Transportation (2012) 39:1281–1299
DOI 10.1007/s11116-012-9389-6

An assessment of cost management regimes in British rail infrastructure provision

Jonathan Cowie · Sarah Loynes

Published online: 19 February 2012

Abstract Over the last decade, British railway engineering efficiency has come under close scrutiny, with general perceptions of massive maintenance cost escalations and a general lack of control over these costs. This is exemplified by headline figures such as Roger Ford's perceptions of a 50% rise in maintenance costs since privatisation (Mod Railw 638:8, 2001), or the more recent figure of a doubling in all rail costs since privatisation presented by Shaoul (Public Money Manag 26:151–158, 2006). Little, however, has appeared in the academic literature on the subject. This paper considers these issues through an examination of British railway infrastructure costs over the period 1980–2009, which has seen three different infrastructure management regimes in place—the nationalised BR (1980–1994), the privatised Railtrack (1995–2001) and the not for dividend Network Rail (2002–2010). Infrastructure costs are examined in total for all operating costs (including maintenance but excluding renewals and depreciation), and under two sub categories, signalling and management costs. The results show that in the case of total operating costs, by the end of the period (up to 2010) these had returned to pre-privatisation levels. The results also show that costs increased significantly following privatisation due to imperfect competition in sub contractor markets, but large declines in the last 6 years have eradicated most of these costs increases, although still do not match the best achieved under full public sector management. Management costs associated with the infrastructure on the other hand have increased significantly.

Keywords Rail infrastructure management · X-inefficiency · Privatisation · Imperfect competition

J. Cowie (✉)
SEBE/Transport Research Institute, Edinburgh Napier University, 10 Colinton Road, Edinburgh EH10 5DT, UK
e-mail: j.cowie@napier.ac.uk

S. Loynes
c/o Jonathan Cowie, Transport Research Institute, Edinburgh Napier University, 10 Colinton Road, Edinburgh EH10 5DT, UK

Introduction

Over the last decade, British railway engineering has come under an unprecedented level of public scrutiny, with general perceptions of massive cost escalations and an organisational lack of control over these costs. Shaoul (2006) for example estimates that all rail industry costs have more than doubled since privatisation, with the infrastructure provider being a major contributor to this increase. Roger Ford estimated that maintenance costs of infrastructure had risen by 50% over the first 5 years of Railtrack stewardship (Mod Railw 2001). Such views and general perceptions raise serious questions over the management of rail infrastructure costs in the British industry, however, to date little has appeared in the academic literature on the subject.

The aim of this paper therefore, is to assess the operational cost of providing British railway infrastructure from 1980 to 2010, a period which encompasses three different infrastructure management regimes—the nationalised British rail (BR) (1980–1994), the privatised Railtrack (1995–2001) and the not for dividend Network Rail (2002–2010). This is considered under the framework of Leibenstein's idea of X-inefficiency (Leibenstein 1966), in particular through an examination of agent/principle and impactor/impactee relationships in rail infrastructure provision.

One of the major problems with this research has been in collecting data that actually allows some form of meaningful comparison of the three different ownership regimes to be made. Data on renewals for example, whilst available for most of the period under review, was not considered to be of a sufficiently comparable level to allow any form of meaningful comparisons to be made, hence is not examined in the paper.[1] The whole issue of data collection in the British railway industry, however, appears to be highly problematic. To give a simple if trite example, in the 2006 edition of the annual publication 'Transport Statistics Great Britain' (DfT 2006), some 500 km of the nation's rail infrastructure appears to have disappeared between 2003/4 and 2004/5 due to a break in the series caused by 'a change in methodology'. This begs the question of how many ways can there be to measure the distance covered between two points on a rail network? It also raises the question that if such a simple measure can produce an almost 4% cut in the length of the network, then how are things likely to be with more complex issues? Shaoul (2006) also highlights the difficulty in obtaining relevant and consistent data from the train operating companies, the (then) Strategic Rail Authority and from government statistics. Despite experiencing similar problems, what is presented in this paper are comparisons that are, as far as possible, believed to be 'realistic', although some margin for error to allow for measurement differences should always be present in any such analysis.

Privatisation of British railway infrastructure

With firstly the White Paper, New Opportunities for the Railways (HMSO 1992), and then the Railways Act 1993, the whole railway services sector within Great Britain was transferred to the private sector, including both assets and operations. As this whole process has been extensively documented elsewhere (see for example Freeman and Shaw 2000 and Wolmar 2005), this section only briefly focuses on the position of the infrastructure provider in the privatised structure. Prior to restructuring for privatisation, BR was divided into some seven business

[1] This is for many reasons too numerous to list here, however, one simple example has been the significant increases in renewals that have occurred periodically over the whole period, particularly under Network Rail stewardship, which is far more indicative of a policy of a programme of renewal rather than related to cost management of the infrastructure. For more information, see Wolmar (2005).

sectors, three for passenger, three for freight and one for parcels. Train infrastructure costs were allocated on a prime user basis, where the prime user of a given route bore all the fixed and marginal costs of the infrastructure, with other users only paying their marginal costs. All maintenance and engineering works concerning the infrastructure were carried out by a separate division within BR, British Railway Infrastructure Services (BRIS). Consequently, all track and signalling costs were accounted on a national basis and shown separately in the BR accounts. In restructuring for privatisation, all rail infrastructure activities were transferred to a separate group, and infrastructure costs paid on the basis of a full cost access charge for all users. BRIS was then split up into a single infrastructure operator (Railtrack) and fourteen infrastructure service companies (Infracos). Railtrack was then floated on the Stock Exchange in April 1996 and sold for £1.9bn and the Infracos sold to the private sector in private sales. The 'plan' was that Train and Freight Operating Companies would pay the full cost of infrastructure access, with the access charge being made up of an 'access' charge, i.e. a fixed access fee, and a variable charge dependent upon the distance travelled and rolling stock used. Railtrack would contract out all of its maintenance and renewals to the Infracos. Due to the monopoly position of Railtrack, access charges were regulated by the Office of the Rail Regulator on the basis of a fixed percentage of the value of the regulatory asset base (originally 8%). These were to be set over 5 year control periods, the first running from 1996 to 2001, the second 2001–2004, CP3 from 2004 to 2009 and CP4 from 2009 to 2014.

Under this structure, efficiency improvements in infrastructure maintenance and operation would be driven by a single (regulated) purchaser of railway infrastructure maintenance/renewals (Railtrack) contracting this work out. The Infracos were divided into infrastructure maintenance companies (IMCs) and track renewal companies (TRC), eight and six, respectively, who would bid for this work. This would ensure that costs decreased, with competition in the market further ensuring that these costs remained at a low level, i.e. cost efficient. This was in part countered by poorly specified maintenance and renewal contracts and subsequent market developments when these companies consolidated and merged, so that many IMCs and TRCs ended up under the same company ownership for reasons of structural symmetry and profit maximisation.

Following the network wide disruption which followed the Hatfield accident and the subsequent administration of Railtrack in 2001, the government, after an intervening period of 12 months, formed the not for dividend Network Rail to take over the operation and maintenance of the rail infrastructure. This is a state owned private company limited by guarantee. This brought much of the infrastructure provision back in house, and led to a significant increase in the size of the infrastructure provider.[2] Control period 3 also saw a revision to the system of access charges, in particularly the heavy reliance on these for operational funding. Infrastructure operations are now funded through a combination of access charges, other revenue and direct grant (in a rough 30–10–60 split), and CP4 saw further revisions to freight operator charges, where these are now based on the marginal cost.

Efficiency and productivity in rail infrastructure

Research on the subject of the efficiency/productivity of rail infrastructure provision is relatively scarce and patchy, certainly when compared to the volume of research relating to

[2] To give some indication of the scale of this increase, staff levels rose rapidly from 9,000 employees under Railtrack management to 27,000 within the new Network Rail, and now, at the time of writing, stands at around 35,000.

various aspects of integrated railway operations. This is due to the fact that there has been little interest or indeed opportunities to study the topic prior to the Swedish (then highly radical) division of infrastructure from operations in 1988. In a comparatively 'early' piece of research, Preston (2002) considered a number of issues surrounding the then privately owned Railtrack, including the cost of infrastructure provision. This he found to have increased by 20% since privatisation. In a comparison of Railtrack costs with that of the Swedish Rail Administration (Banverket), however, these were found to be broadly comparable when measured across a number of different standardising variables such as train kilometres. The author noted that this was a somewhat surprising result, given Banverket was a publicly owned body and, citing Larsson and Ekstrom (1993), highlighted that it is one that had been considered to have engaged in gold plated engineering in the past.

Of the remaining literature relevant to the current context, most centres on the British experience and in particular has arisen out of the regulatory issue of the setting of efficiency improvement targets for the infrastructure provider. The first such study of note was the NERA report (NERA 2000) undertaken for the then UK Office of the Rail Regulator to examine efficiency in the provision of infrastructure. NERA examined five countries (America, Canada, Australia, Japan and Sweden) selected on the criteria that a significant proportion of services had been split from operations. Most of their analysis however concentrated on US Class 1 railroads, i.e. vertically integrated railways. Whilst accepting that differences in both traffic mixes and densities could significantly affect the cost of infrastructure provision, they concluded that a productivity improvement of between 3.3 and 3.9% found from their analysis of US railroads was the 'true' value of long term productivity growth in infrastructure provision. Whilst unquestionably providing a benchmark figure, its transferability to a European context may be more problematic due to the relatively simpler signalling and electrical installation and the lower density of US railroads (see for example Booz Allen and Hamilton Consultancy 1999). In the more technically advanced and heavily used rail systems found in Europe, the potential for such productivity growth may be less attainable as 'simple' productivity gains may be far more difficult to achieve.

The NERA report makes reference to an earlier study by LEK (2000) undertaken on behalf of EWS (the main UK heavy haul freight operator at the time). LEK compared Railtrack's infrastructure charges to EWS with the five largest US Class I railroads, and also analysed changes in productivity since the American Staggers Act (i.e. de-regulation) in 1980. Based upon single ratio productivity measures, LEK found productivity improvements averaged 6.7% over the 19 years reviewed. Nevertheless, this approach to productivity assessment was heavily criticised by NERA (2000) as failing to account for economies of density, which in this case arose from a combination of increasing traffic volumes and route rationalisations arising from company mergers. Failure to account for such effects would lead to a considerable over exaggeration of the estimated productivity improvements. The estimated figure is also considerably above the findings of a desktop exercise on the impact of US deregulation on productivity carried out by Cowie (2010). Whilst he found the LEK figure to be consistent with the short term impacts of Staggers on productivity (which were in the order of 6/7%), the vast bulk of the research reviewed suggested longer term productivity improvements of around 3%.

Booz Allen and Hamilton Consultancy (2000) in a commissioned assessment of Railtrack's own efficiency savings forecast of 1.5% (Railtrack 1999), undertook what they described as a 'bottom up' approach of examining spending needs by expenditure category (business segment). In a report very critical of Railtrack's asset management, BAH derived a target figure of between 4 and 5% for efficiency gains for Railtrack in the period 2001–2006. This would be achievable through a combination of 'catch up', i.e. the firm adapting to the practices of a private sector company, and long term improvements in the efficiency of infrastructure provision, i.e. technical change. The authors identified that the latter effect would in the main arise from improved contractual relations, improved supply chain management, the introduction of new technology (both hard and soft) and finally through improved internal organisational systems.

Lastly, Kennedy and Smith (2004) examined the efficiency of the privatised Railtrack through estimation of a distance function by comparing Railtrack's seven geographical zones over a period of 7 years. In summary, the authors concluded that Railtrack achieved efficiency gains of around 8% per annum over the early part of the period reviewed, although all of these cumulative savings were more than offset by post Hatfield unit cost increases. Nevertheless, through their internal benchmarking approach they suggested that if all zones adopted (British) best practice, then efficiency savings of around 13% (in total) could be achieved.

At the time, Smith (2005) highlighted that despite studies that produce such 'targets', the approaches taken to such assessments had not been sufficiently robust to restrain costs to what could have been considered as efficient levels. This he suggested was due to a lack of external comparators based upon hard data.

The 'theme' of efficiency and productivity assessment continued under the more recent Periodic Review in 2008 (PR2008), however, focused more directly upon the performance achieved by Network Rail rather than what could be considered as feasible. For example, Smith et al. (2008) estimated a fairly sophisticated model of infrastructure costs and performance in order to assess the efficiency of the British infrastructure provider over an 11 year period from 1996 to 2006 (inclusive). The data was taken from the Union de Chemin de Fer (UIC)'s Lasting Infrastructure Cost Benchmarking database (UIC 2007). This contains key infrastructure data on 13 European infrastructure companies (or divisions). Using their preferred model, the authors found that British infrastructure management averaged an efficiency score of around 62% of best practice (of the 13 firms) over the whole period reviewed, although this ranged from a high of 77% in 2000 to a low of 52% in 2004. Furthermore, the authors found that in 2006 Network Rail was one of the least efficient rail infrastructure providers in the data set (4th lowest overall). In a follow up study 2 years later (ORR 2010), the same authors noted that Network Rail's performance had improved to 66% efficiency as against best practice, and that this improvement had been achieved through 'true' efficiency gains (as opposed to technological developments). In a subsequent article based upon the same body of research, Smith et al. (2010) suggest that the efficiency gap that remains is down to management inefficiency, as they highlight that no barriers to the implementation of best practice into the British network were found in an assessment carried out by Railkonsult (2008).

Earlier work by Smith (2006), suggests that some of this inefficiency and rising infrastructure costs may have been part of an industry wide deterioration in cost control. He highlights that cash costs rose dramatically by some 47% over the period 2000–2002, but that the train operating companies accounted for some 42% of that increase. The main cause of this was what the author terms the 'Hatfield' effect, which relates to an accident on 5th April 2001 which resulted in four fatalities and was caused by a broken rail that was known beforehand to be at risk. The subsequent fallout from this led to a period of lengthy delays and considerable disruption across the whole network. The control over costs therefore, may have lessened in terms of priorities for the industry as a whole, and hence any such cost 'drift' may reflect industry wide refocusing rather than operator inefficiency.

One final area worth considering in the current context is integrated v vertically separated railways and in particular the existence or otherwise of economies of scope in infrastructure and service production, i.e. are there any savings in having these provided by the same organisation. Research by Growitsch and Wetzel (2009) based on European railways suggests that there are, which can be loosely quantified as 9% with regard to returns to scope (productivity) and a considerably higher 30% with regard to actual economies of scope (unit costs). Cantos et al. (2010) provide an overview of research on the topic of separation, from which they generally conclude that studies have been inconsistent in their findings due to the relative 'newness' of the topic. They then go on to examine sixteen European railways over a 20 year period. What they find is that those systems that have introduced both vertical and horizontal separations have experienced, by far, the greatest increases in total factor productivity and all of this has come from technical change, and not through efficiency catch up. This would clearly indicate that such a division represents a major step change in railway organisation, and hence such divisions open up the prospect of greater productivity improvements. Those systems that have only introduced vertical or horizontal separation on the other hand, have experienced only minor improvements. This would imply that only by 'truly' introducing competition into the market will result in significantly improved productivity to such an extent that it surpasses any gains from returns to scope arising from fully integrated operations. Friebel et al. (2010) find similar results with regards to aspects of railway reform, which they break down into three different components—vertical separation, third party access and independent regulatory authority. Their results show that where at least one of these elements have been introduced, this has had a significant impact on railway efficiency, however, where only one was present this only had a minor effect.

In summary, the studies cited above have found a very diverse range of estimates of actual and potential productivity gains. Whilst undoubtedly different traffic mixes and densities indicate that there is no one general figure that may be applicable in all situations, estimates of 1.5% annual increases would appear to be on the low side, whilst estimates of 7% on the high. What should be highlighted, however, is that figures such as the NERA (2000) estimate of around 3.5% productivity annual increase have been achieved in growing rail markets where productivity gains may be easier to achieve. For example, 3.5% cumulated over 13 years (the time period of that particular study) results in a total productivity increase for the whole period of just over 56%, a phenomenal improvement. The growth in traffic levels, however, over that same period was around 51%, and it is difficult to believe that similar improvements in productivity would have been possible in stagnate or declining markets. Whilst inputs, certainly in the short run, are reasonably flexible upwards in growing markets, and investment, both human and capital, far more likely to occur, inputs tend to be sticky downwards due to the restructuring costs associated with any downsizing. A question also arises over how much of that productivity gain was due to improvements in the infrastructure and how much was due to improvements in the provision of services? Despite organisational separations, the railway remains in reality a single complete system, and thus it could be strongly argued that any productivity assessments of the individual parts are purely arbitrary, as there is no way of objectively separating the two components. This highlights the obvious difficulties involved when undertaking this type of analysis on the productivity of rail infrastructure, but it nevertheless remains an important area of study.

As regards the current topic, taken at face value previous research would indicate that given the high increases in the volume of traffic on the network that have occurred in recent years and the considerable 'slack' present within the system, productivity should have considerably increased over that particularly period, and hence costs significantly declined. With both a vertical and horizontal split, such gains should far exceed any loss in economies of scope.

Data sources and issues

The remainder of the paper concerns the assessment of costs of British railway infrastructure provision under the three different regimes of the nationalised BR, the private sector Railtrack and the not for dividend Network Rail, in order to determine the true extent of cost changes since privatisation. Rail privatisation, however, occurred over a number of years, hence cannot be discretely assigned to a single year. Whilst the majority of asset sales occurred over the period 1995–1997, re-organisation for privatisation occurred even earlier, generally over the periods 1993/4 and 1994/5 following the passing of the Railways Act on 7th November 1993. For example, Railtrack was created as a subsidiary of BR in April 1994. As a final year comparator therefore, 1992/3 is taken as the last year of full BR management, and 1995/96 as the first full year of the (Railtrack based) reformed structure.

To allow these comparisons to be made, the data used comes from a variety of different sources, which makes it problematic for time series analysis. However, whilst undoubtedly different ownership regimes will have differences in the accounting practices employed and hence the figures could never be used for highly detailed cost comparisons,[3] they are believed to be of a nature to allow broad comparisons of the costs under the three different ownership regimes to be made. As far as possible, the data have been validated to ensure consistency across these different ownership periods and all sources and individual items are summarised in Appendix Table 1 and discussed below.

Beginning with the nationalised BR, data came from the BR Annual Reports from 1980 through to the final BR report of 1994/5. These present total operating costs broken down by activity, and included costs under the main headings of operations—operation control, area management, control, signalling operations; infrastructure—track and associated structures, signalling, telecommunications. This division of costs allowed infrastructure costs to be isolated for the purposes of this analysis. The management costs of BR were also found in the Annual Reports but only refer to the (whole) Rail Group.

Costs relating to Railtrack proved far more problematic, as the Railtrack Annual Reports provided very little detail as regards specific costs. The main source therefore is the BAH Report (Booz Allen and Hamilton 1999) which was produced for the Rail Regulator. For the years 1995–1999 this included expenditure under the following headings: expenditure on operating, maintaining and renewing the network. Management costs were also found in the BAH report, however, signalling costs had to be estimated on the basis of signalling staff wages, as BAH (1999) highlight that staff costs dominate this expense.

Network Rail costs for 2002–2010 came from the Regulatory Financial Statements (see for example Network Rail 2004) which for the first 4 years include costs under the following headings: maintenance, track, train control, electrification, other OPEX own costs, signalling staff cost, other staff costs, other production and management costs. For the remaining years, statements only contained two headings; total maintenance and operating expenditure, hence the series which split out staff costs was discontinued, thus it was no longer possible to analyse management and signalling costs separately.

The only 'missing' year was the last (full) year of Railtrack stewardship, 2000/01, which was estimated through simple extrapolation of the data and included in the interests of completeness; however, none of the analysis is based upon these figures.

[3] Indeed this is no different from any other cost analysis contained in cross sectional or panel data, as this is no different from accounting variations between firms.

Results

The results are presented below under the subheadings of infrastructure operating costs, signalling costs and management costs, although note that the last two are components of the first. In all cases, evaluations are based upon standardising the data by three operating statistics related to infrastructure provision—route kilometre, train kilometre and passenger kilometre—with changes since 1980 tracked through index numbers (1980 = 100). These standardising units are similar to those derived by Preston (2002) in a comparison between British and Swedish rail infrastructure costs. As regards the actual measures, train movements as represented by train kilometres are probably the main one by which costs should be standardised, as it is arguably the main purpose of a railway system to produce train services. For completeness, all costs and relevant statistics are also given in Appendix Table 2.

Infrastructure operating costs

Figure 1 shows the changes in infrastructure operating costs, including maintenance, signalling and management costs, for the period 1980–2010, but as highlighted earlier does not include renewals. In the case of Network Rail, operating costs generally account for around 70% of total infrastructure costs.

The results show a very ‘chunky’ type pattern, which in some ways is to be expected given that maintenance of the network represents a large element of total operating costs, and these activities can either be delayed or advanced given the prevailing financial climate. Nevertheless, several very clear patterns emerge. Over the first part of the period up to around 1989, total infrastructure operating costs per train kilometre fell to around 75% of their 1980 level in real terms. To that point, the general trend had been downwards, and this closely matches the period (1982) when BR began the process of reorganising the whole organisation into national business sectors with more focus on the market, rather than an organisational structure based upon geographical divisions. After 1989, however, fairly significant cost increases emerge, with costs rising in the following 3 years before falling dramatically in the run up to privatisation. This restructuring period, however, can be largely discounted in the overall pattern as it does not reflect a ‘steady state’ and hence no real trend implications can be implied. Railtrack ownership in 1996 represents a

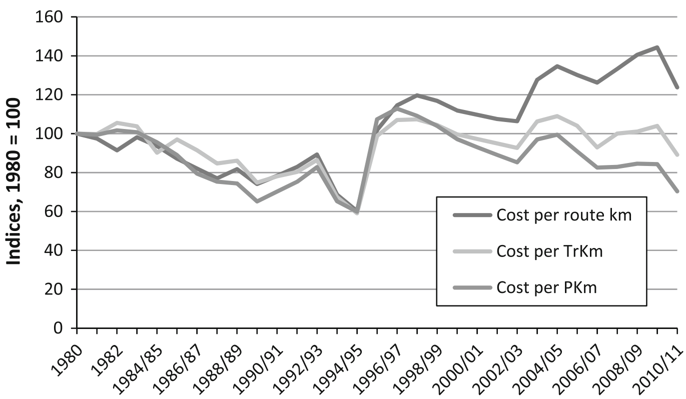

Fig. 1 Change in total infrastructure costs by route, train and passenger kilometre

significant increase in costs, putting costs effectively back to 1980 levels, with further increases in the following 2 years. Interestingly however, whilst completely subjective, it could be argued that the long term increase in costs from 1994 onwards actually began earlier in the latter days of BR ownership.

The beginning of the Network Rail period in 2002 is also characterised by significant increases over the first 2 years. This will be to a large extent as a consequence not only of restructuring and the administration of Railtrack, but also as a result of the continuing fallout from the Hatfield accident. This was then followed by a general downward trend from 2003 onwards, as characterised by large reductions in the final year of the analysis. This may be an indication of some of the benefits, in terms of reduced maintenance costs, of the significant investment undertaken by Network Rail over the last several years. Whilst on a straight route kilometre basis infrastructure operating costs are considerably higher under Network Rail than either Railtrack or BR, this is not the case when standardised by one of the other two variables. Using train kilometres as the main measure suggests that costs are 10% lower than the best achieved under Railtrack (in 1997/8), but are still generally higher than that achieved under BR—3% higher since privatisation (BR1992/3) and 14% higher than the best achieved (BR1988/9).

With rising train kilometres, these cost savings in the latter part of the period could of course not actually represent any real cost savings, but rather arise from economies of density in infrastructure maintenance. Whilst the exploitation of economies of density are a key factor in railway economics, evidence as to the point at which such economies are exhausted tends to be inconsistent. Johanson and Nilsson's (2004) research based upon Swedish and Finnish railways suggests that economies of density in infrastructure provision are highly significant for lightly used lines, but that these are not endless (albeit remaining declining) and are exhausted at a level of around 1.5bn Gross tonne kilometres. Additional information gathered in the course of this research[4] also suggested that density effects in infrastructure provision above a given level of output are minimal if present at all. This would therefore indicate that most of the cost variations presented in Fig. 1 are a consequence of organisational or operational change rather than density effects. The whole area of economies of density in rail infrastructure provision (rather than service provision), however, is one that is clearly in need of further empirical research and also lies outside the scope of this paper.

A final obvious point to note from Fig. 1 is that cost increases appear to be associated with change, whether that be with the change from BR ownership to Railtrack, or Railtrack to Network Rail. Whilst some increases in costs are bound to be associated with restructuring, particularly with the first change, these appear to be more than simple reorganising costs, and are too long lasting to be the transaction costs of moving from one regime to another. This may reflect a refocusing of aspirations as custody changes from one organisation to another and a lessening of downward pressure on costs, i.e. increased x-inefficiency.

Signalling costs

The second component of operating the infrastructure is controlling traffic movements on it, and this is done through operation of the signalling system. These costs are again analysed over the three management periods of BR, Railtrack and Network Rail and expressed as standardised cost movements in the form of route, train and passenger kilometre. As noted above, this data series ends in 2005/6.

[4] In the form of informal discussions with railway engineering experts.

Although not immediately obvious from Fig. 2, the overall pattern is considerably smoother than the figures relating to infrastructure operations and maintenance, which given the more continuous nature of signalling operations is to be expected. This effect is particularly noticeable during the periods of restructuring in 1993–1994 and 2001–2002. Beyond that, however, there is actually very little in this figure to comment upon. The overall patterns are as before, with cost reductions under the period of BR sectorisation and rises in the latter period of BR ownership. Costs then rose significantly under Railtrack, and the maintenance of high cost remains under Network Rail. The one difference is that cost variations are less pronounced between the different management regimes for signalling than operations.

Management costs

The final set of costs considered relate to management expenditure. Of all of the cost comparisons made, these are by far the least comparable, however, this will be more fully outlined in due course. To begin, the change in total management costs per route, train and passenger kilometre are shown in Fig. 3.

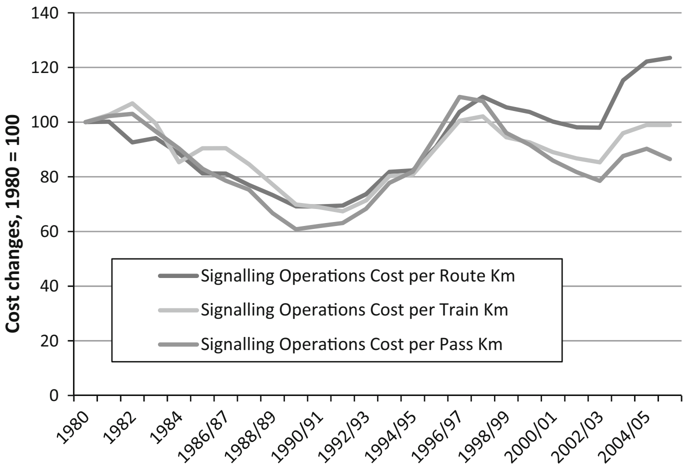

Fig. 2 Change in signalling operations costs by route, train and passenger kilometre

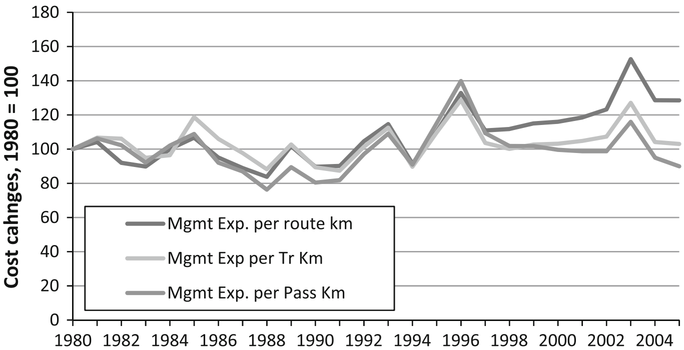

Fig. 3 Change in management expenditure per route, train and passenger kilometres, 1980–2005

Figure 3 does not initially paint too pessimistic a picture, with management costs per train kilometre at about the same level at the end of the period shown under Network Rail as with BR at the beginning. In fact, the gradual upward 'drift' in these costs could simply be due to increased transaction costs, as more rules and regulations relating to railway operation existed in 2005 in comparison to 1980, and hence management costs may be expected to increase. If true, the only 'notable' cost increases are during the periods of restructuring for privatisation and the Railtrack administration, and these were only short term 'blips'. The major problem, however, with Fig. 3 is that BR management costs refer to the whole of BR, train services and operations, and not just the infrastructure. From 1995 onwards, however, management costs under both Railtrack and Network Rail relate solely to the management of the infrastructure. In order to increase comparability therefore, BR management costs that relate solely to the infrastructure need to be split out. As this data is simply not available, this has to be estimated. This was done on the basis of staff numbers employed in the different divisions within BR i.e. scaled on the basis of the percentage of staff employed in infrastructure and signalling operations. As should be noted in the following analysis, dividing management costs in such a manner is undoubtedly an oversimplification of the problem and almost certainly will produce an underestimate of the costs involved as it completely ignores the concept of overhead.[5] Figure 4, however, provides these pro-rata comparisons.

Bearing in mind the reservations noted above, the figures shown in Fig. 4 nevertheless present a radically different picture from Fig. 3. Whilst undoubtedly a large part of this will be down to definitional differences between BR and Railtrack, what Fig. 4 implies is a massive rise in management costs, increasing by over a factor of five when measured by route kilometre. These costs have continued to rise since privatisation to now stand at over six times higher than under the final years of BR stewardship, this despite a reduction in staff, either directly or indirectly, that are employed in the railway sector. It is also interesting to note that while management costs appear to be the area where BR made the

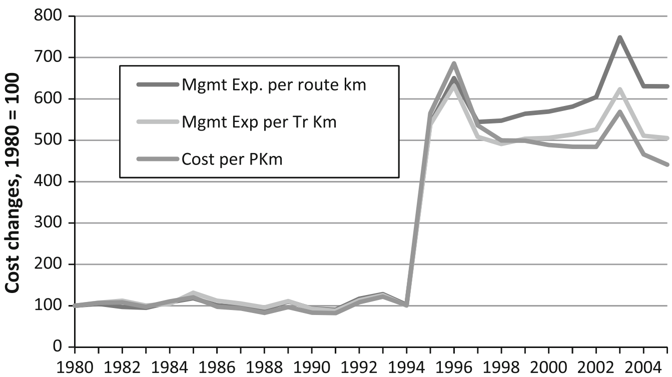

Fig. 4 Change in management expenditure per route, train and passenger kilometres, 1980–2005, BR Mgmt cost apportioned on staff numbers

[5] Nevertheless this method actually apportions a significantly higher percentage of management costs onto infrastructure than the only other alternative that could have been used, which is based on the share of total operating costs accounted for by infrastructure and signalling operations.

least 'efficiency' savings, it is the same area that has seen massive increases since privatisation.

Due to the incompatibility of these costs over the three ownership periods, however, all that can be clearly concluded from Figs. 3 and 4 is that the cost of managing the infrastructure has risen by somewhere between 3 and 505% when measured per train kilometre. No other clear 'evidence' can be presented. However, even assuming that the apportioned figures significantly understate BR's infrastructure management costs, it is clear that there has been a considerable rise in these costs. The Transport Select Committee (1995) for example estimated that total interface costs for the whole 'new' railway to be in the order of £700m a year, and the figures presented above would suggest that a large proportion of these interface costs can be accounted for by management expenditure on the infrastructure. Furthermore, research undertaken by Merkert and Cowie (2010) estimated management costs of the Train Operating Companies (TOCs) to be in the order of £150m a year. Management train operating costs under BR1992/3, based on the same rough pro rata measurement used to estimate management infrastructure costs, would be estimated to be around £100m in 2008 prices. Whilst showing a significant increase over the period, the £50m estimated additional TOC management costs accounts for a small percentage of the Transport Select Committee's £700m figure. This further suggests that the majority of the increase in management costs of the whole 'new' structure are associated with increased infrastructure management costs.

Discussion of results

The results as presented show mixed evidence as regards the costs of rail infrastructure provision over the three management regimes analysed. Undoubtedly the cost of running the infrastructure has increased significantly, as evidenced by large increases when standardised by route kilometre. However, over the period there has also been a significant rise in train kilometres. Hence when standardised by these units, costs for the operation of the network in 2010 have almost returned to BR1992/3 levels, and with even larger increases in passenger kilometres, the cost per passenger kilometre is now lower. Management costs, however, have significantly increased, irrespective of the standardising unit used.

Is this therefore evidence of x-inefficiency (Leibenstein 1966) in rail infrastructure provision? X-efficiency theory highlights the importance of the environment impacting upon an individual's work effort and hence under a certain set of circumstances an individual may fail to maximise their work effort. The classic example used to underline the concept is a large state owned monopolistic enterprise, ironically one such as BR. Such a working environment is said to produce low rewards to management and the workforce, a loss of the sense of the individual and removes the threat of bankruptcy, hence leading to a reduced effort and the failure to adopt 'best practice'. X-efficiency differs from traditional (neo classical) economic theory in that it recognises that firms may not produce at the lowest possible cost, hence the average and marginal cost curves may be higher than they should be. The theory is not without its equally persuasive critics, most notably Stigler (1976) and De Allesi (1980), but does nevertheless have considerable appeal in the area of efficiency analysis. Leibenstein highlighted seven areas where x-inefficiency theory differs from traditional economic theory,[6] two of which appear to be particularly relevant to this

[6] The five other components not listed here centre around the areas of the individual, selective rationality, effort, inert areas and interpersonal relations (Leibenstein 1978).

context—agent-principle relationships and cost impactor/impactee relations (Leibenstein 1978).

Beginning with a review of management costs, if the rather bold assumption is made that the basic underlying cost of managing the infrastructure has not fundamentally changed,[7] then all of the increase in management costs must have resulted from x-inefficiency introduced into the system through agent-principle relationships i.e. interface costs. The fragmentation of the rail industry has led to a vast increase in the number of these relationships within the sector and the infrastructure provider lies at the very centre of this increased complexity. Furthermore, the nature of impactor/impactee relations has also fundamentally changed. Whilst before there was one controlling body, the British Railways Board, that closely co-ordinated all of the various activities required in the production of train services, these relations have now been externalised and separated/divided. As a result, impactor/impactee relations have either become far less clearly defined or completely transformed in nature and form and as a result have become far more costly to manage. This, however, cannot be taken as clear evidence of x-inefficiency, as the counter would be that all of the increase in costs are as a result of increased transaction costs, and more specifically, that these increased costs 'should have been'[8] more than off-set by efficiency improvements, as indicated by the research cited earlier on railway reform. Such gains would be brought about by increased focus on the market and the introduction of competitive tendering in the actual maintenance and running of the whole railway, infrastructure and services. The fact that efficiency improvements on such a scale have not been forthcoming, however, [see for example Cowie (2009) or Smith and Wheat (2012)], would suggest that these cost escalations are simply added costs with no net benefit, hence evidence of x-inefficiency in management costs.

With regard to infrastructure operational costs, these need to be considered at two levels—the medium term and the long term. In the medium term, costs increased significantly, and whilst there may again be a suggestion of x-inefficiency, this is less clear as the primary cause of these increases. More specifically, these appear to have been driven by the consolidation of the Infracos that resulted in a lack of competition to drive costs down. Furthermore, the 'transfer' of the narrow knowledge base in the industry to the private sector, coupled with other practices, most notably the tightening up of the market through measures such as the exclusive leasing of track maintenance rolling stock from the ROSCOs, effectively created a mini-monopoly in rail infrastructure maintenance. Operational cost increases would therefore simply appear to be as a result of imperfect competition in the rail infrastructure industry rather than evidence of x-inefficiency. In the longer term, however, with most, but not all, of these activities back 'in house', infrastructure operational costs have fallen significantly since 2003, so that in the 'long' term when measured per train kilometre, in 2010 these had virtually returned to their 1992/3 level (the privatisation reference point). In other words, Network Rail, after considerable improvements in efficiency, are doing no better or worse than BR1992/3.

[7] In other words, the basic management cost involved of a train running on the infrastructure, which must still be present under the current structure, although note the point made earlier regarding transaction costs, hence this is a rather bold assumption.

[8] A very loose reference to 'efficiency improvements' referred to in the Government's White Paper "New Opportunities for the Railways" (HMSO 1992).

Summary, conclusions and areas for further research

The main finding of this paper is that, when measured by the most appropriate standardising unit (train kilometres), infrastructure operational costs initially rose by just under 33% under Railtrack stewardship, and then a further 11% under Network Rail. By the end of the period reviewed, however, these had returned to pre privatisation levels, although still not at the level best achieved in the public sector (in 1989). The long term trend at the end of the period reviewed, however, was very strongly identified as downward, suggesting that further efficiency improvements may follow in the future.

With regard to the headline figures and general inefficiency perceptions surrounding infrastructure provision which originally motivated this research, these have in the main been found to have been unsubstantiated by the data in the longer term. Such perceptions may have originated from medium term cost increases that have not been sustained, and also based upon new build or major upgrade projects, most notably the West Coast Mainline upgrade, which had seen costs rise significantly above those that were originally budgeted for over the lifetime of the project.[9]

Whilst that is true of operational costs, as regards the management of the British railway infrastructure, the paper finds clear evidence of x-inefficiency which has led to significant increases in management costs. These have not been offset by any efficiency improvements in the provision of rail infrastructure operations or indeed efficiency improvements elsewhere in the railway industry. In other words, rail infrastructure is far more costly to manage in the private sector than it ever was in the public sector with no discernable improvement in technical and cost efficiencies. Much of this 'inefficiency', however, was introduced with the privatised structure and its need for (considerable) interface costs between the various components of the railway, and much of these increased costs appear to have fallen on the infrastructure provider. This is a clear case of x-inefficiency arising out of agent-principle relationships.

One final conclusion is that, with significant cost increases during the 'market' period of infrastructure maintenance provision, this would strongly indicate that creating markets in infrastructure maintenance is inadvisable. Some may reasonably argue, however, that the British structure was so severely flawed that it would never have allowed the potential for such a market to be fully explored and exploited even if it did offer real cost savings. The counter is that irrespective of whatever structure was adopted, the market is of such an inherent nature that it is a long way from the economist's model of perfect competition. It also is one that allows significant opportunities for those in the market to consolidate and hence create an imperfectly competitive industry with all the associated economic 'ills' of such market structures.

In the course of the research, in many respects more questions have been raised than answered, and this obviously highlights potential areas for further research which are useful to close with. One obvious area is returns to density in rail infrastructure operation, and the point at which these are virtually exhausted. Although not the main focus of this paper, the topic created much discussion during the refereeing process and seemed to produce quite dispirit views, clearly highlighting the need for quality empirical research on the subject. The second key area is in the role played by capital in infrastructure costs, specifically renewals, and the relationship this has with infrastructure maintenance and operation. This is far from straightforward and would probably require qualitatively based

9 As pointed out by one of the referees, however, such cost 'increases' may have been present all the time, the problem of increasing budgetary requirements may have resulted from the initial under estimation of costs.

research. The final area worth highlighting, although seemingly perhaps naive to do so, is that of productivity apportionment in railway systems, and specifically the relationship between train productivity and infrastructure productivity. This would enable the individual parts of the rail system to be assessed on some form of objective basis.

Acknowledgments The authors would like to express their thanks to three anonymous referees and Martin Richards (Editor-in-Chief), who provided detailed and carefully considered observations that proved to be very valuable in the completion of this paper. Any errors or omissions that may remain in the paper, however, are entirely the responsibility of the authors.

Appendix

See Tables 1, 2.

Table 1 Sources of data

	Nationalised BR	Privatised railtrack	Not for dividend network rail
Operational costs	Taken from BR annual reports, includes costs under the following main headings: Operations: operation control, area management control, signalling operations Infrastructure: track and associated structures, signalling, telecommunications	BAH Report (1999) Table 5–25 on page 102 includes expenditure under the following headings: expenditure on operating and maintaining the network	Taken from annual regulatory financial statements and includes costs under the following headings: Maintenance; track (permanent way), train control (signalling and telecommunications), electrification, other Opex own costs: signalling staff costs, other staff costs, other production and management
Maintenance	As above, purely maintenance of infrastructure: track and associated structures, signalling and telecommunications	Single total given in report, however, Table 5–13 on page 83 itemises maintenance spend for the whole of CP1 as track, signalling, structures (excluding stations) and electrification	As above, maintenance of track (permanent way), train control (signalling and telecommunications), electrification, other (structures)
Signalling operating costs	Taken directly from BR annual reports	No specific value assigned, however, BAH (1999) note that 'staff costs are dominated by the operation of the signalling system' (p. 19). Based on an examination of previous costs and NR costs, this 'domination' can be quantified as 80% of staff costs	As with Railtrack, based on signalling staff costs from the annual regulatory financial statements until 2006 when these were no longer separated out
Management costs	Taken directly from BR annual reports (for the whole group)	Taken directly from BAH Report Table 8 on page 19	Taken directly from the annual regulatory financial statements until 2006 when management costs no longer shown separately

Table 2 All infrastructure costs and performance statistics, BR, Railtrack and Network Rail, all shown at constant 2005 prices

Year										Ratios		
Financial	Calendar	Passenger (km, bn)	Route (km)	Train (km, ms)	Opex (£ms)	Maintenance	Signalling	Mgmt costs	Adj Mgmt costs	Opex/Pass (km)	Opex/Route (km)	Opex/Tr (km)
Network rail												
2010/11	2010	53.7	14510.0	479.5	2361.0	1275.5	n/a	n/a	n/a	0.0440	162,717	4.92
2009/10	2009	52.2	14494.0	478.4	2749.7	1258.1	n/a	n/a	n/a	0.0527	189,715	5.75
2008/09	2008	50.7	14494.0	479.3	2676.8	1196.5	n/a	n/a	n/a	0.0528	184,684	5.58
2007/08	2007	49.0	14484.0	459.1	2537.8	1228.7	n/a	n/a	n/a	0.0518	175,216	5.53
2006/07	2006	46.2	14353.0	464.0	2382.4	1223.0	n/a	n/a	n/a	0.0516	165,984	5.13
2005/06	2005	43.2	14328.0	426.5	2452.0	1271.0	n/a	n/a	n/a	0.0568	171,133	5.75
2004/05	2004	40.9	14356.0	421.7	2540.6	1449.9	280.0	425.0	425.0	0.0621	176,971	6.02
2003/04	2003	39.7	14328.0	409.5	2404.8	1286.0	276.8	425.0	425.0	0.0606	167,842	5.87
2002/03	2002	39.1	14883.0	406.6	2081.7	1096.2	260.7	503.4	503.4	0.0532	139,874	5.12
2001/02	2001	38.2	15042.0	405.0	2125.7	1223.7	230.1	422.1	422.1	0.0556	141,320	5.25
Railtrack												
1999/00	1999	36.5	15042.0	401.9	2213.4	1484.5	237.8	401.8	401.8	0.0607	147,146	5.51
1998/99	1998	35.6	15042.0	400.4	2310.8	1656.2	246.2	398.3	398.3	0.0649	153,623	5.77
1997/98	1997	34.7	15038.0	398.8	2365.6	1802.0	249.9	386.4	386.4	0.0682	157,305	5.93
1996/97	1996	32.1	15024.0	382.6	2261.9	1771.5	259.2	383.7	383.7	0.0705	150,549	5.91
1995/96	1995	30.0	15034.0	368.4	2011.9	1680.7	245.7	458.7	458.7	0.0671	133,820	5.46
BR[a]												
1994/95	1994	30.4	14357.0	348.3	1136.8	779.2	186.6	302.2	68.9	0.0374	79,179	3.26
1993/94	1993	31.7	14317.0	346.9	1292.3	901.2	184.8	377.8	86.1	0.0408	90,263	3.73
1992/93	1992	32.5	14317.0	351.7	1680.5	1319.2	166.4	344.8	78.6	0.0517	117,376	4.78
1991/92	1991	33.2	14318.0	351.4	1560.3	1219.1	157.0	297.1	60.8	0.0470	108,973	4.44
1990/91	1990	33.6	14309.0	341.6	1473.6	1146.8	156.2	295.4	62.6	0.0439	102,984	4.31

Table 2 continued

Year										Ratios		
Financial	Calendar	Passenger (km, bn)	Route (km)	Train (km, ms)	Opex (£ms)	Maintenance	Signalling	Mgmt costs	Adj Mgmt costs	Opex/Pass (km)	Opex/Route (km)	Opex/Tr (km)
1989/90	1989	34.3	14318.0	337.4	1395.6	1085.2	156.4	335.3	74.0	0.0407	97,471	4.14
1988/89	1988	33.1	14309.0	323.2	1538.2	1216.4	165.6	275.9	61.1	0.0465	107,499	4.76
1987/88	1987	30.8	14302.0	309.6	1448.8	1125.2	173.7	292.8	64.4	0.0470	101,298	4.68
1986/87	1986	31.1	14304.0	305.3	1542.9	1209.8	183.2	313.1	67.7	0.0496	107,866	5.05
1985/86	1985	29.5	14310.0	305.8	1639.2	1635.5	193.3	351.2	79.3	0.0556	114,550	5.36
1984/85[a]	1984	29.5	14304.0	352.9	1759.5	1539.3	203.5	329.3	72.6	0.0596	123,007	4.99
1983	1983	29.5	14375.0	323.5	1855.1	1396.4	213.6	297.2	64.1	0.0629	129,048	5.73
1982	1982	27.2	14371.0	296.3	1727.4	1283.6	210.1	304.2	65.6	0.0635	120,203	5.83
1981	1981	29.7	14394.0	334.2	1843.9	1358.3	227.6	345.0	70.8	0.0621	128,103	5.52
1980	1980	30.3	14394.0	342.4	1892.0	1418.1	227.1	331.3	67.5	0.0624	131,445	5.53

[a] Under BR management, financial years matched calendar years until 1984, when the financial year moved to 1st April. As a consequence, in year 1984/85 all costs have been annualised

References

Booz Allen and Hamilton: Railtrack's expenditure needs 2001–2006: a report to the office of the rail regulator. BAH, London (1999)
Booz Allen and Hamilton: Response to railtrack's may 2000 cost submission: a report to the office of the rail regulator. BAH, London (2000)
Cantos, P., Pastor, J.M., Serrano, L.: Vertical and horizontal separation in the european railway sector and its effects on productivity. J. Trans. Econ. Policy. **44**, 139–160 (2010)
Cowie, J.: The British passenger rail privatisation—conclusions on subsidy and efficiency from the first round of franchises. J. Trans. Econ. Policy **43**, 85–104 (2009)
Cowie J (2010) Productivity and performance in the British rail freight industry since privatisation, paper to be presented at the 12th World Conference on Transport Research. Lisbon, Portugal, 11th–15th July
De Allesi, L.: The economics of property rights; a review of the evidence. In: Zerbe, R. (ed.) Research in Law & Economics, vol. 2. JAI Press, Greenwich (1980)
DfT: Transport Statistics Great Britain, 2006. DfT, London (2006)
Freeman, R., Shaw, J.: All Change—A History of British Railway Privatisation. PWC Publications, London (2000)
Friebel, G., Ivaldi, M., Vibes, C.: Railway (de)regulation: a European efficiency comparison. Economica **77**(1), 77–91 (2010)
Growitsch, C., Wetzel, H.: Testing for economies of scope in European Railways: an efficiency analysis. J. Trans. Econ. Policy. **43**, 1–24 (2009)
HMSO: New Opportunities for the Railways. HMSO, London (1992)
Kennedy, J., Smith, A.: Assessing the efficient cost to sustaining Britain's rail network. J. Trans. Econ. Policy **38**(2), 157–190 (2004)
Larsson, S., Ekstrom, A.: The case of Swedish Railways, in Privatisation of Passenger Railways, ECMT Round Table 90. OECD, Paris (1993)
Leibenstein, H.: Allocative efficiency vs. "X-efficiency". Am. Econ. Rev. **56**, 392–415 (1966)
Leibenstein, H.: General X-Inefficiency Theory and Economic Development. Oxford University Press, New York (1978)
LEK: Benchmarking of Railtrack's Freight Charges and Costs. LEK, London (2000)
Merkert, R., Cowie, J.: A quantitative cross modal analysis of transportation firms transaction costs, are airlines any different? Paper presented at the 2010 ATRS Conference, Porto, 6th–9th July (2010)
Modern Railways.: Roger Ford's Informed sources. Mod. Railw. **638**, 8 (2001)
NERA: Review of Overseas Railway Efficiency: A Draft Final Report for the Office of the Rail Regulator. NERA, London (2000)
Network Rail: Regulatory Financial Statements for year ended 31st March, 2004. Network Rail, London (2004)
ORR: International Cost Efficiency Benchmarking of Network Rail. ORR, London (2010)
Preston, J.: Railtrack—problems, solutions and absolutions. Paper presented at the 34th UTSG Conference, Edinburgh, (2002)
Railkonsult.: Review of European renewal and maintenance methodologies—study overview. Report for the Office of Rail Regulation, March (2008)
Railtrack.: May 1999 Cost Submission to the Office of the Rail Regulator (1999)
Shaoul, J.: The cost of operating Britain's privatized railways. Public Money Manag. **26**, 151–158 (2006)
Smith, A.S.J.: The role of efficiency estimates in UK regulatory price reviews; the case of rail. Util Policy **13**, 294–301 (2005)
Smith, A.S.J.: Are Britain's railways costing too much? Perspectives based on TFP comparisons with British Rail; 1963–2002. J. Trans. Econ. Policy **40**(1), 1–45 (2006)
Smith, A.S.J.: International Benchmarking of Network Rail's Maintenance and Renewal costs: an econometric study based on the LICB dataset (1996–2006). Report for the Office of Rail Regulation (2008)
Smith, A.S.J., Wheat, P., Smith, G.: The role of international benchmarking in developing rail infrastructure efficiency estimates. Util Policy **18**, 86–93 (2010)
Smith, A.S.J., Wheat, P.: Evaluating policy response to franchise failure—evidence from the passenger rail sector in Britain. J. Trans. Econ. Policy **46**(1), 25–49 (2012)
Stigler, G.: The xsistence of x-efficiency theory. Am. Econ. Rev. **66**, 213–216 (1976)
Transport Select Committee.: Railway Finances. Fourth report of the session 1994/1995, vols 1 & 2. HMSO, London (1995)
UIC: Lasting Infrastructure Cost Benchmarking (LICB): 10 Years of Benchmarking 1996–2005. UIC, Paris (2007)
Wolmar, C.: On the wrong line: how ideology and incompetence wrecked Britain's railways. Aurum Press, London (2005)

Author Biographies

Jonathan Cowie is a lecturer in Transport Economics at Edinburgh Napier University. His research interests surround public transport supply side economics, where he has published articles in the specific areas of production economics, regulatory reform and x-inefficiency. His areas of teaching cover transport economics, research methods, freight transport and transport policy.

Sarah Loynes is a Principal Consultant at a leading global engineering firm, where she specialises in the analysis of assets associated with transportation and the development of transports links with wider economic and social issues. Sarah previously worked for Network Rail as a Project Sponsor.