Chapter 9
Railways in Colonial India: An Economic Achievement?

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1 Introduction

Railways were the most important infrastructure development in India from 1850 to 1947. They were inter-connected with all aspects of Indian society. In terms of the economy, railways played a major role in integrating markets and increasing trade. Domestic and international economic trends shaped the pace of railway construction and the demand for the important traffic flows to the ports. In terms of politics, railways shaped the finances of the colonial government and the Princely States. At the same time, Indian political institutions influenced railway ownership and policy, which in turn influenced railway performance. As the twentieth century progressed, railways became a force for independence and democracy.

In this chapter we focus on the development and organization of the network, the trends in railway performance, the effects of ownership and regulatory policies, and the impact of railways on the Indian economy. A broader historical and social science analysis of Indian railways is beyond the scope of the chapter. For such an approach, we direct the reader to Kerr (2007). We make several general points below. First, the Government of India had a strong influence on railways from the beginning, but the Government's role increased over time. Railways were partially nationalized between 1880 and 1908 as the Government of India assumed a majority ownership stake in the former guaranteed railway companies. Complete nationalization occurred between 1924 and 1947 as the colonial government assumed full control over operations. Second, the performance of Indian railways can be classified into two periods: pre-1920 and post-1920. There was a trend to higher output, productivity, and profits between 1850 and 1919, but after 1920 there was a leveling off. Fares and freight

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charges exhibit similar patterns, declining from 1850 to 1919 and then rising somewhat until 1940. Third, dividend guarantees were a key feature of the early era of private ownership. We argue that guarantees weakened incentives to lower costs, but they also encouraged rapid railway development. We also review the relationship between Government of India ownership and operating efficiency. Perhaps surprisingly there is evidence that state ownership reduced operational costs. The final theme concerns the effect of railways on market integration and national income. There is clear evidence that railways increased market integration and raised incomes, but the magnitude of the effect and the precise mechanisms are still in doubt. There is a larger question as well: could railways have done more to aid Indian economic development?

2 Development of the Network

Before the arrival of railways, the Indian transportation network was poor. Roads were few and poorly constructed with many being inaccessible in the monsoons. Water transportation was limited to the coast and the Indus and Ganga river systems, both important commercial arteries connecting the north to the western and eastern coasts respectively. Unlike the north, river transportation in the south was less reliable because the rivers relied more on rainfall. Thus, transport costs were high outside of the great river systems and the Grand Trunk Road connecting Calcutta to Peshawar. Markets for most bulky goods were small and regional. Only high value to weight luxury goods, like printed cotton textiles, could reach national or international markets (Hurd 1983).

The initial advocates for developing railways were mercantile firms in London and Manchester with trading concerns in India (Thorner 1955). The expectation was railways would lower transport costs and allow English merchants easier access to raw cotton from India. Simultaneously railways would open Indian markets to British manufactured products such as cotton textiles. Neither the railway promoters nor the East India Company envisioned much of a demand for passenger traffic at that time. It was a short-sighted view because passenger traffic would eventually become a major source of revenue. The initial development of the network was slow under the East India Company, but the pace picked up once the British crown took control in 1858.

The first passenger line measuring 20 miles opened in 1853 connecting the port of Bombay to Thana. Subsequent connections from the ports of Calcutta and Madras to the interior opened in 1854 and 1856 respectively. Figure 1 graphs total route miles from 1854 to 1940. The network grew rapidly in the nineteenth century, especially in the 1880s and 1890s. Route mileage increased from 9,308 in 1880 to 24,752 in 1900 representing an average annual growth

rate of 7.5%. The rapid pace of development slowed in the twentieth century and by the 1920s mileage growth averaged 1.3% per year.

By the early 1900s India had the fourth largest rail network in the world. Nonetheless, the scale of the network relative to India's population was not as impressive. For example, Brazil's rail network had six times as many miles per person as India in 1910. Russia had almost three times the rail miles per capita. Within Asia, Japan had a similar number of rail miles per capita as India in 1910, but by 1940 Japan's network had expanded more rapidly. That said, India was far ahead of China in the early 1900s in large part because Chinese rail development was extraordinarily slow.[1]

Maps 1 to 3 illustrate the spread of the network from 1870 to 1930. Lord Dalhousie envisioned the initial route as trunk lines connecting the ports of Bombay, Calcutta and Madras to Delhi in the interior following existing commercial routes. Several different lines traversed the alluvial plains along the Ganga River. While the four major ports were well connected to the interior of the country, there were fewer interior-to-interior connections. Moreover, less developed parts of the country, like the southeast, had very few lines even as late as 1930.

The Government of India (henceforth GOI for short) largely determined route placement, even when private companies constructed the lines. In a famous minute, Viceroy Lord Dalhousie emphasized "[in] the selection of the great trunk lines of railway in India must be first the extent of political and commercial advantages that it is calculated to afford" (Khosla 1988, p. 19). He then laid out projected routes connecting Calcutta to Delhi to the North West Frontier, Bombay to cities in the United Provinces, and Madras to Bombay. Despite the dual aims expressed by Dalhousie, it appears commercial viability dominated military concerns at least until the 1870s. For example, according to Horace Bell, a consulting engineer for the East Indian, "The importance of the railway system in India for military purposes was naturally recognized at the outset, and great stress was laid on this in Lord Dalhousie's minute of 1853. But until the outbreak of the Afghan War, at the end of 1878, no comprehensive views had been taken of the interconnection of our frontier communications, nor any program laid down for railway construction for purely or mainly military objects" (Bell 1894, p. 46). That changed in the 1880s when the GOI merged three railways in the north and decided to manage their operations. These railways were collectively referred to as military lines in official reports. Military and strategic concerns also influenced which cities received railway stations and the placement of stations within cities (Derbyshire 2007). Following the famines of 1877, the GOI advocated an agenda of protective works following the recommendations of the Famine Commission. The Southern Mahratta system in south

[1] Cross-country data on rail network development is from Bogart (2009) and Mitchell (1997).

India and Bengal Nagpur in central India are two examples of railways designed to alleviate famines. Greater emphasis on public objectives is one reason why the rail network grew rapidly in the 1880s and 1890s.

The initial trunk lines were constructed on the standard gauge of 5 feet 6 inches, which was wider than the standard gauge of 4 feet 8 inches employed in much of the United States and Britain. When Indian railways were constructed, the engineering community in Britain favored the broad gauge because it was believed to lower the cost of operating high-volume railways (Puffert 2010). Opinions changed by the 1870s and engineers began advocating the metre gauge (3 feet $3\frac{3}{4}$ inches), which was cheaper to build. The GOI favored the metre gauge for feeder lines connecting to the main trunk lines. New metre gauge systems were also constructed such as the Rajputana Malwa system in the northwest. By 1900, the metre gauge lines comprised 41% of the network compared to 56% on the Indian standard gauge. In yet another break of gauge, many of the small branch lines connecting to the main network in the twentieth century were constructed on narrow gauges (i.e., less than 3 feet).

The initial gauge choice and subsequent break of gauge generated heated debates among the different constituent groups. While it was recognized that a break of gauge was undesirable in many respects, the cheaper construction costs of the metre gauge won out. The long-term economic implications of the mixed gauge network, especially the costs of inter-connection, are believed to have been significant, but more research is needed before a definitive statement can be made.

3 Organization of the Network

The construction and management of the Indian rail network primarily involved private British companies, the GOI and Indian Princely States. The organization can be broken down into four different phases. In the first phase up to 1869, private British companies constructed and managed the trunk lines under a public guarantee. In the second phase, the GOI entered the field constructing and managing state railways in the 1870s. The third phase, beginning in the early 1880s, involved hybrid public-private partnerships between the GOI as majority owner of the lines and private companies in charge of construction and operation. Finally in the fourth phase, the GOI began taking over railway operations beginning in 1924.

Ten private companies incorporated in Britain constructed and managed the early trunk lines (see map of India in 1870). By 1869 there were two mergers, leaving eight major railway companies, namely the (1) East Indian, (2) Great Indian Peninsula, (3) Eastern Bengal, (4) Bombay, Baroda and Central India, (5) Sind, Punjab and Delhi, (6) Madras,

(7) South Indian, and (8) Oudh and Rohilkhand.[2] These companies constructed the major trunk routes connecting the ports to each other and to the interior on the broad gauge.[3]

Private railways were organized as joint stock companies set up via contracts entered into with the Secretary of State for India seated in London. The contracts were enforced and administered by the GOI under the direction of the Governor-General in India. More than 90 percent of the company shareholders were British and almost all the capital was raised through equity rather than debt. The shareholders were represented by a board of directors in London, which included the heads of British companies with interests in India, retired members of the British military and other members of the British financial elite. Railway companies were organized as multi-departmental organizations similar to British railways. A key difference was the role of the 'agent' resident in India. The agent was the general manager and acted as a liaison to the board of directors in London. The agent also hired sub-contractors to carry out the construction (Kerr 1995).

The early contracts establishing Indian railway companies shared common features. The GOI determined the route and gauge. They also had the authority to supervise construction and subsequent operations. The GOI gave companies free land and a 5 percent guarantee on the capital at a fixed exchange rate of 1s. 10d to the rupee. The contracts were valid for 99 years. While the company could hand over the railways to the GOI at any time during the 99 years, the GOI could only purchase the company at 25 or 50 years from the date of the original contract.

The guarantee is arguably the most important and infamous feature of the contracts. It worked as follows. Net earnings (i.e., gross earnings minus working expenses) were paid into the treasury and rebated to the company. If net earnings as a proportion of capital outlay yielded less than the guaranteed return of 5 percent in any year, the Government compensated the company the difference up to 5 percent. Such guarantee payments were treated as debt. When annual net earnings exceeded the guaranteed level, the company was required to repay any past guarantee payments by transferring half of their surplus profits over 5 percent to the Government. After all past guarantee payments were paid off, the company received the entire surplus profits (Bell 1894).

As it turned out, guarantees proved to be quite costly to the GOI. Construction costs on the early lines exceeded expectations and cost almost 20,000 pounds per mile compared

[2]The Great Southern of India and Carnatic railways were merged in 1873. The Calcutta and South-Eastern railway was formed in 1859, but the company surrendered the lines to the GOI in 1868 because of continuos losses. This line was eventually merged with Eastern Bengal when the latter was taken over by the GOI in 1884.

[3]The only exception is the South Indian,which started out on a standard gauge but was subsequently converted to a metre gauge line.

to the initial estimate of 12,000 pounds. The early lines were also unprofitable for several decades (i.e., earned less than 5 percent) because traffic developed slowly and revenues were modest. For example, in 1860 net earnings averaged less than 0.9 percent of capital outlay gradually increasing to 3 percent by 1869. Hence, the GOI was forced to honor the 5 percent guarantee to shareholders and interest payments totaling almost 30 million pounds by 1869 (Hurd 1983). The GOI also incurred losses on account of the fixed exchange rate stipulated in the contracts. In the 1860s and 70s, the rupee was worth no more than 1s. 8d while the contract rate for guarantee payments was 1s. 10d to the rupee. The devaluation amounted to approximately a 10% increase in real payments collected by companies.

It is important to recognize that guarantees were commonly used outside of India during the mid-nineteenth century. In Brazil, Argentina, and Russia, foreign railway companies also received dividend guarantees, but in those cases they were granted by sovereign nations (Eichengreen 1995, Summerhill 2003). Elsewhere the terms of guarantees were similar to Indian railways and in some cases even more generous. In Argentina, for example, the guaranteed rate of return was 7%, compared to 5% in India (Lewis 1983).

Guarantees were not the only form of government intervention in Indian railways. As per the contracts, a GOI representative, appointed by the Secretary of State, sat on company boards and in principle had the authority to veto any decision. The Government also appointed a consulting engineer to approve all construction and operational work. While strong in theory, GOI representatives often found it difficult to implement their preferred policies. According to Thorner, "the railway companies' men did not want to wait for their operations. In practice, they went ahead, did things, and later told the Government what they had done" (2001, p. 84). Few GOI officials had any practical knowledge about constructing and operating railways. In contrast, the companies had more experienced and technically sophisticated workers.

The subordinate authority of the GOI to the Secretary of State is one reason for their limited ability to effectively regulate. Since the Secretary of State was housed in London, he was more susceptible to lobbying by the boards of the private British companies. The companies would appeal to the Secretary whenever they opposed a policy change initiated by the GOI and the Secretary would side with the private companies. In the 1860s, for example, the GOI pressed for a merger among the private railways in southern India. The Madras railway company refused and was successful in getting the Secretary to defeat the merger (Sanyal 1930, p. 63).[4]

[4]Another example relates to a proposal by the Government in 1885 to create a 'clearing house' to settle inter-railway disputes and secure unification and simplification of rates and working. It also failed because of opposition from private companies (Sanyal 1930, p. 181).

The events of 1869 provide another important example of the tensions between the GOI and the Secretary of State. In that year, the Secretary renegotiated contracts with three of the four big private railways, without first consulting the GOI. Company debts on account of past guarantee payments were cleared in exchange for 50 percent of surplus net profits above the guarantee from that point forward. The Secretary also waived the GOI's right to purchase the railways at the 25th anniversary. The GOI opposed the renegotiation because it forgave interest debts just as private companies were beginning to earn profits above 5 percent. Despite the protests of the GOI, the 'deal of 1869' went through as the Great Indian Peninsula, the Bombay, Baroda, and Central India, and the Madras railways accepted the Secretary's offer. The East Indian refused most likely because it was less reliant on GOI support. Such episodes suggest the GOI wanted private companies to be accountable for their guarantee payments and their interests were perhaps more aligned with the Indian taxpayers in this period.

The late 1860s also marked a turning point in new rail construction. 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, Governor-General 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 view became official policy in the 1870s ushering a second phase of railway development. The GOI constructed and operated railway lines using borrowed capital. Government financing was encouraged by favorable financial conditions. Yields on GOI bonds dropped below 4% for the first time in the early 1870s. No new contracts were signed with private companies other than a few minor extensions. Private companies continued to own and operate trunk lines, while the GOI now owned and operated what might be termed secondary lines. Notably, many GOI railways broke from the standard gauge to the smaller metre gauge because of their lower construction costs.

The GOI railway construction phase was short lived. The economic depression of the 1870s coupled with the war in Afghanistan increased the GOI's fiscal burdens and helped to turn the tide against government provision. Moreover, severe famines in 1877 further undermined the cause. The subsequent Famine Commission recommended a rapid extension of railways, which the GOI was unable to achieve because of the annual constraints on

government borrowing. Advocates of private provision capitalized on the Government's economic woes and won their battle in 1879 when the Secretary of State called for an end to the era of GOI owned and operated railways.

In the third phase between 1880 and 1924, the Government assumed greater ownership over railways. Among the former guaranteed companies, the East Indian was the first whose concession contract reached its 25th anniversary in 1879. As the date approached, it was unclear whether the GOI would exercise its takeover option. After negotiations between the board of directors, the GOI, and the Secretary, it was announced that the GOI would purchase four-fifths of the shares in the East Indian and a reconstituted private company controlling the remaining one-fifth of the shares would manage railway operations under a new concession contract for a minimum of 25 years starting in 1880. The profits would be split between the GOI and the reconstituted company in proportion to their respective capital shares. The purchase price was based on the mean market value of the company's stock in the preceding three years and payments were made in the form of annuities (Bell 1894, p. 66-72). The guarantee was retained on the remaining capital stock of the East Indian railway company, but it was lowered significantly to 3 to 4 percent.

The Government used a similar procedure to purchase all the original private railway companies (eight railways in total). A majority were bought on the 25th year of the original contract in 1884, 1886, 1889, and 1891. For the remainder, the GOI exercised the purchase option on the 50th year (Great Indian Peninsula in 1900, Bombay, Baroda and Central India in 1906, and Madras in 1908). There was a delay for the last three railways because of the renegotiated deal of 1869. In five cases, the GOI entered into agreements with directors of the former companies to operate the railways after takeover. The contract terms were similar to the revised concession contract of the East Indian. In three cases the Government chose to operate the railways directly without company assistance. After takeovers the Government chose to operate the Eastern Bengal, Sind, Punjab and Delhi, and Oudh and Rohilkhand railways, but the precise reasons for managing operations were different in each case.[5] The colonial Public Works Department managed the GOI owned lines. Surpluses were paid into the treasury and capital was provided through annual appropriations from the GOI budget. Guarantees were completely eliminated on these railways.

Beginning in the 1880s, any new railway line was organized as GOI owned and privately operated, similar to the five original reconstituted companies taken over by the Government in the 1880's, 1890's and 1900's. But, there was more variation in the contractual terms of

[5]For example, after the takeover of the Sind, Punjab and Delhi, the GOI merged it with two GOI railways and decide to directly manage operations because of the strategic military location of the line. In the case of Oudh and Rohilkhand, the GOI decided to manage operations because the railway had been performing poorly under private management.

these new companies. For example, the Bengal Central received free land and a 5 percent guarantee for 5 years, while Rohilkhand and Kumaon received a 4 percent guarantee during the construction phase and an annual subsidy of Rs. 40,000 for 10 years after construction.[6] Under these schemes, the GOI generally owned a majority of the capital while the companies were entrusted with construction and subsequent operations. In exchange, the companies shared net profits with the GOI in proportion to their respective capital shares. The companies raised the necessary capital, which was guaranteed at lower amounts and often for shorter periods.

There were several railway mergers shortly after the old guaranteed railways were taken over. For example, the Sind, Punjab and Delhi railway was merged with the state owned Indus Valley and Punjab Northern lines to create the Northwestern railway system managed by the GOI. In many cases, these mergers brought large railway lines together with smaller lines. The Great Indian Peninsula railway merged with the Indian Midland railway in 1901, but the Indian Midland railway had less than a third of the traffic of the Great Indian Peninsula. In some cases, the GOI would ask the large systems managing the trunk routes to also manage the operations of the branch or feeder lines in their network for a share of the profits. While these were not technically mergers, the accounts of the principal railway system would often include information on all the secondary lines worked by the principal system regardless of ownership.

By the 1900s the GOI enjoyed greater authority to impose managerial or operational changes without intervention by the Secretary. The Government also had greater experience with railway management because of its direct involvement with railway construction and operation since the 1870s. The GOI organized regular railway conferences, introducing 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. A special committee met regularly to adopt standards, arrange experiments, and publish research (Bell 1894, p. 114). In another development, railways were separated from Public Works and placed under the direct authority of a newly constituted Railway Board in 1905. The board determined future railway policy including extensions of the network, construction of new stated owned lines and managing operations on existing lines. An important goal of this re-organization was "the improvement of railway management with regard both to economy and public convenience" (Moral and Material Progress 1906, p. 132).

Railways served many strategic functions during the First World War. The most important was to carry supplies for the British war effort. The demands of war meant that most major repairs and renewals were postponed till the end of the war. As a result, Indian

[6]See Sweeney (2009) for more details on the Bengal Central.

railways are thought to have been undercapitalized in this period. However, as we show later Indian railways became less capital intensive from the mid-1890s through the 1910s. One general explanation for undercapitalization was that the company operated railways had to secure approval from the GOI for increases in capital outlay and such approvals were not forthcoming. The railway budget was tied to the general budget and hence capital outlays for railways were subject to the general budget conditions.

By the 1920s Indians grew increasing dissatisfied with British private operation of GOI owned railways. Specifically, Indians were unhappy with the quality of third class passenger facilities, the treatment of third class passengers (the most important category of passenger revenues) and the relative under-representation of Indians in upper management railway positions. As the operations contract of the East Indian came up for renewal, the GOI set up a commission chaired by Sir William Acworth to assess the relative advantages and disadvantages of state versus private management of railways. The Acworth Committee Report (1921) made numerous important recommendations that were subsequently adopted by the the GOI. The railways budget was separated from the general GOI budget and given a larger measure of independence in exchange for fixed annual contributions to general revenues. To improve efficiency, the Railway Board was reconstituted with a Chief Commissioner, Financial Commissioner and three other members. The Chief Commissioner was assisted by directors in charge of different operational categories such as traffic and mechanical engineering.

While the Report was unanimous in recommending increases and improvements to railway finances, the Committee did not reach an agreement on the appropriate organization for management. Half the members recommended a complete transfer of railway management to the GOI and the other half recommended transferring the management of the East Indian and possibly Great Indian Peninsula to Indian domiciled private companies. The GOI opted for the former strategy and in 1925 the management of the East Indian was transferred to the GOI. Over the next two decades, the GOI took over operations from all the privately operated railway lines as their contracts came up. The nationalization of Indian railways was complete by Indian independence.

Unlike the earlier periods, labor and passenger issues came to the forefront in the 1920s and 1930s. An additional member responsible for labor issues was appointed as director to the Railway Board in 1928. Labor strikes became more common and the GOI partially responded by offering better dispute resolution, improved working conditions, sick leave and other benefits. But, the GOI was also forced to make significant labor cuts due to calls for retrenchment following the Great Depression. The GOI made efforts to increase Indian workers among the upper level management positions and issued orders for communal rep-

resentation of Muslims and other minorities in 1934. On the passenger side, Local Advisory Committees were created to increase dialogue between the general public and railway administrators. The GOI also created a Railway Rates Advisory Committee to resolve rate disputes between traders and specific railways.

The literature has just begun to analyze the effects of policy changes in the 1920s and 1930s as well as the earlier period. A first step is to establish the general trends in railway performance. We now turn to this topic.

4 The Performance of Indian Railways

4.1 Data Sources

British authorities collected a wealth of data on Indian railways, even surpassing the information collected for British railways. In 1859 an expert on Indian railways, Juland Danvers, published the 'Report to the Secretary of State for India in council on railways in India'. It contained railway line data on investment, employment, traffic, earnings, and expenses among other operational items. The Report was published annually from 1859 to 1883 and was a major achievement in terms of data collection.

In 1884 the GOI began publishing the 'Administration Report on the Railways in India.' It contained the same railway line data and more detailed information on inputs, outputs, revenues, and expenses. The Administration Report was published annually through the 1920s. It provides the most detailed statistics on railway operations. The Administration Report was replaced by the 'Report by the Railway Board on Indian Railways' and was published annually up to 1947.[7] The annual Statistical Abstracts summarize much of the information in these detailed reports.

Historians have begun compiling the data from the Reports but the project is still ongoing. Morris and Dudley (1975) published the first aggregate or industry-level series on Indian railways using the Reports. They list an array of statistics on total miles, capital outlay, employment, passengers carried, and goods carried.[8] Hurd (2007) published some similar series as Morris and Dudley at the railway system level. For example, Hurd's series include passenger miles (i.e., number of passengers carried one mile) for 17 railway systems from 1884 to 1939. We have extended the series on railway systems to include other operational variables including a detailed accounting of working expenses by department and accidents by railway line (Bogart and Chaudhary 2012a).

[7] This series continues up to the 1970's.

[8] Many of their series exclude Burma railways, which were a part of colonial Indian railways until 1936.

As is common with any data series, the Reports have some problems. Morris and Dudley (1975) argue the capital investment series is the most problematic. Construction costs and the purchase of new capital goods such as locomotives were included in capital outlay. But, capital did not include the cost of the land, which was provided free of charge to private companies. In the early decades of railway construction, there was some ambiguity about the types of expenses charged against capital versus working expenses. This led to an official minute in 1864 clarifying the specific expenses to be enumerated in each account. Another accounting change in 1923-24 created a separate depreciation fund to better account for wear-and-tear in the capital numbers. Despite some idiosyncrasies, the capital outlay series is still revealing of the broad trends in capital costs over time. We turn now to a discussion of the performance trends starting with inputs like capital and labor.

4.2 Trends in Inputs, Outputs, and Safety

Capital outlays on all Indian railways increased by a factor of 32 between 1860 and 1939 according to the Morris and Dudley (1975) series. The average annual growth rate of capital was 4.4% over this period. Clearly, capital grew rapidly, but there is a caveat—changes in the price of capital goods are not taken into account. In Bogart and Chaudhary (2012b), we calculate the capital stock for all major railways from 1860 to 1913 using a real investment series. We find that nominal capital outlay understates the capital stock by around 15% in 1913. As a result, the capital stock grew by more than 4.4% per year.

Regardless of the series employed there was a decline in capital investment per route mile from the 1860s to the 1910s. Figure 2 plots real capital outlay per route mile in 1873 rupees between 1860 and 1939. The relatively high capital costs of the 1860s do suggest private companies were not overly concerned with high construction costs. That said, a large number of technically sophisticated bridges were constructed in this period that also increased costs along with the wider, 5 foot 6 inch, gauge. There was a general trend towards lower capital outlays in the late nineteenth and early twentieth century as the GOI became the dominant owner of the lines and cheaper metre gauge lines were introduced. Critics of the GOI ownership and private operation structure often suggest railways were severely undercapitalized in this period because private companies needed GOI authorization for capital outlays that was not always forthcoming. Following the Acworth Committee Report in 1921, railway finances were separated from general fiancees. As figure 2 shows, capital outlays increased from the 1920s. It appears that investment was used to improve the condition of existing lines.

Figure 3 documents the aggregate trends in labor between 1860 and 1939 using the

Morris and Dudley series (1975) supplemented with data from the Statistical Abstracts and Administration Reports. Total employment per route mile and per capital outlay show a similar cyclical pattern. There was a large decline in the 1860s driven by the slowdown in railway construction among the trunk lines. In the 1870s employment increased relative to capital and mileage before declining in the 1880s and 1890s. One factor in the reversal is that many of the former guaranteed companies were taken over by the GOI in this period. Elsewhere we show that the shift to GOI ownership reduced labor inputs relative to capital (Bogart and Chaudhary 2012a). The reduction in labor intensity is one of the surprising effects of state ownership in India. We shall say more on this momentarily. Returning to Figure 3, labor per mile and per unit of capital increased again in the 1900s and 1910s before another stark reduction in the late 1920s. Most of the rise in labor intensity in the 1920s was due to reductions in labor rather than higher capital or route mileage.

While total employment fluctuated, the proportion of non-Indians (largely Europeans) continuously declined falling to just over 2 percent in 1939 after peaking at 8 percent in 1869. Europeans accounted for a small and declining share of railway employment, but they occupied most of the upper management and highly skilled positions. The disproportionate representation of Europeans in these positions was hugely unpopular in India. In the 1920s the GOI finally began to hire and promote more Indians (Kerr 2007).

The third key input, fuel, is not available in any of the published series compiled by historians though information on fuel is in the official reports. The most likely reason is that fuel inputs changed from the 1860s to the 1910s. Initially, British coal and Indian wood were the main fuel sources. But, the Indian coal industry expanded over time and by the First World War Indian coal had supplanted British coal as the primary fuel source. In terms of British thermal units or BTU, Indian coal yielded less energy than British coal and wood was obviously worse than either of the two sources of coal. There was also variation in the BTU of different types of Indian coal. We have constructed a quality adjusted fuel consumption series for most railway systems between 1874 and 1912 (Bogart and Chaudhary 2012b). The data show a substantial growth in fuel. For example, the East Indian's fuel consumption increased by a factor of 4 or average annual growth of 3.7 percent.

Similar to inputs, outputs grew tremendously on Indian railways. The ton mile is the standard measure of output for freight traffic and the passenger mile is the same for passenger traffic. To calculate both it is necessary to know total passengers or tons carried and the average distance travelled. Average distances were recorded for all railway systems starting in 1884. It is possible to estimate average distance travelled for earlier years, but we stick with the published series for ease. Hurd's (2007) series from 1884 to 1939 indicates that freight output increased by a factor of 9.6 and passenger output by a factor of 6.5. The

average annual growth rate was 4.2 and 3.5% respectively. Freight and passenger traffic grew at roughly the same rate until the 1930s when freight traffic far outstripped passenger traffic. However, the proportion of passenger and freight revenues remained constant for most of this period with freight revenues averaging 66% of total revenues between 1884 and 1939 (Hurd 2007).

When outputs grow faster than inputs, productivity must increase. And, this was indeed the case for Indian railways, at least before the 1920s. Passenger and freight output grew by 3.5 and 4.2% respectively between 1881 and 1939. By comparison route miles and employment increased by approximately 2.5% over the same period. Figure 4 shows the trends in freight and passenger output divided by route miles from 1884 to 1939. Output per mile more than doubled from the early 1880s to the 1920s. Over the next fifteen years output per mile fluctuated around the same level. The trends are similar for output per worker. Passenger miles per worker increased by 73% from 1884 to 1919. Ton miles per worker increased by 100% over the same period. Both leveled off in the 1920s and 30s. Based on these series, Indian railways experienced high labor and capital productivity growth from the 1880s to the 1910s. Productivity then stagnated in the 1920s and 1930s.

In Bogart and Chaudhary (2012b) we estimate total factor productivity (TFP) for the pre-1913 period using newly constructed series on capital and fuel. The results imply a healthy growth rate of 2 to 2.6 percent per year. India's TFP growth in railways was better than Britain and most other countries in the nineteenth century. What accounts for the high productivity growth? Since train miles also increased in this period, one may be concerned that the TFP growth is a proxy for an increase in capacity utilization. But, even after controlling for capacity utilization, the TFP estimate remains high with capacity utilization accounting for only 15% of TFP growth on average. Reallocation effects including entry, exit, and changes in market shares across railways, are also not responsible for the TFP growth. Rather, productivity increased within railway lines, especially the major trunk lines. The qualitative evidence suggests Indian railways moved closer to the technology frontier by adopting new technologies such as vacuum brakes, better signal stations and higher capacity wagons in the early 1900s.

The performance of Indian railways stands in stark contrast to the rest of the Indian economy. The annual growth rate of output per worker in agriculture averaged 0.4 percent in the late nineteenth century and 0 percent in the early twentieth century. TFP growth rates for the overall economy were close to zero driven largely by this poor performance of agriculture (Broadberry and Gupta 2010). Perhaps even more surprisingly, Indian railways had a higher average TFP growth rate than British railways in this 38-year period (for British TFP growth see Crafts, Mills, and Mulatu 2007).

Less is known about the causes of the productivity slowdown after the First World War. The collapse of world trade in the 1920s is probably the most immediate explanation for the productivity decline of the 1920s. The productivity of railway track closely tracks the level of demand, which dropped substantially as international markets got into trouble. Other factors were certainly relevant as well. Labor for example might have been shed more quickly in the 1930s as demand fell. More research is needed on the causes of the productivity changes to get a complete picture of the performance on Indian railways under the Raj.

In figure 5, we assess changes in the safety of railway service focusing on the number of injuries and deaths associated with railway related accidents.[9] The trends in safety mirror those for productivity. Accidents and deaths decreased from the 1860s through the 1900s and remained low until the 1920s. Compared to other countries in the early twentieth century, India appears to have a typical or average safety record for railways. However, injuries per passenger increased significantly in the 1920s. While deliberate arson was responsible for some of these injuries, others were due to trains being derailed on account of bad weather, signaling mistakes and accidents in railway yards. Most of these injuries were not fatal because the number of deaths per passenger did not increase. The data on injuries is very detailed in the 1920s and 1930s. But, it is unclear if these new categories of injuries were missing in the pre-1920 series. Future research needs to better account for the increase in injuries, but not deaths.

4.3 Trends in fares, revenues, and profits

In competitive industries one would expect prices to evolve with productivity. But, in regulated industries such as railways, the relationship is less predictable because prices could deviate depending on the decisions of regulators and firms. We examine the trends using Hurd's (2007) series on real average revenue per ton mile and real average revenue per passenger mile from 1884 to 1939. The average revenues per unit provides a reasonable proxy for prices, with the caveat that fares and freight charges often differ by time of purchase and commodity. Thus, there is no single market price even for the same trip.

Figure 6 plots the average revenue per ton mile and passenger mile in real terms from 1884 to 1939. The decline in rates is remarkable. Freight charges in 1919 are 21 percent of their level in 1884. Fares in 1919 are 43 percent of their level in 1884. There was a reversal in trend after 1919. Freight charges and fares rose and by 1939 they had returned to a similar level as the early 1900s. It is notable that the trends in productivity are quite similar to fares and freight charges. Railways could charge lower prices and still earn decent profits

[9] These data series are compiled from the Statistical Abstracts.

because their productivity was rising.

The reduction in railway fares and freight charges prior to 1919 had substantial implications for the Indian economy. International and interregional trade costs decreased substantially, leading to higher exports and domestic trade. As we discuss below, the literature has emphasized the gains that were achieved by railways on the eve of the First World War. However, less attention has been paid to the reversal in freight charges and fares by 1930, and the implications for Indian economic development. We return to these issues below.

Profits were arguably the most important indicator of performance for railway investors and the colonial treasury. Profits are the difference between revenues and operating costs, known as working expenses in the Administrative Reports. 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, traffic and administration expenses. Gross earnings include freight and passenger revenues with the former accounting for 65 percent of revenues on average between 1884 and 1939. To illustrate the trends figure 7 plots real working expenses and gross earnings from 1860 to 1939 (expressed in 1873 rupees). It is clear the value of railway services grew rapidly, as did the cost of providing railway services. Revenues increased by a factor of 128 over the 80 year period, implying an annual average growth rate of 6.2%. The revenue figures also provide an indication of the value of railways services relative to the Indian economy. In 1901 railway revenues were approximately 2.6% of national income using Sivasubramonian's (1997) estimates. By 1919 railway revenues represented 3.2% of national income and by 1939 railways represented 4.9%. Thus railways relative importance in the Indian economy grew with time.

The revenue series also track economic and trade cycles. Revenues peaked in years with good harvests and sharply declined in bad years such as the decline in 1908. Earnings also decreased following the end of the first world war. That combined with the steep rise in working expenses on account of long overdue repairs and renewals caused a sharp decline in net earnings after 1921. Prior to the 1920s the difference between revenues and working expenses was generally growing. Railways were enjoying high profits as a result. The value of net earnings as a percent of capital outlay rose from 3 to 4 percent in the 1860s and 1870s to 5 percent in the 1880s and 1890s. Net earnings peaked towards the end of the War at 7 to 8 percent thereafter dropping to 4 to 5 percent. Initially railways did not pay large returns to investors, but eventually they yielded a very good return.

5 Government Ownership, Policy, and Performance

Railways were a regulated sector throughout their history. As we discussed earlier, railways began under private ownership with dividend guarantees. In the 1880s, 1890s, and 1900s the GOI purchased a majority ownership stake in all the original private railways, which included the major trunk lines. The private sector was not eliminated however as companies continued to operate railways, albeit with lower guarantees. After the 1920s the GOI assumed control over operations as well. What influence did these various ownership and policy changes have on the performance of railways? In this section we address these questions.

The initial public guarantees have been heavily criticized by both contemporaries and subsequent researchers (Sanyal 1930, Thorner 1955, Hurd 1983, Derbyshire 2007 and Sweeney 2011). According to their critics, guarantees were responsible for the high construction costs of the 1860s, the poor performance of the initial lines, the related interest costs imposed on the GOI (and hence Indian tax payers) and the inability of railways to transform the traditional agricultural economy into a modern industrial one. In this view, guarantees were yet another example of colonial policy stifling Indian economic development at the expense of British interests. Government viceroys and officials were among the most vociferous critics in this group. For example, the finance member of the Viceroy's council, S. Laing, contended that guarantees neutralized the advantages of private enterprise because "no adequate motive existed for restraining the outlay on the works" (Bell 1894, p. 65-66). The guarantees exacerbated existing agency problems within companies because most of the shareholders and boards of directors were non-resident. Hence, it was difficult for them to control the resident agents. For example, the agent of the Sind, Punjab, and Delhi railway company was accused of incompetence, nepotism and embezzlement. Several employees were eventually prosecuted in one of the celebrated trials in early Indian railway history (Kerr 2007).

Guarantees clearly undermined private incentives for economy and efficiency, but they *also* allowed for the construction of the first Indian railways. Incorporating the recent literature on infrastructure provision and regulation in developing countries offers a more complete and nuanced picture of the guarantee system. Economists now recognize that infrastructure investments, be it in roads, gas, electricity, or railways, are notoriously difficult to administer, contract and regulate, especially in developing economies (Laffont 2005, Estache and Wren-Lewis 2009). Unlike rich countries that can rely on domestic capital markets to finance projects owned either by the public or private sector, developing economies have to borrow money on international capital markets or attract foreign capital that is often not forthcoming without an implicit subsidy or guarantee. Recent theoretical studies on the contractual foundations of public-private partnerships in infrastructure explicitly emphasize the

need for governments to insure risk-averse private providers because of demand uncertainty (for example, Engel, Fischer and Galetovic 2009, 2010). Though necessary, such minimum income guarantees and related government inducements may weaken incentives to decrease costs and improve efficiency. Thus, governments have to strike the right balance between attracting private capital and minimizing moral hazard by private firms.

The experience of Indian railways in the nineteenth century highlights the same issues. While countries with well developed capital markets such as Britain, France, and Germany raised domestic capital to finance railways, Indian capital markets were too weak to raise sufficient money for such a large infrastructure project. Colonial India had two options: the GOI (or East India Company in the early 1850s) could directly borrow money on international capital markets or the GOI had to attract foreign direct investment, which required an implicit subsidy or guarantee. GOI attempts to raise private capital without a guarantee were unsuccessful for most of the colonial period.[10] Since the GOI was unable to borrow large sums on favorable terms in the 1850s and 60s, guarantees were necessary to attract private foreign capital to India.

The evolution of GOI borrowing costs and guarantees is illustrated in Figure 8. The guarantee is plotted as 5 percent up to 1880 and then 3.5 percent from 1881 to 1940.[11] The evolution of net earnings divided by capital outlay is also plotted for comparison. In the 1860's, railway company earnings were far below the 5 percent guarantee averaging just over 2 percent. The low earnings of private railways could have been influenced by the guarantees, but it is very likely that even without government intervention, rates of return on capital would have been less than 5 percent. Private foreign investment required some type of subsidy. As an alternative the GOI could have borrowed to finance investment, but this policy would not have obviously been better. The public cost of borrowing averaged 4.62 percent in the 1860s and thus was not substantially below the 5 percent guarantee. In the 1870s the opportunities for direct public financing improved. Public borrowing costs decreased to under 4 percent. It was at this time that the GOI started to finance and construct state owned railways. As GOI bond yields continued to decline in the 1880s and 1890s, the GOI could have publicly financed the next phase of railway development. As it turns out, there was a decision to continue with private financing and to lower guarantees to match the cost of government borrowing. Here lobbying influenced policy-making. According to Sweeney (2011) London financial and commercial interests, including the Rothschilds, successfully pushed for a 'second wave' of guaranteed rail companies. Many retired GOI officials also became active investors in private railway companies and used their former influence with

[10] The only exceptions were a few small tramways and mountain railway lines. See Bell 1894, Sanyal 1930.

[11] The guarantees in the third phase varied across companies, but we use 3.5 just as an average.

the GOI to push projects.

The shift to majority GOI ownership and operation was another major policy change in the colonial era. The economics literature generally suggests state ownership is detrimental for the performance of railways (Megginson and Netter 2001). But, these claims are often based on cross-sectional comparisons across different lines or aggregate patterns over time that are likely to be biased. Fortunately, the official publications report detailed information for the main railway systems and thus it is possible to evaluate the role of private and GOI ownership and operation. We have begun the first step in this direction by constructing a rich panel dataset on inputs, outputs and costs for the primary standard and metre gauge railway systems between 1874 and 1912 (Bogart and Chaudhary 2012a). Using this data, we assess whether the takeover of the original private guaranteed companies increased or decreased working expenses after controlling for changes in input prices, output, and fixed capital. We find working expenses were 13 percent lower on average following a change to GOI ownership. The cost declines are not driven by firms anticipating takeovers, poor quality, changes in reporting standards, or long run trends. Rather, the evidence suggests the GOI reduced operational costs by cutting labor costs. Controlling for total route miles, total employment decreased by 25 percent on average including both Indian and European workers.

While our focus was on ownership changes, we also analyzed the effects of changes in operation from private to state (i.e., GOI) and vice versa. The qualitative literature suggests GOI ownership combined with private operations may have undermined performance, but we find no significant differences in working expenses between GOI operated and privately operated lines before 1912. More research on the 1920s and 30s is needed before firm conclusions can be drawn regarding GOI operation versus private operation.

Our work and related discussions in official reports and the secondary literature paint a complicated picture of the GOI's relationship with railways. Clearly, the GOI's financial stake in the railway sector increased over time as they became the majority shareholder following takeovers. Hence, the Government stood to financially gain if railways successfully cut costs. Figure 9 graphs Government railway revenues as a fraction of total Government revenues from 1868 to 1939. Due to changes in how the series are reported, we plot gross revenues earned by the GOI and net revenues (gross revenues - working expenses) as a proportion of total GOI revenues. Although railways contributed a small share to public income in the 1870s, by 1916 almost 37 percent of total tax revenues came from railways.[12] Even after accounting for working expenses, net railway revenues accounted for 12 percent of

[12]Calculations based on total gross public revenues of British India and total public revenues derived from railways. Both series are reported in the *Statistical Abstracts of British India* (1915).

GOI revenues in the 1920s and 1930s. This suggests railway profits were intertwined with the GOI's revenue goals. Increasing railway profits became a key policy objective for the GOI in the early twentieth century. But, the GOI's objectives and constraints were constantly changing. Future research needs to include a theoretical perspective on the commercial, military and political objectives of the GOI vis-à-vis railways.

Another related and much neglected area of the study is the organization of the Princely State lines. Of these, some work has looked at the Nizam's line (Ray 1984), but we still know very little about the operations and management of these lines. Were they comparable to other GOI owned lines operating in the vicinity? How did their contracts with private companies differ from the GOI contracts? Future research should address these questions.

6 Railways and Indian Economic Development

Traffic developed slowly in the first decade of railway operations, but the subsequent increase in traffic surprised even official estimates. In the absence of comparable substitutes, Indians used railways to transport goods and people leading to price convergence and market integration across different regions of India. A large literature has examined the economic effects of railways focusing on two main themes. First, whether the introduction of railways increased market integration and price convergence. Second, whether railways substantially increased income. The two themes speak to a larger question: did railways spur economic growth and development in colonial India?

6.1 Railways and Markets

A large body of research has examined the effects of railways on price convergence (Hurd 1975, Mukherjee 1980, McAlpin 1974, Derbyshire in Kerr, ed. 2007). Most of these studies look at measures of crop price variation across districts. Hurd (1975) compared average prices and standard deviations of prices across railway and non-railways districts. In railway districts, prices were less dispersed and closer to the mean as compared to non-railway districts. McAlpin (1974) found that prices of both food and nonfood crops converged as railway development expanded. Collins (1999) extended the analysis to wages and finds limited evidence of wage convergence in colonial India. The latter finding is perhaps less surprising since labor is generally less mobile than products, like grain or cotton.

Two recent studies have re-examined the impact of railways on market integration using detailed datasets and sophisticated econometric techniques. Andrabi and Kuehlwein (2010) regress the price gap for wheat and rice between major Indian cities on an indicator variable

for whether a railway connected the two cities in each year. The focus is on changes in price gaps over time, that is before and after a market pair is linked by the railway. Andrabi and Kuehlwein's estimates imply that railways can explain only 20 percent of the overall 60 percent decrease in price dispersion between the 1860s and 1900s. They conclude that the effects of railways on market integration is over-stated.

Donaldson (2010) arrives at a different conclusion studying variation in salt prices. His approach is novel because salt was produced in only certain parts of India and then distributed to different districts. Using a theoretical model, Donaldson shows that inter-district price differences in salt are equal to trade costs because salt is produced in only one district and consumed in many other districts. He then empirically measures trade costs and finds the arrival of railways significantly reduced trade costs. His empirical exercise also controls for alternate modes of transportation. Road transport increased price gaps in salt markets by a factor of 8 relative to rail implying that railways could lower trade costs by as much as 87 percent in markets that were only served by roads. The estimated effects of river or coastal transport relative to rail are smaller in magnitude (price gaps are nearly 4 times larger), but still quite substantial. Using the estimated trade costs parameter, he also finds that railroads significantly increased trade flows.

The literature on railways and market integration yields somewhat contradictory conclusions. Andrabi and Kuehlwein (2010) find a small effect of railways and Donaldson (2010) finds a large effect similar to older studies. The different conclusions partly stem from the commodity being studied. Grain was a more important good than salt in terms of total value, but it was not always traded between regions even after railways entered. The conclusions may also differ because there is a missing variable in both analyses: the freight rates charged by railways in each market. Hurd's data demonstrates that average freight rates differed across railways. Data from the *Administration Reports* also show that freight rates differed across commodities, with special rates sometimes being offered on grain or coal. Overall more research is needed to understand how railways influenced markets incorporating the role of freight rates and different goods and factors of production.

Related to the literature on market integration, several studies have also examined the link between railways, price volatility within regions, and famines (McAlpin 1974). One view argues railways may have contributed to famines because they allowed food grains to leave drought stricken areas during times of famine (Sen 1981). Many researchers also argue railway extensions in the 1880s and 1890s failed to mitigate the effects of famines in the 1890s and 1900s (Sweeney 2011). Using district level data on famine intensity and railways, Donaldson and Burgess (2011) find famines were less devastating in districts connected to a rail network. In fact, they find that rainfall shocks were unable to cause famines once a

district was connected to the railways. More quantitative research of this nature is needed to better understand the relationships between railways, price volatility, crop patterns and famines.

6.2 Railways and Income

Historians have long argued that national income would have been far smaller in most countries if railways had never been introduced. Economic historians of the 1960s developed the "social-savings" methodology to determine whether railways were indispensable (Fogel 1970, Fishlow 1965). The goal is to measure how much consumer surplus was gained from railways at some benchmark date, say 1900. The reasoning is that railway customers would have relied on alternative transport modes, like wagons and boats, in the absence of railways. A simple approximation of the gain in consumer surplus is the difference between freight rates for wagons and railroads multiplied by the quantity of rail traffic in the benchmark year. Prices are meant to capture the marginal costs of each technology under perfect competition and the quantity of traffic proxies for consumer demand.

Hurd (1983) was the first to make a social savings calculation for Indian railways. Hurd assumed that without railways freight rates would have been between 80 and 90 percent higher based on the observed differences between rail freight rates and those for bullock carts during the mid-nineteenth century. Using the volume of freight traffic in 1900, Hurd estimated the social savings to be Rs. 1.2 billion or 9 percent of national income. The estimated social savings of railways are large considering real GDP increased by around 50 percent from 1870 to 1913 (Maddison 2004). The social savings of Indian railways also look large compared to the U.S. and Western European countries where the social savings of railways rarely exceed 5 percent of national income. However, compared to other less developed countries, Indian railways look less impressive. Summerhill (2005), for example, argues that the social savings from railways in Brazil were at least 18 percent of national income around 1913.

Why did railways have a relatively large impact in India? We think there are two reasons. First, railways were far superior to the existing transport technology in India. Bullock carts were not an effective substitute to railways and India did not have an extensive inland waterway network. Second, Indian railways experienced high levels of TFP growth after they were constructed. The social savings of any technological innovation is partly due to improvements in efficiency after the original breakthrough (Crafts 2004). According to our estimates the high level of railway TFP growth accounts for over 13 percent of all national income per capita growth from 1874 to 1912 (Bogart and Chaudhary 2012b).

The social savings methodology provides a powerful and simple tool, but it has some problems. First, it is not clear what the price of road or water transport would have been in the absence of railways. Congestion would have increased on roads and rivers with the increased traffic volume. The cost of using alternative transport modes is arguably underestimated in most cases as a result (McClelland 1968, p. 114). Second, the social savings calculation omits spillovers. In theory, railways should increase demand for iron and steel and increase competition in manufacturing. They also contribute to agglomeration of economic activity, like the emergence of cities.

In spite of these critiques, there are reasons to doubt the importance of spillovers in the Indian case. Most iron and steel imports came from Britain and thus backward linkages of this kind had a limited effect. The manufacturing sector was small as well, so forward linkages were weaker. Indian cities also remained quite small well into the twentieth century. The urbanization rate barely moved upward from 10 percent in 1870. Donaldson (2010) has explored this issue further. He develops a theoretical model where railways only impact is to increase farm gate prices via lower trade costs. Donaldson then finds that the estimated effect of railways on agricultural income is very close to that which would be predicted by the model.

It appears that railways primary impact in the Indian economy was to increase interregional and international trade. But this raises a different question. Why didn't railways do more, such as spurring a higher rate of economic growth? Some scholars blame colonial policy. The GOI paid a lot of attention to profits and freight rates were perhaps not set at the socially optimal level. There is also criticism that passenger services were given insufficient attention. Fares were quite high considering income levels in India. For example, the Robertson Report (1903) argued that Indian fares and rates should be one-sixth of English fares when in fact they averaged between one-third to two-third. Improvements in quality were also ignored at times. For example, there was a long debate about whether lavatories were necessary in third-class carriages. Greater attention to comfort and lower fares would have certainly increased travel and perhaps the exchange of ideas.

7 Conclusion

This chapter reviewed the development and organization of the Indian rail network, the trends in railway performance, the effects of ownership and regulatory policies, and the impact of railways on the Indian economy. The major conclusions are the following: The Government of India had a strong influence over railways from the beginning, but the Government's role increased with time culminating with nationalization. The performance of

Indian railways was quite different before and after 1920. There was trend to higher output, productivity, and profits between 1850 and 1919, followed by stagnation from 1920. Dividend guarantees and government ownership had some surprising effects on railway performance. Lastly, railways increased market integration and national income, but it appears that railways could have done more to aid Indian economic development.

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Figure 1: Growth of Route Mileage, 1853-1939

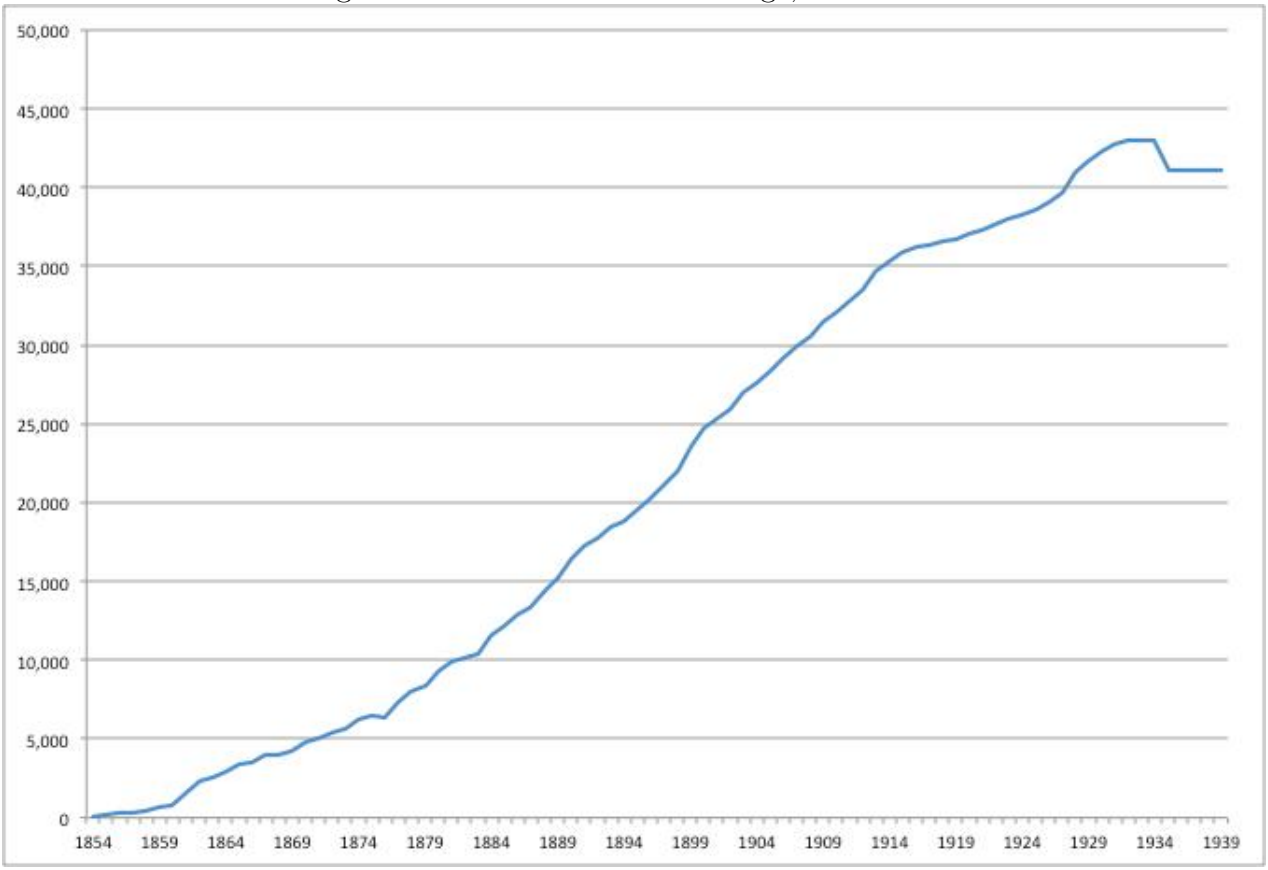


Figure 2: Real Capital per Mile (1873 Rupees)

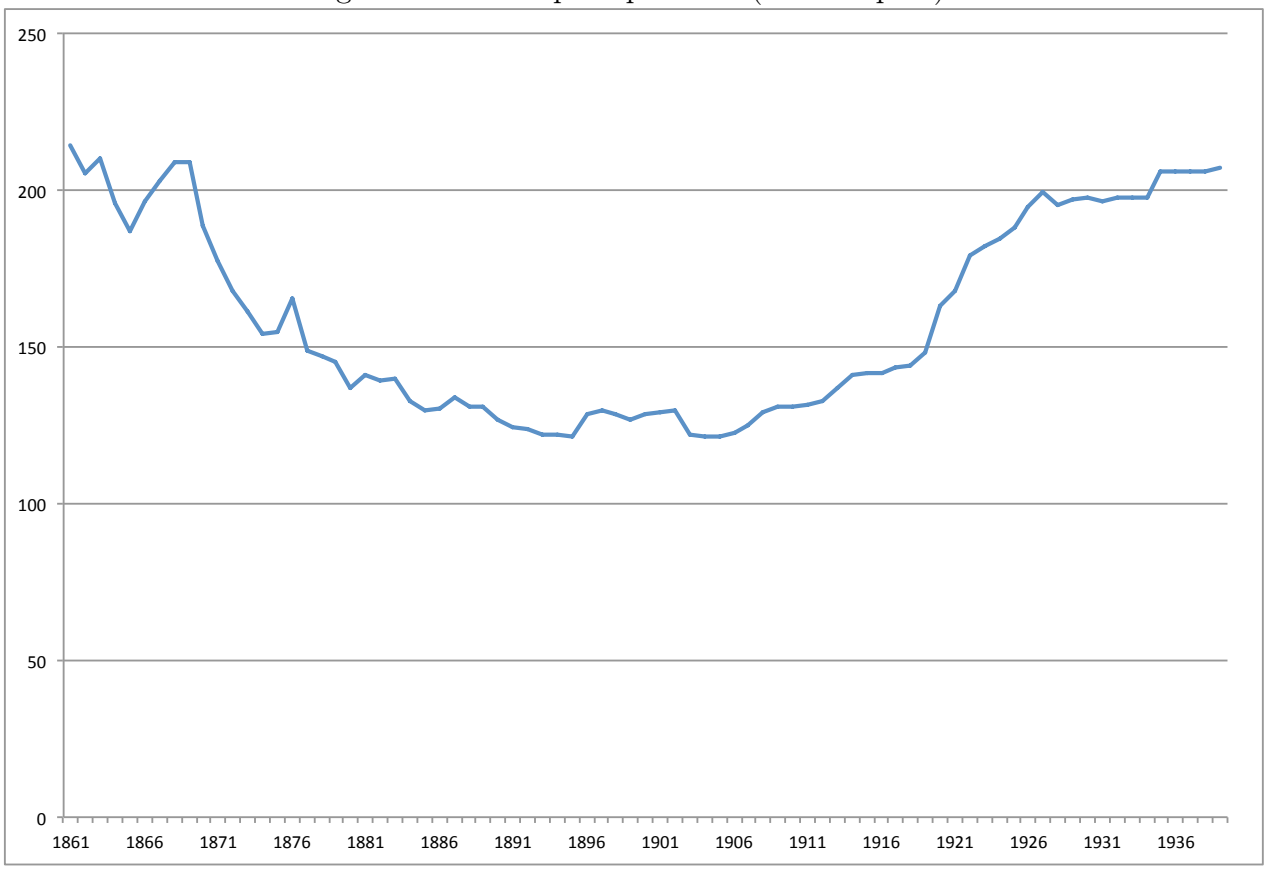


Figure 3: Trends in Employment

Figure 4: Output

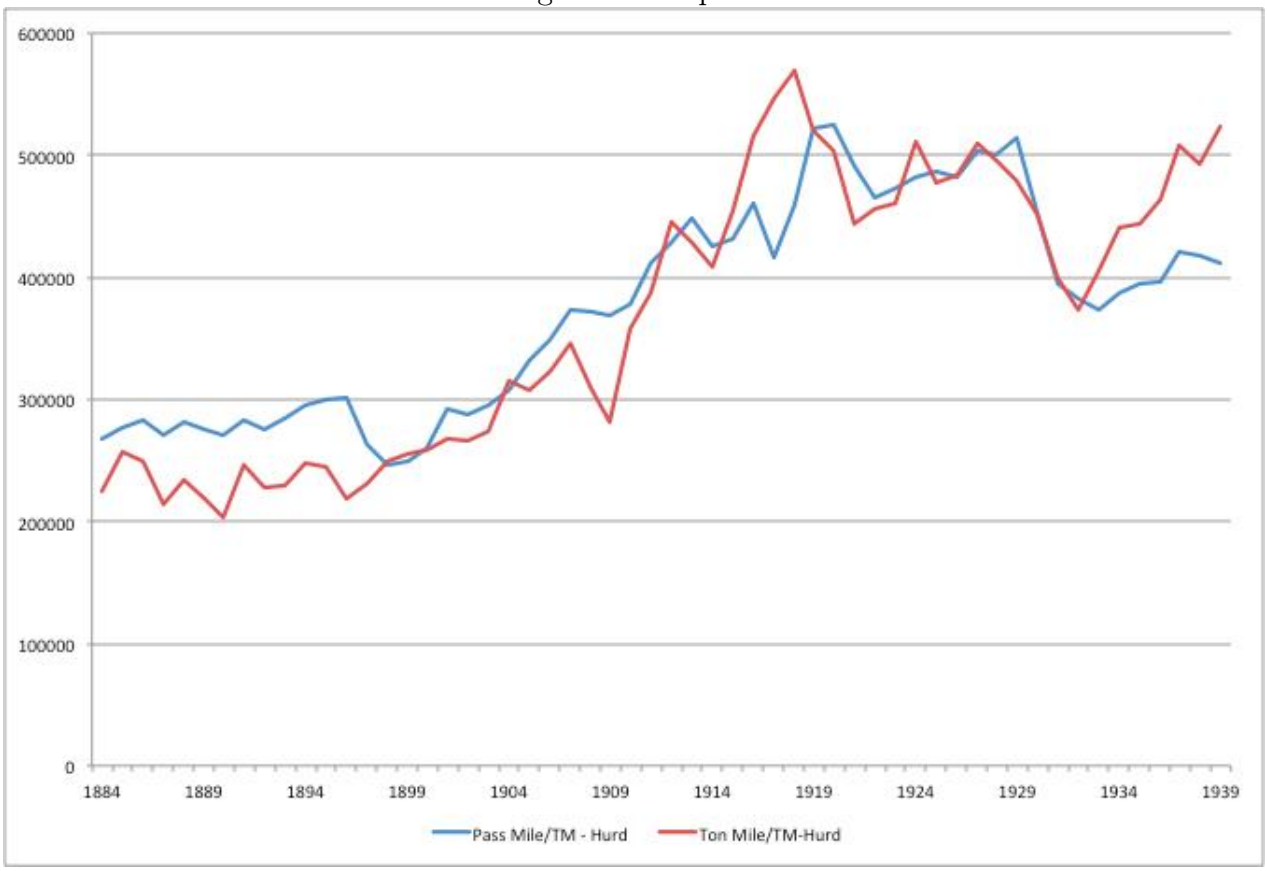


Figure 5: Railway Safety

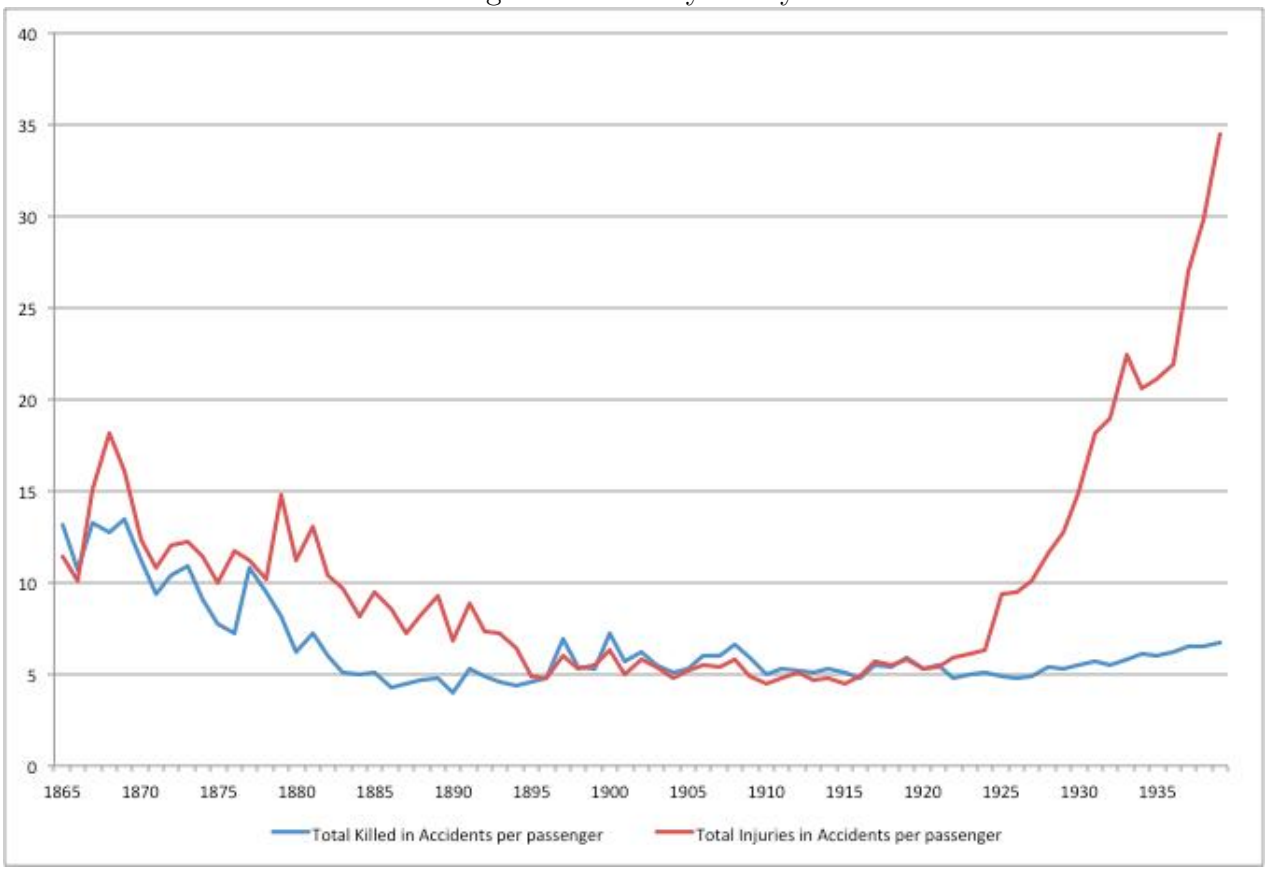


Figure 6: Fares

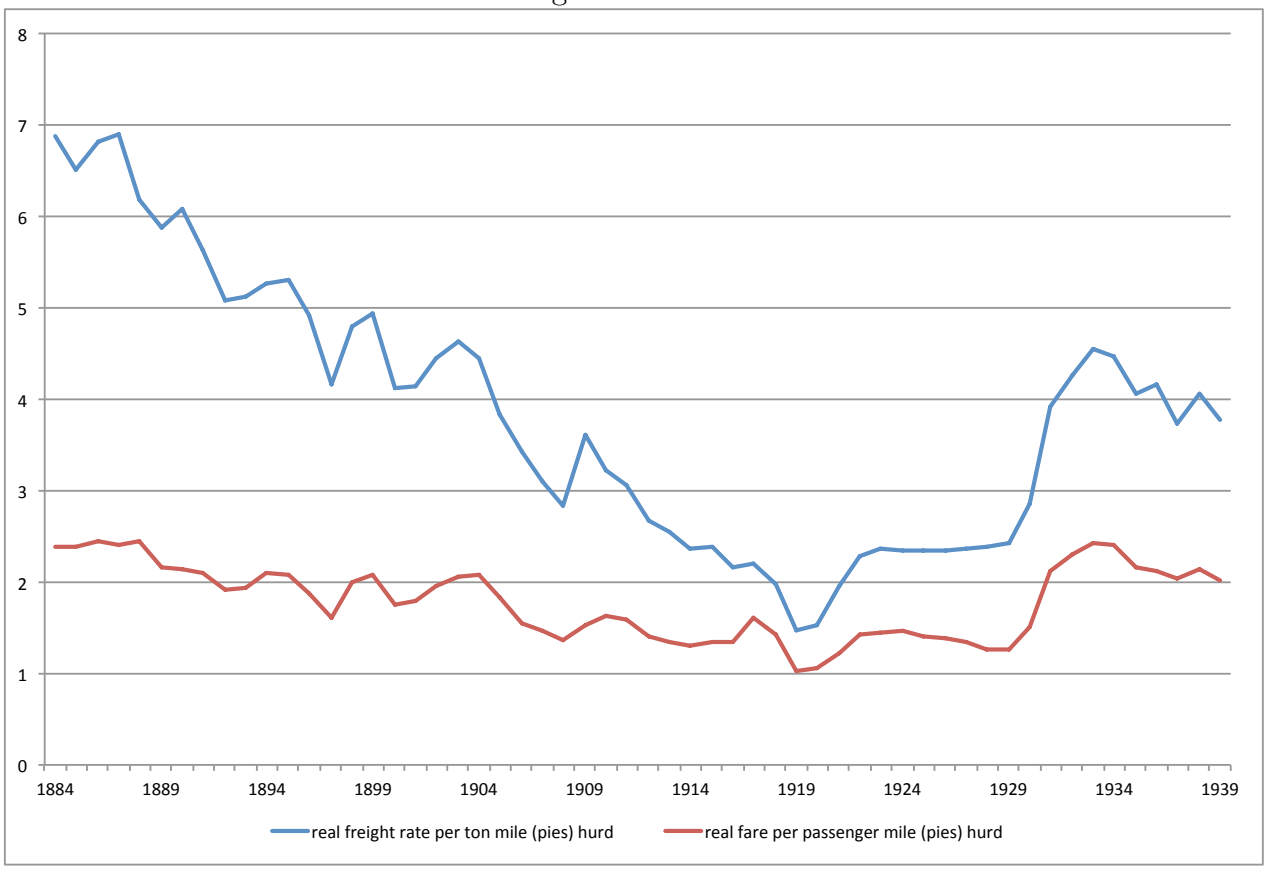


Figure 7: Revenues and Working Expenses (1873 Rupees)

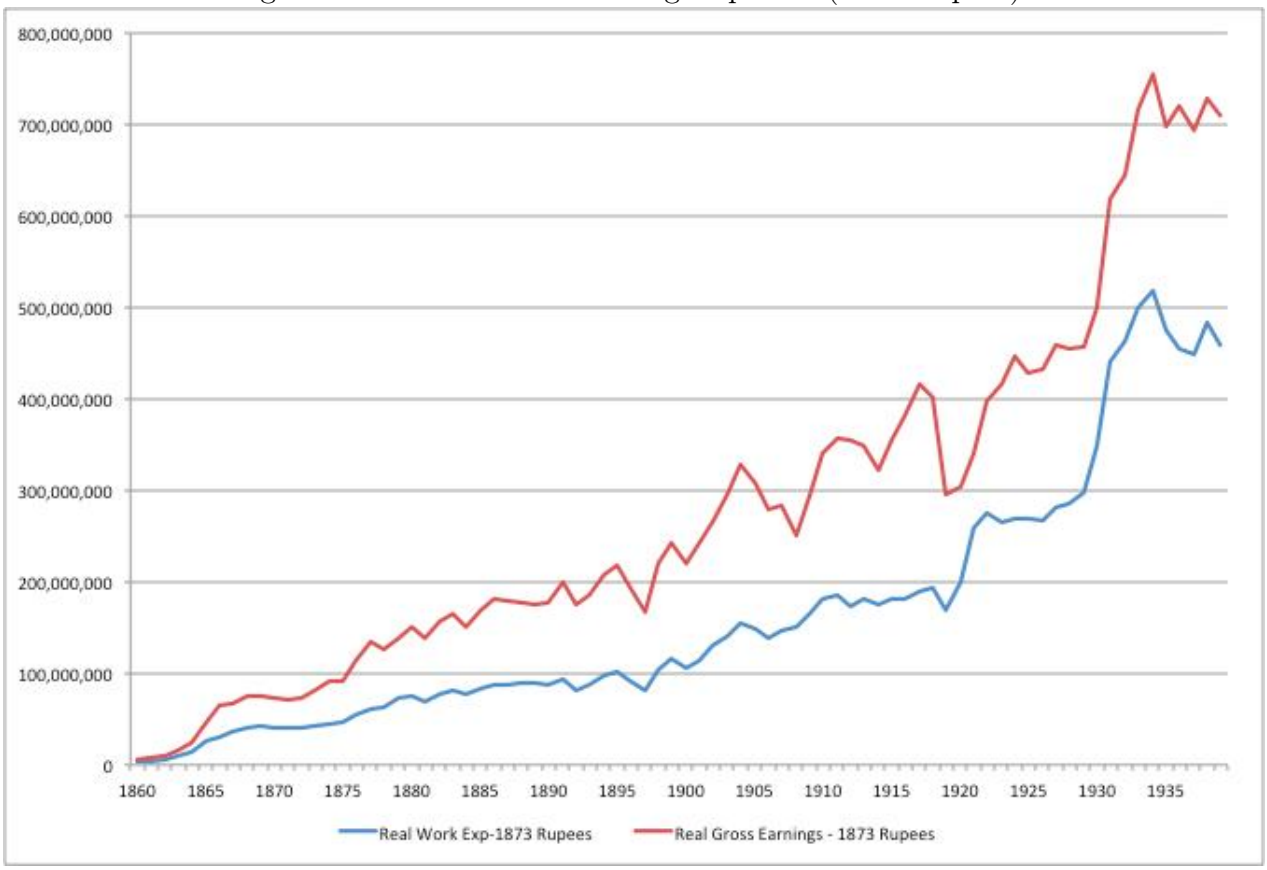


Figure 8: Guarantees and GOI Bond Yields

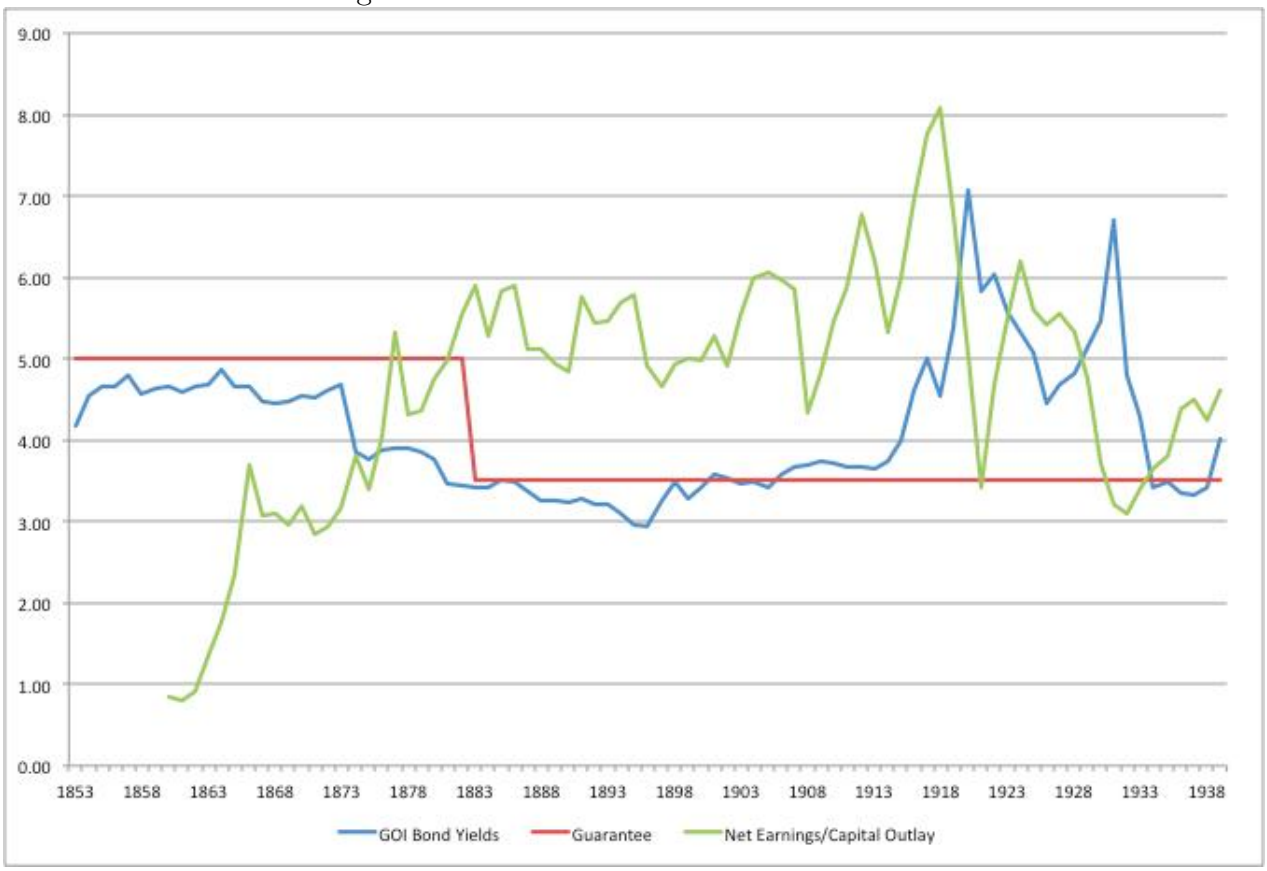
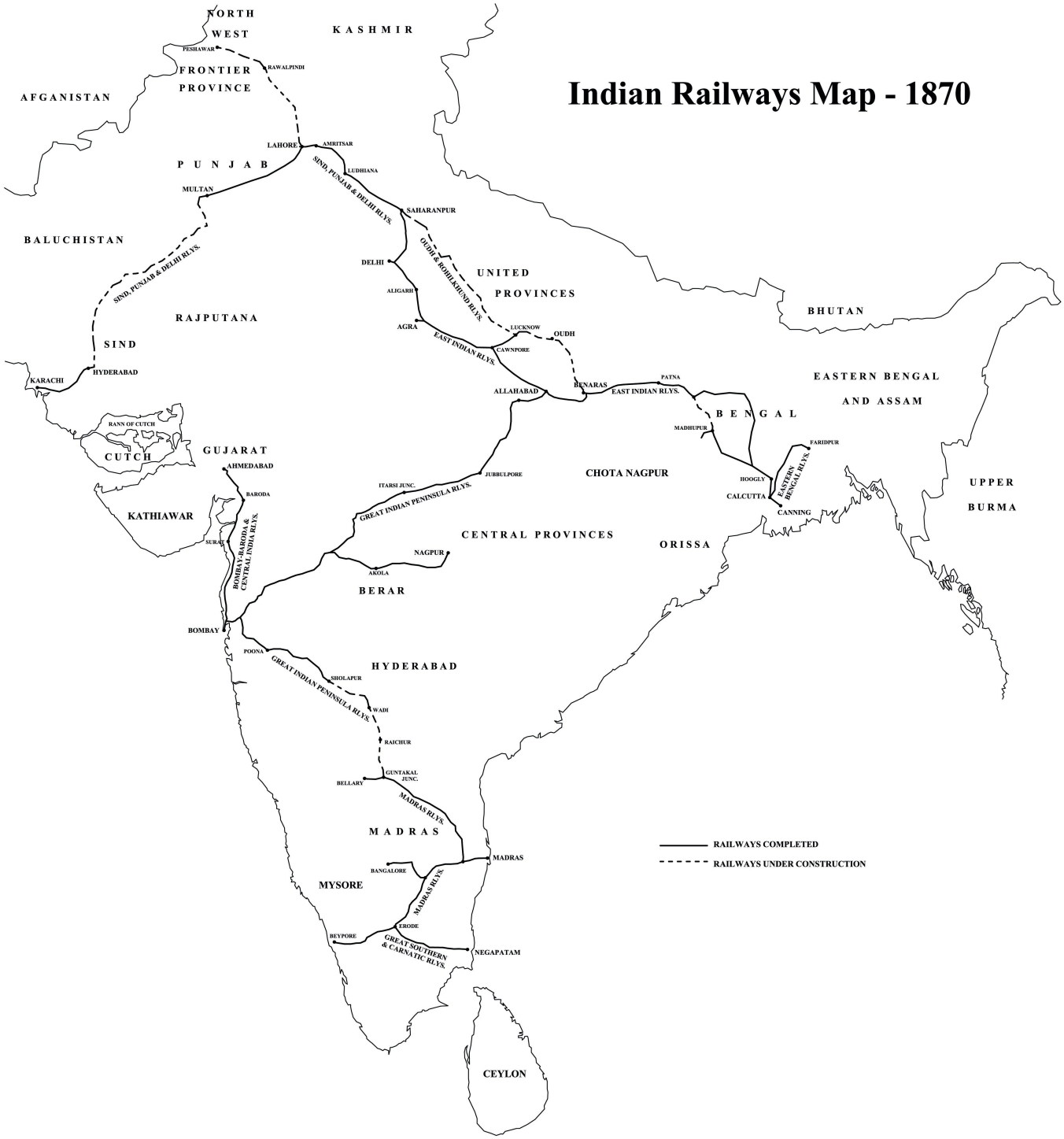
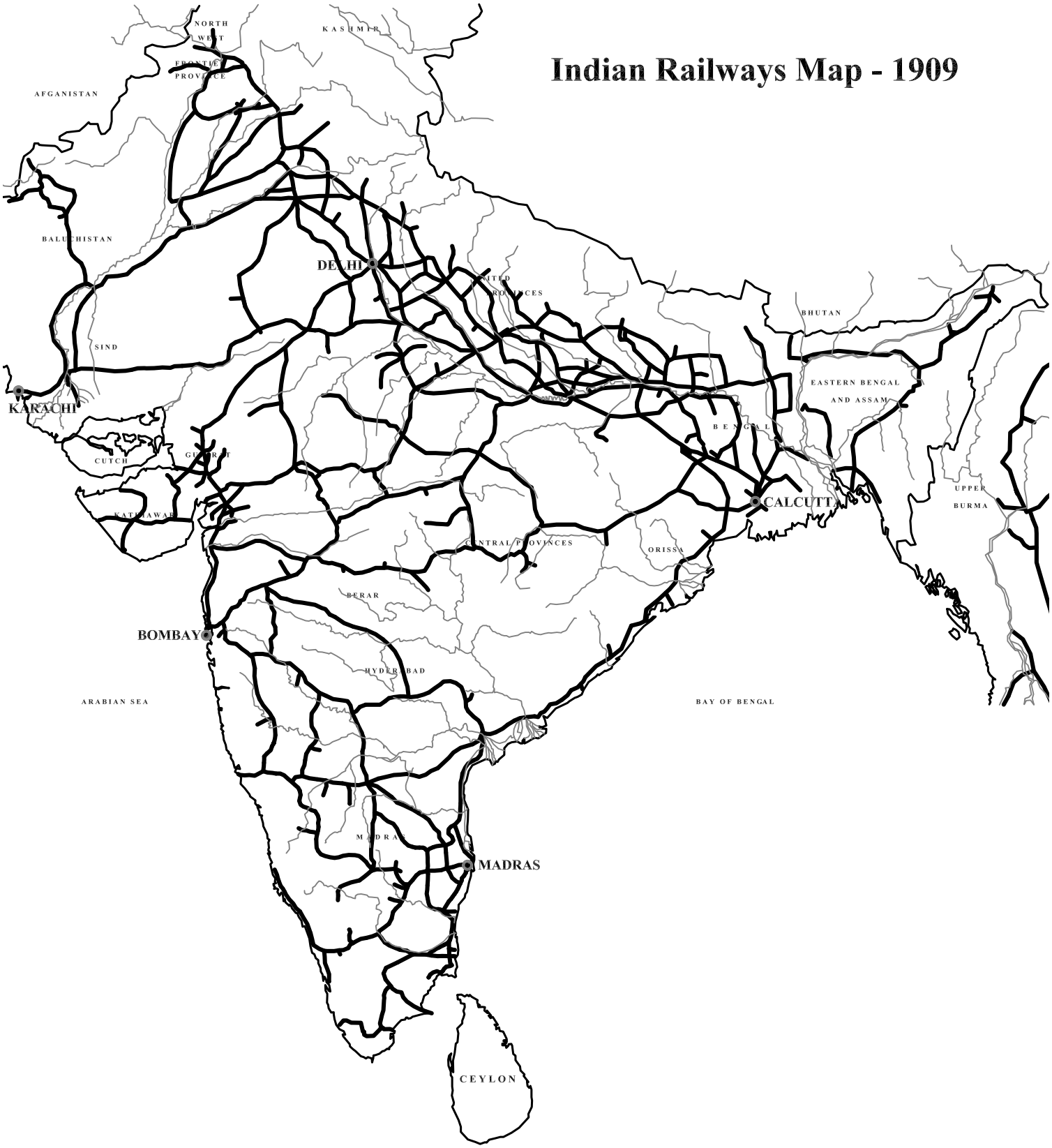
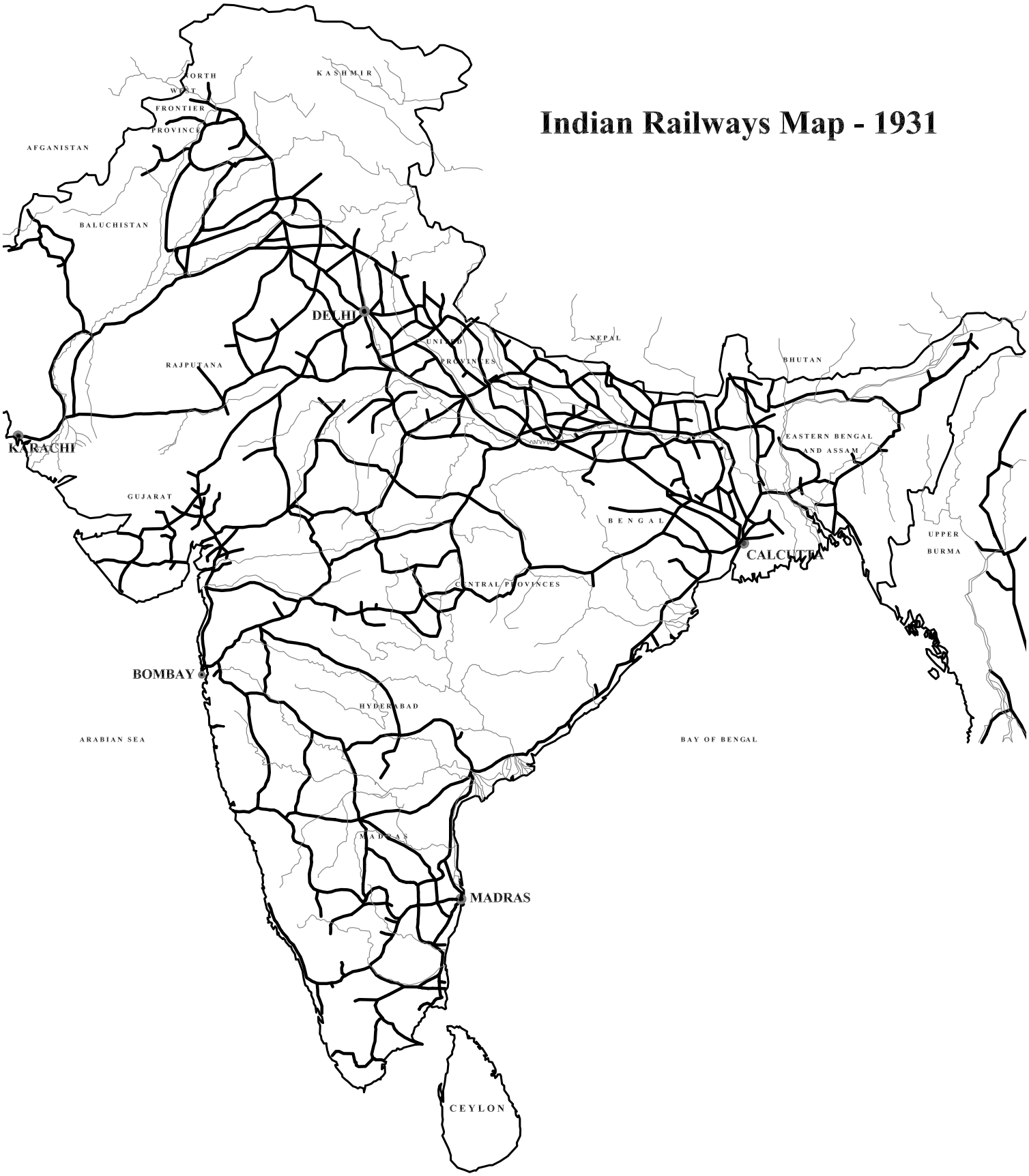


Figure 9: Railway Revenues as a Percentage of GOI Revenues

Indian Railways Map - 1870



Indian Railways Map - 1909



Indian Railways Map - 1931