The Productivity of Australia's Railways in the 20th Century – Consequences for a Growing, Sustainable Industry

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1 Introduction

During the course of the 20th Century, the role of railways in Australia's transport system has changed in ways few could have foreseen at its outset. 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 early 20th Century economists focussing on the first few decades of the century and contemporary studies rarely extending back further than 1970. In part, this analytical shortfall is due to a lack of useful data, and to this end, the Planning and Transport Research Centre (PATREC) is building a database covering the economic aspects of Australia's railways from Federation until the present day. It is hoped that, once developed, this database will stimulate more economic analysis of the industry. This paper represents some preliminary analysis of long-term productivity trends in Australia's railways, utilising an early version of the growing database.

Section Two of this paper describes the modelling procedures and data used. Section Three presents the productivity results and some brief analysis. Section Four concludes, and suggests some policy lessons for sustainability based on the past century of productivity growth within the railways.

2 Productivity Measurement and Data

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, Dean & Harper, 2001 for such a discussion) nor of its application in the analysis of railways, but rather a brief description of the methods used here.[1] The paper builds upon earlier work examining productivity in Australian railways, most particularly that of Brunker (1992) and Hensher, Daniels & DeMellow (1992,1994). It also draws methodologically on the quite substantial US literature on railway productivity, particularly Caves Christiansen & Swanson (1981), Bitzan & Keeler (2003) and Wilson (1997).

2.1 Productivity Measurement

Two approaches to productivity measurement are used in this paper. The first involves the use of a Tornqvist index, which is particularly useful where inputs and outputs change considerably over time as it uses a moving average approach, rather than a single base year. It is described in detail in Salerian & Jomoni (1994) and can be described as follows:

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

[1] I do not cover, for example, the decomposition of growth into technical and efficiency factors, which many authors have addressed by using a production frontier approach (see Perelman & Pestieau, 1998 and Cantos & Maudos, 2001, for two examples of this approach). The measures here might be interpreted as gross measures, which have not been decomposed.

Where:
TFP = total factor productivity
R = the share in total revenue of each of the *i* outputs.
Y = the amount of each output
S = the share in total costs of each input
X = the amount of each input *j* used in production

TFP growth is an annual comparison. However, to construct the graphs in Figure One, one needs a starting point, and hence TFP in 1900/01 is given a value of 100. Annual percentage changes are then applied with this as a starting point, but TFP groth itself is based on a moving average, not a base year. Waters & Street (1998) note that an arbitrary starting point is problematic, as it may not correspond to a time period where cost is minimised. I therefore constructed a second series whereby the starting point was the year in which freight density is maximised, a rough proxy for cost minimisation. In almost all cases, the maximum freight density occurred in the final years of the time period sampled, and hence the shape of the graphs in Figure One are not altered by this approach.

Hensher et al (1994) note that productivity in the different railways may have been very different in the base year, and hence that one cannot simply compare Tornqvist TFP indices across railways. For comparison across railways, we augment the Tornqvist index with another index, suggested by Caves, Swanson & Diewert (1982) and used in the Australian rail context by Hensher and his colleagues. 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:

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

Variables are defined as previously, with the addition of a *b* subscript, referring 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.

2.2 Description of the Data

As noted by numerous analysts of railways in Australia (see for example, the work of Hensher et al 1992, 1994, as well as the 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 amongst 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 to 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 2007). Whilst 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. Future work will extend the dataset, and thus the total factor productivity indices, to the present day, thus bringing into the analysis the past decade of institutional reforms in the industry. The data are described below.

2.2.1 Inputs

Capital: Capital is calculated via a perpetual inventory method, (see Brunker, 1992). The cost of each railway's capital in 1900/01 (expressed in 1991/92 dollars) forms a base. Each year investment is added to, and depreciation subtracted from this base to provide the change in the capital base for that year. Depreciation is straight line over 50 years, and investment figures are derived from ABS *Yearbooks*. 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 20th Century. In ABS data, operating expenses are divided into headings of "Maintenance", "Locomotives and Rolling Stock", "Traffic Expenses" and "Other Charges", and it is not clear exactly what portion of these expenses should be included in capital. Determining this division is an ongoing part of the construction of the railways database.

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 percent.[2] This represents the opportunity cost of capital. Hensher et al (1992, 1994) use an opportunity cost of capital of seven percent, which is reasonable for the time period they analyse, but which seems less appropriate for earlier decades. The figure of 3.08 percent represents the average from 1969 to 2005 of the difference between the yields on 10 year government bonds and CPI growth.[3] 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 patchy to be used for the whole 20th Century. Part of the ongoing work involving the database will be to develop a more rigorous measure of the cost of capital.

Labour: Labour 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 labour is sourced primarily from ABS figures on salaries and wages. Whilst all *Yearbooks* provide data on staff numbers, only Western Australia provides a consistent series on salaries and wages for the whole 20th Century. However, relative wages amongst the railways tended to maintain their proportional relationship over many years. Thus, to estimate salary and wage costs where data do not exist (primarily prior to 1930, and during World War Two), 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 (the total of the four categories above) minus salary and wages costs. As noted in the discussion on capital, this will include a certain amount of expenditure on rolling-stock that should more properly be included as capital, a modification which is a work in progress. Hensher et al (1992, 1994)

[2] Where CPI has decreased from year to year, the CPI increase is set to zero.
[3] See http://www.rba.gov.au/Statistics/Bulletin/index.html F Tables.

separate data from 1971 to 1992 into energy and materials, calculating materials in the same way as this paper and using mega-joules of energy to account for different energy sources. In earlier years, reporting in ABS *Yearbooks* on fuel used and the cost of fuel is sporadic. However, separation of this data is intended to ultimately occur in the database being built. 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 used.

2.2.2 Outputs

Freight: Freight output is calculated as the number of net-tonne-kilometres (ntks) of freight per annum. New South Wales, Tasmania and South Australia report this figure right from the outset of the 20th Century, but other railways begin later. All railways except Western Australia and Queensland cease reporting this data for the duration of World War Two. All railways, for all years in the sample, report total train miles, 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 miles, 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 dependent 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. 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. In each case, the best regressions predicted within a few percentage points of the actual values.

Passengers: Passenger outputs were measured by passenger kilometres. As with ntks of freight, the data series were incomplete. However there was a complete series for passenger journeys and passenger revenue. It was also possible to derive a series for passenger train kilometres using extant ABS data. Thus, passenger kilometres, where data did not exist, were estimated econometrically in the same manner as ntks of freight above, with passenger train kilometres, passenger journeys and passenger revenues forming potential independent variables and regressions being chosen on the basis of their predictive ability. In general, passenger kilometres 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 kilometres to the ABS at all and hence there was means of estimating a regression in first differences specifically for Queensland. Moreover, using time series data from other railways and the usual approach with non-stationary data of finding a cointegrating relationship could not be employed as, with no data on Queensland passenger kilometres, there was no robust way of determining the error vector to include in an error correction mechanism. Thus, seven cross-sectional OLS regressions were run for each year for all railways together (except Queensland), with the actual or predicted (via the method described above) passenger kilometres as the dependent variable, and passenger train kilometres, passenger revenues and passenger journeys as potential independent variables. 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 for passenger journeys, passenger train kilometres and passenger revenues (as appropriate) to obtain a figure for passenger kilometres for a given year. This was done for 1900 to 1977. After this date, South Australian and Tasmania were subsumed into Australian National (AN), and the cross-sectional dataset went from six railways to four, significantly reducing the degrees of freedom available in each regression. Thus, for data post 1977, the predictive methodology described above, using the values derived via cross-sectional regressions for Queensland passenger kilometres from 1900 to

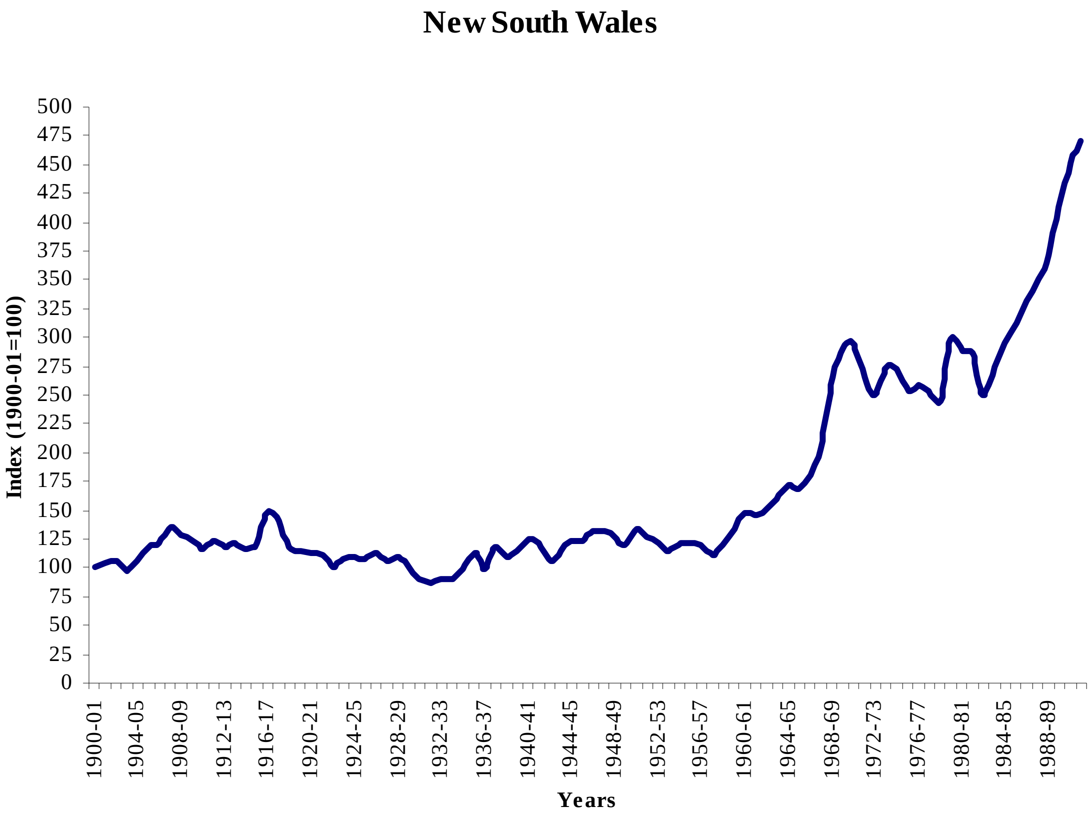
1977, was used. The same methodology was used to eliminate the three or four outliers which annual cross-sectional regressions produced.[4]

The ad-hoc nature of the calculation of the passenger kilometre series, particularly in the case of Queensland, is acknowledged. One task for the ongoing work on the database will be to improve this series, by using other data sources, such as annual reports, where more data might be available.

3 Results

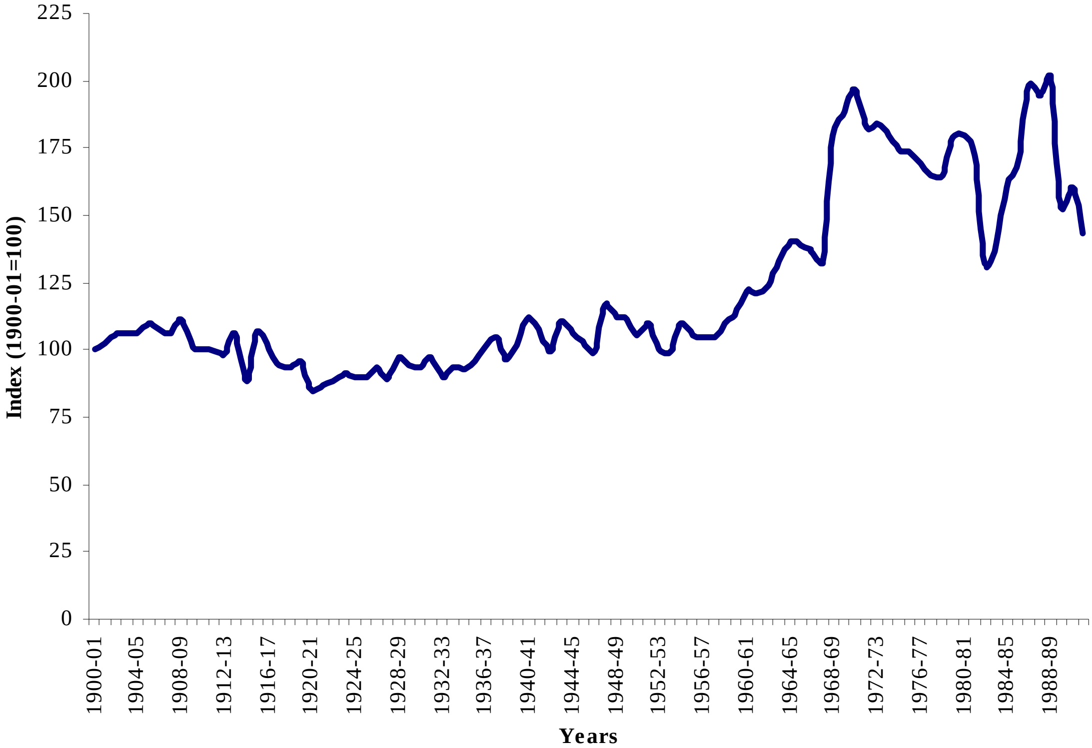
The first results presented are those for the Tornqvist productivity index. Since each railway had a different level of productivity in 1900/01, comparisons can only be made inter-temporally for a single railway, not across railways. Figure One presents this comparison.

Figure 1 Tornqvist Total Factor Productivity Results

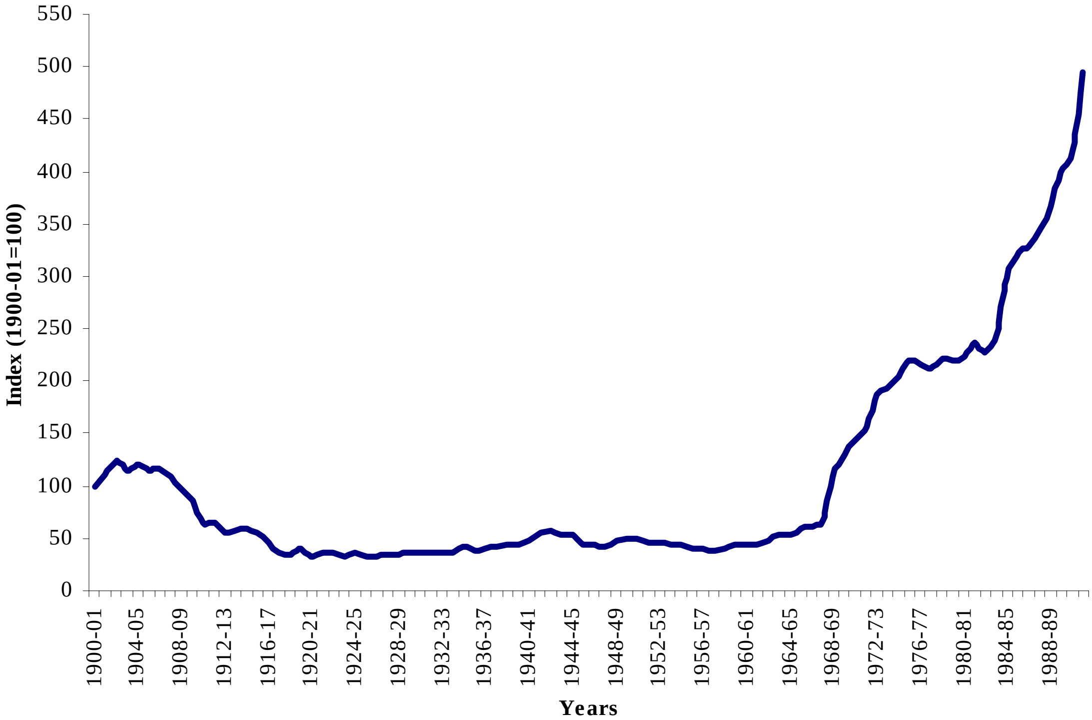


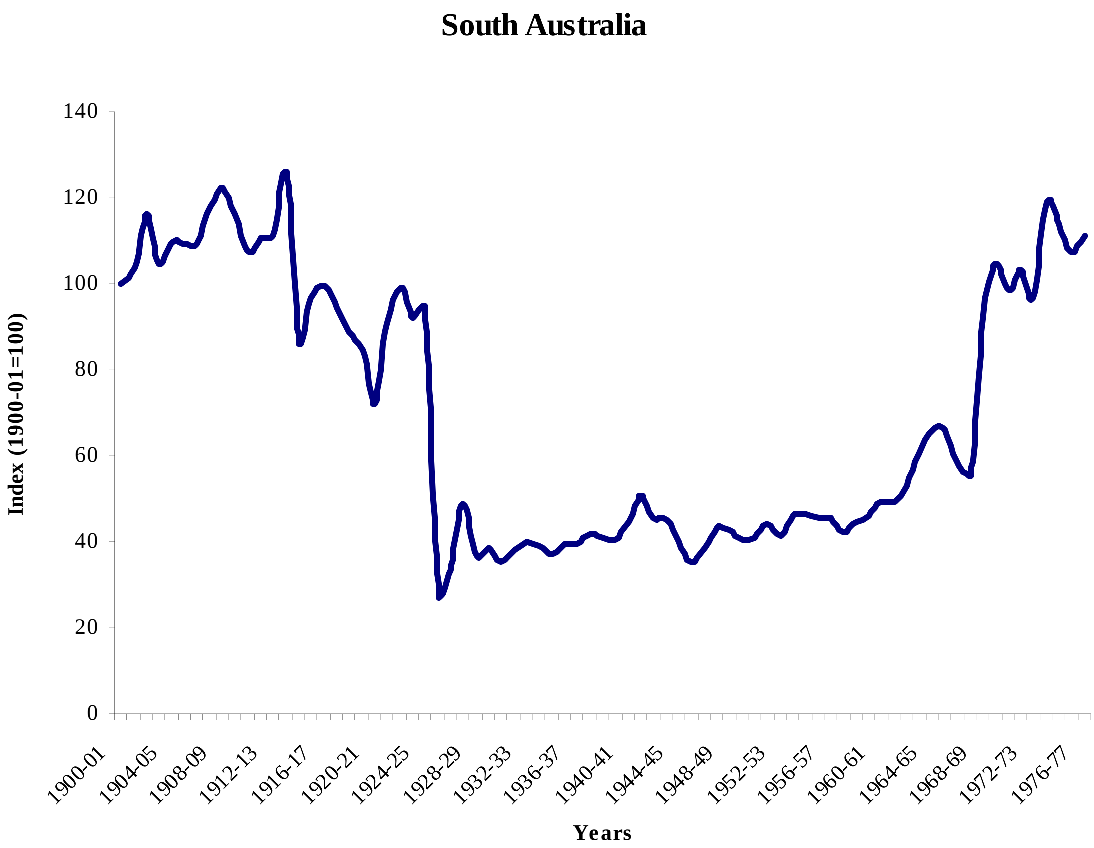
[4] In these three or four cases, the derived figures for passenger kilometres was very different from those in years either side, and the data on revenues, journeys and train kilometres did not seem to support such a large digression. They were thus re-estimated.

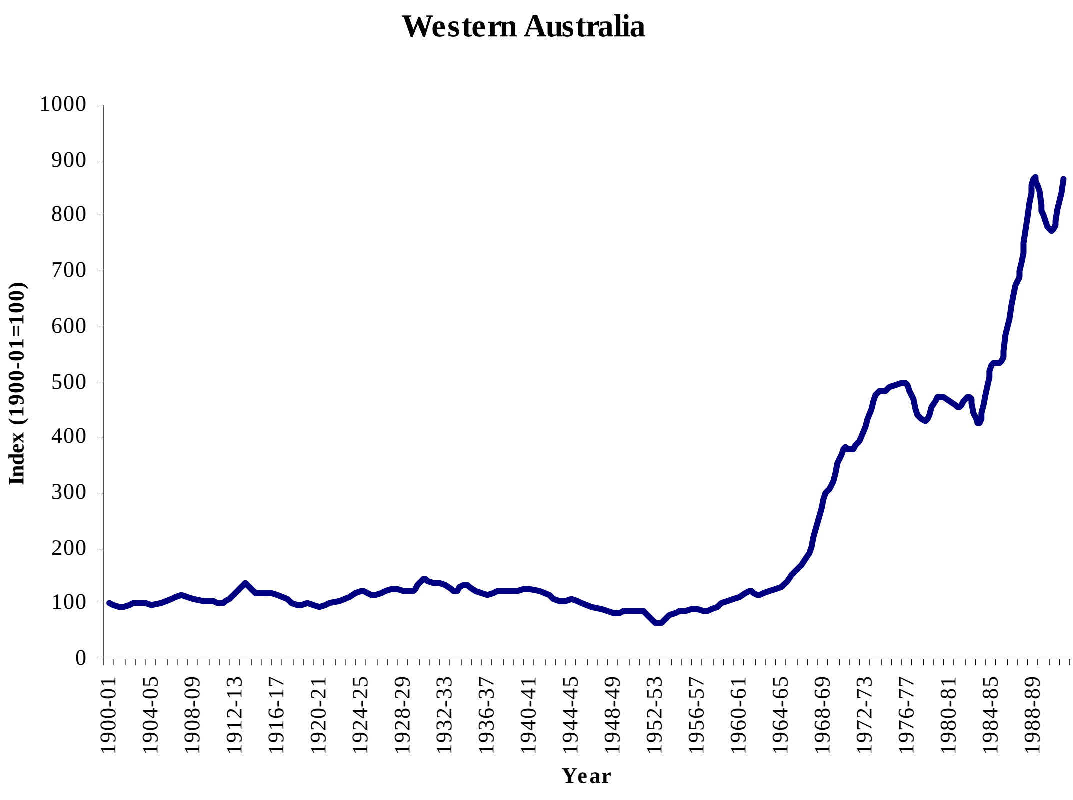
Victoria

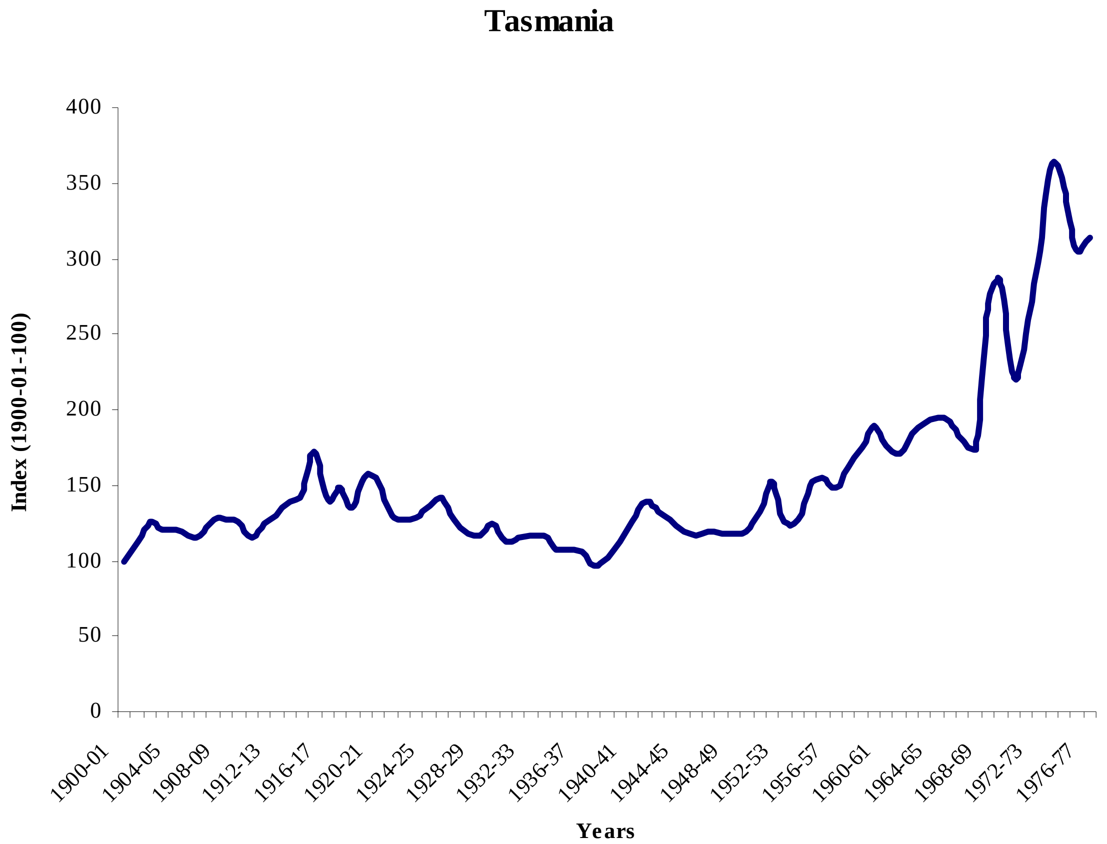


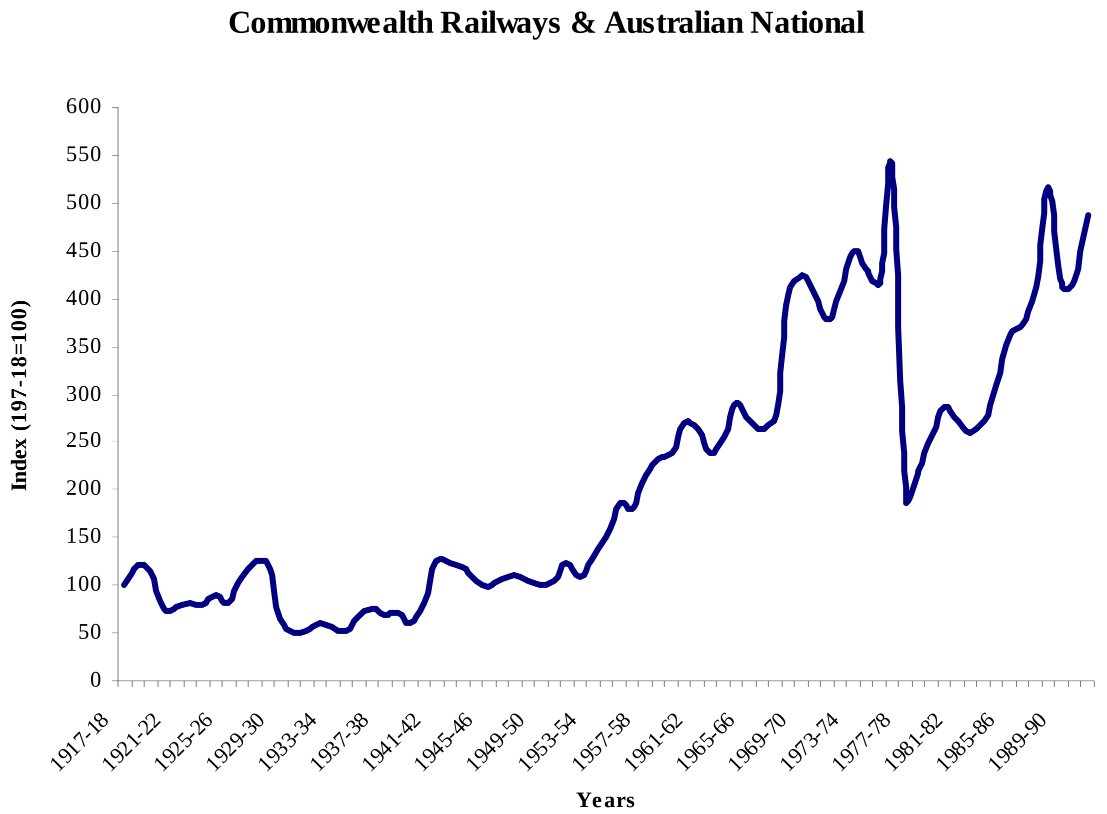
Queensland




South Australia
Index (1900-01=100)
140
120
100
80
60
40
20
0
1900-01
1904-05
1908-09
1912-13
1916-17
1920-21
1924-25
1928-29
1932-33
1936-37
1940-41
1944-45
1948-49
1952-53
1956-57
1960-61
1964-65
1968-69
1972-73
1976-77
Years


Western Australia
Index (1900-01=100)
1000
900
800
700
600
500
400
300
200
100
0
1900-01
1904-05
1908-09
1912-13
1916-17
1920-21
1924-25
1928-29
1932-33
1936-37
1940-41
1944-45
1948-49
1952-53
1956-57
1960-61
1964-65
1968-69
1972-73
1976-77
1980-81
1984-85
1988-89
Year


Tasmania
400
350
300
250
200
150
100
50
0
Index (1900-01-100)
1900-01
1904-05
1908-09
1912-13
1916-17
1920-21
1924-25
1928-29
1932-33
1936-37
1940-41
1944-45
1948-49
1952-53
1956-57
1960-61
1964-65
1968-69
1972-73
1976-77
Years


Commonwealth Railways & Australian National
600
550
500
450
400
350
300
250
200
150
100
50
0
Index (197-18=100)
1917-18
1921-22
1925-26
1929-30
1933-34
1937-38
1941-42
1945-46
1949-50
1953-54
1957-58
1961-62
1965-66
1969-70
1973-74
1977-78
1981-82
1985-86
1989-90
Years

Each of the railways has quite a different history. In particular, some have clearly fared much worse than others, with productivity improvements over the century ranging from 25 percent in Victoria to an almost eight-fold increase in Western Australia. However, it is possible to break the century into four 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 much of the growth in the land transport task, keeping its freight task roughly constant whilst road took most of the additional demand, particularly outside bulk minerals and particularly after 1954, when the Privy Council decision in respect of the Hughes and Vale case resulted in the deregulation of interstate road transport. 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 affect productivity much. Then, from the late 1950s until the early 1970s, railways replaced their 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 for services they controlled. The railways had to seek Parliamentary approval for any price increases, and this was rarely given during this time. However, Parliaments could not prevent input prices from increasing and the railways began to make massive losses. 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 percent for each, which was then compounded by a drought in Victoria in 1982/83 which saw the grain haulage task fall by two-thirds. With no concomitant drop in costs, productivity fell by a quarter in one year, taking several years to recover.

The debt crisis in Australia's railways forced a major change in government policy during the 1980s. In order to try and reduce debt, the focus of railway operation was shifted from public service to commercial viability. The practical response to this shift in policy was a shedding of excess staff and closing of unproductive lines and services (the latter possible as common carrier obligations were removed). Part of the policy shift was a removal of legislation dating from the 1930s which reserved certain freight tasks to rail in order to 'protect' the railways from competition in these freight tasks. Freed of such 'protection' and subject to inter-modal competition, railways responded by focussing on the niches where they could perform best. This response happened very quickly, and the timing of the reforms can be dated with reasonable accuracy by examining the upward shifts in productivity in each railway. Westrail, which began commercial corporate planning in the 1970s, saw the earliest gains (later lost due to government pricing restrictions) and provides a clear example of the size of productivity gains associated with the response to a commercial focus for rail policy. In a few short years in the middle of the 1980s, Westrail cut 15 percent of its staff and stopped providing loss-making less than container-load services. The result was a 35 percent increase in productivity in just three years. AN and Queensland Rail, given commercial charters in the late 1970s and early 1980s respectively began their productivity gains next, and New South Wales and Victoria, who waited longest before instituting reforms, did not see benefits arising until the latter half of the 1980s.

Three points of expected similarity do not arise; productivity increases during wartime were moderate, and productivity did not seem to decrease markedly in response to the Depression in the early 1930s for most railways. The lack of large wartime peaks may be due to capacity constraints; either the railways literally could not expand to accommodate all of the extra demand or the increase was so large and rapid that the railways began to suffer diseconomies of scale and scope. Capacity constraints existed partially because funds were limited for capital expansion or the purchase of new rolling stock, and partially because wartime also placed a large strain on manpower available for the railways; Victoria, for example, lost 15 percent 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 optimisation as a steady minerals freight task might provide. The lack of a trough in the Depression may be due to government policies to reserve freight tasks for rail (as well as railway construction projects to soak up unemployment) initiated in the early 1930s. Thus, whilst 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. [5] WA data does not cover iron ore railways in the Pilbara, which are amongst the most productive in the world. The productivity increases from unit train minerals haulage in New South Wales are clouded somewhat by the fact that New South Wales also has substantial other rail services. Queensland provides the starkest example of what minerals transport can do. 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 are the most productive in the country (see Figure Two below) by the end of the period of analysis.

Minerals traffic was not, however, a necessary requirement for productivity growth, as the history of Commonwealth Railways and AN 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. Firstly, it was a long thin railway, with the Trans-Australia link in particular providing a business where it could compete very well with trucks for intermodal haulage. Secondly, successive Federal governments were determined to use AN (particularly) 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 AN was required to act in a commercial manner under its government charter. The commercial focus of AN allowed it to recover relatively quickly from the absorption in 1978 of Australia's least productive railways, Tasmania and South Australia. National Rail, the successor to AN's freight business after the period analysed, continued its productivity growth.

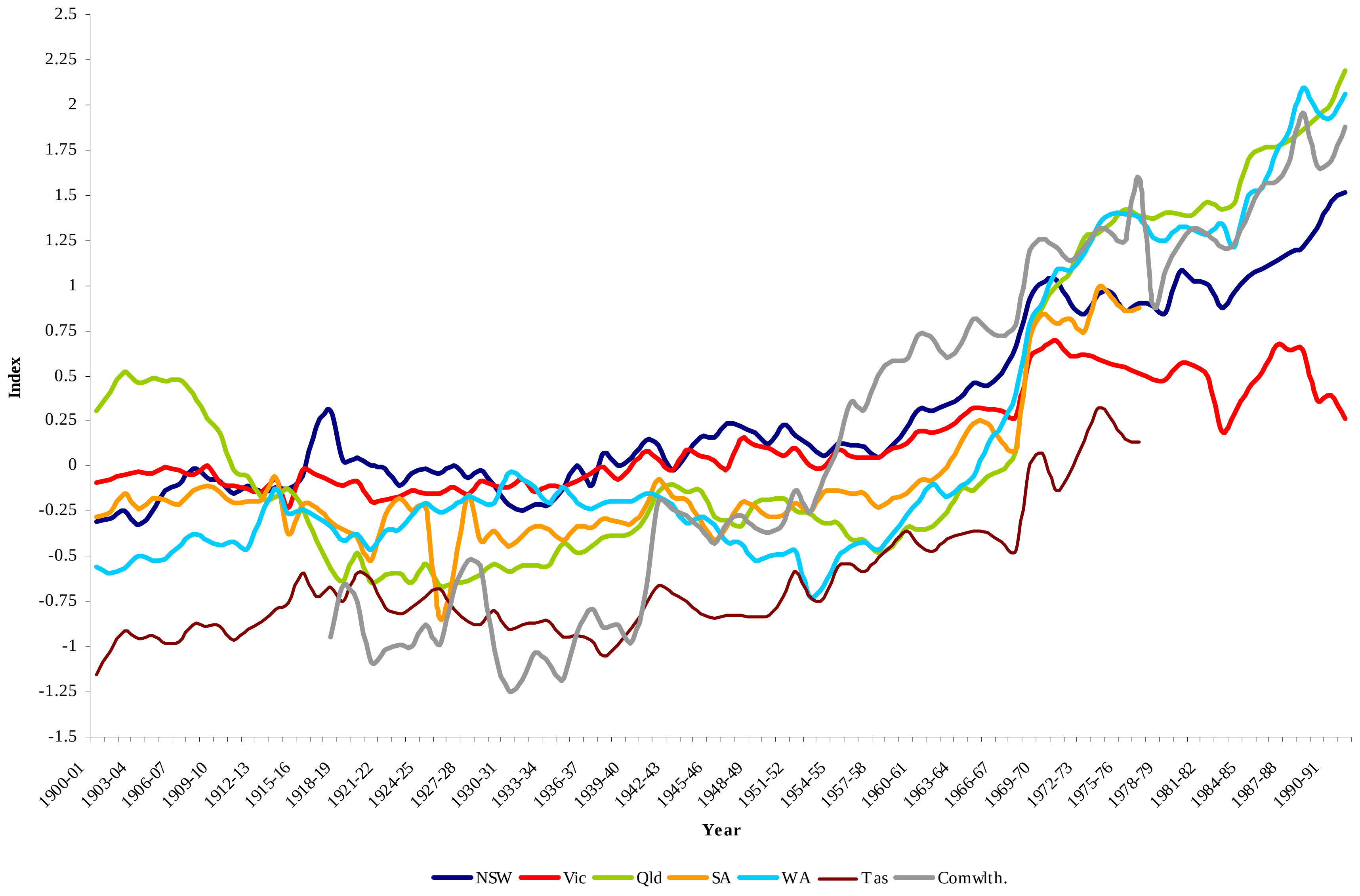
In the inter-war years, productivity at most railways trended downwards. In part, this was due to the early rise of the trucking industry, using surplus war materiel and operated by returning servicemen. Additionally, the Depression of the 1930s reduced demand for services. South Australia, however, experienced a very sharp drop in productivity in the mid 1920s, which deserves exploration. In 1923, William Webb, an American, was employed at great expense as the Commissioner of the South Australian railways. Webb immediately embarked upon a major programme of reform and modernisation. This reform, which Webb made little effort to sell to local stakeholders, was both very costly and deeply unpopular (see Jennings, 1990). The high costs associated with new capital purchases and upgrades lead, unsurprisingly, to an immediate drop in productivity in the middle of the decade as the railway became over-capitalised. Webb managed to claw back some of this productivity loss through 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.[6]

The second piece of productivity analysis follows the methodology of Caves et al (1982), and allows one to compare across railways as well as across time. Figure Two shows the result.

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

[6] In the early 1970s, productivity results for both South Australia and Tasmania show a sharp shift upwards. However, in the period prior to Federal takeover, both railways received government funding and made structural changes to facilitate the takeover. It is not clear what extent these activities, rather than genuine increases in operational efficiency, are driving results.

Figure 2 Railway Total Factor Productivity: Cross Railway Comparison



Even as most railways experienced upward trends in productivity, particularly during the latter half of the 20th 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. It seems most likely to be driven by the nature of the haulage task. Prior to the export coal haulage of the 1960s, the freight task 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 centred around the capital cities and thus had greater opportunities to capture economies of density in freight haulage. The nature of the freight task in Queensland made it particularly susceptible to competition from trucking. Western Australia experienced a similar issue after World War Two when the large network of relatively light rail lines, opened in the inter-war period to promote agricultural development, began to impact substantially on the ability of the railway to operate productively against increased competition from trucks. In the mid 1950s, many of these lines were closed and productivity began to increase rapidly, assisted by dieselisation, which began soon after.

New South Wales and Victoria possess remarkably similar histories in their railway productivity, through until the early 1960s, when export coal haulage began to become more important in the former case. From that date, Victoria, which had begun the century as the second most productive railway, suffered productivity losses, ending the period as the least productive railway by a quite 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. However, it does raise the question as to how sustainable Victoria's rail network actually is. The fact that the most recent owners of the system have returned the infrastructure to the State government suggests perhaps that quite large changes might need to be made to the network to ensure its sustainability.[7]

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 Two. This was underpinned first by technical progress, and later by improved government policy towards railways, allowing them to be operated as businesses and to find their niche in the developing logistics chains supporting both export and domestic freight tasks. The Industry Commission (1991) called the reforms covered by the last decade of the period of observation of this paper "Phase One" reforms; essentially all the railways could do without some fundamental changes to their structure. Structural reform began in the early 1990s, and the next phase of this work will examine how this has influenced productivity in more recent years.

4 Conclusions and Further Work

The work of this paper is in a sense incomplete. Total factor productivity has been calculated and some factors driving its growth have been discussed. However, it remains to establish the extent to which each of the factors identified influenced productivity. This is a task for regression analysis, in a similar vein to that of Hensher et al (1992, 1994), and will form an important component of ongoing work.

However, even from the initial work undertaken to date, some lessons for the future sustainability of the industry, can be ascertained. Ongoing productivity growth is crucial for an industry such as rail, whose economics are heavily affected by the ability to increase train loads and which faces intermodal competition where productivity is growing rapidly. It remains, then to consider what this brief analysis suggests for policymakers concerned with the sustainability of the rail industry. Four lessons seem particularly clear.

[7] The Freight Network Review is currently looking into this issue, and is due to report in November 2007.

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 task of Sydney. Thus, technical change would appear more successful when focussed on parts of the railway business where economic drivers are more important, and hence productivity is more able to respond to technical stimuli.

Secondly, 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 the transport task 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 below-rail infrastructure was ageing and the lack of comparable gauges hampered the degree to which rolling stock could be shared across the nation to meet localised increases in demand associated with war-traffic. In part also, the type of freight matters. Moving troops and tanks around to disparate locations does not provide the same above-rail 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 tasks) should be foremost in their considerations.

Thirdly, government policy can both help and hinder the railways. Government fiscal policies 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 rigours of competition clearly had a major positive impact on their productivity growth.[8] As a general rule, policy which aims to move the railways towards what they do best as a business (rather than, say, 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 which they are able to attain. Moreover, policy which supports other goals, removed from a clear economic goal, seems less likely to assist the railways. The experiences of the railways in the 1970s, when asked to assist in fighting inflation, clearly show this.

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, endeavours 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. Although 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, and policies which close passenger railways are invariably unpopular. Policymakers who focus, like Webb, solely on efficient operation, without effective stakeholder management, might similarly discover that rail is an industry where good ideas are necessary but not sufficient to ensure a sustainable future.

[8] Whether the policy decisions of the 1990s which assumed the possibility of competition above rail and opened railways to third party access will result in similar productivity gains remains to be seen.

References

Akaike H (1973) Information Theory and an Extension of the Maximum Likelihood Principle pp243-7 of Petrov B N & Csaki F (eds) *2nd International Symposium on Information Theory* Akedemia Kiado, Budapest

Australian Bureau of Statistics (ABS) (various years) *New South Wales Year Book* ABS Cat no 1301.1

Australian Bureau of Statistics (ABS) (various years) *Queensland Year Book* ABS Cat no 1301.3

Australian Bureau of Statistics (ABS) (various years) *Rail Transport Australia* ABS Cat no 9213.0

Australian Bureau of Statistics (ABS) (various years) *Rail, Bus and Air Transport* ABS Cat no 9201.0

Australian Bureau of Statistics (ABS) (various years) *South Australian Year Book* ABS Cat no 1301.4

Australian Bureau of Statistics (ABS) (various years) *Tasmanian Year Book* ABS Cat no 1301.6

Australian Bureau of Statistics (ABS) (various years) *Victorian Year Book* ABS Cat no 1301.2

Australian Bureau of Statistics (ABS) (various years) *Western Australian Year Book* ABS Cat no 1301.5

Australian Bureau of Statistics (ABS) (various years) *Year Book Australia* ABS Cat no 1301.0

Bitzan J D & Keeler T E (2003) Productivity Growth and Some of its Determinants in the Deregulated US Railroad Industry *Southern Economic Journal* 70(2) 232-53

Brunker, D (1992) Total Factor Productivity in Australian National Railways: An application of shadow prices *Transport Research B* 268 (6) 449-459.

Bureau of Transport and Regional Economics (BTRE) (2006) *Freight Measurement and Modelling in Australia*, Report 112, BTRE, Canberra

Cantos, P & Maudos J (2001) Regulation and Efficiency: The case of European railways *Transportation Research A* 35 459-72.

Caves D W , Christiansen L R & Swanson J A (1981) Productivity Growth, Scale Economies and Capacity Utilization in US Railroads, 1955-74 *American Economic Review* 71 (5) 994-1002.

Caves D W, Christiansen L R & Diewert W E (1982) Multilateral Comparisons of Output, Input, and Productivity Using Superlative Index Numbers *The Economic Journal*, 92 (365) 73-86.

Hensher, DA, Daniels, R & DeMellow, I (1992) A comparative Assessment of the Productivity of Australia's Rail Systems 1971/72-1990/91 *Institute of Transport Studies Working Paper 92-7* University of Sydney.

Hensher, DA, Daniels, R & DeMellow, I (1994) Revision and Update: Productivity of Australian Railways 1971/72 to 1991/92 *Institute of Transport Studies Working Paper 94-14* University of Sydney

Hulten C R , Dean E R & Harper M J (eds) (2001) *New Developments in Productivity Analysis* London: University of Chicago Press

Industry Commission (1991) *Rail Transport*, IC Report no 13, AGPS, Canberra.

Jennings, R I (1990) Webb, William Alfred (1878-1936) *Australian Dictionary of Biography Vol 12* Melbourne: Melbourne University Press 428-29

Productivity Commission (1999) *Progress in Rail Reform*, Report no 6, August 1999, AGPS, Canberra

Perelman, P & Pestieau, P (1988) Technical Performance in Public Enterprises: A comparative study of railways and postal services, *European Economic Review,* 32 432-41

Salerian J & Jomoni P (1994) Total Factor Productivity, Annual User Charges, Capital Stocks and Cost Allocation: A synthesis *Australian Economic Review* 3rd qtr 1994 55-63

Schwarz G (1978) Estimating the Dimension of a Model *The Annals of Statistics* 8 461-4

Waters J G & Street J (1998) Monitoring the Performance of Government Trading Enterprises *Australian Economic Review* 31(4) 357-71

Wills-Johnson, N (2007) *Separability and Subadditivity in Australian Railways*, PATREC Working Paper 11, Available from http://www.patrec.org/publications/index.php

Wilson W W (1997) Cost Savings and Productivity in the Railroad Industry *Journal of Regulatory Economics* 11 21-40