Public-Private Partnerships and Efficiency: A Historical Perspective from Indian Railways

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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 Government of India, but were allowed to retain operations in most cases. Moreover, some state-owned lines switched from Government to company operation. By exploiting switches in ownership and operation within the same railway system, we find that the move to state ownership led to significantly lower operating costs, but there were minimal effects from the move to private operation. The findings have implications for the broader debate about the divide between public and private authority.

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1. Introduction

Economists and policy makers alike continue to debate whether the provision of public services such as infrastructure should be a public or private sector concern. Although economists in general advocate the superiority of private ownership, recent work by Hart, Shleifer and Vishny (1997), Besley and Ghatak (2001), and Hart (2003) emphasizes the virtues of state ownership or public-private partnerships under some incomplete contractual environments. Empirical studies of public-private partnerships are relatively rare in large part because cooperative agreements between the government and the private sector are a recent phenomenon (see Fiszbein and Lowden 1999 on NGO's and Duggan 2000 on hospitals). History however offers a number of illuminating perspectives on the public-private divide. In our paper, we focus on the historical case of colonial India to examine the effects of changes in public-private authority on the performance of a key sector of the economy—railways.

In the 1800s and early 1900s, governments around the world were devising various arrangements to finance railways and provide services. In Britain, the government authorized companies to construct and operate railways through acts of Parliament, but they provided no subsidies and little coordination. Other countries experimented with this form of 'pure' private ownership but relatively fast it became the norm for national and sub-national governments to provide construction subsidies or interest and dividend guarantees. After 1870 some government authorities started to nationalize private railway companies and construct their own railways. The trend continued over the next four decades. By 1910 the fraction of the world's railway miles owned by private companies decreased to 70 percent whereas in 1870 it was around 90 percent (Bogart, 2009a).

Indian railway development is especially interesting because although India

experienced a similar shift from private to state ownership, it adopted a rather unique form of state ownership and private operation while pure state or private authorities were the norm around the world. Beginning in 1853, the first railway lines were constructed in India by private British companies relying on capital raised in Britain with a 5 percent guarantee backed by the Government of India. Until 1869 '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, but their proportion of total mileage remained small.[1] In this early phase, Government railways earned little and private companies relied almost exclusively on the state guarantee to pay off their shareholders.

The prospects for profitability began to increase for the guaranteed railways by the 1880s. Under the terms of their guarantee, the companies were obligated to pay 50 percent of the surplus to the Government once their net earnings (i.e. revenues minus operating expenses) exceeded 5 percent of the capital stock. Tensions began to increase between the companies and the Government, which was naturally eager to ease its fiscal problems by collecting a portion of railway profits. Government leaders also began to voice their frustration with the guaranteed companies, arguing that they were complacent about cutting costs and adopting innovations. In this context the Government moved to restructure the system by buying-out private railway companies. Several deals were brokered by the Secretary of State in London, 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 proportional to their ownership shares, which effectively translated into companies receiving less than a

[1] The Native States, also known as the Princely States, compromised 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.

quarter of the net profits on average. This form of government ownership and private operation increased throughout the 1890s and 1900s and came to be the dominant form until the nationalizations of the 1920s.

The Indian case thus offers a unique opportunity to identify the effects of changes in public-private ownership on performance. Unlike many episodes of structural change, there is an abundance of information on the finances and operations of Indian railways available from *Annual Reports on the Administration of Indian Railways*. For the econometric analysis, we collected detailed information on mileage, passenger and goods traffic, fuel consumption, wages, working expenses and capital outlay among other variables from 1882 to 1912. We focus on this key period because many of the private guaranteed companies switched to state ownership and private operation. Some railway lines also switched from private operation to state operation, and vice versa. The data allow us to precisely identify the ownership and operation status of each railway system including when the state took ownership of private lines or when the state outsourced the working of lines to private companies.

Our econometric analysis shows that a switch from private to state ownership conferred significant efficiency gains for Indian railways. Working expenses are 6 to 8 percent lower on average following a switch from private ownership and operation to state ownership and private operation controlling for input costs, network density, railway and year fixed effects, and railway specific time trends. Working expenses decreased by a similar amount following a switch from private ownership and operation to state ownership and operation. Additional specifications confirm that the rise of state ownership was the key factor reducing operating costs.

Our findings broadly contribute to two different and important literatures. First, they

relate to the Indian economic history literature, which has analyzed the impact of railways on social savings and trade issues such as expansion of markets, price and wage convergence, and increased 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 operation to state ownership and private operation contributed to India's transformation from a relatively inefficient to a more efficient rail network by the early 20th century (Bogart 2009b).

Second and more broadly, our results highlight the effects of contractual relationships between the public and private sector. Shleifer (1998) argues that managers and other crucial decision makers are better able to appropriate the returns on their investments under private ownership, making it generally superior to state ownership. In the Indian case however private ownership failed to provide strong incentives for improving operational efficiency. Shareholders were guaranteed a 5 percent return, regardless of their effort. Moreover, companies had to share half of the surplus profits with the Government under the old system if profits increased above the 5 percent return. Shareholders thus had little incentive to exert effort in monitoring managers and ensuring they lowered costs.

In contrast, the shift to state ownership and private operation in India provided stronger incentives to improve efficiency because it accounted for the externalities arising from investments. Besley and Ghatak (2001) show that when projects have public good features the incentives for investment may be greater when it is owned by the group who values the public good aspects the most. Once the Government of India became the primary owner of the rail network, it highly-valued investments which raised the efficiency of all railways. The

Government took actions to coordinate operations across railway lines and promoted the development of technologies. The Government also alleviated some of the incentive problems by giving their employees a financial stake in the performance of state-owned railways. Improvements in the Government's incentives were a significant contributing factor to efficiency gains for early 20th century Indian railways.

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

2. Background on the Development of Indian Railways

Before railways, transportation infrastructure in India was weak with few roads and the Ganga river system. Recognizing the economic and political benefits of railways, the East India Company began to encourage railway construction in the mid-19th century with the initial push coming from railway promoters representing British merchant houses (Thorner 1951). The first railway line totaling 20 miles was opened in 1853 connecting the port of Bombay to Thana. Lines connecting the ports of Calcutta and Madras to interior districts were opened in 1854 and 1856 respectively. The subsequent construction of railways was very rapid especially between 1890 and 1910. Open mileage grew to 838 miles in 1860, 9,162 miles in 1880, 24,752 miles in 1900, and 34,656 miles in 1913. By the early 1900's, India had the fourth largest national rail network in the world (Government of India, 1955). The network continued to expand up to Indian independence in 1947, but at a slower rate. Figure 1 shows the railways map of lines by gauge in 1909.[2] The most populous region, such as the Ganga river valley, had a relatively dense

[2] All the early lines before 1870 were built on the broad 5' 6" gauge, auxiliary lines were built on a meter 3' 3 3/8" gauge and a few narrow 2' gauge lines were also constructed.

network of railways. Moreover, there were several connections between the port cities (Bombay, Calcutta and Madras) and the interior as compared to interior-to-interior lines.

Indian railway development was characterized by four distinct phases of ownership and operation. 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. Beginning in 1882, the third phase of development ushered in a complex public-private partnership whereby the private guaranteed companies were taken over by the state but retained operation of the lines. New private companies 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.

Throughout India's early railway development, 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) led to different outcomes.

Private companies incorporated in Britain constructed and managed the early lines under the guarantee system up to 1868 (phase one). Ten companies were sanctioned between 1849 and

1864 under contracts with the following general terms.[3] Capital was raised in Britain but the Government provided free land and a 4.5 to 5 percent guarantee on capital at a fixed exchange rate of 1s. 10d to the rupee. The net receipts were paid into the Government treasury and rebated to the company. If the net receipts yielded less than the guaranteed return to shareholders, the government compensated the company. If they exceeded the guaranteed return, the Government 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. The Government also retained the right to purchase private railways after 25 or 50 years. The contracts stipulated that the purchase price be based on the mean market value of the stock in the preceding three years (Bell 1894, pp. 66-72).

Guarantees were a key feature of the first phase of Indian railway development. British railway promoters negotiating with the directors of the East India Company in the 1840s emphasized the difficulty of raising British capital for a potentially risky Indian infrastructure project without an explicit guarantee. Subsequent attempts to finance private railways without guarantees failed, suggesting that government subsidies were necessary for Indian railway development at least through the 1870s (Bell 1894, p. 73). Unfortunately, the early lines were 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.

[3] 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). The year of sanction and contract noted in brackets is from Sanyal (1930). All the lines were built on a broad gauge – 5 feet 6 inches.

Contemporaries generally regarded the guarantee system as ineffectual in restraining construction and operational costs. Official representatives for the Government of India criticized the system in 1861 because "shareholders had their 5 percent whatever happened (Bell 1894, p. 66)." The Secretary of State in 1868 advocated the use of guarantees, but admitted that "the system tends to weaken the ordinary motives to efficient management and superintendence (Bell 1894, p. 19)." Ornate railway stations and luxury cabins testify to private extravagance on a public purse. The Government had the authority to supervise private companies, but they were also viewed as being 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)."

Two events marked the second phase between 1869 and 1882. First, contracts between the state and guaranteed companies were renegotiated in 1869. The companies were indebted to the Government on account of past guarantee payments. With the first years in which the Government had the right to purchase private railways approaching, the Government indicated they were moving in the direction of state ownership (Bell 1894, pp. 75-76). The Secretary of State, however, without the knowledge of the Government offered to clear company debts and extend their terms for another 25 years. In return companies had to share half of all surplus net profits with the Government of India from that point forward. Other than the East Indian, the other guaranteed companies (the Great Indian Peninsula, Madras, South Indian and Bombay, Baroda and Central India) accepted the offer. The Government of India opposed the renegotiation because it forgave interest debts just as private companies were beginning to earn profits above 5 percent. The episode had a lasting effect by souring relations between private companies and the Government (Bell 1894, pp. 26-27).

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:

> "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."

Lord Lawrence's views were shared by his successor, Lord Mayo, and the Duke of Argyll, Secretary of State in the 1870s. Under their authority, the Government constructed and operated more railway lines. No new contracts were signed with private companies through the early 1880s 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 meter gauge (3 feet 3 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 to reintroduce the private sector.

The public-private partnership phase in Indian railway development began in 1879 when a Parliamentary committee on Indian Public Works limited the funds which the Government could borrow to 2.5 million sterling annually (Bell 1894, p. 30). A year later the Secretary of State

issued a dispatch to the Government advocating a modified form of the guarantee, which would give the shareholders "a real interest in the efficient and economic administration of railways (Bell 1894, p. 77)." The Government accepted the plan but wanted better terms and more supervisory control. The new arrangement was implemented through the take-over of guaranteed companies. East Indian Railways 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. 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 were under more stringent state supervision. The profits of the companies continued to be guaranteed, but at lower rates of 3 to 4 percent. Surplus profits were shared 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.

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. For example, Southern Mahratta Railway Company incorporated in 1882 was 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).[4]

The Government also introduced new incentive structures through the State Railway Provident Fund. After 1880 employees were required to contribute a portion of their salary to the fund, which was paid out upon death or departure from employment. The Government contributed one-half of one percent of the net earnings from state railways, disbursed among the employees in proportion to their salary. Europeans, who held the highest positions, contributed one-sixteenth of their salary, while Indians contributed one-thirty-second of their salary. European state railway employees thus received a higher portion of state railway earnings (Bell 1894, pp. 109-110).

New organizational structures were also added. In 1879 a new position was created, the Director-General of railways. The Director-General had supervisory authority over all operations of state railways and served as the Government's agent in dealing with private guaranteed companies. Shortly after this post was created the Government began to organize 'railway conferences,' designed to elicit exchanges between state railway officials and companies. The first railway conference in 1880 introduced a code of general rules for the working of all lines, including agreements for the interchange of rolling stock, a uniform classification of goods, and accounting standards. Subsequent conferences in the 1880s and 1890s tried to assimilate the construction of rolling stock. A special committee met regularly to adopt standards, arrange experiments, and publish research (Bell 1894, p. 114).

State-owned and privately-operated railways were the norm until the 1920's when public

[4] Another example is the Bengal Central Railway Company 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. The Government eventually purchased the Company in 1905 and merged it with the Eastern Bengal State Railways.

opinion turned against private operation. There was a perception of high rates, mistreatment of Indian passengers, and discrimination against Indian employees. The Acworth committee in 1921 issued a report recommending complete nationalization. Its general recommendations were followed and the Government of India gradually took over all railway operations.

3. Theoretical Framework

Although incentives changed for private railway companies and the Government of India following their newly designed partnerships, they were not unambiguously in a direction that encouraged efficiency. This section draws on the theory of incomplete contracts to postulate the effects of changes in public-private authority over Indian railways.

Private companies could increase operating efficiency on railways by making investments in new technologies and organizational structures. Many of these investments were unverifiable and therefore contracts were necessarily incomplete. The key question is whether ownership structures provided the appropriate incentives. Companies naturally considered whether their financial gains from non-contractible investments would offset their costs. Under the original contracts, companies were guaranteed a 5 percent return on their capital investment regardless of their effort. Companies also had to share half of the surplus profits with the Government if profits increased above the 5 percent return. These two conditions provided weak incentives to invest.

Private investment decisions can be analyzed with a simple model. Suppose companies can increase surplus by exerting effort, but effort is non-contractible. If companies exert an effort level e they incur a cost given by the quadratic function $(a/2)e^2$ where a is a constant. Their payoff function can be modeled as follows. The guarantee ensures they receive a payoff of 5 irrespective of their effort. If the surplus exceeds 5 they receive half of any surplus with the

Government taking the other half. For simplicity assume that if companies exert an effort level *e* the surplus is *e.* It can easily be shown that the company will not choose the optimal effort level (we ignore the Government's investment decision for the moment). The 5 percent guarantee implies the company will exert zero effort if the costs are sufficiently large. Even if the company exerts some effort, it will work less than the optimum because the company has to share half of the surplus with the Government.[5]

Following the new partnership with the Government, the guaranteed returns to companies were reduced to 3 or 4 percent, but they received only a fifth or a quarter of the surplus above the guarantee. The companies' new payoff can be modeled as follows. The guarantee ensures they receive a payoff of 4 irrespective of their effort and if the joint surplus exceeds 4 they receive a quarter of the surplus. In this case it can be shown that there are two opposing effects of the new contract. The lower guarantee encourages more effort, but the company appropriates only a quarter of the surplus it generates, discouraging effort. If the latter effect dominates, the company incentives to reduce costs are weaker.[6]

This analysis suggests that private incentives for efficiency were not necessarily higher following the change in public-private authority. What about the Government of India's incentives? Modeling the behavior of any government is difficult as it has multiple objectives. There is abundant evidence that the Government of India considered the financial returns they

[5] The first best is obtained by choosing an effort level that maximizes joint surplus, $e - (a/2)e^2$. The optimal effort level is $e = 1/a$. The company faces different objectives. If the company exerts positive effort, it will maximize its payoff $(e/2) - (a/2)e^2$. The solution is to choose an effort-level $e = 1/2a$ with a payoff of 3/8*a*. The company will exert positive effort only if 3/8*a* is greater than 5 or when *a* is less than 3/40.

[6] In this case, if the company exerts positive effort, it maximizes the payoff $(e/4) - (a/2)e^2$. The solution is to choose $e = 1/4a$ with a payoff 7/32*a*. The company will exert positive effort only if 7/32*a* is greater than 4 (its lower guarantee) or when *a* is less than 7/128. Notice that 7/128 is less than 3/40 implying they are less likely to exert effort.

would receive from railways.[7] Originally the Government received half of the surplus above the 5 percent return on capital, but after the contractual change it typically received three-quarters to four-fifths of the surplus. By the logic developed earlier, the government should have a greater incentive to exert effort because it captures a higher share of the surplus.

There is an important caveat to this argument, however. Shleifer (1998) argues that government incentives for investment can be weak even if they earn 100 percent of the surplus because government managers cannot appropriate the benefits of their investments. The surplus generally goes into a state treasury where it is shared by government officials and taxpayers. The dulling of managers' incentives is important because they arguably make the crucial investments, which enhance efficiency. Building on this view, it is unclear whether the Government of India could motivate its managers to undertake investments from which they derived limited benefits. The Government would have to introduce a profit-sharing agreement with its crucial employees to increase their incentives.

Considering the public good benefits of investment can strengthen the case for government ownership increasing incentives. Besley and Ghatak (2001) show that investment incentives can be greater when projects are owned by the individual who values the public good benefits the most, even if their investments are not the most crucial. Besley and Ghatak define ownership over the public good as the right to complete the project in the event of a bargaining failure between employees and the owner (i.e. residual control rights). With the authority to complete the project, the highest valuing individual has greater incentive to invest because they will not be held-up by an owner who cancels the project in the event of a disagreement. This framework suggests that incentives to make non-contractable investments may have been greater

[7] Bell (1894) for example discusses the fiscal motivations of the Government of India.

following the Government of India's take-over of guaranteed companies. The Government had a financial stake in more than half of the network following its take-over of private companies. Therefore it would place a high value on investments that enhanced the joint profitability of all railways such as the coordination of accounting and technological standards, the development of new locomotives, or the establishment of forums for dispute resolution between companies. Private companies, on the other hand, would have valued these unique investments less because they owned a small number of railway lines compared to the Government.

Overall the theoretical literature provides ambiguous predictions about whether India's public-private partnerships enhanced operational efficiency. Incentives to undertake investments with positive externalities for the railway sector improved, but incentives to undertake investments with purely private benefits (i.e. those that improved efficiency on a railway line) were not obviously higher. The theory does suggest that if India's new partnerships increased operational efficiency then it is likely that the Government addressed the incentives of its most crucial employees and that greater public good investments played a key role.

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* (Director General of Indian Railways), *The Statistical Abstracts of British India* (Board of Trade), and *History of Indian Railways* (Government of India, 1947). Most of the data is from the *Administration Reports* published annually from 1882 onwards. 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 variables 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, ton miles (i.e. the number of tons carried one mile), passenger miles, and average cost and sum received for carrying either one passenger or one ton of goods one mile. Working expenses measure the operational costs of railways and include the wage bill for train staff and station staff, spending on fuel, spending on maintenance to the track, plant, and equipment. Construction costs and the purchase of new capital goods like locomotives are included in the capital outlay, not working expenses.

For the post-1900 variables, we either aggregate or average the variables over the two half years to construct an annual observation.[8] In a few cases of missing observations, we do a linear interpolation using the nearest years of available data.[9] 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.

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

[8] 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.
[9] 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.

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, 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, the 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 (Tarakessur 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 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.[10] A detailed appendix is available upon request, which describes the principal railway systems and the secondary lines included in the system. To handle mergers, we follow the "principal railway system" and all secondary lines in the years before they merged. We thus include Tirhoot State Railways, Bengal Central, East Coast State and Indian Midland Railways before they merge with their principal systems. In principle, we can also exclude merged lines from the panel in the years before they merge. To ensure including lines before they merge does not drive our results, we present results for both panels.

[10] 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.

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]

We code ownership in two ways given our observations are defined for the "principal railway system." First, we use the organization of the dominant railway line within a system to code the entire system. Dominant railways lines represent the 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. We present results for both variables, but on average the fraction mileage variable is a more accurate measure of ownership relative to the simple dummy variable.

Figure 2 plots the fraction of total miles under different ownership and operational structures for our analysis period from 1882 to 1912. The fractions are weighted by train miles to illustrate the structures, which handled the most traffic. In the early 1880s, state-owned and privately-operated lines comprised less than 20 percent of Indian railways but they grew to almost 90 percent by 1912. Part of the increase came through the elimination of old guaranteed companies that switched to state ownership and private operation over these decades.[12] This transition is reflected in the declining share of privately-owned and operated miles. Notice also that the fraction of state-owned and state-operated miles decreased from over 50 percent to around 10 percent. In a number of cases, the state contracted with private companies to operate their lines after they had been operated by the state for an earlier period.

[11] We thus exclude the Nizam's Guaranteed State Railway, Jodhpore-Bikaneer, 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.

[12] State-owned and privately operated miles also increased because the state built more lines and then contracted with companies to operate them.

Table 1 displays the summary statistics by year and organization type. Privately-owned and operated lines had lower working expenses on average than 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.

Differences across ownership types can also be seen in figure 3, which shows the average cost of hauling one ton, one mile. The average costs for state-owned and privately-operated railways trended downward after 1890 and were below average costs for privately-owned and operated railways. Average costs for state-owned and state-operated railways also trended downward and went below privately-owned and operated railways after 1890. Although these mean differences across ownership types are informative, it is difficult to disentangle the factors contributing to differences in costs. We now turn to regression analysis to quantify the effect of ownership structures on performance by comparing the same railway system before and after it changes ownership.

5. Empirical Strategy

Our empirical 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-system fixed effects, year fixed effects, and variables for ownership and operation.

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

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

$\ln c_{it}$ 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 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. 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 working expenses, but note that the sum of the coefficients on ton miles and passenger miles should be less than one if there are economies of scale. 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 with greater mileage.

Our main variables of interest are sp_{it} and ss_{it}. In most specifications, sp_{it} is the fraction of state-owned and privately-operated miles in railway system *i* and year *t* and ss_{it} is the fraction of state-owned and operated miles in railway system *i* and year *t*. The omitted category is the fraction of privately-owned and operated miles in railway system *i* and year *t*. The fraction provides an intensive measure of ownership and operation at the railway system level. We also use an extensive measure of ownership and operation 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 dummy variable taking the value 1 in years when the system is state-owned and operated and 0 otherwise.

In some specifications we also isolate the ownership status of a railway system by creating a dummy or a fraction variable for state-owned railway systems, $stateown_{it}$. The omitted category is privately-owned railway systems. The operational status is similarly isolated with a variable for state-operated railway systems, $stateoperate_{it}$.

As the specification includes railway-system fixed effects, we identify the effects of ownership from changes in 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.[13] 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.[14] If this ownership and operational change lowered costs then the coefficients on ss_{it} should also be negative and statistically significant.

All the transitions mentioned above involved a shift from private ownership to state ownership. If it was the ownership change that lowered costs, then the coefficients on $stateown_{it}$ should be negative and statistically significant. Some of the transitions involved a shift from private operation to state operation. In addition, three state-owned and operated railways also switched to state ownership and private operation.[15] If it was the operational change that affected costs then the coefficients on $stateoperate_{it}$ should be statistically significant.

By including railway system fixed effects, we effectively control for any time-invariant unobserved heterogeneity at the railway-system level. Geography and railway gauges are two important sources of heterogeneity that could bias the results. For example, constructing and

[13] 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 1906; Madras in 1908; and Bengal and Northwestern in 1890. Bengal and Northwestern was somewhat unique. It 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.

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

[15] Rajputana Malwa (1885), Burma (1896), and Nagpur and Chattisgarh (1887) switch from state-state to state-private.

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 (meter or smaller) are believed to have had lower costs than standard gauge railways (5 feet 6 inches). 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 Government of India was more likely to take ownership of private lines when costs were declining, then ownership changes would be endogenous to working expenses. To illustrate this problem, 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. Both the switchers and non-switchers have strong and different trends in working expenses. We therefore include railway system specific trends in our analysis to control for any unobservables trending up or down at the railway level.

As an additional robustness check, 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 cost residuals for individual lines from specifications that omit our organizational variables and 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 for both our railway system panels and the fraction mileage variables for ownership. Our fraction of state-owned mileage variable captures both state and native state lines within a railway system, but our results are robust to controlling for native state mileage separately.[16] Specifications 1 to 4 focus on the panel including secondary lines before they merge into a system, and specifications 5 to 8 focus on the panel excluding those lines. Specification 1 is our most parsimonious regression where we only control for input costs, network density and year fixed effects. Working expenses are 2 to 4 percent lower for any type of state-owned lines.

Specification 2 documents the negative and statistically significant effect of state ownership and private operation on working expenses after controlling for railroad and year fixed effects. A 100-percentage point increase in the fraction of state-owned and privately-operated lines reduces working expenses by 6.5 percent. Interestingly, state-owned and operated lines also have lower costs than private-private lines on the order of 6 .1 percent in the fixed

[16] The fraction variable 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.

effects specifications.[17] Specification 3 controls for railroad-specific trends and the coefficients increase in magnitude. 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 6.5 to 8.5 percent on average.

Specifications 4 to 6 repeat the same specifications for the railway panel excluding secondary lines and the findings are similar in magnitude. Table 2b presents results using dummy variables for the different organizational types. We include separate dummies for state owned and operated, and state-owned and privately-operated (privately-owned and operated is the omitted group). The dummy variables confirm our findings on the fraction mileage variable although the magnitude of the effects is slightly smaller—a switch to state ownership and private operation reduces costs by 6 percent for the panel including lines before they merge to principal systems and 4.9 percent excluding these lines (specification 3 and 6 respectively).

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. This concern is partly alleviated because the Government of India could only purchase private guaranteed railways 25 or 50 years after their original contract. Table 3 explores the timing issue in more detail 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

[17] We are hesitant to put 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.

only present results for our bigger panel including pre-merger lines but the results are unchanged for the smaller panel.

We find some 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 and operation in 1889 as compared to Eastern Bengal the other private company taken over by the state in 1884.

To illustrate the unique case of these changes to pure state organization, figure 5 plots the residuals of working expenses from regressions controlling for input costs, year fixed effects and railroad fixed effects for the Oudh and Rohilkhand Railways and Eastern Bengal against years before and after the switch. While Eastern Bengal appears to have lower working expenses on average after switching to state ownership, the case of Oudh and Rohilkhand is more complicated. The declining trend in working expenses several years before switching to state ownership and operation suggests that the Government of India's decision to take over ownership and management of Oudh and Rohilkhand Railways may have been endogenous to cost considerations. Discussions in the *Annual Reports* also note some strategic concerns vis-à-vis the location of this particular line. Although our ownership variables capture average effects, the differential trends in working expenses and timing of the switch between these two state railway systems indicate that the effects may be heterogeneous across different types of lines.

The lack of comparable findings on rising working expenses for state-private lines two and three years prior to an actual change is thus reassuring that the timing of the change is less endogenous. Unlike the case of Oudh and Rohilkhand, the evidence in favor of rising costs before a switch and declining costs thereafter is very stark if we focus on a few key railroads that switched from private to state ownership such as the Great Indian Peninsula, Madras, South Indian, and Bombay, Baroda and Central India. These are 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 6), but costs fell sharply following the switch to state ownership and private operation.

Based on our theoretical discussion in section 3, we believe working expenses declined for the guaranteed companies due to a switch to state ownership as opposed to a restructuring of the terms for private companies. To manage operations, private companies only received surplus profits proportional to their capital investment that was typically small after the railways were converted to public-private partnerships. On the other hand, a switch to state ownership entailed stronger incentives for the Government because they 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 by providing them 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.

To illustrate the advantage of state ownership, table 4 presents our final set of results using the fraction of miles under state ownership regardless of operation. Specification 1 parallels the findings for state ownership and private operation in table 2a with a 100 percent increase in state owned miles translating into a 6.4 percent decrease in working expenses relative to privately owned lines. Moreover, the magnitude of the effect increases to 8 percent when we control for rail specific trends in specification 3. Specifications 2 and 4 using a dummy for state ownership also find comparable results although the effect is not as precisely measured when we control for just year and rail fixed effects.

The negative finding of state ownership on costs is also an extremely robust result. In specification 5, we cluster the standard errors at the year level to allow for correlation across railway lines in the same year, which corrects for any peculiarities of the annual data gathering process. Given the time series nature of our data, serial correlation is another important concern so specification 6 estimates fixed effects models controlling for an AR (1) disturbance.[18] The findings on state ownership are robust to both these tests.

We conducted a similar set of tests using a dummy variable for state operation. The results in columns 7 to 9 show that when the effects of state operation are isolated there is no statistically significant change in working expenses. These results suggest it mattered far less whether the state or private companies operated railways.

7. Conclusion

In this paper, we estimate the efficiency gains achieved by Indian railways when they switched to state ownership. Using a novel data set on the principal Indian railway systems and by comparing changes within systems, we find a switch from private ownership to state ownership reduced working expenses by 6 to 8 percent controlling for input costs, density and

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

railway specific trends. Moreover, the timing of the switch to state-private organization does not appear to be endogenous to costs. The transfer of majority of the privately owned mileage to state owned, we believe contributed to India's transition toward a more efficient rail network. In the late 19th century India had a very low railway efficiency rank relative to other countries in the world, but by the early 20th century she was ranked second behind Belgium and ahead of Britain at rank 11(Bogart 2009b).

Our findings are surprising in light of commonly held views about ownership and efficiency. The work by Shleifer (1998) and others suggests that efficiency should be lower under state ownership because managers and other crucial actors cannot appropriate the returns from their investments. Our analysis suggests that in the Indian context, private ownership provided weak incentives. Guarantees discouraged efforts to cut costs as did the profit sharing arrangement with the Government. The Government of India also improved incentives by contributing a part of state railway earnings to each employee in proportion to their salary and position. State railway employees also had the option of turning to private railways in India or elsewhere in the British Empire, once they had developed a reputation for having prudently managed railways or adopted new technologies.

Our results also highlight the link between state ownership and the incentive to undertake investments of a public good nature. Theoretical work by Besley and Ghatak (2001) suggests that incentives to undertake public good investments are greater when the individual that values the public good benefits the most owns the project. The Government of India placed a high value on investments that improved operational efficiency on all railways because it was the primary owner of more than half the network. As the main residual claimant in the railway sector, the Government had the incentive to organize the Railway Conferences of the 1880s and 1890s. The

Conferences improved coordination by introducing a code of general rules for the working of all lines. They also fostered the development and application of new carriage and locomotive technologies, which benefitted all lines (Bell 1894, p. 114).

Based on the institutional history, we argue that improved incentives for the state as opposed to private companies were primarily responsible for the observed efficiency gains. What changed in the Indian context was not a simple transfer of private railways to state authority, rather the state was given the 'right incentives' to improve performance. Over the last decade there has been a substantial increase in public-private partnerships across the world in many different sectors such as infrastructure, banking, etc. India's historical experience suggests that for these partnerships to succeed, state actors need the proper incentives to cut costs and improve efficiency. Public good investments should also be a key consideration. As the Indian case illustrates, public and private authorities will have different incentives to implement improvements and innovations with broader effects.

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Figure 1: Map of Indian Railways by Gauge

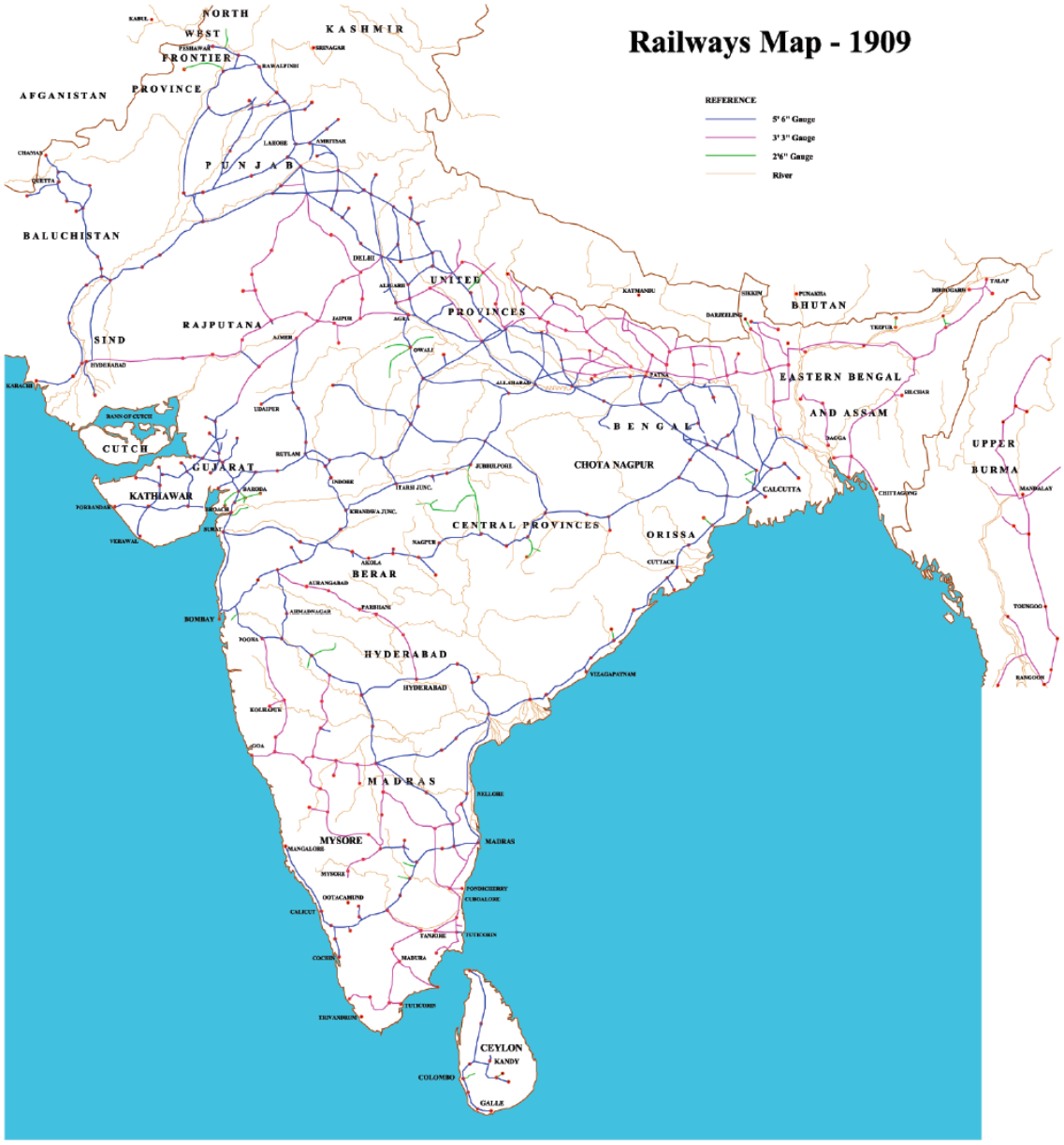

Figure 2: Indian Railways Mileage by Type

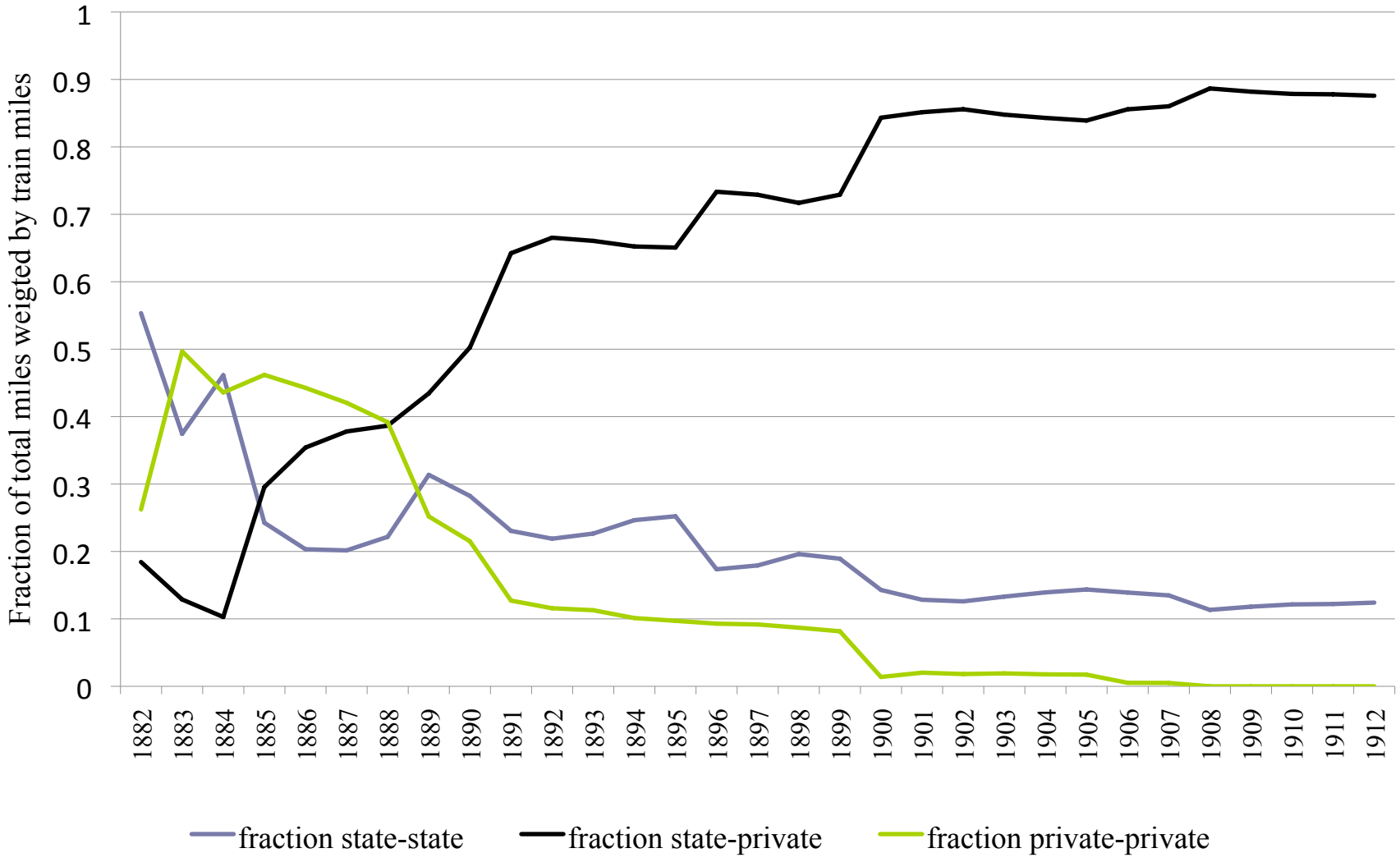

Table 1: Summary Statistics by Organization Type

	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	

ns include information on pre-merged lines.

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

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

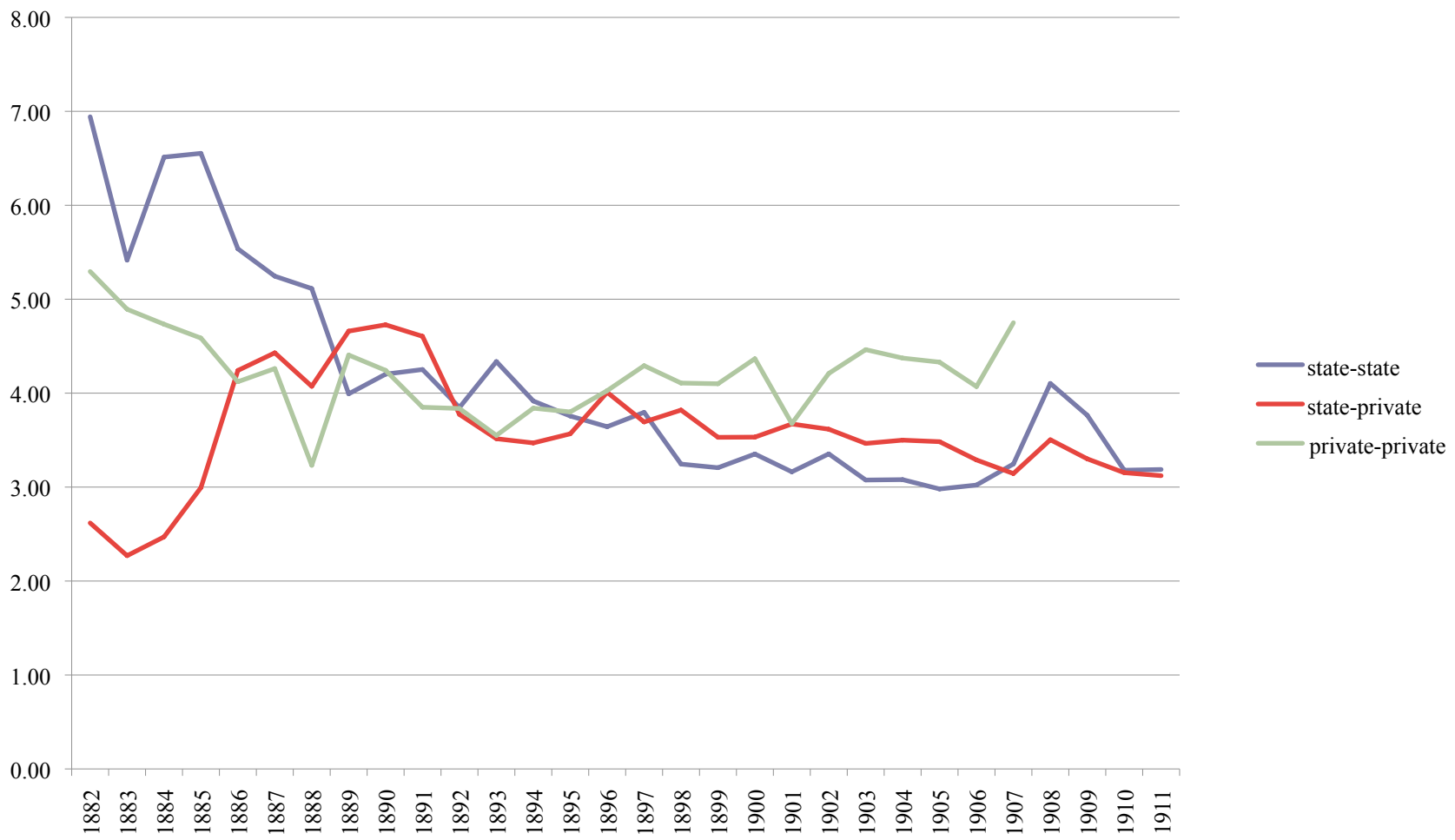

Figure 4: Residuals from Regression of Working Expenses on Input Costs, Year and Railroad FE

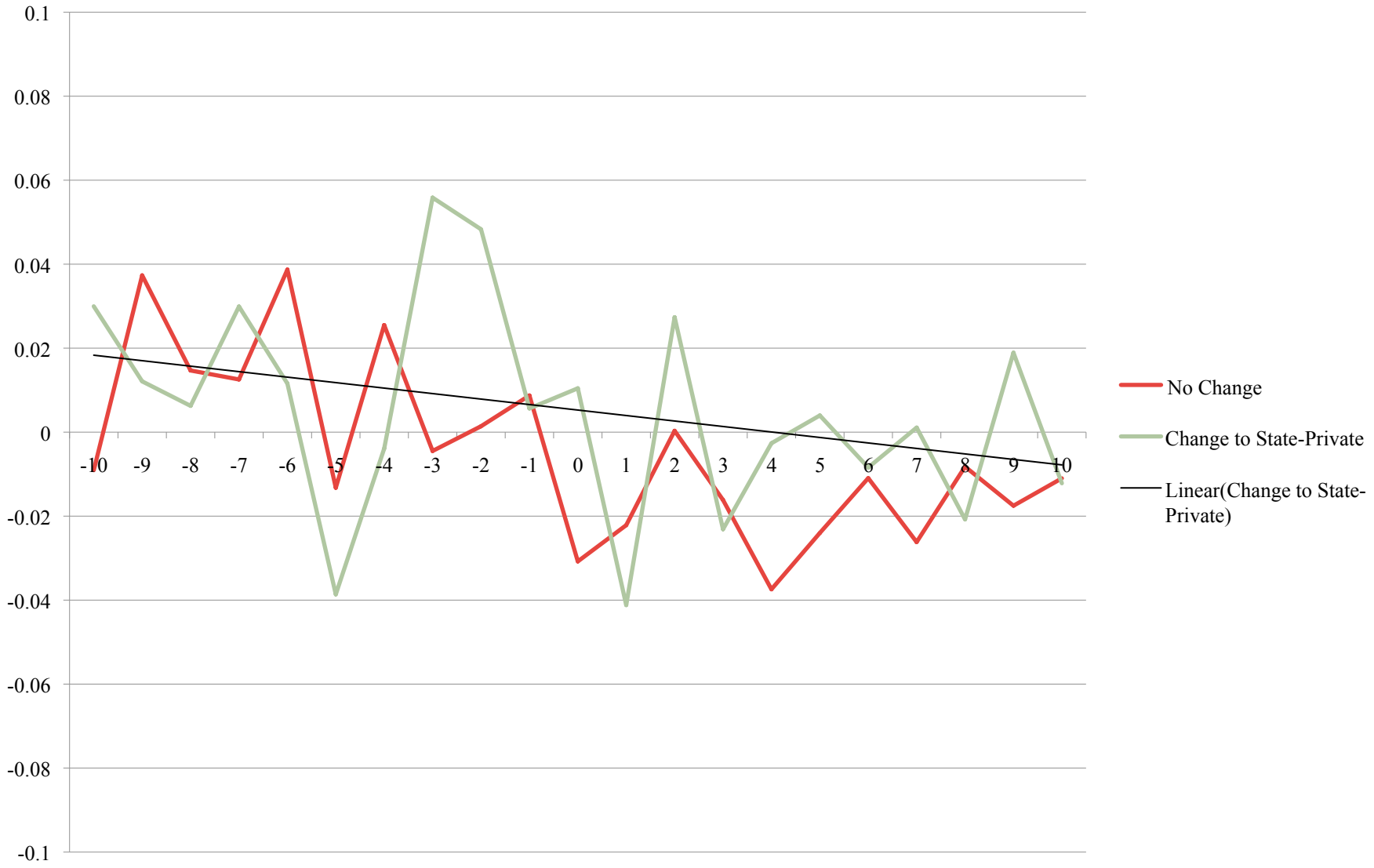

Table 2a: Effects of Ownership (Fraction) on Log of Working Expenses

	Including Pre-Merger Lines			Excluding Pre-Merger Lines		
	(1)	(2)	(3)	(4)	(5)	(6)
Logs						
Avg Cost of Fuel	0.1623***	-0.0064	0.0029	0.1559***	-0.0101	0.0015
	[0.0125]	[0.0229]	[0.0250]	[0.0118]	[0.0240]	[0.0258]
Cost of Train Staff per Mile	0.2631***	0.2885***	0.2286***	0.3444***	0.2853***	0.2274***
	[0.0585]	[0.0446]	[0.0501]	[0.0398]	[0.0457]	[0.0510]
Passenger Miles	0.2556***	0.0606***	0.0754***	0.2911***	0.0640**	0.0827**
	[0.0477]	[0.0154]	[0.0214]	[0.0264]	[0.0250]	[0.0389]
Ton Miles	0.2876***	0.3341***	0.3424***	0.2595***	0.3425***	0.3441***
	[0.0325]	[0.0285]	[0.0251]	[0.0212]	[0.0307]	[0.0296]
Total Mileage	0.3712***	0.4679***	0.4590***	0.3232***	0.4445***	0.4159***
	[0.0343]	[0.0405]	[0.0435]	[0.0262]	[0.0434]	[0.0474]
Capital Outlay per Mile	0.2576***	0.2013***	0.1537*	0.2656***	0.1885***	0.1304
	[0.0336]	[0.0699]	[0.0836]	[0.0334]	[0.0720]	[0.0836]
Fraction state owned lines	-0.0482	-0.0615**	-0.0724**	0.0069	-0.0623**	-0.0646*
	[0.0315]	[0.0309]	[0.0356]	[0.0315]	[0.0313]	[0.0353]
Fration state owned and privately operated lines	-0.0199	-0.0650**	-0.0853**	0.0162	-0.0616**	-0.0650*
	[0.0309]	[0.0277]	[0.0353]	[0.0271]	[0.0272]	[0.0343]
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Railroad FE	No	Yes	Yes	No	Yes	Yes
Railroad Specific Trends	No	No	Yes	No	No	Yes
Constant	-0.4878	2.9344***	7.6433*	-0.3599	3.0291***	8.4941*
	[0.3846]	[0.7049]	[4.2874]	[0.3540]	[0.7181]	[4.4227]
Observations	488	488	488	451	451	451

Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table 2b: Effects of Ownership (Dummy) on Log of Working Expenses

	Including Pre-Merger Lines			Excluding Pre-Merger Lines		
	(1)	(2)	(3)	(4)	(5)	(6)
Logs						
Avg Cost of Fuel	0.1437***	-0.0136	-0.0027	0.1427***	-0.017	-0.0035
	[0.0115]	[0.0223]	[0.0249]	[0.0119]	[0.0235]	[0.0258]
Cost of Train Staff per Mile	0.2588***	0.2903***	0.2331***	0.3397***	0.2867***	0.2288***
	[0.0542]	[0.0453]	[0.0503]	[0.0379]	[0.0463]	[0.0513]
Passenger Miles	0.2364***	0.0619***	0.0769***	0.2754***	0.0664**	0.0850**
	[0.0458]	[0.0159]	[0.0221]	[0.0258]	[0.0261]	[0.0400]
Ton Miles	0.2984***	0.3376***	0.3396***	0.2687***	0.3455***	0.3416***
	[0.0317]	[0.0292]	[0.0255]	[0.0213]	[0.0315]	[0.0301]
Total Mileage	0.3927***	0.4536***	0.4466***	0.3411***	0.4291***	0.4056***
	[0.0339]	[0.0407]	[0.0426]	[0.0266]	[0.0438]	[0.0463]
Capital Outlay per Mile	0.2179***	0.2134***	0.1605*	0.2360***	0.2012***	0.1349
	[0.0331]	[0.0718]	[0.0855]	[0.0349]	[0.0741]	[0.0850]
State owned and operated	-0.0848***	-0.0333	-0.0521	-0.0313	-0.0346	-0.0495
	[0.0283]	[0.0296]	[0.0346]	[0.0286]	[0.0301]	[0.0346]
State owned and privately operated	-0.0960***	-0.0246	-0.0600**	-0.0539*	-0.0227	-0.0493*
	[0.0315]	[0.0255]	[0.0283]	[0.0285]	[0.0254]	[0.0278]
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Railroad FE	No	Yes	Yes	No	Yes	Yes
Railroad Specific Trends	No	No	Yes	No	No	Yes
Constant	0.0699	2.8014***	8.1054*	0.0449	2.8859***	8.5816*
	[0.4026]	[0.7159]	[4.4123]	[0.3778]	[0.7298]	[4.5374]
Observations	488	488	488	451	451	451

Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table 3: Changing the Ownership Switch Year (Railway System Panel - Including Pre-Merger Lines)

	(1)	(2)	(3)	(4)	(5)	(6)
	Ln (Working Expenses)					
Logs						
Avg Cost of Fuel	-0.0118	-0.0013	-0.0083	0.0036	-0.0054	0.0107
	[0.0224]	[0.0247]	[0.0222]	[0.0251]	[0.0221]	[0.0254]
Cost of Train Staff per Mile	0.2930***	0.2439***	0.2963***	0.2527***	0.2943***	0.2480***
	[0.0451]	[0.0508]	[0.0444]	[0.0498]	[0.0440]	[0.0481]
Passenger Miles	0.0650***	0.0802***	0.0720***	0.0860***	0.0773***	0.0888***
	[0.0162]	[0.0222]	[0.0165]	[0.0222]	[0.0171]	[0.0215]
Ton Miles	0.3372***	0.3404***	0.3369***	0.3406***	0.3356***	0.3381***
	[0.0291]	[0.0256]	[0.0283]	[0.0252]	[0.0272]	[0.0244]
Total Mileage	0.4487***	0.4378***	0.4358***	0.4244***	0.4269***	0.4199***
	[0.0396]	[0.0421]	[0.0388]	[0.0417]	[0.0369]	[0.0396]
Capital Outlay per Mile	0.2110***	0.1603*	0.2074***	0.1608*	0.2064***	0.1640**
	[0.0708]	[0.0847]	[0.0691]	[0.0837]	[0.0668]	[0.0833]
One year earlier						
State owned and operated	-0.0452	-0.0601				
	[0.0332]	[0.0373]				
State owned and privately operated	-0.025	-0.0540*				
	[0.0256]	[0.0284]				
Two years earlier						
State owned and operated			-0.0770**	-0.1020**		
			[0.0356]	[0.0409]		
State owned and privately operated			-0.0174	-0.0356		
			[0.0248]	[0.0295]		
Three years earlier						
State owned and operated					-0.1132***	-0.1516***
					[0.0378]	[0.0389]
State owned and privately operated					-0.0069	-0.0076
					[0.0247]	[0.0303]
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Note: All specifications include infor	Yes	Yes	Yes	Yes	Yes	Yes
Railroad Specific Trends	No	Yes	No	Yes	No	Yes
Constant	2.8096***	8.6705*	2.8126***	10.7671**	2.7947***	12.6258***
	[0.7052]	[4.5221]	[0.6817]	[4.4613]	[0.6584]	[4.4036]
Observations	488	488	488	488	488	488

Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Figure 5: Residuals for Oudh-Rohilkhand and Eastern Bengal

Figure 6: Residuals for BB&CI, GIPR, Madras and South Indian

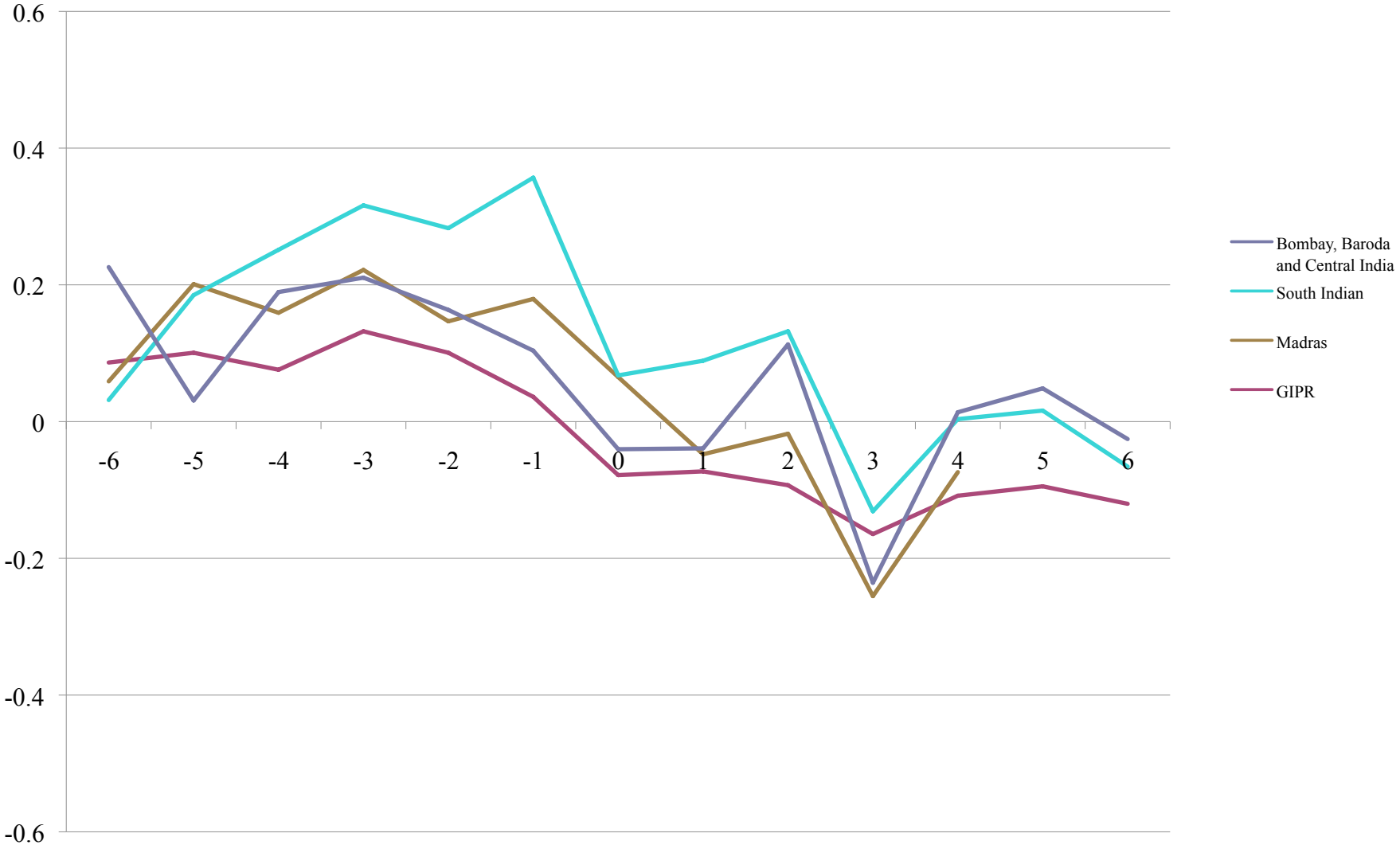

Table 4: Effect of State Ownership on Log of Working Expenses (Including Pre-Merger Lines)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Logs									
Avg Cost of Fuel	-0.0061	-0.0149	0.0038	-0.0018	0.0038	0.0067	0.1624***	-0.0186	-0.0096
	[0.0228]	[0.0222]	[0.0248]	[0.0247]	[0.0266]	[0.0245]	[0.0126]	[0.0225]	[0.0247]
Cost of Train Staff per Mile	0.2892***	0.2882***	0.2313***	0.2344***	0.2313***	0.1953***	0.2544***	0.2998***	0.2673***
	[0.0446]	[0.0449]	[0.0498]	[0.0500]	[0.0614]	[0.0585]	[0.0595]	[0.0446]	[0.0495]
Passenger Miles	0.0612***	0.0604***	0.0764***	0.0776***	0.0764***	0.0485***	0.2583***	0.0605***	0.0763***
	[0.0155]	[0.0158]	[0.0215]	[0.0221]	[0.0195]	[0.0171]	[0.0466]	[0.0159]	[0.0226]
Ton Miles	0.3341***	0.3378***	0.3417***	0.3393***	0.3417***	0.2407***	0.2900***	0.3464***	0.3433***
	[0.0284]	[0.0292]	[0.0252]	[0.0256]	[0.0264]	[0.0255]	[0.0329]	[0.0279]	[0.0256]
Total Mileage	0.4668***	0.4559***	0.4562***	0.4454***	0.4562***	0.5109***	0.3643***	0.4445***	0.4349***
	[0.0412]	[0.0411]	[0.0427]	[0.0422]	[0.0439]	[0.0385]	[0.0321]	[0.0386]	[0.0414]
Capital Outlay per Mile	0.2005***	0.2163***	0.1515*	0.1585*	0.1515	0.0890*	0.2624***	0.2205***	0.1791**
	[0.0688]	[0.0711]	[0.0824]	[0.0836]	[0.0914]	[0.0491]			
Fraction state owned lines	-0.0635**		-0.0794**		-0.0794**	-0.0619*			
	[0.0258]		[0.0313]		[0.0297]	[0.0349]			
State owned lines		-0.0274		-0.0577**					
		[0.0237]		[0.0264]					
State operated lines							-0.0267	-0.0162	-0.0121
							[0.0206]	[0.0253]	[0.0316]
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Railroad FE	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Railroad Specific Trends	No	Yes	Yes	Yes	Yes	No	No	No	Yes
Robustness Checks					SE Clustered at Year	SE adjusted for AR (1)			
Constant	2.9419***	2.7801***	7.9641*	8.3225*	7.9641**	5.7954***	-0.6093*	2.6446***	13.9396***
	[0.6894]	[0.7039]	[4.2272]	[4.3400]	[3.6802]	[0.3264]	[0.3327]	[0.7120]	[4.0541]
Observations	488	488	488	488	488	468	488	488	488

Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1 All specifications include information on pre-merged lines.