

# Off the Rails: Is State Ownership Bad for Productivity?

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## Abstract

The performance of Indian railways in the nineteenth century provides a great context to study the effects of state ownership on productivity and other aspects of operations. We rely on a key feature of the institutional background whereby the Government of India purchased a majority ownership stake in private railways at pre-determined dates set by contracts negotiated decades before the companies came under state ownership. Controlling for individual railway fixed effects, year fixed effects, and railway-specific time trends, we find no evidence of a decline in TFP following state takeovers of private companies. Instead of reducing productivity, as the recent experiences with privatization would suggest, we find that the Government of India maintained productivity when it became the owner of railways. Government ownership influenced certain areas of operations such as the capital-labor ratio, but not others such as fares. This suggests the state was able to achieve similar productivity without following the blueprint of private companies.

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# 1 Introduction

Economists and policymakers alike have long been interested in the costs and benefits of private versus state ownership. Although state ownership has been on the decline since the 1970s, large and important industries in many developing countries, especially Brazil, India, Russia, and China continue to remain under state ownership. In these and other countries where the state has a large ownership presence it is important to know whether there are any productivity losses from state ownership. The empirical literature on privatization argues that private ownership usually results in increased productivity suggesting that state ownership has efficiency costs (see surveys by Megginson and Netter 2001, Djankov and Murrell 2002, Guriev and Megginson 2007, and Estrin et al. 2009). However, many of the empirical findings are based on estimation strategies that are not always well identified. For example, it is often difficult to find a good control group to compare to privatized firms. Also firms undergoing privatization can be a selected sample because of their recent or expected productivity performance.

This paper uses the lens of history to better understand the effects of state and private ownership. Our historical setting—railways in Colonial India—is especially suited to study this question because there was a complete transition from private ownership to majority state ownership and because the timing of state-takeovers was exogenous with respect to firm performance. The initial rail network in India was built and owned by British companies through the 1870s. A clause in the original contracts allowed the colonial Government of India to purchase railway companies only at specified future dates. Beginning in the 1870s, the Government began to exercise its purchase option and over the next three decades the Government of India took ownership of all the former private railways. By 1910 the Government owned over 70 percent of railway miles compared to less than 10 percent in 1875. The state takeover of Indian railways was different from railway nationalizations taking place in other countries at this time. Most experienced only a partial nationalization of the network and many were driven by economic or political expediencies as in Japan and Switzerland (Bogart 2010).

In this paper, we examine how state takeovers in India influenced a wide range of performance measures namely, total factor productivity or TFP, partial productivity in capital, fuel and labor, and other aspects of firm behavior such as investment, the capital-labor ratio, and average freight and passenger fares. Following the standard approach in the productivity literature, we measure TFP as a residual from a production function (Syverson 2011, Van Biesebroeck 2008) using passenger miles and ton miles as outputs. The inputs are labor,

fuel, and capital. We estimate TFP for two panels: (1) the ‘joint’ panel, which accounts for any mergers of railways by including information on the pre-merged railway(s) in the years before a merger and (2) the ‘solo’ panel, which follows individual railway systems and does not account for any mergers. Railways disappear from the ‘solo’ panel once they merge to another railway. We prefer the joint panel because state ownership was followed by a few key mergers and the joint panel effectively allows us to separate the effects of such mergers from state ownership.

Our baseline specification is fully loaded and controls for individual railway fixed effects, year fixed effects, and railway-specific time trends. Thus, we are identifying the effects of ownership by exploiting variation within railways over time. In our view, the Indian case offers a number of advantages from an identification perspective. First, the Government of India took over all the original private railways eliminating concerns about selection. Second, the timing of state takeovers was predetermined. The Government of India could only takeover a railway company either 25 or 50 years after its original contract. Five railway companies were taken over on their 25<sup>th</sup> anniversary and due to an intervention by the British Secretary of State in 1869 the last three private companies were purchased on the 50<sup>th</sup> year of their contract. The state could not manipulate takeovers to coincide with periods of increasing or decreasing productivity.

Although the takeover year was exogenous, private railways may have anticipated the takeovers and these anticipation effects could bias the results on state ownership. To test this hypothesis, we interact state ownership with an indicator variable for the 3-year window before takeover. To test for differential short and long run effects, we also interact state ownership with an indicator variable for the first three years after takeover including the year of takeover, and for 3 or more years after takeover.

The empirical results yield a clear conclusion: state ownership had a negligible impact on the TFP of Indian railways. Our period of study was one of high productivity growth in railways. Even after state takeovers, railways did not deviate from this general trend of high productivity growth. Controlling for anticipation effects does not change the results and there are no significant differences between the short run and the long run. The results on partial productivity measures and fares also find no evidence of a negative effect of state ownership.

These findings relate to a growing literature on the organization of Indian railways.<sup>1</sup> In

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<sup>1</sup>Historians have written extensively about the private and state ownership of colonial Indian railways (for example, Kerr 2007, Thorner 1977). Much of the economics literature has focused on how railways influenced price convergence, but there has been a renewed interest in the question of ownership. See Hurd and Kerr (2012) for a review of current research on Indian railways in economics and history.

previous work we find that variable costs declined following the switch to state ownership in India without any increase in the number of accidents (Bogart and Chaudhary 2012). Variables costs and safety speak to one dimension of efficiency, but they omit the role of fixed capital investments that are especially important in railways. The present paper offers a comprehensive analysis of the effects of state ownership on Indian railway performance using newly constructed series on the capital and fuel inputs of each railway that are used to estimate different productivity measures along with additional performance indicators such as freight and passenger fares. While we do not find any positive effects of Government ownership on total factor productivity or fares, we can confidently rule out any negative effect. The overall picture suggests the Government takeover of Indian railways had a neutral effect on performance.

Our findings are different from many empirical studies in the privatization literature. For example, in a study of Estonia, Jones and Mygind (2002) find that firm-level productivity increased by 15.2 percent following privatization. Similar or larger estimates are reported in other studies (e.g. Ramamurti 1997, La Porta and Lopez-de-Silanes 1999, Laurin and Bozec 2001, Claessens and Djankov 2002). A recent survey by Guriev and Megginson (2007) suggests average productivity improves by 20 percent following privatization. However, in our case a 95 percent confidence interval for the long run effect of state ownership on TFP ranges from negative 7 percent to positive 8 percent. It is far from a 20 percent decline in productivity that would be predicted by many privatization studies.

Although different from much of the literature, we are not the first to find negligible or mixed effects from state ownership. For example, Kole and Mulherin (1997) find no difference in performance of US firms that came to be government-owned during World War II. Feng, Sun and Tong (2004) find no difference in income and efficiency between government-linked companies and a matched sample of non-government-linked companies in Singapore. Studies of firms in China (Sun and Tong, 2003) and Spain (Villalonga, 2000) also fail to find large positive effects of privatization.

Within railways, a classic study by Caves and Christensen (1980) finds no difference in performance between the Canadian National and Canadian Pacific Railroads. Using historical cross-county data, Bogart (2010) finds that railway nationalizations are associated with lower cost efficiency but the manner of nationalization is also important. Efficiency is lower when the state takes over private railways compared to when the state constructs national railways. One may be hesitant to extrapolate from these studies because of potential endogeneity concerns or their unique contexts. But, even one of the most rigorous studies in this literature finds mixed evidence in support of privatization (Brown, Earle and Telegdy

2006). Using a large panel of Eastern European firms, Brown et al. find an increase in TFP after private takeovers in Romania and Hungary, no effect of private takeovers on TFP in the Ukraine, and a negative effect in Russia. Taken together, these studies suggest private ownership is not always more efficient.

Finally, our analysis speaks to an important outstanding question in the literature: when is state ownership harmful for productivity and when is it no worse than private ownership? The Indian case suggests at least four factors that are relevant. First, the private companies that originally owned India's railways were guaranteed a 5 percent return on their capital investment. The guarantees were designed to encourage investment, but they also weakened incentives to improve performance. Second, the undemocratic colonial state was not beholden to public sector labor unions or local politicians. The British administrators that ran India had little incentive to use railways as a tool to buy votes—say by providing jobs or building a station in every town.

Third, Government owned railways were a key contributor to total government revenues—35 percent by 1913. India had a weak fiscal system and thus could not easily generate the same revenues from other sectors such as manufacturing. Fourth, railways provided key logistical support in defending the empire. Britain's control over India would have been more tenuous had it not been able to quickly move troops to various frontiers. Overall the combination of weak incentives for railway companies and the fiscal and political costs to the state of an unproductive railway system contributed to a similar level of productivity under private and state ownership in India.

The rest of the paper is organized as follows. Section 2 describes the relevant institutional details followed by how the theoretical literature on ownership applies to the Indian context in section 3. We describe our data in section 4 and empirical strategy in section 5. The results are presented in section 6 followed by conclusions in section 7.

## 2 Background on Indian Railways

The main Indian trunk lines were constructed in the 1850s and 1860s by British railway companies. Ten such companies incorporated in Britain entered into contracts with the Secretary of State, a British Cabinet member with formal control over the administration of India.<sup>2</sup> Figure 1 depicts the railway companies operating in India in 1870 and their routes. The oldest and largest of these companies were the East Indian and the Great Indian Peninsula Railways connecting the ports of Calcutta and Bombay respectively to the

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<sup>2</sup>Two of the original companies merged leaving 8 such companies by 1870.

interior of the country. Sind, later renamed the Sind, Punjab, and Delhi Railway company also had a large network in the northwest connecting the port of Karachi. Connecting the main ports to the interior and to each other was an important goal of colonial rail policy in keeping with Britain's military, political and trade interests in India.

These private British companies were joint stock companies and their contracts with the Secretary of State shared common features. Land was provided free of cost by the Government of India. The companies raised capital in Britain via shares and received a 5 percent guarantee on the share capital at a fixed exchange rate. The net earnings from railway operations were paid into the Government treasury and rebated to the companies. If net earnings as a proportion of capital outlay fell short of the guaranteed 5 percent, the Government made up the difference up to 5 percent. However, such guarantee payments were treated as debt. If annual returns exceeded 5 percent, the Government received half of all surplus profits above the guarantee and shareholders received the other half. Once past guarantee payments were paid off, company shareholders received all the profits.<sup>3</sup>

In exchange for the guarantees, the Government retained control over certain aspects of the railways. The Government had ultimate authority on route placement and gauge. They could also influence operations through a government director who sat on the company boards. Finally, the Government could purchase private railways on the 25<sup>th</sup> or 50<sup>th</sup> anniversary of their original contract with the mean market value of the company's stock in the preceding three years determining the purchase price (Bell 1894, p. 66-72). This is a key contractual feature from an identification perspective because the Government could not time takeovers depending on company performance.

India's experience with railway guarantees was mixed. While such contracts allowed British capital to finance Indian railway construction, many of the companies were unable to generate returns over 5 percent in the 1850s and 1860s. Hence, the Government and Indian taxpayers made up the difference to British shareholders via the guarantee payments. Years of such payments turned official opinion in India against private ownership, which many believed did not work well alongside the guarantee system (Sanyal 1930). The question of whether guaranteed companies should be allowed to retain ownership came to the forefront in the 1870s with the approaching 25<sup>th</sup> year anniversary of the East Indian railway in 1879. In 1877, the Secretary sent a letter to company directors indicating the Government's intention to purchase the line but suggested a new arrangement whereby the company would operate the railway in exchange for a portion of the profits and a reduced guarantee (Huddleston, 1906 p. 101). Thus, the East Indian railway came under Government ownership in 1880

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<sup>3</sup>See Sanyal (1930) for details.

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.

Over the 1880s, 1890s, and 1900s, the Government purchased all the original guaranteed companies. Most of them were taken over on the 25<sup>th</sup> year of their original contract, with the exception of the Great Indian Peninsula Railway, Bombay, Baroda and Central India Railway and the Madras Railway. These three were taken over on their 50<sup>th</sup> contract anniversary because of a negotiated deal in 1869 with the Secretary of State in which their past guarantee debt payments up to that year were forgiven in exchange for sharing surplus profits above 5 percent with the Government from that year forward. The Secretary also agreed to not takeover these railways on their 25<sup>th</sup> anniversary.<sup>4</sup> The Government's motivation in taking over the guaranteed companies was to end the guarantee system and secure more favorable terms for the Government (Sweeney 2011, Government of India 1955).

Although most of the railways retained private operations, the Government chose to operate a few railways after takeovers.<sup>5</sup> In the other cases, the Government entered into agreements with directors of the former railway companies. The newly formed companies generally held less than 20 percent of the capital. The profits were guaranteed, at lower rates of 3 to 4 percent and at smaller capital values. Surplus profits were shared with the Government in proportion to their respective capital shares. The shift to state ownership led to a substantial increase in Government control and supervision (Huddleston 1906). The Government also pushed through a few important mergers in the years immediately following takeovers.<sup>6</sup> To separate the confounding effects of mergers from takeovers, we construct a special 'joint' panel of railways described in the data section.

Our empirical analysis exploits Government of India takeovers of these guaranteed companies to identify the effects of state ownership on productivity. In addition to the treatment group, the Indian context offers a control group because many railways did not experience a change in ownership. On account of the disappointing performance of the guaranteed

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<sup>4</sup>This deal was offered only to the four biggest railways, these three plus the East Indian. However, the East Indian refused the offer because it was a profitable company and its past debts on account of the guarantee were small compared to the others. We believe railway fixed effects capture the differences in size and any other time invariant factors that lead to these companies being taken over on their 50<sup>th</sup> anniversary.

<sup>5</sup>We do not study operations in detail because different reasons appear to have driven the operation decision such as military concerns in one case versus private mis-management in another case. This potential endogeneity combined with fewer operational switches in the data make it difficult to accurately identify the effects of operation. That said, we do not find any correlation between operational changes and performance.

<sup>6</sup>For example, the private Sind, Punjab and Delhi Railway was merged with the state owned Indus Valley and Punjab Northern lines upon takeover, Great Indian Peninsula Railway was merged with Indian Midland after takeover, and the three southern lines of Madras, Southern Mahratta and South Indian were merged and re-organized after the takeover of Madras.

railways in the 1860s, the Government decided to construct and manage state owned railways in the 1870s. The Government borrowed money on the London capital markets in the form of Government of India bonds to finance these projects. Beginning in 1869 no new contracts were signed with private companies and the Government constructed several new lines on a smaller and cheaper meter gauge. This period of extensive state construction largely ended in the early 1880s. The economic depression in the 1870s coupled with the war in Afghanistan increased the Government's borrowing costs. India experienced devastating famines in 1877 and subsequent commissions called for a rapid extension of the network, which the Government was now unable to finance. To address the need for more railways, the Government relied on a public-private partnership model similar to the one negotiated with the guaranteed companies upon takeover. Beginning in the 1880s, the Government entered into contracts with new private companies whereby the state owned the railway but the company constructed and managed the lines in exchange for a small portion of the surplus profits. The Government also supported a few privately owned railways in the 1880s with state subsidies. These smaller private assisted companies were never taken over in our period of study. Finally, a few Princely States also constructed and managed their own railways.<sup>7</sup> Such railways (under Government ownership, Princely State ownership or private ownership) constructed after the 1870s did not experience any change in ownership and represent the control group.

The transition to state ownership between 1874 and 1912 was the key first step in India's move to complete nationalization of its railways. Beginning in the 1920s, public opinion turned against private operation and the Government gradually took over railway operations in the 1930s and 1940s. Apart from witnessing the transition to more Government ownership, this period is also interesting because Indian railways witnessed tremendous productivity growth. In Bogart and Chaudhary (2013), we find railway TFP averaged 2.3 percent per year between 1874 and 1912 exceeding productivity growth in other sectors of the economy. These aggregate gains were not driven by reallocation within the industry or an increase in capacity utilization. Rather Indian railways moved closer to the technology frontier in the early 20<sup>th</sup> century by adopting key technological improvements. At the aggregate-level, the Government also promoted many changes in the railways sector to improve performance across all railways regardless of ownership. In this paper, we specifically test whether the transition to Government of India ownership at the micro-level influenced productivity and other aspects of firm performance.

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<sup>7</sup>The Princely States represent a large number of semi-autonomous kingdoms ruled by native Indian rulers in contrast to British India that was under direct colonial authority. In exchange for local autonomy, the Princely States deferred to the British on matters of defense and foreign affairs.

### 3 Theory and its Application to Indian Railways

A vast theoretical literature in economics has studied the relationship between public or private ownership and performance (for example, Shleifer 1998, Djankov and Murrell 2002, and Shirley and Walsh 2000) with researchers making arguments both for and against state ownership. It is useful to briefly explain how the Indian case relates to these theories before turning to the data. Sappington and Stiglitz (1987) argue that the main difference between private and public firms centers on the ease of government intervention to firms' production activities. In this vein, researchers have argued that state ownership reduces performance because governments generally cannot commit and thus they appropriate the surpluses associated with managerial investments. The hold-up problem, as it is known, is one key reason why managers in private firms have stronger incentives to cut costs and improve efficiency (Hart, Shleifer, and Vishny 1997, Shleifer 1998).

However, it is unclear if the hold-up problem was significant in India. Anecdotal evidence at least seems to suggest that the Government of India took an active interest in the management of railways once they were state owned. For example, repairs to locomotives and carriages were centralized in the Lahore workshop following the merger and reorganization of the Sind, Punjab, and Delhi Railway company with the Indus Valley and Punjab Northern state lines in 1886. Concentrating the repair process in a single location contributed to the use of more sophisticated technology and avoided the redundancy of having three individual workshops in the region (Kerr 2007, p. 85). As another example the Government also took measures to motivate railway employees. In 1880 the Government introduced a profit sharing agreement with state railway employees known as the Railway Provident fund and contributed one-half of one percent of the net earnings of state railways that were then disbursed to employees in proportion to their salary and position (Bell 1894, pp. 109-110).

A different theoretical argument in favor of private ownership suggests that state owned firms may promote political objectives over profit maximization. For example, they may pursue schemes of greater employment or universal coverage of service that are not necessarily efficient (Boyko, Shleifer, and Vishny 1996). Some examples from the historical record raise doubts about this view in the Indian case. For example, there were requests from farmers and merchants to extend the network of the East Indian railway when it was under state ownership into less populated regions and to expand its wagon stock to handle exceptional periods of freight. The Government of India refused these requests because they were considered uneconomical (Huddleston 1906). It could safely make such choices because there were fewer political consequences from ignoring constituent demands for an

authoritarian government.

The Government also stood to benefit from a well functioning railway sector because of its heavy fiscal reliance on railways. Almost 35 percent of GOI gross revenues came from state owned railways (Statistical Abstract relating to India 1915). The Government's dependence on railway revenues was due to a weak tax system. Per capita taxes in British India were only 5 to 8 percent of those in Britain (Roy 2011). The Government relied heavily on land taxes but was unable to increase rates to capture increases in productivity and landed wealth. According to Roy (2011), land taxes as a share of agricultural production declined from 10 percent in the 1850s to under 5 percent in the 1930s (p. 256). Indian opposition to taxes made it difficult for the colonial state to tap into new sources of tax revenue especially in the 20<sup>th</sup> century and the tax to GDP ratio continued to remain low up to Indian independence. While this weak fiscal system was undesirable from a development perspective, it may have provided a mitigating factor for railway productivity.

In contrast, guarantees to the railway companies appear to have weakened incentives to improve performance in the Indian context. Subsidies or guarantees to private companies are not uncommon.<sup>8</sup> They have been studied in the theoretical literature especially in the case of infrastructure where private firms require insurance against downside demand risk, but their efforts in reducing costs are not readily observed.<sup>9</sup> In such contexts, Engel, Fischer and Galetovic (2009, 2010) show that the optimal procurement contract contains minimum revenue guarantees to mitigate downside risk, but they should not be too generous as to induce sub-optimal cost-reducing effort.

The Indian case suggests the 5 percent dividend guarantee was perhaps too generous and likely dulled company incentives to manage costs judiciously. Contemporaries often criticized the guarantee system exactly for this reason. Horace Bell in his history of Indian railways disapprovingly noted that "shareholders had their 5 percent whatever happened (Bell 1894, p. 66)." The Secretary of State in 1868 advocated the use of guarantees, but admitted, "the system tends to weaken the ordinary motives to efficient management and superintendence (Bell 1894, p. 19)." Images from the time of ornate railway stations and luxury cabins testify to some private extravagance on a public purse.

To summarize, the standard models, which assume that state owned firms do not maximize profits or have weaker incentives than private companies, do not appear to be a good description of Indian railways. Similar to many other contexts, we believe the question of

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<sup>8</sup>Guarantees to private companies were commonly offered during the historical era of railway construction (Eichengreen 1995). Even today such guarantees are often part of the package when private companies invest in developing countries. We return to this issue in the conclusion.

<sup>9</sup>See Martimort (2006), Auriol and Picard (2009), Estache and Wren-Lewis (2009).

whether state ownership influenced the productivity of Indian railways is an empirical one and we use detailed data from this period to answer the question.

## 4 Data

Our dataset builds on earlier work (Bogart and Chaudhary 2013), which constructed new consistent series on output, labor, capital and fuel for the major standard and meter gauge railways operating in India between 1874 and 1912.<sup>10</sup> The sources for the data include the annual *Report to the Secretary of State for India in Council on Railways in India*, published from 1860 to 1883 and the *Administration Reports on the Railways in India*, published from 1884 to 1912. These series report information on passenger miles, tons miles, fuel, labor, the value of capital, fares and the ownership structure of each railway. We begin by describing our unit of analysis followed by the construction of the main variables used in the regressions.

Our analysis follows a railway or railway system, which includes the main line accounting for more than 90 percent of the mileage on average and any secondary lines operated by the system that are owned by either the Government of India, companies or Princely States.<sup>11</sup> Ideally, we would like to follow this railway system for the entire time period but mergers between lines complicate this process in two important ways. First, after a merger, we only have data on the new merged railway system. Second, the state takeover of private railways was followed by mergers in many cases. For example, the Great Indian Peninsula Railway company was taken over by the state in 1900 and was merged with the Government owned Indian Midland railway in 1901. In a few cases, the Government used takeovers to merge neighboring regional lines into one system such as the merger of the private Sind, Punjab and Delhi Railway (taken over in 1886) to the Indus Valley and Punjab Northern state railways in 1886. To address the issue of mergers, we follow a railway system and include information on the pre-merged lines to each system before they are officially merged together.<sup>12</sup> We call

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<sup>10</sup>We begin the analysis in 1874 when the official documents begin reporting consistent output and input data. As is the common in the transportation literature, our measure of output is a weighted average of passenger miles (number of passengers carried 1 mile) and ton miles with cost elasticities serving as the weights. We direct the interested reader to Bogart and Chaudhary (2013) that describes in detail how we constructed the output and input series. Bogart and Chaudhary (2012) studies the effects of state ownership on working expenses and does not include these newly constructed capital, fuel or fare series.

<sup>11</sup>For example, the East Indian railway system operated the primary East Indian line owned by the East Indian Railway Co. up to 1879 and the Government from 1880 onwards, three state-owned lines, and by 1912 three lines owned by other companies. For railways that manage multiple lines, the railway system is the most consistent unit we can follow because the data are reported for the system. When the railway does not operate secondary lines, the unit of analysis is the railway.

<sup>12</sup>The only exceptions are the break up of East Coast State Railways in 1900 and the re-organization of Madras, Southern Mahratta and South Indian Railways in 1908. East Coast Railway began operations in

this our ‘joint’ panel of railways. By following a consistent joint panel of 20 railway systems, mergers are less likely to confound our results on state ownership. As a robustness check, we also follow a ‘solo’ panel of railways where each system enters as a separate observation even if it goes on to merge to another system in future years.

We use information from the Reports on the timing of state takeovers to construct an indicator variable for state ownership, which switches to one in the first year the state becomes an owner of the main railway and remains one for the rest of the time period. The main lines on average represent the majority of total mileage but our railway systems also include a small mileage of lines that may be under different ownership from the main line. As a robustness check, we also construct the fraction of miles within a system that are state owned.

We focus on two measures of total factor productivity (TFP). Our first TFP measure is the commonly used Index Number approach where TFP is the difference between output growth and a weighted average of the growth of the inputs namely capital, labor and fuel. The weights are the share of total costs paid to each input. We do not observe these cost shares but the Reports suggest working costs accounted for 45 percent of total revenues on average from 1882 to 1912, implying 55 percent of revenues were paid to capital. We rely on evidence from the East Indian Railway to determine the split between labor and fuel where labor costs were two-thirds of working expenses (Derbyshire 1987). This implies a capital cost share of 0.55, labor 0.3, and fuel 0.15. These shares are in line with historical studies on railway productivity.<sup>13</sup>

The Index Number method assumes constant returns to scale and perfect competition that are perhaps problematic assumptions in the railway context because many railways could be operating as monopolies in their geographic location and may exhibit scale economies. Hence, we also use TFP estimates derived from regression analysis. The main concern in parametric estimations of TFP is generating unbiased estimates of input elasticities. If input choices are correlated with unobserved productivity shocks, then the coefficients on the input elasticities are likely to be biased. One solution to this problem is the Levinsohn and Petrin (2003) estimator, which assumes the capital stock is determined by the previous period’s investment decision and hence is uncorrelated with unobserved productivity shocks in the current period. The LP method is appropriate for our setting because railway cap-

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1895. In 1900, part of the railway was merged with Madras and another section was merged with Bengal Nagpur making it difficult to accurately assign the pre-merge information.

<sup>13</sup>For example, Crafts, Mills, and Mulatu (2007) assume a 0.63 share for capital, 0.34 for labor, and 0.03 for fuel on British railways. Fishlow (1966) assumes shares of 0.52, 0.38, and 0.1 for capital, labor, and fuel respectively on U.S. railroads.

ital clearly evolved from investment decisions made in prior years. We first estimate the coefficients on capital, fuel and labor using the LP approach, and then calculate the log of individual railway TFP as follows:

$$tfp_{it} = y_{it} - (\hat{\alpha}_0 + \hat{\alpha}_l l_{it} + \hat{\alpha}_k k_{it} + \hat{\alpha}_m m_{it})$$

where  $\hat{\alpha}$ 's are the estimated parameters. In addition to these two measures of TFP, we study the effects of state ownership on partial productivity measures namely capital, fuel and labor productivity, investment, the capital-labor ratio and average passenger and freight fares (the sum received for carrying one passenger one mile or one ton of goods one mile).<sup>14</sup>

Table 1 reports summary statistics for the main variables in the joint panel. TFP is the most important and it increased rapidly for most railways. To illustrate the trend figure 2 shows an index of the output-weighted average of railway TFP in each year beginning in 1874. Industry TFP was very volatile in the late 1870s on account of the severe famines in 1877 highlighting how macro events influenced railways. Average TFP growth changes from being stagnant in the 1890s to accelerating at a very fast pace in the 1900s. While these productivity gains were evident for most railways, there were important differences in levels across railways as reflected by the standard deviation in table 1.

Another important variable is the indicator for state ownership. Figure 3 shows the fraction of total railway miles in our sample by ownership. While guaranteed companies accounted for most of the total mileage in the 1870s at over 90 percent in 1874, their share declined to 0 by 1908 when the last guaranteed company (Madras Railway company) was taken over. As private guaranteed mileage decreased, there was a parallel increase in Government of India owned mileage from less than 10 percent in 1874 to over 70 percent by 1912. The remaining miles were owned by a small number of second generation private assisted companies formed in the 1880s and 1890s accounting for less than 10 percent by 1912. Finally, the Princely State owned railways accounted for just over 10 percent of the mileage by 1912.

## 5 Empirical Framework

Much of the recent literature on ownership and firm performance has studied the transition to private ownership because many countries have moved away from state owned enterprises to private firms over the last three decades. These studies of privatization encompass firms in post Communist transition economies (review by Estrin et al. 2009), in Latin American countries (Anuatti-Neto et al. 2004, Galiani et al. 2004) and even in China where state

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<sup>14</sup>The data on fares are reported from 1880-1912.

firms have adopted elements of private ownership (Li 1997, Dong, Putterman and Unel 2006). The early works in this literature were cross-sectional comparisons between private and state owned firms controlling for other factors influencing productivity and ownership. But, omitted variables were an important concern because private firms are likely to differ from state firms in many observable and unobservable dimensions.

Beginning with the work of Megginson, Netter, and Randenborg (1994), studies compared the pre and post privatization performance of firms. Akin to a single difference, this method exploits the change in ownership within a firm. The main concern with these studies is the lack of an appropriate control group with which to compare the performance of privatized firms. One solution is to exploit panel data on firms that undergo privatization and those that do not over the same time period, i.e., a difference-in-difference approach. Although an improvement, the main concern with the difference-in-difference approach is endogeneity in the timing of private takeover. States may privatize firms whose performance is likely to change in the future. For example, they may privatize firms that are expected to become more productive because it would yield a higher sale price. Such situations create identification problems making it difficult to identify the effects of ownership. Our institutional setting allows us to address this key issue.

We begin by implementing a simple reduced form framework as shown below.

$$y_{it} = \alpha + \beta StateOwnership_{it} + \delta_i + \gamma_t + \lambda_i Year + \varepsilon_{it}$$

Here  $y_{it}$  captures railway level outcomes such as TFP (IN or LP), partial input productivities, investment, the capital-labor ratio and fares. *StateOwnership* is a dummy for when private railways came under Government of India ownership. Our panel of railways includes both switchers and non-switchers that remain state owned or native state owned throughout the period of study. Thus, in our joint panel we are comparing the average change in performance for 8 switchers relative to 12 non-switchers. We also include a robust set of fixed effects. We exploit within railway variation by including railway fixed effects,  $\delta_i$ . We control for annual macro-economic or other temporal shocks that may influence railways in the same manner by including year fixed effects,  $\gamma_t$ . We also include interaction terms between a time trend and a dummy for each railway,  $\lambda_i Year$ , to control for unobservable trends at the railway level. If the Government of India happened to purchase private lines when their productivity was trending up or down, the coefficient on state ownership would be biased. Including railway specific trends allows us to identify the effects of state ownership by comparing deviations in TFP from the railway trend before and after the change to state ownership within a railway system. Lastly, the standard errors are clustered at the railway level to address potential serial correlation in the data.

Our institutional background offers two key advantages vis-à-vis identifying the effects of ownership. First, the state took over all the original private guaranteed companies, which reduces selection concerns that the state was taking over only the most profitable companies. Second, the Government could not time the takeovers to periods of low or high productivity because the takeover dates were determined decades in advance. The Government could only takeover firms on the 25<sup>th</sup> or 50<sup>th</sup> anniversary of their original contracts. This institutional feature marks a significant improvement over most studies in the literature where the endogeneity in the timing of ownership changes is suspect. But, it also raises concerns that private firms could have anticipated and reacted in advance to state takeovers. To investigate such anticipation effects, we estimate the dynamics of state ownership by interacting a dummy for state ownership with a three-year bin before takeover. We focus on the three year window because the price at takeover was determined by the average stock price of the railway over the three years before takeover. Private railways were taken over in different years during our period of study and so we observe them for a different number of pre and post years. Fortunately, we observe all the railways for three years pre and post takeover, which ensures we are studying a balanced panel during those windows. We also investigate differences between the short and long run dynamics of state takeovers by interacting state ownership with a three year window after takeover including the year of takeover plus one and two years after takeover (short run effect), and with years three and beyond after takeover (long run effect).

## 6 Results

### 6.1 TFP and Partial Productivity

Table 2A presents our first set of results on the relationship between state ownership and productivity in the long run. Panel A captures the change in ownership with a simple dummy variable for when majority of the mileage came under Government ownership. We find no significant long run negative effect of state ownership on either measure of total factor productivity. The coefficient on state ownership in the case of TFP-LP is very close to zero: a positive and insignificant effect of 0.4 percent following state takeovers. Since the Levinsohn-Petrin TFP estimate addresses any potential endogeneity of input choices, we prefer LP to the Index Number estimate. That said, we present results on both TFP measures to highlight that our findings are similar regardless of the metric used. In the case of TFP-IN, the coefficient on state ownership suggests a negative effect of -2.4 percent, but is statistically insignificant. Most privatization studies find a positive effect on firm

performance on the order of 20 percent following a switch to private ownership. Applying these findings to a nationalization suggests state ownership should reduce firm performance by 20 percent on average. Even the lower end of the 95 percent confidence interval on our state ownership coefficients does not produce negative effects of that magnitude. Rather, state ownership in the worst case could have reduced TFP by -13 percent (TFP-IN) or -7 percent (TFP-LP) in our context (the lower end of the 95 percent confidence interval on the estimates presented in table 2A).

Mirroring the results on TFP, we find no significant effects of state ownership on labor, capital or fuel productivity. In fact, the coefficient on state ownership is positive but insignificant for labor productivity contrary to the findings of many privatization studies where a change from state to private ownership improves labor productivity.<sup>15</sup> The coefficient on fuel productivity is small and insignificant, while that on capital is negative but insignificant. Panel B uses the fraction of state owned miles to measure the switch in ownership and essentially finds the same results. An increase in the fraction of state owned miles has no significant negative effect on either TFP or partial productivity of labor, capital and fuel.

Since state takeovers in a few cases were immediately followed by important railway mergers, we prefer the joint panel because it maintains a constant unit of analysis and therefore separates the effects of state ownership from mergers. But, as a robustness check we replicate the analysis from table 2A on the solo panel of railway systems. These results are presented in table 2B. The coefficients on state ownership are slightly larger but never significant, and confirm our main findings of no negative effects of state ownership on productivity. We have subjected the findings to many robustness checks such as weighted regressions and alternate estimates of TFP, but state ownership never has a significant negative effect on productivity.<sup>16</sup>

Although tables 2A and 2B establish state ownership of Indian railways did not reduce productivity on average following takeovers, the exercise does not reveal anything about the short and long run dynamics. Such dynamics are relevant for two reasons. First, it is possible state ownership has differential effects on productivity depending on the time horizon. If a state struggles to manage newly acquired enterprises in the short run, productivity may be negative in the years immediately following a takeover. But, if a state overcomes these challenges, productivity may return to or even exceed pre takeover levels in the long run. These two effects could offset each other leading to an insignificant average effect. One could also imagine the opposite scenario.

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<sup>15</sup>For example, Ramamurti (1997) estimates that labor productivity increased by 370% following the privatization of Argentine railways in the early 1990s.

<sup>16</sup>These results are available upon request.

Second and more importantly, firms can anticipate ownership changes and react to them before a takeover (Brown, Earle and Telegdy 2006). The Government of India could not time takeovers but companies could anticipate the takeover and respond in the preceding years. Anticipation effects complicate the interpretation of state ownership. If firms begin responding to a potential takeover 2 to 3 years prior to the actual takeover, then we may want to compare the TFP under state ownership to TFP some years prior to takeover.

To test for dynamics, figure 4 plots the coefficients on state ownership interacted with -3, -2, -1 years before takeover and 1, 2 and 3 years after takeover. These coefficients are from the loaded regression, which includes railway FE, year FE and railway specific trends. We focus on the three year before and after window because we observe all the switching railways in this period and so our panel is balanced. The coefficients are all insignificant as seen by the wide confidence intervals. TFP did not change significantly in the years before and after a state takeover. It hovers around zero, increasing slightly in the years up to takeover and then decreasing slightly in the years after.

Table 3 presents results on such dynamics creating bins for the three years before takeover, for the year of takeover plus the next two years, and a final bin for years 3 or more after takeover. We find no significant difference between the short run and long run effects of state ownership. For example, in the case of TFP-LP the coefficients are small and insignificant in both cases. The coefficients on the three year window before takeover are also insignificant for the most part. There is a mild anticipation effect for TFP-IN but this does not change the findings on state ownership post takeover. Broadly, these results suggest state ownership did not have differential effects in the short run and anticipation effects are not driving the findings.

There may be some concern that we are not picking up any anticipation effects because they were relevant for only a few firms. Based on the institutional history, we believe only certain firms could have anticipated state takeovers with a reasonable amount of certainty. The East Indian was the first company acquired by the Government of India in 1879 and a lot of uncertainty surrounded this takeover (Huddleston 1906). Firms such as Eastern Bengal, Sind, Punjab and Delhi, Oudh and Rohilkhand, and South Indian were in the next set of takeovers in the 1880s shortly after the East Indian. Similar to the East Indian, it was still unclear if the Government was going to takeover these companies or adopt an alternate policy. However, after these takeovers in the 1880s, the Great Indian Peninsula, Madras, and Bombay, Baroda & Central India Railways were less uncertain about their future when their contracts came due in the 1900s. Recall these three railways were associated with the 1869 deal with the Secretary of State. We would expect anticipation effects to be most

relevant for this group of railways because their probability of takeover was high given the Government's past behavior.

To test whether anticipation effects were indeed larger for the 'Deal 1869' railways, we interact a dummy for these three systems with the same before and after bins as in table 3. We find no evidence of a significant differential anticipation effect for these firms in the three years before takeover (see table 4).<sup>17</sup> Moreover, there are no differential effects of state ownership on TFP for this group. There is one interesting difference between railway systems purchased in the 1870s and 1880s versus in the 1900s. In the former, capital productivity declines substantially in the first three years after takeover, but for the latter capital productivity does not decline and even shows a positive trend (albeit insignificant). It is possible that early takeovers caused more disruptions to capital, but there was some learning which minimized the later effects.

## 6.2 Investment, Capital-Labor Ratio and Fares

We explore the effects of state ownership on other indicators of railway operations in this sub-section. One explanation for why state ownership of Indian railways did not negatively influence productivity is perhaps because Government actions under state ownership were similar to those under private ownership. To assess this conjecture, we test whether the change to state ownership changed investment decisions, the mix of capital to labor, and average fares to transport passengers and freight.

Panel A in table 5 presents the results on the long run effects of state ownership for both the solo and joint panels. In the solo panel of railways, we find investment increased on average under state ownership. This increase is driven by key mergers that occurred in the years immediately following state takeovers. We find no significant effect of state ownership on investment in the joint panel, which accounts for mergers by joining the information of pre-merged lines in the years before they merge. Thus, the Government of India increased investment via mergers under state ownership but this did not negatively influence productivity. One might expect that the increase in scale that we observe in the solo panel after state takeovers contributed to higher TFP. But, it did not because we observe similar results on TFP across the solo and joint panels (see tables 2A and 2B). The reason is that Indian railways did not exhibit economies of scale in this period. Our estimates of the railway production function do not reject constant returns (see Bogart and Chaudhary

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<sup>17</sup>There is weak evidence for an absolute anticipation effect for GIPR, Madras and BB&CI railways in the solo panel. The sum of the dummy variables for state ownership and the interaction with deal of 1869 railways is negative and marginally significant at the 10 percent level but only in the three years prior to takeover.

2013).

Specifications 3 and 4 focus on the capital-labor ratio. Here we observe a large, positive and significant effect of state ownership in both panels. Under Government ownership, capital-labor ratios increased by 10 percent in the joint panel. This effect is not driven by anticipation effects as seen in the dynamic specifications (panel B) and is not a short run phenomenon. The coefficient on state ownership 3 or more years after takeover is large and statistically significant (specification 4). We know from earlier work (Bogart and Chaudhary 2012) that labor conditional on fixed inputs (miles, locomotives and vehicles) declined under state ownership in India. These findings on the capital-labor ratio match those results.

It may come as a surprise to many readers that the growth rate of capital outpaced the growth rate of labor under Government ownership. Many privatization studies find that capital-labor ratios increase under private ownership contrary to our results here (see the review by Guriev and Megginson 2007). But, as noted in previous sections, the Government of India represented the interests of a colonial state and was not accountable to the Indian population. Similar to private firms, the state could hire and fire labor without political repercussions at least in our period of study. This may account for why the Government chose not to increase labor relative to capital unlike recent governments that are often beholden to labor unions for political power. The larger conclusion is Indian railways under state ownership did not function exactly as under private ownership, but this change in the capital-labor mix had no detrimental effect on TFP.

Specifications 5 to 8 test the effects of ownership on average passenger and freight fares. Similar to the findings on productivity, we find no significant change in fares following the transition to state ownership. The coefficients on state ownership, especially in the joint panel, are small in magnitude and statistically insignificant. Accounting for anticipation effects or dynamics in panel B does not change the picture. The contracts with the guaranteed companies stipulated that firms could set fares only within Government approved minimum and maximum guidelines. It may well be the case that such guidelines forced companies to charge fares similar to what the Government would have charged. The qualitative literature suggests average fares in India were higher than in other parts of the world (Sweeney 2011), but there is no discussion of whether fares under Government ownership were different than under private. Overall, the findings from table 5 suggest the Government made no changes in certain areas such as fares (perhaps because fares under private ownership already reflected state objectives), but did introduce changes in other areas such as the balance of capital to labor without any effect on TFP. Governments can achieve the same productivity as private firms without necessarily following the same blue print.

## 7 Conclusion

A large literature in economics has debated the appropriate ownership structure of firms with the theoretical literature largely highlighting the negative effect of state ownership on productive efficiency. In this paper, we use history to examine a context where identification is more robust compared to other contexts. Our results show there was no negative effect of Government of India ownership on railway TFP, or capital and labor productivity. Government ownership increased the operating scale of railway systems and contributed to a more capital intensive operation of railways, but neither of these changes negatively influenced TFP. The results may appear surprising to some readers in view of standard models of public and private ownership. But, they are consistent with a small number of empirical studies that find limited evidence of negative effects of state ownership.

Two key features of the Indian context are important for understanding our results. First, the Government of India had strong fiscal incentives to maintain the productivity of railways and their colonial authority allowed them to enact changes similar to private companies. The Government was not encumbered by constituent demands for high employment and redundant services. Although it is certainly not a model for development, the Government's structure was not inconsistent with a productive operation of state-owned railways. A broader lesson is that the efficacy of state ownership often depends on institutions. Under some conditions state owned firms can operate like private firms and create similar incentive structures for employees.

Second, private railways in India were regulated and subsidized through guarantees. The high-powered incentives often associated with private ownership were weakened in India. Despite our historical lens, the Indian model of private ownership with subsidies is not exceptional in industries with heavy capital investment. For example, government subsidies and guarantees are common when the private sector plays a role in infrastructure provision. Foster and Yepes (2006) find that in a worldwide sample of 132 water utilities, 39 percent rely entirely on subsidies and another 30 percent only partially recover their operating or capital costs through user-fees. Foster and Briceno-Garmendia (2009) estimate that in Sub-Saharan Africa the electricity sector recovers 75 percent of its costs from user-fees and the water and sanitation sector recovers about 64 percent of its costs. Just last month, Britain agreed to a multibillion subsidy to a foreign company to construct its first nuclear power plant (Wintour 2013).<sup>18</sup> As quoted by journalist Patrick Wintour, "The guaranteed subsidies promised by the government for Hinkley Point C will lead to accusations that ministers are

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<sup>18</sup>See <http://www.theguardian.com/environment/2013/oct/20/nuclear-power-station-hinkley-edf>

loading a further cost on spiralling energy prices by again requiring British taxpayers to subsidise nuclear power. The coalition counters that similar subsidies are going to other carbon-free industries such as renewables and that the country needs the energy security and steady base load that nuclear provides.”

In the historical railway era and today, government guarantees arise because contracts are incomplete and private firms will require some insurance against demand risk before investing. The downside is such guarantees encourage moral hazard problems and can lead to poor operational performance. In many industries, like railways, the debate is not between a theoretical public or private firm in an unregulated market, but rather between state ownership and private ownership with subsidies and regulation. In these settings, private ownership is perhaps less productive than say in manufacturing where firms are less likely to be compensated with subsidies. In conclusion, we believe the debate on the appropriate organizational form for efficiency will likely continue as theory and empirics are suggesting that private ownership with government assistance can yield better or worse performance in different informational and institutional environments.

## References

1. Anuatti-Neto, Francisco, Milton Barossi-Filho, A. Gledson De Carvalho and Roberto Brás Matos Macedo. 2004. “Costs and Benefits of Privatization: Evidence from Brazil,” In *The Truth about Privatization in Latin America*, edited by Alberto Chong and Florencio López-de-Silanes. Stanford University Press.
2. Auriol, Emmanuelle, and Pierre M. Picard. 2009. “Infrastructure and Public Utilities Privatization in Developing Countries.” *World Bank Economic Review*, 23(1): 77–100.
3. Bell, Horace. 1894. *Railway Policy of India: With Map of Indian Railway System*. Irvington: Percival.
4. Besley, Tim and Maitreesh Ghatak. 2001. “Government versus Private Ownership of Public Goods,” *Quarterly Journal of Economics*, 116 (4): 1343–1372.
5. Bogart, Dan. 2010. “A Global Perspective on Railway Inefficiency and the Rise of State Ownership, 1880-1912.” *Explorations in Economic History*, 47 (2): 158-178.
6. Bogart, Dan and Latika Chaudhary. 2012. “Regulation, Costs, and Ownership: A Historical Perspective from Indian Railways,” *American Economic Journal: Economic Policy*, 4 (1): 28-57.

7. Bogart, Dan and Latika Chaudhary. 2013. "Engines of Growth: The Productivity Advance of Indian Railways," *Journal of Economic History*, 73 (2): 340-371.
8. Boycko, Maxim; Andrei Shleifer, and Robert W. Vishny. 1996. "A Theory of Privatization," *Economic Journal*, 106: 309-19.
9. Brown, J. David, John S. Earle, and Almos Telegdy. 2006. "The Productivity Effects of Privatization: Longitudinal Estimates from Hungary, Romania, Russia, and Ukraine," *Journal of Political Economy*, 114 (1): 61-99.
10. Caves, Douglas W. and Laurits R. Christensen. 1980. "The Relative Efficiency of Public and Private Firms in a Competitive Environment: The Case of Canadian Railroads," *Journal of Political Economy*, 88 (5):958-976.
11. Claessens, Stijn, and Simeon Djankov. 2002. "Privatization Benefits in Eastern Europe." *Journal of Public Economics*, 83(3): 307–24.
12. Crafts, Nicholas, Terence C. Mills, Abay Mulatu. 2007. "Total factor productivity growth on Britain's railways, 1852–1912: A reappraisal of the evidence." *Explorations in Economic History*, 44 (4): 608–634.
13. Derbyshire, Ian. 1987. "Economic Change and the Railways in Northern India, 1860-1914." *Modern Asian Studies*, 21 (3): 521-545.
14. Djankov, Simeon, and Peter Murrell. 2002. "Enterprise Restructuring in Transition: A Quantitative Survey." *Journal of Economic Literature*, 40(3): 739–92.
15. Dong, Xiao-yuan, Louis Putterman, and Bulent Unel. 2006. "Privatization and Firm Performance: A Comparison between Rural and Urban Enterprises in China." *Journal of Comparative Economics*, 34(3): 608–33.
16. Eichengreen, Barry. 1995. "Financing Infrastructure in Developing Countries: Lessons from the Railway Age." *World Bank Research Observer*, World Bank Group, vol. 10(1), pages 75-91, February.
17. Engel, Eduardo, Ronald Fischer and Alexander Galetovic. Forthcoming. "The Basic Public Finance of Public-Private Partnerships." *Journal of the European Economic Association*.
18. Engel, Eduardo, Ronald Fischer and Alexander Galetovic. 2009. "On the Efficient Provision of Roads." [http://cowles.econ.yale.edu/~engel/pubs/efg\\_efficient-prov.pdf](http://cowles.econ.yale.edu/~engel/pubs/efg_efficient-prov.pdf).

19. Estache, Antonio, and Liam Wren-Lewis. 2009. "Toward a Theory of Regulation for Developing Countries: Following Jean-Jacques Laffont's Lead." *Journal of Economic Literature*, 47(3): 729–70.
20. Estache, Antonio (2010). *Infrastructure Finance in Developing Countries: An Overview*, EIB Papers, European Investment Bank, Economics Department.
21. Estrin, Saul, Jan Hanousek, Evžen Kočenda and Jan Svejnar. 2009. "The Effects of Privatization and Ownership in Transition Economies." *Journal of Economic Literature*, 47 (3): 699-728.
22. Fang Feng, Qian Sun, Wilson H.S. Tong. 2004. "Do government-linked companies underperform?" *Journal of Banking & Finance*, 28 (10): 2461-2492
23. Fishlow, Albert. 1966. "Productivity and Technological Change in the Railroad Sector, 1840-1910" in *Output, Employment, and Productivity in the United States after 1800*. Ed. Dorothy S. Brady. New York: National Bureau of Economic Research.
24. Foster, V. and Briceno-Garmendia, C. (eds.) 2009. *Africa Infrastructure Country Diagnostic*, The World Bank, Washington, D.C.
25. Foster, V. and Yepes, T. 2006. "Is Cost Recovery a Feasible Objective for Water and Electricity? The Latin American Experience". Policy Research Working Paper No. 3943, The World Bank.
26. Galiani, Sebastián, Paul Gertler, Ernesto Schargrotsky and Federico Sturzenegger. 2004. "The Benefits and Costs of Privatization in Argentina: A Microeconomic Analysis," In *The Truth about Privatization in Latin America*, edited by Alberto Chong and Florencio López-de-Silanes. Stanford University Press.
27. Government of India. 1882-1912. *Administration Report on the Railways in India*. Calcutta: Superintendent Government Printing.
28. Government of India. 1860-1881. *Report to the Secretary of State for India in Council on Railways in India*. Calcutta: Superintendent Government Printing.
29. Government of India. 1955. *History of Indian Railways Constructed and In Progress; Corrected up to 31 March 1955*. Delhi: Ministry of Railways (Railway Board).

30. Guriev, Sergei and William L. Megginson. 2007. "Privatization: What Have We Learned?" In Bourguignon, Francois, and Pleskovic, Boris, ed. *Beyond Transition. Proceedings of the 18th ABCDE*, World Bank.
31. Hart, Oliver, Andrei Shleifer, and Robert Vishny. 1997. "The Proper Scope of Government: Theory and an Application to Prisons," *Quarterly Journal of Economics*, 112 (4): 1119–1158.
32. Huddleston, George. 1906. *History of the East Indian Railway, Volume 1*. Calcutta: Thacker, Spink, and Co.
33. Hurd, John and Ian J. Kerr. 2012. *India's Railway History: A Research Handbook*. Brill Academic Publishers, Inc.
34. Jones, Derek C., and Niels Mygind. 2002. "Ownership and Productive Efficiency: Evidence from Estonia," *Review of Development Economics*, 6(2): 284–301.
35. Kerr, Ian. 1983. "Constructing railways in India—an estimate of the numbers employed, 1850–80." *Indian Economic and Social History Review*, 20 (3): 317–341.
36. Kerr, Ian. 2007. *Engines of Change: The Railroads that Made India*. Westport: Praeger.
37. Kole, Stacey R. and J. Harold Mulherin. 1997. "The Government as a Shareholder: A Case From the United States," *Journal of Law and Economics* 40 (1):1–22.
38. Kornai, János, Eric Maskin, and Gerard Roland. 2003. "Understanding the Soft Budget Constraint." *Journal of Economic Literature*, 41(4): 1095–1136.
39. Laurin, Claude, and Yves Bozec. 2001. "Privatization and Productivity Improvement: The Case of the Canadian National," *Transportation Research Part E: Logistics and Transportation Review*, 37(5): 355–74.
40. Levinsohn, James and Amil Petrin. 2003. "Estimating Production Functions using Inputs to Control for Unobservables." *Review of Economic Studies*, 70 (2): 317–342.
41. La Porta, Rafael, and Florencio Lopez-de-Silanes. 1999. "The Benefits of Privatization: Evidence from Mexico," *Quarterly Journal of Economics*, 114(4): 1193–1242.
42. Li, Wei. 1997. "The Impact of Economic Reform on the Performance of Chinese State Enterprises, 1980–1989," *Journal of Political Economy*, 105 (5):1080–1106.

43. Martimort, D. 2006. "An Agency Perspective on the Costs and Benefits of Privatization," *Journal of Regulatory Economics*, 30: 5-44.
44. Megginson, William, Robert Nash and Matthias van Randenborgh. 1994. "The Financial and Operating Performance of Newly Privatized Firms: An International Empirical Analysis." *Journal of Finance* 49: 403-452.
45. Megginson, William L. and Jeffrey M. Netter. 2001. "From State to Market: A Survey of Empirical Studies on Privatization." *Journal of Economic Literature*, 39 (2):321-389.
46. Ramamurti, Ravi. 1997. "Testing the Limits of Privatization: Argentine Railroads," *World Development*, 25: 1973-93.
47. Roberston, Thomas. 1903. *Report on the Administration and Working of Indian Railways*. London: Darling & Son.
48. Roy, Tirthankar. 2011. *The Economic History of India 1857-1947*. New Delhi: Oxford University Press.
49. Sanyal, Nalinksha. 1930. *Development of Indian Railways*. Calcutta: University of Calcutta.
50. Sappington, David E.M. and Joseph E. Stiglitz. 1987. "Privatization, Information and Incentives," *Journal of Policy Analysis and Management*, 6 : 567-82.
51. Shleifer, Andrei. 1998. "State versus Private Ownership," *Journal of Economic Perspectives*, 12 (4): 133-150.
52. Shirley, Mary M., and Patrick Walsh. 2000. "Public versus Private Ownership: The Current State of the Debate," World Bank Policy Research Working Paper 2420.
53. Sun Qian and Wilson H.S. Tong. 2003. "China's Share Issue Privatization: The Extent of its Success," *Journal of Financial Economics*, 70:183-222.
54. Sweeney, Stuart. 2011. *Financing India's Imperial Railways, 1875-1914*. London: Pickering.
55. Syverson, Chad. 2011. "What Determines Productivity?," *Journal of Economic Literature*, 49 (2): 326-65.

56. Thorner, Daniel. 1977. *Investment in Empire: British Railways and Steam Shipping Enterprise in India 1825-1949*. Philadelphia: University of Pennsylvania Press.
57. Van Biesebroeck, Johannes. 2008. "The Sensitivity of Productivity Estimates: Revisiting Three Important Debates." *Journal of Business and Economic Statistics*, 26 (3): 311-328.
58. Villalonga, Belen. 2000. "Privatization and Efficiency: Differentiating Ownership Effects from Political, Organizational and Dynamic Effects," *Journal of Economic Behavior and Organization*, 42: 43-74.

Figure 1: Map of India, 1870

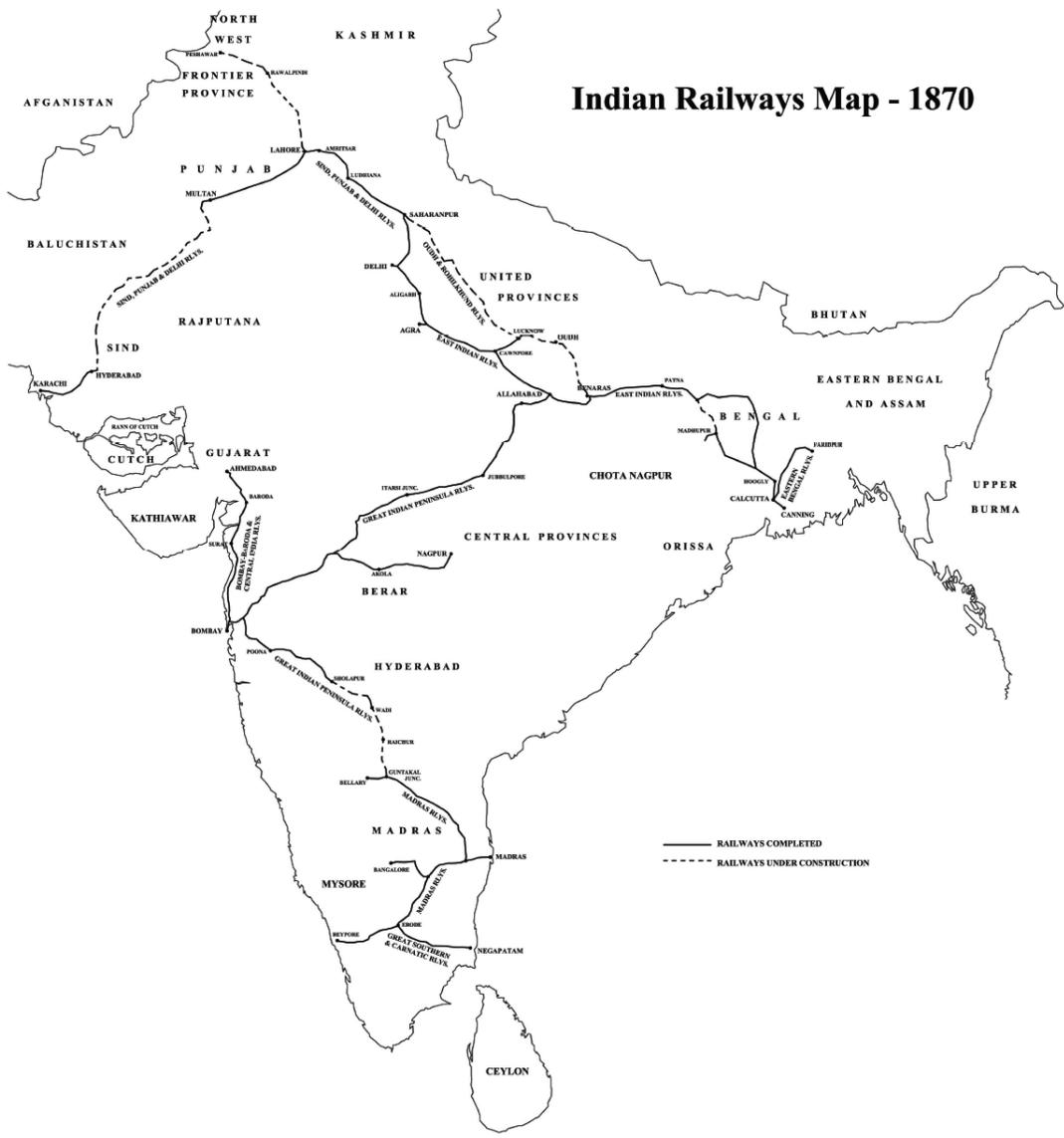


Figure 2: TFP Industry Index, 1874-1912 (1874=100)

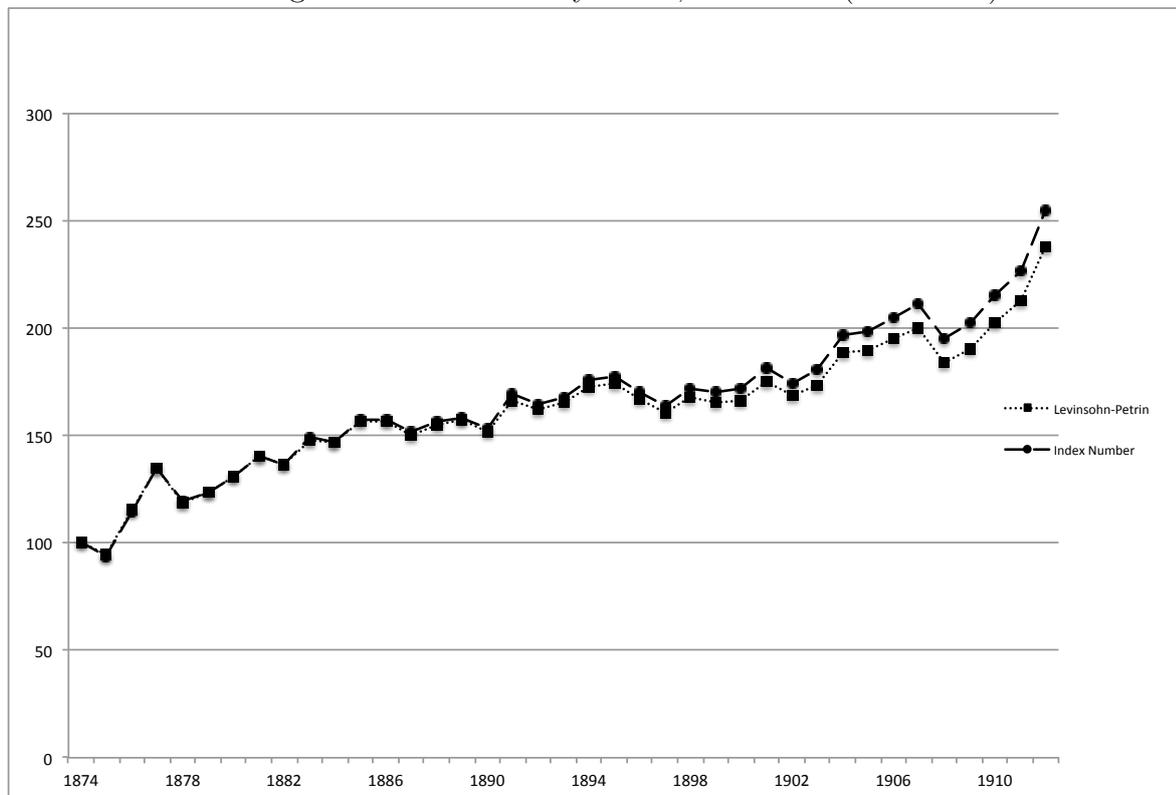


Figure 3: Mileage by Ownership, 1874-1912

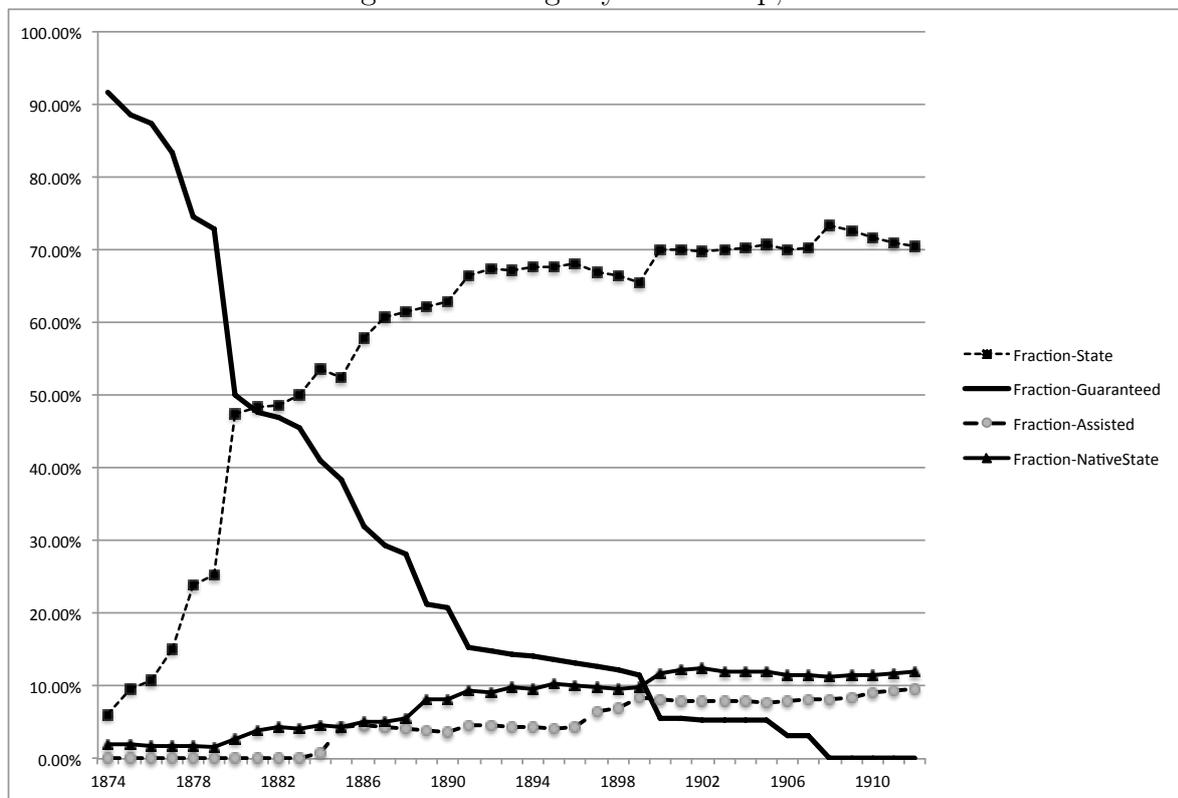


Figure 4: Dynamics of TFP-LP for Switchers 3 years Pre and Post State Takeover

