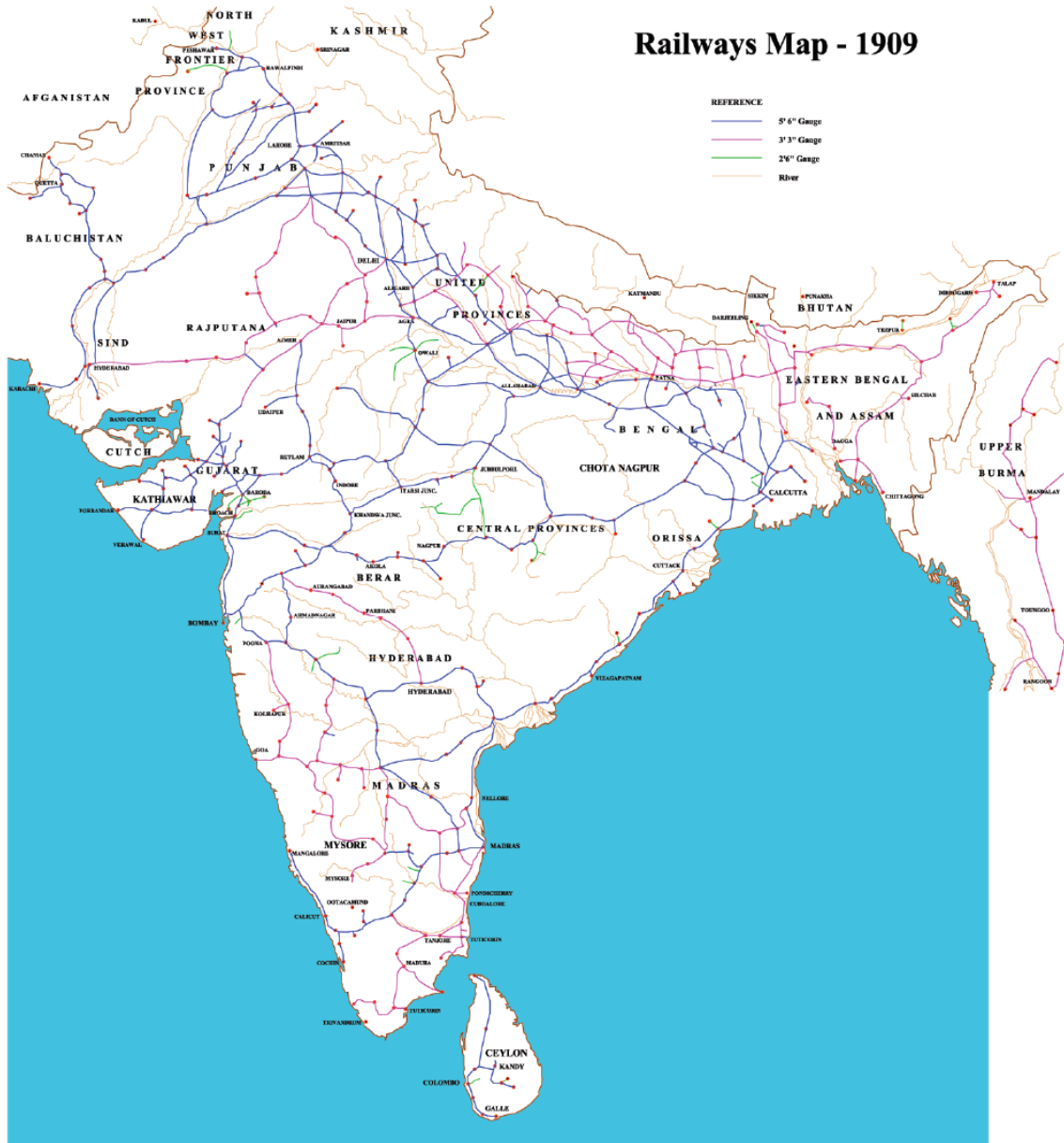


Figure 1: Indian Railways Mileage by Type

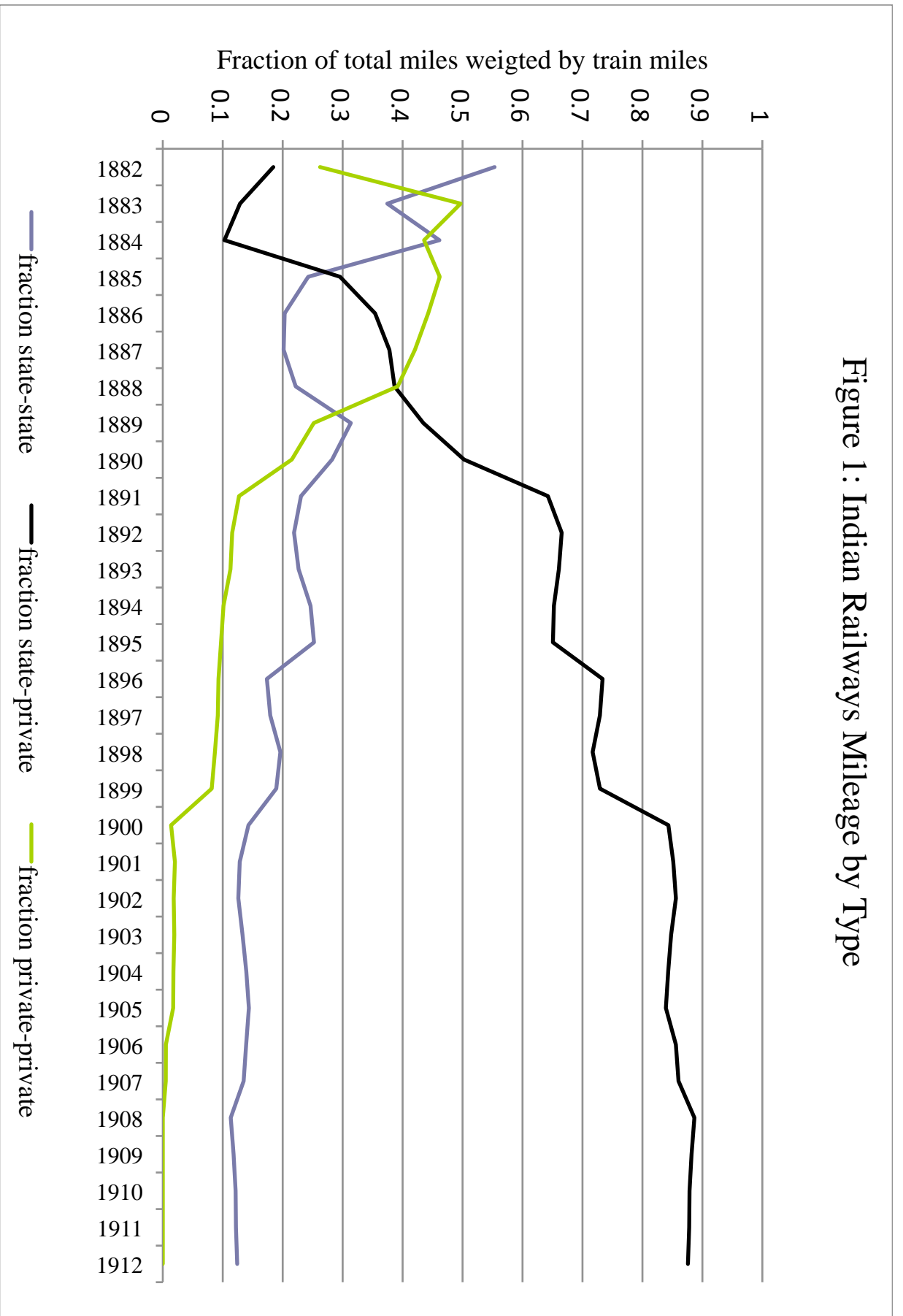


Table 1: Summary Statistics by Organization Type

	1882-1912	1885	1890	1895	1900	1905	1910
Total miles	1,281	811	1,002	1,101	1,245	1,522	1,836
Working Expenses	9,671,973	4,777,322	5,551,550	6,206,814	8,363,979	11,000,000	17,900,000
Capital outlay / Mile	117,466	87,582	102,268	100,472	121,354	120,331	148,379
Avg. Fuel Costs / Ton	9.3	8.6	8.6	7.9	10.4	8.8	10.9
Cost of Train Staff per Train-Mile	0.67	0.55	0.58	0.58	0.68	0.67	0.89
State owned and operated							
Total miles	1,560	750	1,180	1,308	1,878	2,118	2,558
Working Expenses	11,900,000	4,181,920	6,143,189	7,290,167	11,100,000	16,400,000	27,400,000
Capital outlay / Mile	118,439	80,659	103,969	106,658	134,853	137,559	160,421
Avg. Fuel Costs / Ton	10.1	9.7	9.1	8.8	11.1	9.0	9.4
Cost of Train Staff per Train-Mile	0.73	0.58	0.61	0.62	0.74	0.76	1.11
State owned and privately operated							
Total miles	1,357	1,049	984	1,045	1,250	1,562	1,655
Working Expenses	10,100,000	6,325,500	4,366,729	4,664,147	8,319,826	10,700,000	15,500,000
Capital outlay / Mile	114,274	83,138	83,993	78,339	110,410	109,475	145,369
Avg. Fuel Costs / Ton	8.9	6.4	6.9	7.0	9.4	8.3	11.2
Cost of Train Staff per Train-Mile	0.67	0.56	0.55	0.50	0.67	0.65	0.83
Privately owned and operated							
Total miles	803	733	852	976	595	791	0
Working Expenses	6,354,814	4,400,169	6,737,142	8,876,122	5,734,594	6,592,969	
Capital outlay / Mile	124,186	94,420	127,981	151,245	144,335	139,291	
Avg. Fuel Costs / Ton	9.6	9.1	10.6	8.7	12.9	10.1	
Cost of Train Staff per Train-Mile	0.62	0.53	0.58	0.74	0.62	0.66	

Source: See text for details. Working expenses, Capital outlay per mile, Fuel costs and Cost of train staff are expressed in real 1900 rupees.

Figure 2: Avg Cost of Hauling 1 Passenger 1 Mile (annas)

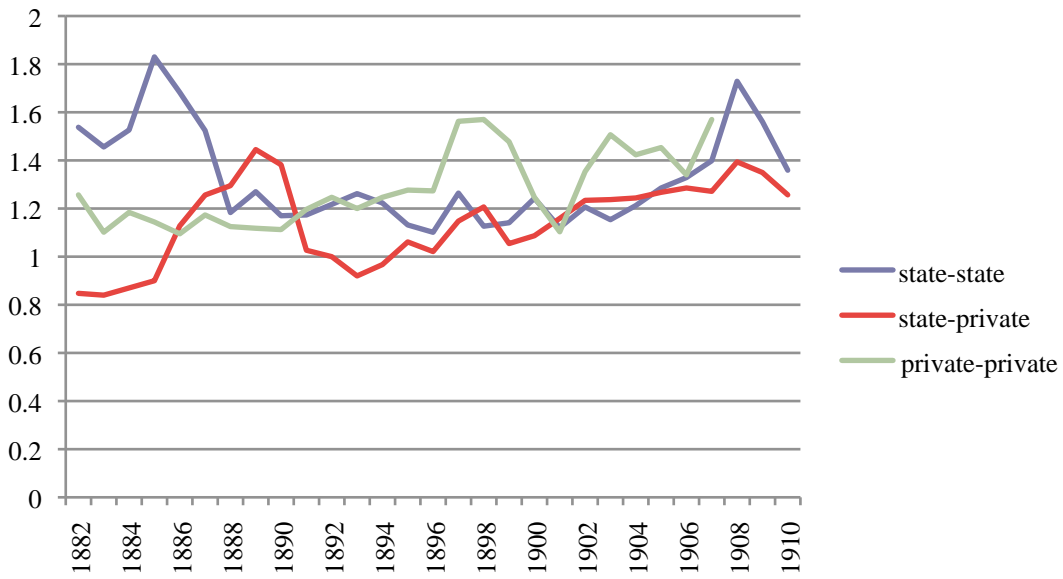


Figure 3: Avg Cost of Hauling 1 Ton 1 Mile (annas)

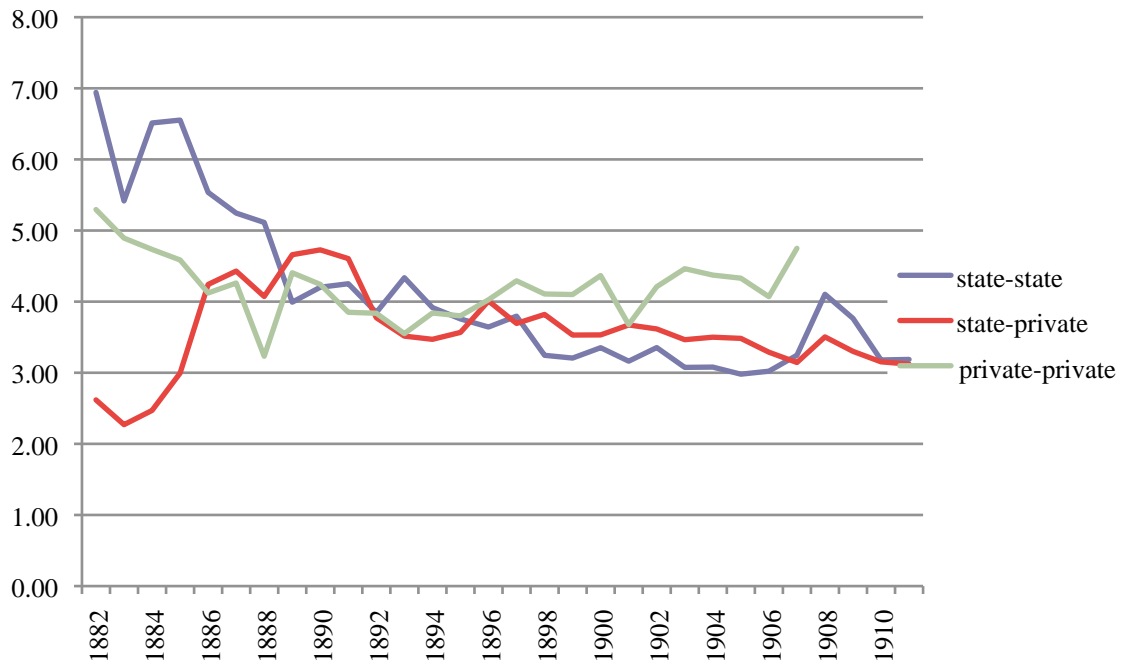


Table 2a: Effects of Ownership on Log of Working Expenses (Railway System Panel - no Secondary Lines)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Logs</i>								
Avg Cost of Fuel	0.1380*** [0.0142]	0.1362*** [0.0146]	-0.0066 [0.0247]	-0.0174 [0.0278]	0.0053 [0.0245]	-0.0102 [0.0278]	0.0066 [0.0268]	0.0107 [0.0267]
Cost of Train Staff per Mile	0.2919*** [0.0310]	0.3642*** [0.0392]	0.2316*** [0.0512]	0.1807*** [0.0594]	0.2405*** [0.0506]	0.1862*** [0.0592]	0.1080* [0.0646]	0.1188* [0.0640]
Passenger Miles	0.2603*** [0.0219]	0.2946*** [0.0250]	0.1318*** [0.0312]	0.1595*** [0.0314]	0.1347*** [0.0306]	0.1580*** [0.0309]	0.1023*** [0.0272]	0.1055*** [0.0272]
Ton Miles	0.2510*** [0.0216]	0.2334*** [0.0229]	0.2206*** [0.0240]	0.2057*** [0.0233]	0.2168*** [0.0239]	0.2040*** [0.0235]	0.1016*** [0.0205]	0.1025*** [0.0204]
Total Mileage	0.3733*** [0.0277]	0.3617*** [0.0282]	0.4984*** [0.0398]	0.4772*** [0.0406]	0.5088*** [0.0391]	0.4878*** [0.0412]	0.5508*** [0.0448]	0.5570*** [0.0453]
Capital Outlay per Mile	0.2915*** [0.0338]	0.2593*** [0.0345]	0.2677*** [0.0566]	0.2103*** [0.0629]	0.2581*** [0.0557]	0.2141*** [0.0626]	0.0952* [0.0515]	0.0974* [0.0514]
State owned and operated	-0.0349 [0.0252]	-0.0328 [0.0252]	-0.0637** [0.0311]	-0.0732* [0.0390]			-0.0796* [0.0478]	
State owned and privately operated	-0.0805*** [0.0255]	-0.0542** [0.0272]	-0.0486* [0.0254]	-0.0664** [0.0312]			-0.0541* [0.0357]	
Fraction state owned lines					-0.1096*** [0.0329]	-0.1087** [0.0439]		-0.1160** [0.0516]
Fraction state owned and privately operated lines					-0.0743** [0.0293]	-0.0622 [0.0399]		-0.0540 [0.0420]
Year FE	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Railroad FE	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Railroad Specific Trends	No	No	No	Yes	No	Yes	No	No
Standard Errors Adjusted for AR(1)	No	No	No	No	No	No	Yes	Yes
Constant	-0.3183 [0.3527]	-0.0396 [0.3613]	2.4689*** [0.6035]	-5.281 [4.6784]	2.5213*** [0.6023]	-4.6166 [4.6071]	7.1548*** [0.3220]	6.9992*** [0.3236]
Observations	452	452	452	452	452	452	436	436
Adjusted R-squared	0.978	0.979	0.962	0.968	0.962	0.968	0.846	0.851

Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table 2b: Effects of Ownership on Log of Working Expenses (Railway System Panel - with Secondary Lines)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Logs</i>								
Avg Cost of Fuel	0.1424*** [0.0145]	0.1365*** [0.0149]	-0.0112 [0.0238]	-0.0193 [0.0271]	0.0015 [0.0237]	-0.0104 [0.0270]	0.0058 [0.0262]	0.0098 [0.0261]
Cost of Train Staff per Mile	0.2490*** [0.0310]	0.2795*** [0.0386]	0.2259*** [0.0499]	0.1781*** [0.0583]	0.2342*** [0.0493]	0.1826*** [0.0581]	0.1047* [0.0624]	0.1153* [0.0619]
Passenger Miles	0.2388*** [0.0201]	0.2511*** [0.0227]	0.0930*** [0.0229]	0.1101*** [0.0223]	0.0954*** [0.0225]	0.1102*** [0.0221]	0.0615*** [0.0178]	0.0629*** [0.0178]
Ton Miles	0.2716*** [0.0212]	0.2647*** [0.0223]	0.2317*** [0.0222]	0.2213*** [0.0219]	0.2290*** [0.0221]	0.2201*** [0.0222]	0.1149*** [0.0201]	0.1167*** [0.0201]
Total Mileage	0.4127*** [0.0269]	0.4173*** [0.0275]	0.5367*** [0.0354]	0.5311*** [0.0365]	0.5454*** [0.0350]	0.5404*** [0.0370]	0.5875*** [0.0389]	0.5930*** [0.0392]
Capital Outlay per Mile	0.2643*** [0.0338]	0.2424*** [0.0349]	0.2877*** [0.0545]	0.2322*** [0.0606]	0.2725*** [0.0539]	0.2285*** [0.0605]	0.1213** [0.0513]	0.1223** [0.0513]
State owned and operated	-0.0853*** [0.0247]	-0.0877*** [0.0248]	-0.0536* [0.0304]	-0.0689* [0.0387]			-0.077 [0.0468]	
State owned and privately operated	-0.1104*** [0.0256]	-0.0990*** [0.0272]	-0.0523** [0.0250]	-0.0771** [0.0309]			-0.0617* [0.0350]	
Fraction state owned lines					-0.1015*** [0.0323]	-0.1163*** [0.0435]		-0.1095** [0.0503]
Fration state owned and privately operated lines					-0.0802*** [0.0288]	-0.0789** [0.0393]		-0.0622 [0.0410]
Year FE	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Railroad FE	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Railroad Specific Trends	No	No	No	Yes	No	Yes	No	No
Standard Errors Adjusted for AR(1)	No	No	No	No	No	No	Yes	Yes
Constant	-0.2592 [0.3577]	0.0017 [0.3684]	2.5002*** [0.5807]	-4.5507 [4.5764]	2.6198*** [0.5753]	-3.838 [4.5176]	7.1157*** [0.3196]	6.9974*** [0.3201]
Observations	489	489	489	489	489	489	469	469
Adjusted R-squared	0.98	0.98	0.96	0.966	0.961	0.966	0.853	0.857

Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table 3a: Changing the Ownership Switch Year (Railway System Panel - no Secondary Lines)

	(1)	(2)	(3)	(4)	(5)	(6)
	Ln (Working Expenses)					
<i>Logs</i>						
Avg Cost of Fuel	-0.0024 [0.0246]	-0.0148 [0.0278]	0.0026 [0.0245]	-0.0094 [0.0278]	0.0069 [0.0242]	-0.0016 [0.0276]
Cost of Train Staff per Mile	0.2380*** [0.0508]	0.1920*** [0.0582]	0.2427*** [0.0503]	0.2004*** [0.0573]	0.2415*** [0.0498]	0.1938*** [0.0566]
Passenger Miles	0.1412*** [0.0315]	0.1685*** [0.0316]	0.1550*** [0.0316]	0.1792*** [0.0318]	0.1678*** [0.0313]	0.1871*** [0.0314]
Ton Miles	0.2189*** [0.0240]	0.2046*** [0.0233]	0.2176*** [0.0238]	0.2042*** [0.0232]	0.2142*** [0.0236]	0.2007*** [0.0229]
Total Mileage	0.4858*** [0.0398]	0.4637*** [0.0401]	0.4631*** [0.0401]	0.4439*** [0.0400]	0.4474*** [0.0397]	0.4363*** [0.0394]
Capital Outlay per Mile	0.2626*** [0.0562]	0.2086*** [0.0625]	0.2609*** [0.0553]	0.2137*** [0.0618]	0.2588*** [0.0547]	0.2180*** [0.0611]
<i>One year earlier</i>						
State owned and operated	-0.0844** [0.0337]	-0.0931** [0.0414]				
State owned and privately operated	-0.0468* [0.0248]	-0.0610** [0.0302]				
<i>Two years earlier</i>						
State owned and operated			-0.1227*** [0.0371]	-0.1385*** [0.0460]		
State owned and privately operated			-0.0355 [0.0245]	-0.0402 [0.0303]		
<i>Three years earlier</i>						
State owned and operated					-0.1673*** [0.0399]	-0.1945*** [0.0492]
State owned and privately operated					-0.0233 [0.0244]	-0.0124 [0.0306]
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Railroad FE	Yes	Yes	Yes	Yes	Yes	Yes
Railroad Specific Trends	No	Yes	No	Yes	No	Yes
Constant	2.4640*** [0.5979]	-4.6967 [4.6410]	2.4035*** [0.5911]	-2.9154 [4.6054]	2.3416*** [0.5857]	-2.7874 [4.5206]
Observations	452	452	452	452	452	452
Adjusted R-squared	0.96	0.97	0.96	0.97	0.96	0.97

Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table 3b: Changing the Ownership Switch Year (Railway System Panel - with Secondary Lines)

	(1)	(2)	(3)	(4)	(5)	(6)
	Ln (Working Expenses)					
<i>Logs</i>						
Avg Cost of Fuel	-0.0082 [0.0238]	-0.0174 [0.0272]	-0.0044 [0.0237]	-0.0126 [0.0272]	-0.0015 [0.0235]	-0.0058 [0.0271]
Cost of Train Staff per Mile	0.2322*** [0.0495]	0.1934*** [0.0573]	0.2375*** [0.0492]	0.2049*** [0.0566]	0.2369*** [0.0489]	0.2007*** [0.0560]
Passenger Miles	0.0974*** [0.0231]	0.1145*** [0.0225]	0.1048*** [0.0232]	0.1203*** [0.0226]	0.1101*** [0.0229]	0.1227*** [0.0223]
Ton Miles	0.2320*** [0.0222]	0.2215*** [0.0220]	0.2326*** [0.0221]	0.2215*** [0.0220]	0.2318*** [0.0220]	0.2195*** [0.0218]
Total Mileage	0.5281*** [0.0354]	0.5196*** [0.0361]	0.5125*** [0.0356]	0.5050*** [0.0361]	0.5031*** [0.0353]	0.5006*** [0.0356]
Capital Outlay per Mile	0.2856*** [0.0542]	0.2327*** [0.0603]	0.2837*** [0.0536]	0.2356*** [0.0598]	0.2833*** [0.0531]	0.2396*** [0.0593]
<i>One year earlier</i>						
State owned and operated	-0.0662** [0.0328]	-0.0772* [0.0410]				
State owned and privately operated	-0.0476* [0.0245]	-0.0651** [0.0301]				
<i>Two years earlier</i>						
State owned and operated			-0.0968*** [0.0361]	-0.1142** [0.0456]		
State owned and privately operated			-0.0341 [0.0243]	-0.0394 [0.0303]		
<i>Three years earlier</i>						
State owned and operated					-0.1330*** [0.0387]	-0.1634*** [0.0487]
State owned and privately operated					-0.0212 [0.0243]	-0.01 [0.0308]
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Railroad FE	Yes	Yes	Yes	Yes	Yes	Yes
Railroad Specific Trends	No	Yes	No	Yes	No	Yes
Constant	2.4916*** [0.5758]	-3.9195 [4.5561]	2.4722*** [0.5702]	-2.4908 [4.5277]	2.4477*** [0.5662]	-2.4182 [4.4709]
Observations	489	489	489	489	489	489
Adjusted R-squared	0.96	0.97	0.96	0.97	0.96	0.97

Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Figure 4: Residuals from Regression of Working Expenses on Input Costs, Year and Railroad FE

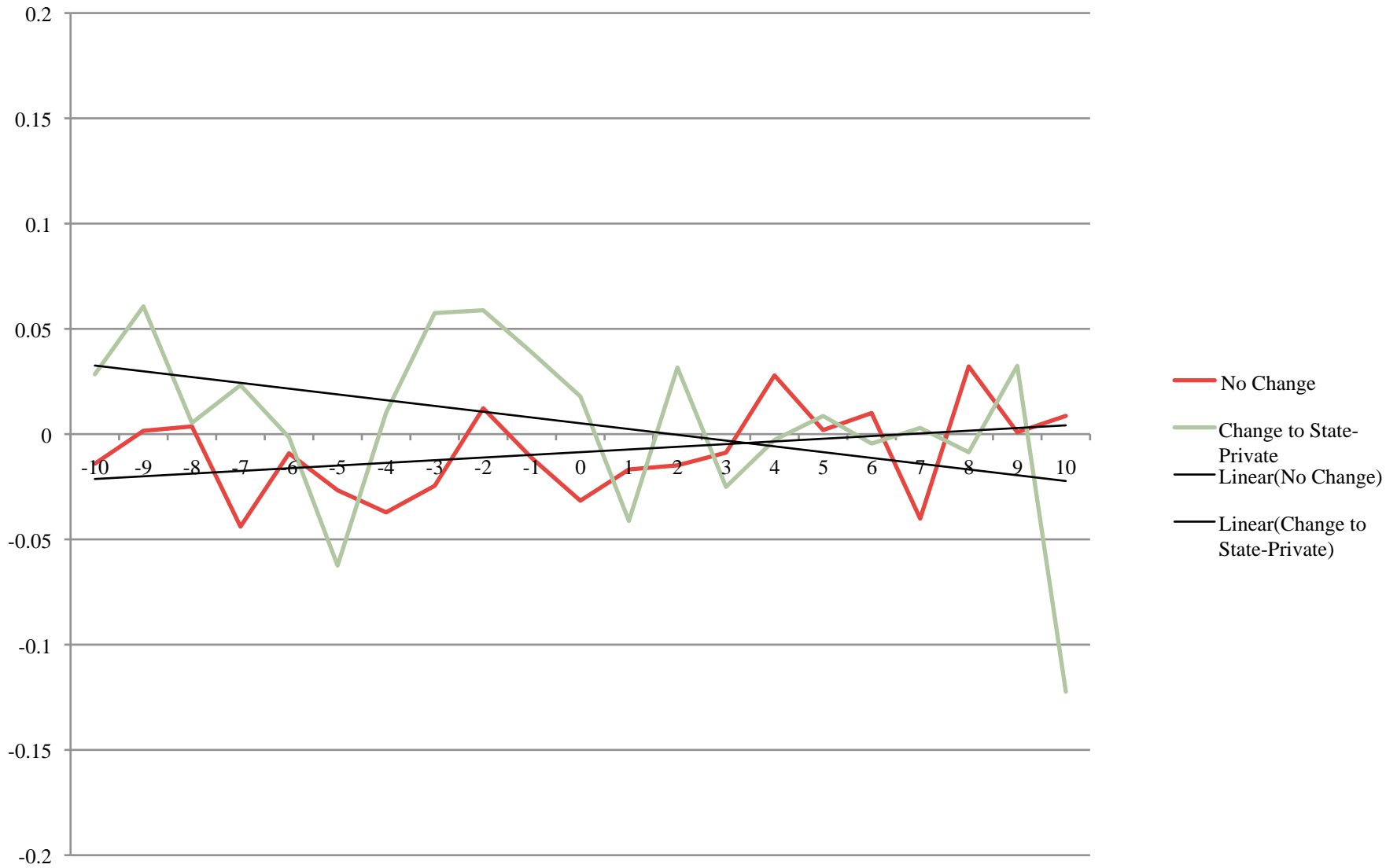


Figure 5: Residuals for BB&CI, GIPR, Madras and South Indian

