The Productivity of Australia's Railways in the 20th Century

by Nick Wills-Johnson

This paper utilizes a unique, century-long dataset for the Australian railways to examine the productivity of Australia's railways over the course of the 20th Century. The long timeframe allows one to trace out the paths of the many technical and policy innovations the industry has experienced. The aim of this analysis is to assist in framing a focus for future rail policy to ensure railways maintain a central role in the sustainable future of Australian land transport.

INTRODUCTION

During the course of the twentieth century, the role of railways in Australia's transport system has changed in ways few could have foreseen. The evolution of the industry contains important lessons for both its own future and for newer industries with similar economic characteristics. However, analysis of the long-term economic trends of the industry has been rare, with contemporary economists focusing generally on either end of the century. This analytical shortfall is partly due to a lack of useful data. This paper utilizes a unique dataset that provides consistent data for the operations of Australia's railways over the course of the twentieth century. The dataset is currently being developed for use as a public resource.[1]

The second section of this paper provides a brief overview of the historical development of Australia's railways. The third describes the modeling procedures and data used. The fourth section presents the productivity results and a brief analysis. The last section makes some conclusions and policy suggestions based on the past century of productivity growth within the railways.

Australian Railways – History and Status

Australia's railways began in the 1850s as individual systems in New South Wales, South Australia and Victoria, with Western Australia, Tasmania and Queensland following later. They were designed to facilitate the economic development of each of the (then) colonies by providing a land transport link, enabling agricultural exports to be transported from the rural hinterland of each colony to its major port in each capital city. They were not designed for future interconnection (even the gauges were different), and it was not until 1995 that Australia's state capitals were all joined by a standard gauge system.The capital of the Northern Territory, however, did not join the system until 2002.

The railways were owned and operated by their colonial governments, who often used them as a tool of inter-colonial rivalry (see Clark 1908). At federation, when the six colonies came together to form Australia in 1901, attempts to impose more centralized federal regulation on the railways were stridently opposed, and the railways maintained their strong intra-state focus throughout most of the twentieth century. They also remained unregulated, being controlled directly by their government owners. Regulation came only in the 1990s, as the railways were privatized.

During the twentieth century, Australia had seven major public rail systems.[2] Each state government (New South Wales, Victoria, South Australia, Western Australia, Tasmania and Queensland) owned and operated its own railway, and the federal government operated a railway company (named first Commonwealth Railways, and later Australian National) on track which it owned in the Northern Territory, in the Australian Capital Territory, in South Australia, and crossing the Nullabor Desert into Western Australia. In the 1970s, the railways of South Australia and Tasmania were taken over by the federal government.[3] Thus, seven railway systems became five.

Figure 1 provides an operational overview of the railways during the twentieth century. They were rarely profitable, generally requiring both operational and investment support from their government owners. The main reason for this was the railways were not designed primarily for profit. Although their managers, the (public servant) railway commissioners who controlled the railways for more than 100 years from the 1880s to the 1990s, were required to minimize losses, the railways were required to provide a great many unprofitable services such as rural passenger and small parcel services. They also remained overstaffed due to the power of their public-sector unions. Railway losses exploded during the 1970s when, as part of government attempts to control

Figure 1: Historical Snapshot of Australia's Railways

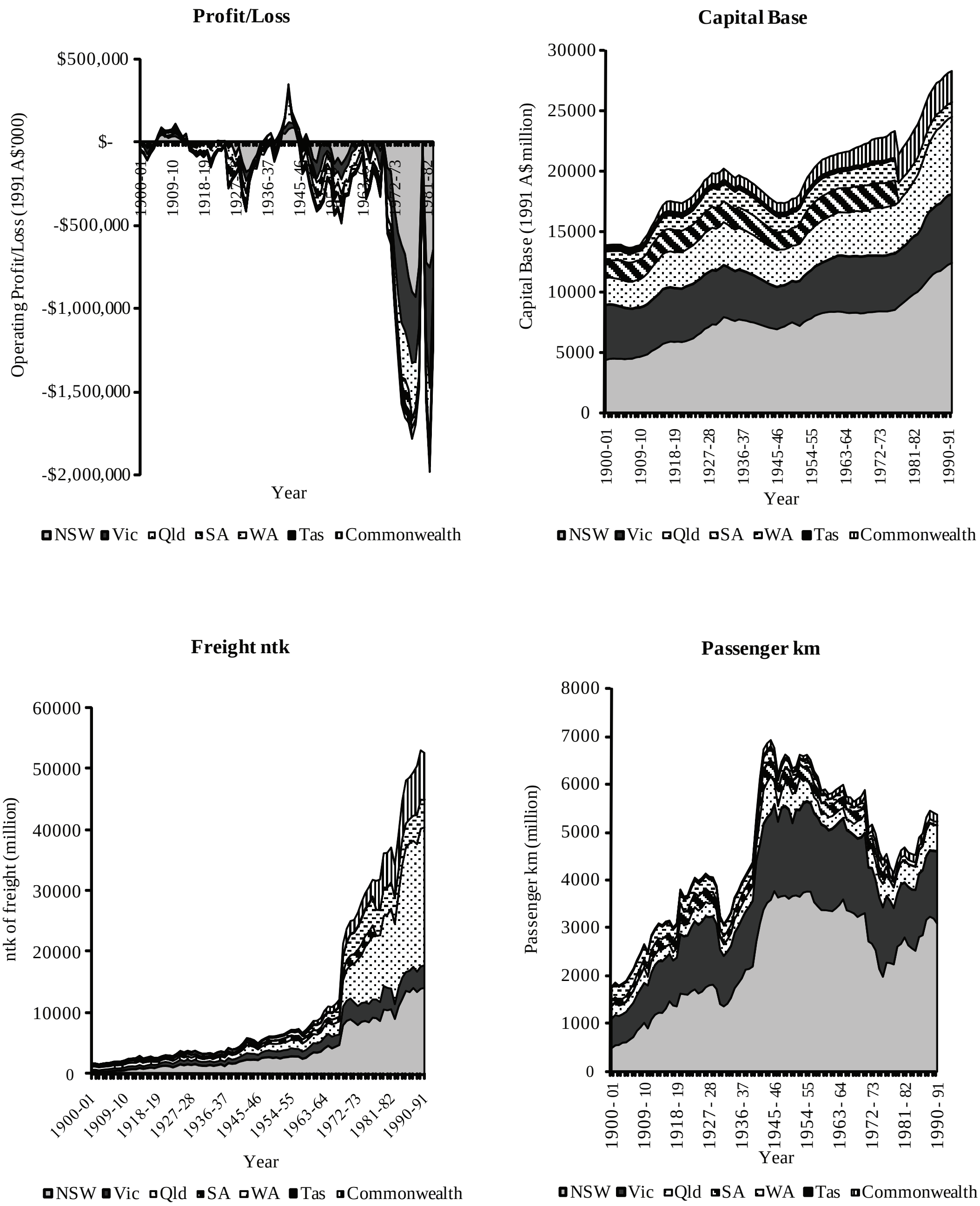
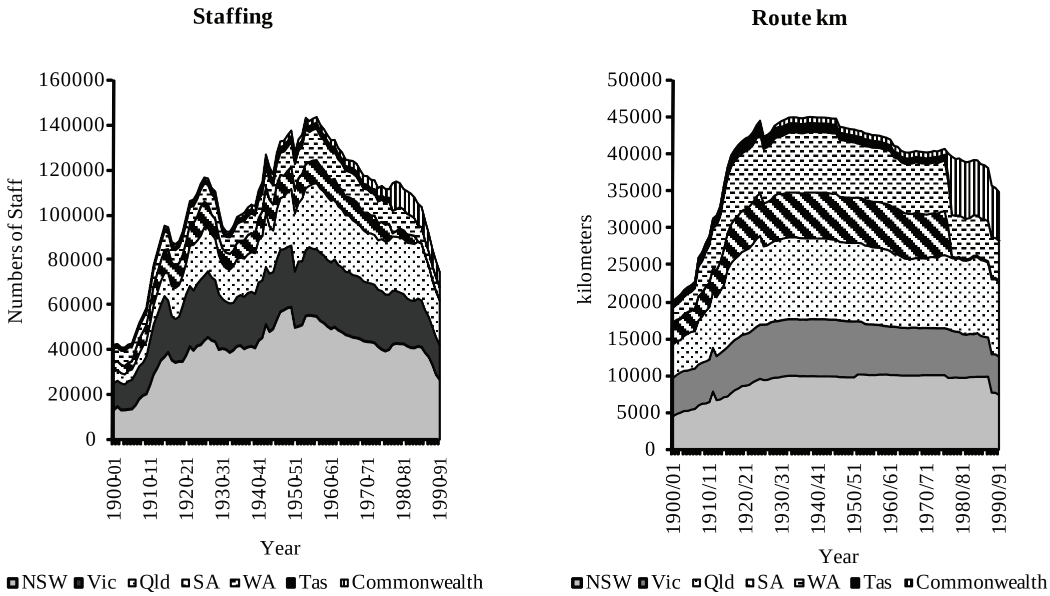


Figure 1 (continued): Historical Snapshot of Australia’s Railways



inflation, their prices were frozen while the cost of key inputs (fuel and wages) increased sharply. These losses created an industry debt of around $3.7 billion (BTCE 1995) by 1984-85, threatening the viability of the industry and providing a catalyst for reform. The process of reform was uneven, given that each railway was controlled by a different government, but it involved a switch from a public-service focus to a more commercial orientation. Reforms included shedding excess labor and non-productive assets, and focusing on niche markets (particularly bulk freight) to improve profitability. The reform process is detailed in the Industry Commission’s (1991) report on the railways. By 1991, the benefits from these productivity reforms had largely been realized, and the industry began a process of structural reform. This involved the vertical separation of track and signaling infrastructure from train operations in some railways, privatization of other railways and third party access to railway-track across the country. See Wills-Johnson (2007) or Everett (2005) for overviews of this ongoing process.

The rise of the automobile is clearly related to the postwar decline in passenger kilometers. Each of the railways (with the exception of Commonwealth Railways) operated a commuter rail system in their state capital cities and it was these systems that suffered the greatest decline. In recent years, New South Wales has recovered some of its urban passenger traffic, perhaps due to an increase in congestion in Sydney. Freight has exhibited an opposite trend. Most of this is due to bulk minerals traffic, most evident in Queensland where coal is the dominant commodity. Overall, railways have not kept pace with growing land-freight traffic, ceding market share to trucks.

Australia today has four distinct types of railway systems. The first includes the intra-state freight systems, which fan out from each state capital into the surrounding rural hinterland. The second is the interstate network, a standard gauge link which runs from Brisbane through Sydney, Melbourne and Adelaide to Perth on the West coast, with a second line running North from Adelaide to Darwin. The third is a system in the North-West of Western Australia, which is privately owned and serves the iron mining industry. This is not connected to the rest of the system. The final type of system is the commuter rail system in each state capital, except Hobart. A map of the Australian railway system is available from the Association of Australian Railways (http://www.ara net.au/ railnetwork.htm). Australia shares the experience common elsewhere in the world of railway route miles peaking early in the century and declining thereafter. Jefferson (1928) provides a much earlier summary, and map, of Australia’s railways.

Productivity Measurement and Data

Productivity, in broad terms, measures the efficiency with which inputs are turned into outputs. Measures can be either partial, measuring the relationship between change in some inputs and output, or total, measuring the relationship between changes in all inputs and output. Partial productivity measures, such as labor productivity, are often easier to calculate. But they can be misleading because they ascribe all output change to changes in a single input, when many inputs may be changing at once. Productivity is a useful measure for business because it focuses on operations and thus provides useful information about how a company might improve them. Productivity can be improved by adopting better technology (like diesel locomotives), by changes in the legislative environment governing the industry (such as the Staggers Act in the US), or by the firm in question changing its business focus to incorporate niche markets to which it is better suited (such as railways closing inefficient lines or focusing on unit train traffic).

This section provides a brief overview of the methodology used to construct the productivity indices. It is not intended to be a detailed discussion of the science of productivity analysis (see Hulten et al. 2001 for such a discussion) nor of its application in the analysis of railways. Rather, it is a brief description of the methods used here. This paper builds upon earlier examination of productivity in Australian railways, particularly that of Brunker (1992) and Hensher et al. (1992, 1994). It also draws methodologically on the quite substantial US literature on railway productivity, particularly Caves et al. (1981), Bitzan and Keeler (2003) and Wilson (1997).

This paper contributes to the literature not only because of its focus on Australian railways, relatively poorly studied compared to those in the United States, but also because of the long timeframe of its analysis. Railway assets are long-lived, and decisions made by railway managers and policymakers can have long-term implications for the industry. However, owing to the difficulty of obtaining consistent, long-term data series, quantitative analyses of the long-term development of the industry are rare. This paper, therefore, fills a useful niche.

Productivity Measurement

Two approaches to productivity measurement are used in this paper. The first is the Tornqvist index. This index is particularly useful in cases where inputs and outputs change considerably over time and is described in detail in Salerian and Jomoni (1994). It can be described as follows:

$$(1)\quad \ln\left(\frac{TFP_t}{TFP_{t-1}}\right)=\sum_{i=1}^{2}\left[\left(\frac{R_{i,t}+R_{i,t-1}}{2}\right)\ln\left(\frac{Y_{i,t}}{Y_{i,t-1}}\right)\right]-\sum_{j=1}^{3}\left[\left(\frac{S_{j,t}+S_{j,t-1}}{2}\right)\ln\left(\frac{X_{j,t}}{X_{j,t-1}}\right)\right]$$

Where:

TFP = total factor productivity.
R_i = the share in total revenue of each of the i outputs.
Y_i = the quantity of each of the i outputs produced by the railway in log form.
S_j = the share in total costs of each input j.
X_j = the quantity of each input j used in production in log form.

The index is given a base of 100 in 1900/01 and annual changes are shown with reference to this base. As Waters and Street (1998) and Hensher et al. (1994) note, the use of an arbitrary starting point can be problematic. Hensher et al. (1994) point out that it makes it difficult to compare one railway with another, as each may have had different levels of productivity during the first period. Waters and Street (1998) suggest that problems may arise if the base year is not one where cost is minimized.

To allow for a comparison among the railways, I augment the Tornqvist index with another index, suggested by Caves et al. (1982) and used in the Australian context by Hensher and his colleagues. This is discussed below. To address the issue of the base year potentially not being one where costs are minimized, the Tornqvist index was modified slightly to define all percentage changes in total factor productivity from the year in which freight density was maximized, a rough proxy for cost minimization. However, in all cases the maximum occurred in the last few years of the time period analyzed, meaning a graphical representation of results would change little from that given below.

The index developed by Caves et al. (1982), instead of comparing year-on-year, compares each year with a base: the average of each variable over the entire dataset. This allows for railways to be compared with one another. It can be described as follows (for each railway):

$$\text{(2)}\quad \ln\left(\frac{TFP_t}{TFP_b}\right) = \sum_{i=1}^{2}\left[\left(\frac{R_{i,t}+\bar{R}_i}{2}\right)\ln\left(\frac{Y_{i,t}}{\bar{Y}_i}\right)\right] - \sum_{i=1}^{2}\left[\left(\frac{R_{i,b}+\bar{R}_i}{2}\right)\ln\left(\frac{Y_{i,b}}{\bar{Y}_i}\right)\right]$$
$$-\sum_{j=1}^{3}\left[\left(\frac{S_{j,t}+S_{j,t-1}}{2}\right)\ln\left(\frac{X_{j,t}}{X_{j,t-1}}\right)\right] + \sum_{j=1}^{3}\left[\left(\frac{S_{j,b}+\bar{S}_j}{2}\right)\ln\left(\frac{X_{j,b}}{\bar{X}_j}\right)\right]$$

Variables are defined as previously, with the addition of a *b* subscript that refers to the base of the relevant variable and the line over selected variables, referring to their arithmetic (in the case of cost and revenue shares) or geometric (in the case of input and output amounts) means for each railway.[4]

Description of the Data

As noted by numerous analysts of railways in Australia (Hensher et al. 1992, 1994, Productivity Commission 1999 and BTRE 2006), obtaining consistent data about Australian railways is very difficult. This, however, was not always the case. A century ago, the railways were among the largest and most important businesses in the country and were government owned. The former made them interesting to statisticians, and the latter meant they were forthcoming with data. The Australian Bureau of Statistics (ABS), in both its national and state *Yearbooks* (ABS cat 1301.0 – 1301.6), provides a great deal of data on Australia's railways. Additionally, *Rail, Bus and Air Transport* (ABS Cat no 9201.0) and its successor *Rail Transport Australia* (ABS cat 9213.0) provide some information not covered in the *Yearbooks*. Moreover, there is reasonable consistency in the data presented, at least through 1985 when the *Rail Transport Australia* publication was discontinued. This consistency makes the ABS data very useful for long time-series analysis.

The data used in this paper were sourced primarily from the ABS publications mentioned above, with some post 1985 data sourced from Hensher et al. (1994) and from a previous study by the author (Wills-Johnson 2008). While some work has been done to reconcile data in annual reports and from other sources, not all variables have been reliably estimated past the beginning of the 1990s. For this reason, the indices developed go only to 1991-92. All monetary figures have been converted from dollars and pounds of the day to 1991 Australian dollars. The data are described below.

Inputs. *Capital:* Capital is calculated via a perpetual inventory method (see Brunker 1992). The asset base of each railway in 1900-01 forms a base. Investment and depreciation change the capital base year on year. Depreciation is straight line over 50 years, and investment figures are derived from ABS *Yearbooks*.[5] The ABS data on capital refer to fixed capital investment; hence the long depreciation period. This is because many railways built, rather than bought, their rolling stock, particularly in the earlier decades of the twentieth century.

Capital costs are calculated as investment per annum multiplied by the five-year moving average of the rate of change of CPI per annum plus 3.08%.[6] This represents the opportunity cost of capital. Hensher et al. (1992, 1994) use an opportunity cost of capital of 7%, which is reasonable for the time period they analyze, but seems less appropriate for earlier decades. The figure of 3.08% represents the average from 1969 to 2005 of the difference between the yields on 10 year government bonds and CPI growth.[7] The Reserve Bank does not publish earlier rates on their website, necessitating the use of this average. Government bond rates, rather than commercial interest rates, were chosen because the railways were government owned and funded by government debt. A moving average was used to smooth the series and because railway debts were typically carried for many years. The ad-hoc nature of this cost of capital measure is acknowledged. Some of the *Yearbooks*, particularly in earlier years, publish the actual cost of capital of the railways. However, the series is too inconsistent to be used for the whole twentieth century.

Labor: Labor is calculated as the number of employees per annum. This includes both operational and construction staff on the payroll of the railways concerned. The cost of labor is sourced primarily from ABS figures on salaries and wages. While all *Yearbooks* provide data on staff numbers, only Western Australia provides a consistent series on salaries and wages for the whole twentieth century. However, relative wages among the railways tended to maintain their proportional relationship over many years.[8] Thus, to estimate salary and wage costs where data do not exist (primarily prior to 1930, and during World War II), the wages per person for Western Australia were modified to reflect the proportional wages of the railway in question (calculated in years where data did exist) and then multiplied by the number of employees.

Materials and Fuel: This was calculated as total operating expenses minus salary and wage costs. Hensher et al. (1992, 1994) separate data from 1971 to 1992 into energy and materials, calculating materials in the same way as this paper and using megajoules of energy to account for different energy sources.[9] In earlier years, reporting in ABS *Yearbooks* on fuel used and the cost of fuel is sporadic. Thus, fuel costs are included with the costs of other materials here. Lacking a consistent unit, such as number of workers, the amount of expenditure on materials and fuel, expressed in 1991-92 dollars, forms the measure of the quantity of this input.

Outputs. *Freight:* Freight output is calculated as the number of net-tonne-kilometers (ntks) of freight per annum.[10] New South Wales, Tasmania and South Australia report this figure from 1901, but other railways begin later. All railways except Western Australia and Queensland ceased reporting this data for the duration of World War II. All railways for all years in the sample report total train kilometers, freight tonnes and freight revenues. Thus, to calculate ntks for the years and railways where they are not reported, econometric models were developed, with total train kilometers, freight tonnes and freight revenues as potential independent variables. Since most of these variables are non-stationary, regressions were carried out in first differences, not levels. The first difference results were then applied to levels data in years for which data did exist, in order to estimate ntks for years where it did not. With three independent variables, seven regressions are possible. For each railway and each block of time, the ability of a given regression to predict accurately was used as the means of determining which regression to use to calculate missing values. In each case, the best regressions predicted within a few percentage points of the actual values. Where data existed on either side of the gap (for example, the missing war years), the ability of a regression to correctly predict ntks after the gap was used. Where the gap was at the beginning (or end) of a time series, the ability of a regression to predict within a sample was used as the selection criteria for prediction outside the sample.

Passengers: Passenger outputs were measured by passenger kilometers. As with ntks of freight, the data series were incomplete. However, there was a complete series for passenger journeys and passenger revenue. It was possible to derive a series for passenger train kilometers using extant ABS data. Thus, passenger kilometers, where data did not exist, were estimated econometrically in the same manner as ntks of freight above, with passenger train kilometers, passenger journeys and passenger revenues forming potential independent variables and regressions being chosen on the basis of their predictive ability. In general, passenger kilometers were reported less frequently than ntks of freight. Thus, more of this series had to be estimated econometrically than was the case for freight.

Queensland did not report passenger kilometers to the ABS at all, Hence there were no means of estimating a regression in first differences specifically for Queensland using an approach like that used for freight above. Thus, Queensland passenger kilometers were calculated on a year-by-year basis via a cross-sectional ordinary least squares regression, using data from the other six railways. For each year, there were three potential independent variables (passenger train kilometers, passenger revenues and passenger journeys) and seven potential regressions. Of the seven, the regression with the best result in terms of its Akaike (1973) and Schwarz (1978) information criteria was chosen, and the coefficients of this regression were applied to known data for Queensland passenger journeys, passenger train kilometers and passenger revenues (as appropriate) to obtain a figure for passenger kilometers for a given year. This was done for 1901 to 1977, a total of 539 regressions. After 1977, the railways of South Australia and Tasmania became part of Australian National, reducing the number of railways from which to draw independent variables from six to four. This left too few degrees of freedom for robust OLS estimation, and therefore the predictive method using first differences (in the estimated Queensland series from 1901 to 1977) described above was used.

RESULTS

The first results presented are those for the Tornqvist productivity index. Since each railway had a different level of productivity in 1900-01, comparisons can only be made inter-temporally for a single railway, not across railways. Figures 2 through 8 present this comparison.

Figure 2: Tornqvist TFP Results – New South Wales

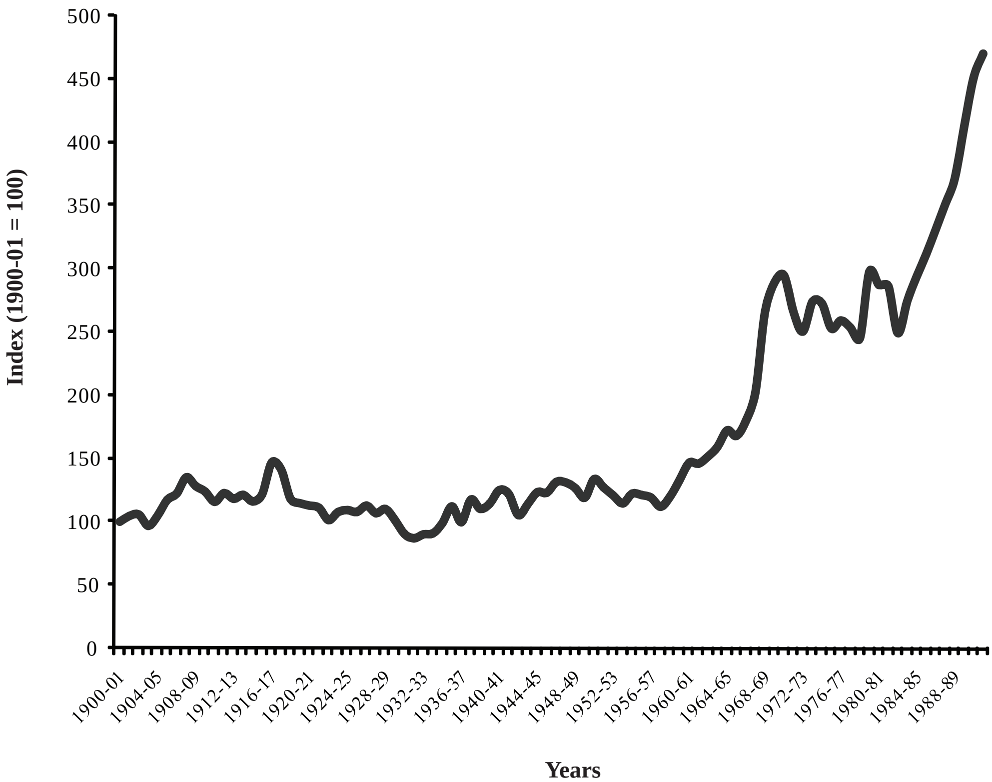


Figure 3: Tornqvist TFP Results – Victoria

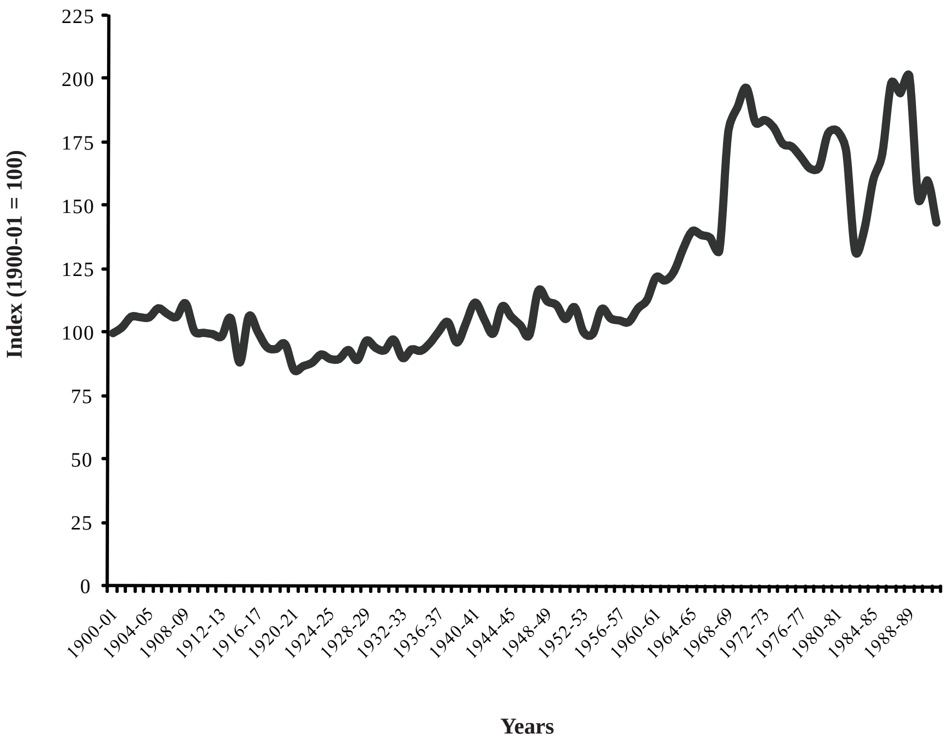


Figure 4: Tornqvist TFP Results – Queensland

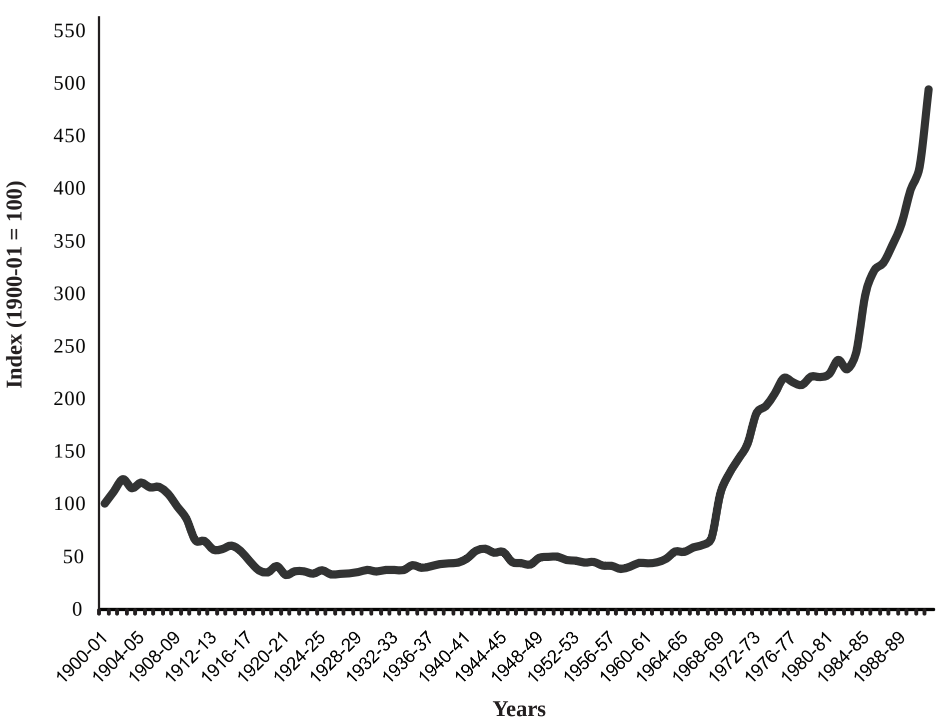


Figure 5: Tornqvist TFP Results – South Australia

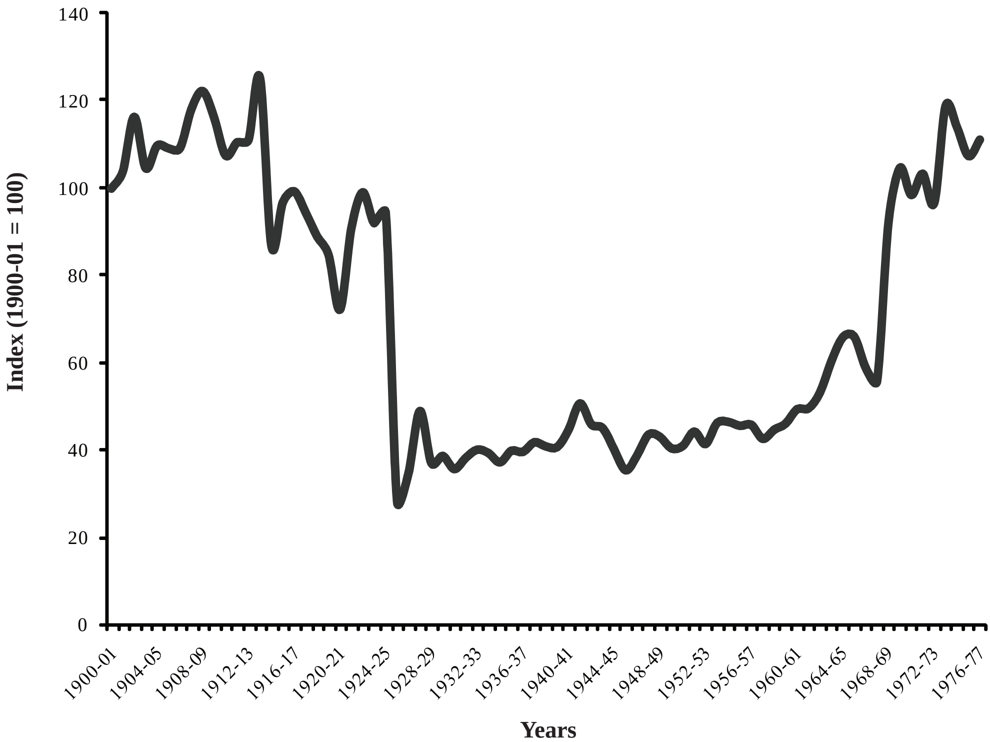


Figure 6: Tornqvist TFP Results – Western Australia

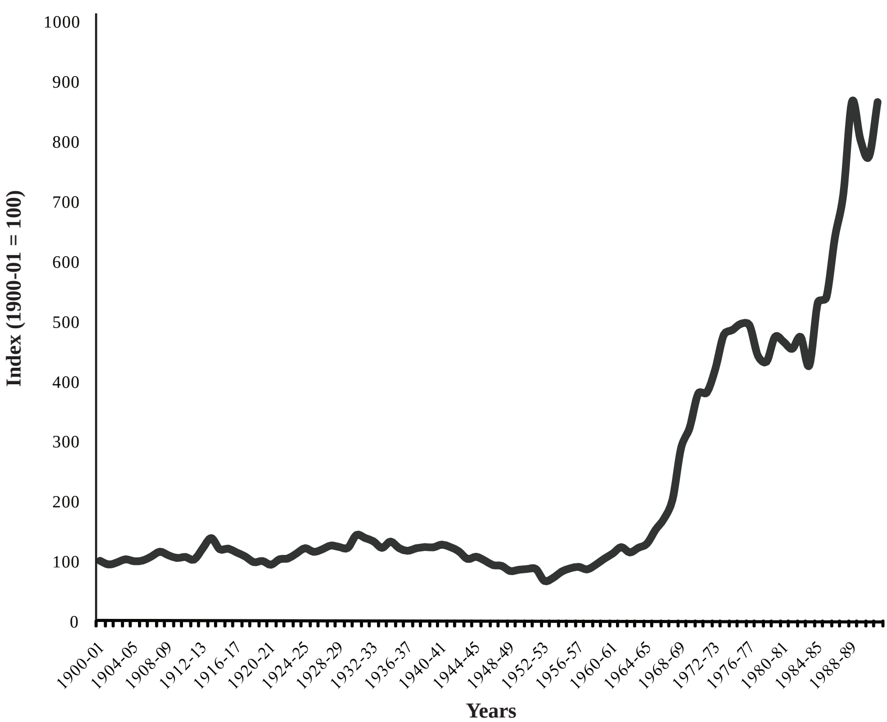


Figure 7: Tornqvist TFP Results – Tasmania

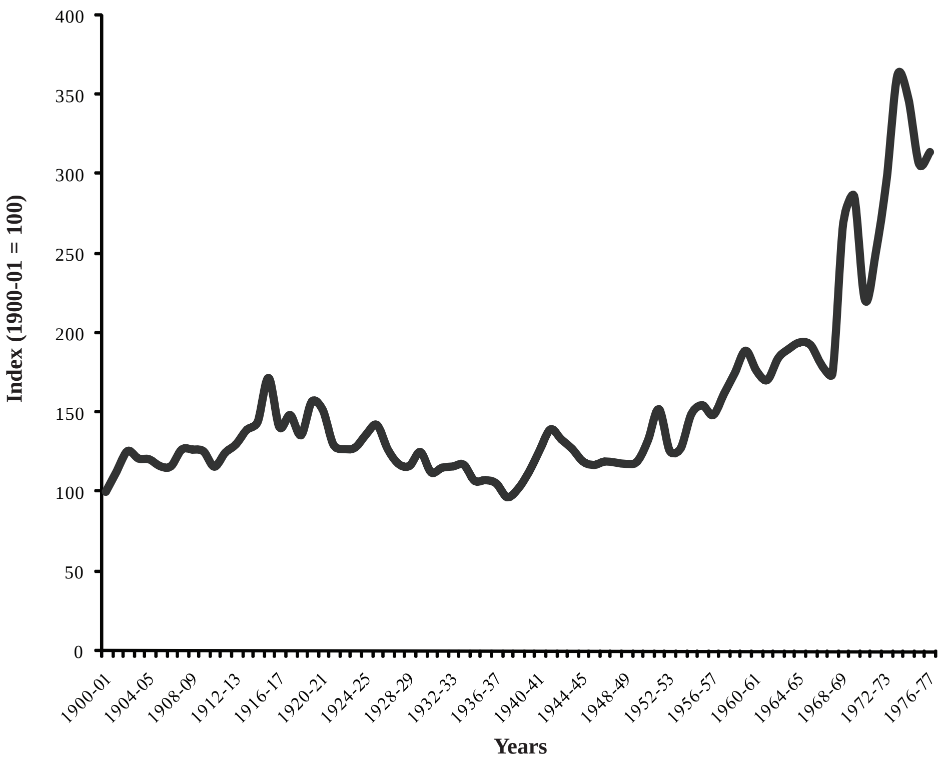
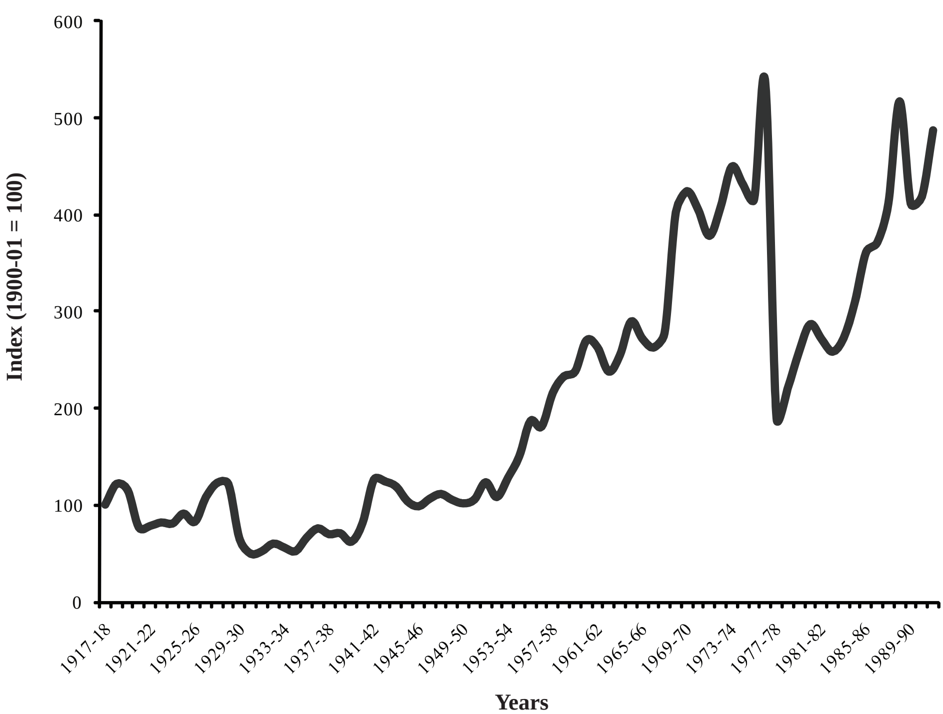


Figure 8: Tornqvist TFP Results – Commonwealth Railways and Australian National



Each of the railways has quite a different history. Some have clearly fared much worse than others, with productivity improvements over the century ranging from 25% in Victoria to an almost eight-fold increase in Western Australia. However, it is possible to break the century into three major periods for all railways.

Up until the early 1960s, productivity was static, or even falling across the whole industry. During much of this period, rail failed to capture growing land transport traffic. It ceded market share to trucks, particularly after 1954, when the Privy Council decision in respect of the Hughes and Vale case resulted in the deregulation of interstate road transport (see Joy 1964). Some technological improvements were made, such as the electrification of Sydney's passenger trains in the 1920s and early 1930s, but these changes did not significantly affect productivity. Then, from the late 1950s until the early 1970s, railways replaced steam locomotives with diesel traction, and all experienced large increases in productivity.

Productivity growth either stalled or reversed during the latter half of the 1970s, as governments sought to combat inflation by limiting price increases. This not only resulted in large debts, but also impacted productivity, as railways sought to reduce costs any way they could. Victoria and New South Wales suffered the biggest losses, some 15%, which was then compounded by a drought in Victoria in 1982-83 that reduced grain traffic by two-thirds and productivity by one-quarter.

The debt crisis in the 1970s forced a major change in government policy during the 1980s, shifting from public service to commercial viability. Part of the policy shift was a removal of legislation dating from the 1930s, which reserved certain freight traffic to rail in order to 'protect' the railways from competition for this freight traffic. Freed of such 'protection' and subject to inter-modal competition, railways responded by focusing on the niches where they could perform best. This response happened quickly. Western Australia provides a clear example of the size of productivity gains possible when a railway shifts from a public service to a commercial focus. In a few short years in the middle of the 1980s, it cut 15% of its staff and stopped providing loss-making, less-than-container-load services. The result was a 35% increase in productivity in just three years. Australian National and Queensland Rail, given commercial charters in the late 1970s and early 1980s respectively, had similar experiences. New South Wales and Victoria, which were the last to begin reforming, did not see benefits arising until the latter half of the 1980s.

Three points of expected productivity change do not arise; productivity increases during wartime were moderate, and productivity did not seem to decrease markedly in response to the Depression. The lack of large wartime peaks may be due to capacity constraints. These existed partially because funds for expansion were limited during wartime, and partially because war placed a large strain on manpower; Victoria, for example, lost 15% of its staff to the armed forces in the First World War. Also, demand for military traffic tended to be diffuse across the network and transport was often required on relatively short notice. This did not allow for the same kind of optimization as can be achieved with steady mineral haulage. The lack of a trough in the Depression may be due to government policies to reserve freight traffic for rail, as well as railway construction projects to reduce unemployment. Thus, while output declined, it perhaps did not decline by as much as might have been expected without such policy intervention.

The major distinguishing feature between railways in terms of their productivity in the post-war years appears to be whether they hauled minerals or not. Export coal in New South Wales and Queensland and iron ore and alumina in Western Australia allowed these railways to reap considerable benefits through the use of unit trains.[11] Queensland provides the starkest example. Without coal, it is not clear whether Queensland's railways, less than half as productive in the early 1960s as they had been in 1900, would have survived. With coal, they became the most productive in the country by 1991.

Minerals traffic, however, was not a necessary requirement for productivity growth, as the history of Commonwealth Railways and Australian National shows. This railway, apart from some iron ore in the Northern Territory in the late 1960s and early 1970s and some coal in South Australia, had limited minerals traffic. Its productivity gains came from two sources. First, it was a long thin railway, with the link across the Nullabor Desert in particular providing an opportunity where it could compete very well with trucks for intermodal haulage. Second, successive federal governments were determined to use it as a vehicle with which to introduce innovation to the Australian rail industry. This was particularly the case in the late 1970s and 1980s, when the commercial focus of the railway allowed it to recover relatively quickly from the absorption in 1978 of Australia's least productive railways, Tasmania and South Australia.

From 1918 to 1939, productivity in most railways trended downwards. In part, this was due to the early rise of the trucking industry, using surplus war materiel and operated by returning servicemen. Additionally, the Depression of the 1930s reduced demand for services. South Australia, however, experienced a very sharp drop in productivity in the mid 1920s. In 1923, William Webb, an American, was employed as the Commissioner of the South Australian railways. Webb immediately embarked upon a major program of reform and modernization. This reform, which Webb made little effort to sell to local stakeholders, was both very costly and deeply unpopular (Jennings 1990). The high costs associated with new capital purchases and upgrades led, unsurprisingly, to a drop in productivity in the middle of the decade, as the railway became over-capitalized. Webb managed to offset some of this productivity loss through the application of improved operating procedures during the latter part of the decade, but when he left office in 1930 these unpopular management reforms were immediately reversed. With expensive infrastructure additions, but without the operational procedures to make best use of them, South Australia's railways stagnated for almost 50 years.

Other railways also experienced sharp shocks. In most cases, these were due to changes in grains traffic. For example, 1967-68 was a good harvest across Australia, and 1982-83 was a poor harvest in Victoria. Strictly speaking, these demand-side shocks represent productivity gains (or losses), as the same inputs are used to produce more (or less) output. However, they are essentially random shocks and are not related to the operational decisions of the railways themselves. As such, they are dissimilar to deliberate productivity improving measures, such as the adoption of diesel locomotives.

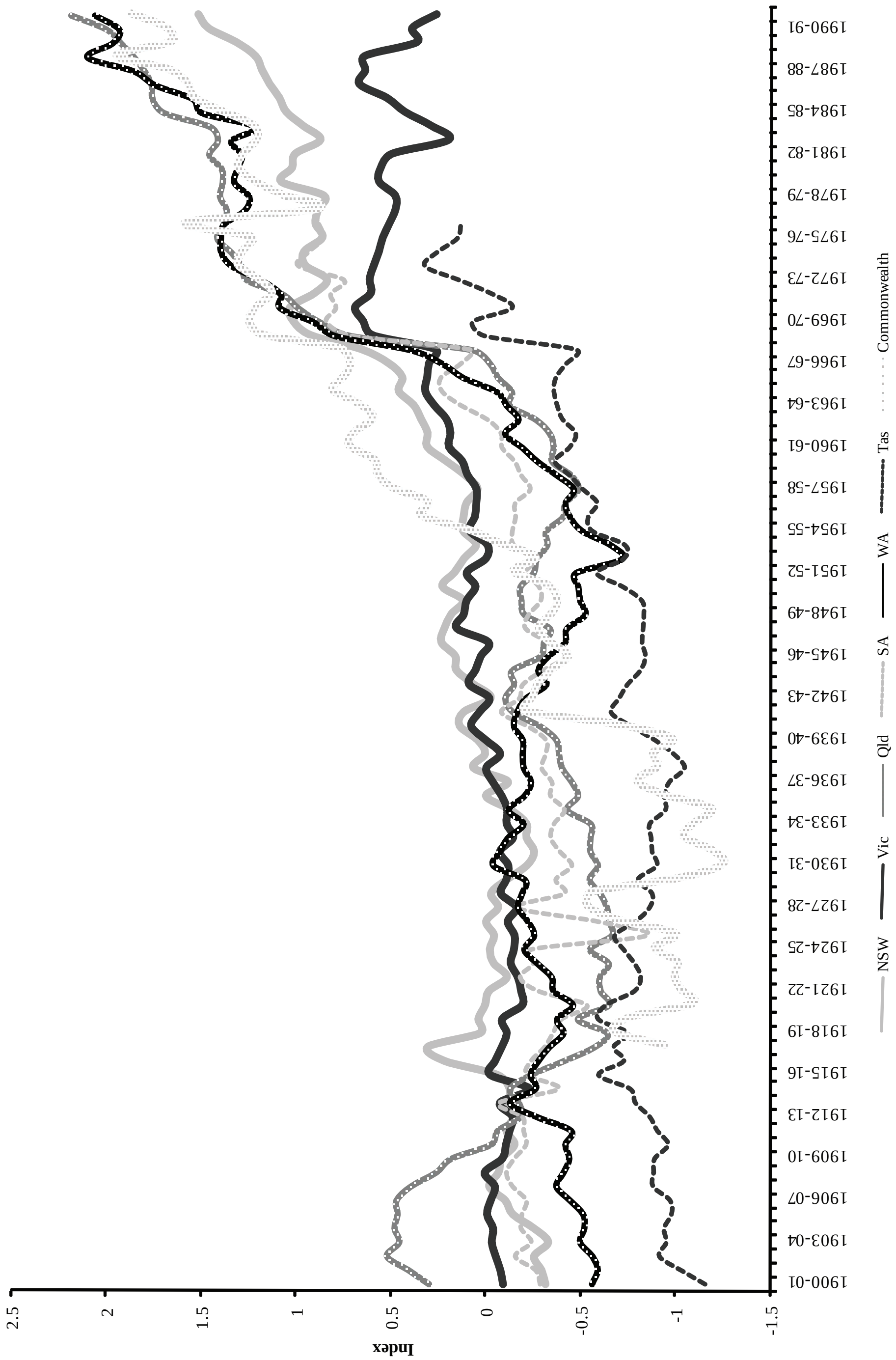
The second piece of productivity analysis follows the methodology of Caves et al. (1981), and allows one to compare across railways, as well as across time. Figure 9 shows the result.

Even as most railways experienced upward trends in productivity, particularly during the latter half of the twentieth century, their relative performances changed substantially. In particular, Queensland's railways began and ended the century the most productive in Australia, but slumped substantially for much of it. Prior to the export coal haulage of the 1960s, freight traffic was mostly agricultural and largely comprised of relatively short hauls to numerous regional ports. This contrasts with the railway systems of the other states, which were focused around the capital cities of each state and thus had greater opportunities to capture economies of density. The nature of freight traffic in Queensland made it particularly susceptible to competition from trucking. Western Australia experienced a similar issue after World War II, when the large network of relatively light-weight rail lines opened in the 1920s to promote agricultural development and began to impact substantially on the ability of the railway to compete against trucks. In the mid 1950s, many of these lines were closed and productivity began to increase rapidly, assisted by dieselization, which began soon after.

New South Wales and Victoria have similar productivity histories through the early 1960s, when export coal haulage began to become more important in New South Wales. From that date, Victoria, which had begun the century as the second most productive railway, performed relatively poorly and ended the period as the least productive railway by a considerable margin. In part, this is due to its reliance on agricultural traffic, which is very susceptible to drought (as in 1982-83) and to limits in the availability of agricultural land.

Although each railway has exhibited different histories, the general trend for all of them, with perhaps the exception of Victoria, has been an increase in productivity, particularly in the period after World War II. This was underpinned first by technical progress and the rise of bulk minerals haulage, and later by improved government policy towards railways, allowing them to be operated

Figure 9: Railway Total Factor Productivity: Cross Railway Comparison



as commercial businesses rather than public service organizations and arms of government transport policy.

CONCLUSIONS

From the analysis above, four lessons for the future sustainability of railways seem particularly clear. The first of these is that technical change clearly matters. If Australia's railways were still steam- driven, they could not hope to reach the levels of productivity seen today. However, not all technical progress improves productivity. Sydney began electrifying its suburban railways in the 1920s, but this seems to have had little influence on the productivity of the railways of New South Wales, despite the very large passenger traffic of Sydney. Thus, technical change would appear more successful when focused on parts of the railway business where economic drivers are more important.

Second, increases in traffic increase economies of network density and can thus improve productivity, as the experience of minerals traffic clearly shows. However, simply piling more freight onto rail will not necessarily make it more productive. The massive increases in traffic during the two World Wars had a relatively limited impact on productivity. In part, this is because the infrastructure was already stretched when the war began; the track and signaling infrastructure was aging and the lack of comparable gauges hampered the degree to which rolling stock could be shared across the nation to meet localized increases in demand associated with war traffic. The type of freight also matters. Moving troops and tanks around to disparate locations does not provide the same economies of scale as moving large amounts of ore in unit trains from a mine to a port. As policymakers consider ways in which to move freight onto rail, the type of freight for which they intend to induce modal shift and the degree to which the rail infrastructure has the spare capacity to absorb it (particularly without adversely influencing other, perhaps more productive rail traffic) should be foremost in their considerations.

Third, government policy can both help and hinder the railways. Policies to reduce inflation during the 1970s were clearly deleterious to the productivity of the railways. Arguably, the decision in the 1930s to reserve freight to rail also had a negative impact on the productivity of the railways, for it removed from them the useful force of inter-modal competition and their productivity growth suffered as a result. By the same token, the policy decisions of the late 1970s and early 1980s to force the railways onto a more commercial footing and expose them to the rigors of competition clearly had a major positive impact on their long-term productivity growth. As a general rule, policy which aims to move the railways towards what they do best as a business (rather than as a public service) and which exposes them to the consequences of any poor business decisions they might make, has the most beneficial effect on the productivity they are able to attain. Policy which supports other non-commercial goals seems less likely to assist the railways improve their productivity.

Finally, the experiences of Webb in South Australia in the 1920s highlight the importance of stakeholder management, particularly if change is rapid, costly and far-reaching. Without it, endeavors to improve productivity may have precisely the opposite effect. Although railways are no longer as crucial as they were in Webb's time, they still play an important role in the public psyche. While industry analysts appreciate and advocate the use of the most efficient transport mode for each transport task, politically, policies which shift freight from road to rail are invariably popular with the general public (who might otherwise have to share roads with large trucks), and policies which close passenger railways are invariably unpopular. Policymakers who focus solely on efficient operation without effective stakeholder management, like Webb, might similarly discover that rail is an industry where good ideas are necessary but not sufficient enough to ensure a sustainable future.

Endnotes

1. The database will be made available on CRAE's website (http://www.cbs.curtin.edu.au/index.cfm?objectid=9BD9DE7E-AAD5-1667-915D15A829680C3E), and inquiries concerning it can be made to the author.

2. There were also numerous private lines early in the century, often created as light railway lines to haul timber. Of these, the two-foot gauge sugar railways of Queensland are the only significant survivors (see http://www.lrrsa.org.au/index.html). In the 1960s, development of iron ore deposits in the Pilbara region in the North West of Western Australia facilitated the creation of 2,000 km of private rail track in the region devoted solely to hauling iron ore from mine to port. This is now the largest haulage task in Australia, comprising almost half of total freight traffic, and the railways themselves are the most efficient heavy haulage railways in the world. They have been subject to considerable controversy in recent years as a new entrant in the region (Fortescue Metals Group) has sought access to the lines of the incumbents (BHP Billiton and Rio Tinto) under Australia's third part access provisions. The website of the National Competition Council (see http://www ncc.gov.au/sector.asp?sectorID=23&page=) provides details of this process and also about the railway operations of the Pilbara region. The iron ore railways are not included in this paper because they are operated by the incumbents as part of the iron ore production chain, offering no services to shippers. There is thus no publicly available data on their operating costs with which to calculate their productivity.

3. In Figure 1, one can see a sharp drop in route miles, and in the asset base figures in the late 1970s associated with this takeover. The process of takeover also influenced the productivity of the Tasmanian and South Australian railways, as they divested non-performing assets ahead of the takeover.

4. Geometric means are used in the latter case because the log of the geometric mean is the arithmetic mean of the log-transformed data. Thus $\ln\left(Y_{ib} / \overline{Y}_i \right) = \ln\left(Y_{ib}\right) - E\left(\ln\left(Y_i\right)\right)$ and similarly for X.

5. Depreciation is more properly based upon asset usage than time. However, there are insufficient data to be able to implement this approach rigorously.

6. Where CPI has decreased from year to year, the CPI increase is set to zero.

7. See http://www rba.gov.au/Statistics/Bulletin/index html F Tables.

8. If one indexes wages for each year using one of the railways as base (in the years where all railways have data), the variance of these index numbers over time for a given railway is less than 1% of the mean (except in the case of Queensland, where it is 3%), suggesting each distribution is narrow, hence the proportional relationships between railways are roughly constant over time.

9. A gallon of diesel fuel contains roughly 146 megajoules of energy.

10. One metric tonne is 1.102 US tons. I use the Australian spelling here to ensure no confusion in the units of measurement.

11. New South Wales had always hauled coal, but coal exports began to take off during the 1960s.

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