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Assessing Network Rail's scope for efficiency gains over CP4 and beyond: a preliminary study

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1. EXECUTIVE SUMMARY

Network Rail's current regulatory settlement runs until March 2009. Preparatory work has already commenced on the next periodic review ("PR2008") that will establish the regulatory settlement for the five-year control period 2009/10-2013/14 ("CP4"). By the end of 2005, ORR needs to make an assessment of the scope for efficiency gains for Network Rail over the next price control period and beyond.

ORR therefore appointed L.E.K. Consulting and Oxera to undertake a study to estimate Network Rail's scope for improving efficiency over the next two price control periods, i.e., CP4 and 2014/15-2018/19 ("CP5").

The primary aim of the study was to develop a plausible range for the overall scope for efficiency improvements in controllable operating, maintenance and renewals ("OMR") expenditure. This range will be used by ORR to inform the 'base case' for future expenditure.

The study was carried out in a relatively short time frame and did not involve any collaboration with Network Rail (as agreed between Network Rail and ORR) nor any additional research within the industry. As such, the study was principally a desk exercise, drawing on Network Rail and ORR publications as well as a range of academic studies and the publicly available records of other regulators and other railways. The results should therefore be interpreted as preliminary and should form an input to the further, more detailed, studies on efficiency that ORR plans to undertake during the course of PR2008.

For CP4, the results of the study indicate a plausible range for Network Rail's unit cost efficiency gains to be between 2% and 8% p.a. across OMR cost. The context for these figures is as follows:

- Adopting an hypothesis that the cost increase following Hatfield and Railway Administration effectively "reset" the industry to a level of inefficiency comparable with pre-privatisation, the analogy would be with the second control period in other UK regulated industries, for which an appropriate average efficiency gain is 5.4% p.a.
- The Class I US railroads achieved 4.2% and 4.5% p.a. in CP2 and CP3 equivalents (i.e., years 6 to 15 after de-regulation) when adjusted for volume growth
- Comparison between the CP3 settlement and the efficiency trajectory implied by the ORR's CP1 and CP2 determinations for Railtrack suggests there may be a substantial cost difference remaining after CP3 (a gap of 15% to 25% in notional OMR cost in 2008/09). A proportion of this gap could be differential efficiency, implying additional catch-up efficiency gains in CP4 above those that have otherwise been observed in analogous time periods for other UK regulated industries
- The top end of the range (8% p.a.) implies a total unit cost reduction from 1996/97 to 2013/14 of approximately 49%, based on certain hypotheses that

remain to be tested. Such a reduction is at the top end of the range achieved in other regulated industries over the long run (approximately 20% to 50%)

- The lower end of this range is based on a frontier level of improvement (1-2% p.a.), and some continued catch-up element because it appears that Network Rail may not have fully realised the benefits of all of the efficiency initiatives from ACR2003 by the end of CP3, implying further catch-up gains will be available in CP4

For CP5, a plausible range is between 1.5% and 5% p.a.. The top end is based on rates achieved by other regulated industries plus a small element of additional catch-up as for CP4. The bottom end is based on a frontier of 1-2% p.a. and some element of catch-up as this continues to be seen elsewhere—for instance, in Ofwat's 2004 periodic review (covering the fourth control period, equivalent to Network Rail's CP6 under the reset hypothesis).

These ranges do not include any explicit allowance for potential efficiency gains from reducing activity volumes which needs to be investigated further.

The evidence available at this stage does not suggest differential ranges for O, M or R expenditure, or for England and Wales versus Scotland (which will be funded separately from April 2006) and consequently these preliminary ranges are intended to apply equally across all these categories.

Secondary aims of this study were to assess the efficiency analysis conducted for the 2003 access charges review (set out in section 3) and develop initial thinking on the scope for further, more detailed, work required for PR2008 (set out in section 9).

2. INTRODUCTION

2.1. Background

Network Rail's current regulatory settlement was established by the ORR's Access Charges Review in 2003 ("ACR2003"), and covers April 2004 until March 2009. This is the third regulatory control period since railway privatisation (commonly known as "CP3"). ACR2003 was a key step in the process of Network Rail's acquisition of Railtrack out of Railway Administration and the re-establishment of stable funding for the industry following the Hatfield derailment and subsequent events, and it determined, *inter alia*, a target for Network Rail to reduce the unit costs of its controllable operating, maintenance and renewal ("OMR") expenditures by an average of 31% over the five-year period.

Since this process was completed, the Railways Act 2005 has restructured the leadership of the industry and has placed additional obligations on the Secretary of State for Transport, the Scottish Ministers and ORR with respect to the determination of future settlements. In particular, the Secretary of State for Transport and Scottish Ministers have a duty to provide ORR with information on desired railway outputs and available public funds, expressed in the form of a "high-level output specification" ("HLOS"). ORR must then estimate how much it would cost in terms of public resources to meet the HLOS and must notify government if this exceeds the funds available. ORR's review process must ensure that any such gap is closed, including by possible adjustments to the output specification.

The determination for the next control period ("CP4"), for the years 2009/10-2013/14, will be established by a periodic review of outputs and funding to be completed in 2008 (known as "PR2008"). Due to the additional requirements of the Railways Act, work to determine the outputs and costs for the HLOS for PR2008 has already begun. An important consideration for this work will be the extent to which Network Rail can be expected to be able to further improve its efficiency over future control periods, and ORR therefore commissioned L.E.K. Consulting and Oxera Consulting to undertake a study into Network Rail's scope for improving efficiency in CP4 and in the following five-year control period, CP5.

2.2. Objectives

The primary aim of this study is to arrive at an initial estimate of the range of potential efficiency improvements in OMR that Network Rail could plausibly achieve over the course of CP4 and CP5. Drawing on the work that would be needed to achieve this, two secondary objectives for the study were to assess the efficiency analyses conducted for ACR2003 and to recommend areas for further more detailed work as PR2008 progresses.

It is important to emphasise the preliminary nature of the estimated ranges of efficiency improvements: they are intended only to inform the early stages of the preparation of the HLOS, and ORR plans to undertake additional studies to refine and substantiate the scope for efficiency improvements as part of the PR2008

determination. The recommended ranges represent our view, at this time, of the plausible range of efficiency improvements that could be achieved, however, given the limitations of the scope of the study, the limited availability of information, and the inherent uncertainties at this stage of the process, there can be no guarantee that the final determination of achievable improvements will lie within the estimated range.

2.3. Approach

To provide useful input into the early stages of PR2008, this study was designed to be completed in a relatively short time frame, drawing only on existing materials, and without any engagement with Network Rail. In keeping with the limited objectives, it is not intended to be a replacement for the thorough and detailed analysis of Network Rail's activities and business plans which will follow. It should also be recognised that the industry is not yet two years into CP3, and Network Rail is still actively pursuing the various efficiency initiatives it has identified since taking control of Railtrack and in response to the ACR2003 process. There is much uncertainty still to be resolved before the PR2008 determination can be made.

Recognising these difficulties, we have sought to approach the determination of the plausible range of efficiency improvements from a range of different angles, rather than relying on any one particular methodology or analysis. In particular, we have investigated the following avenues:

- What has been Network Rail's record of delivering on the efficiency targets set in ACR2003 so far? Are there likely to be any efficiency initiatives that were suggested or planned in ACR2003 that will not be completed by the end of CP3 and which would therefore contribute on-going improvements in later periods?
- What has been the experience of efficiency gains in other regulated industries in the UK?
- How fast might the 'frontier' of annual efficiency improvements be expected to progress in a competitive industry?
- What has been the experience of efficiency gains in other liberalised or privatised railways outside Great Britain?
- What was the possible impact on efficiency of the sharp rise in rail industry costs in the late 1990s and how does this compare to the level of efficiency that might have been expected had the industry not experienced the impact of the Hatfield derailment and the subsequent events including Railway Administration?

In considering the upper end of the range of plausible efficiency improvements, we have, on some occasions, adopted the hypothesis that Network Rail's acquisition of Railtrack out of Railway Administration is analogous to the time of privatisation or the introduction of an economic regulatory regime in other industries, and that the immediately preceding period effectively 'reset' the industry to the relatively high level of inefficiency typically observed pre-privatisation. Significant further catch up

improvements would therefore be expected after what is effectively a new 'first' control period. This approach is discussed in more detail in the relevant sections below.

Similarly, in assessing the lower end of the range of plausible efficiency improvements, we have adopted a contrasting hypothesis that the Regulator's ACR2003 determination identified the vast majority of the gap between the efficiency of the company as Network Rail was taking control and that of a competently managed firm in a competitive industry, and that the only remaining improvements to be expected therefore correspond to the annual efficiency gains that such a firm might typically achieve through the movement of the efficiency frontier plus the improvements from any catch up initiatives that required longer than the five-year control period to deliver their full benefits.

2.4. Structure of the report

The next section of this report, section 3, reviews the principal efficiency studies undertaken in ACR2003, their findings and the limitations within which they were conducted.

The following four sections describe our findings from each of the approaches we have found helpful in informing our view of the range of plausible efficiency improvements. Section 4 reviews the available evidence relating to Network Rail's efficiency improvements so far in CP3 and its reported progress with specific initiatives identified in the ACR2003 studies. Section 5 reviews the efficiency improvement achievements observed in other regulated industries in the UK and section 6 considers comparable evidence from other railways. Section 7 considers how the industry's costs might have been expected to evolve in the absence of the shocks from the Hatfield derailment and Railway Administration and compares this to the targeted outturn for the end of CP3.

Section 8 then provides a summary of our findings and synthesises these into a recommended range of the plausible range of efficiency improvements that could be identified for CP4 and CP5, and section 9 sets out recommendations for further more detailed work in PR2008 to allow more precise and robust estimates to be determined.

3. REVIEW OF ACR 2003 EFFICIENCY WORK

3.1. Introduction

During the ACR2003 process, ORR and Network Rail commissioned a series of studies related to efficiency, including:

- An analysis of the variations in unit costs within Network Rail based on performance benchmarking across its regional business units ('Regional benchmarking', L.E.K.)
- A cross-industry comparison aimed at assessing where Network Rail is undertaking activities and business processes that are carried out by other (non-railway) companies and quantifying relative efficiency against best practice ('Process benchmarking', Oxera)
- A study of whether Network Rail adopts best practices in managing its contractors and quantifying the savings that could be generated if the business were to improve the way in which it organises the maintenance and renewal of the network ('Review of Network Rail's Supply Chain', Accenture)
- A comparison of the cost-effectiveness of Network Rail's maintenance and renewals processes with those employed in other railways ('International benchmarking', L.E.K., Halcrow, TTCI)

The results from these studies, in terms of identified efficiency savings, were summarised by the ORR in the final conclusions to ACR2003 as shown in Figure 3.1 below.

Figure 3.1 Results of benchmarking analysis

Benchmarking technique	Potential efficiency savings
Intra-company benchmarking (L.E.K.) plain line track renewals maintenance operating expenditure	 up to 13% up to 24% up to 19%
OPEX process benchmarking (Oxera)	18% to 20%
Analysis of procurement strategy (Accenture) procurement of renewals procurement of maintenance	 17% 18%
International benchmarking (L.E.K./Halcrow/TTCI)	No immediate savings indicated, as the principal differences were found to be around approaches to whole-life asset management that would require significant changes in operating practices and long-term investments.

Having considered the overlap of the different studies, the Regulator concluded that the efficiencies identified amounted to 31% on average across the business as a whole, with relatively higher scope for savings in maintenance (35%) and a relatively lower scope for savings in the other activities (30%) (Figure 3.2.).

Figure 3.2 ACR2003 Final conclusions on annual reduction in unit costs

	2004/05	2005/06	2006/07	2007/08	2008/09	Total
Maintenance	8%	8%	8%	8%	8%	35%
Renewals	8%	8%	8%	5%	5%	30%
Controllable opex	8%	8%	8%	5%	5%	30%
Total	**8%**	**8%**	**8%**	**6%**	**6%**	**31%**

These savings specifically related to unit cost efficiency improvements, and did not include any allowance for the potential for Network Rail to reduce the scope of work (e.g., renewals volumes) whilst maintaining network outputs. In addition, these savings did not allow for any further efficiency from changing to more efficient patterns of engineering access.

As a first part of this study, we were asked to briefly review each of these main ACR2003 efficiency studies. The following sub-sections summarise these reviews.

3.2. Regional benchmarking

3.2.1. Approach

The regional-benchmarking study was designed to provide an estimate of how much Network Rail could reduce its unit costs if it was able to achieve its own best demonstrated practices ("BDP") consistently across company. The study applied an intra-company benchmarking methodology across Network Rail's regionally-structured business units, and therefore could only consider costs controlled on the regional level.

In terms of coverage, the study examined:

- 61% of 2002/03 non-signaller operating cost of £413m
- 72% of 2002/03 total maintenance cost of £1,209m
- 38% of 2002/03 plain line renewals (PLR) cost (excluding WCRM) of £493m.

Costs were considered at varying levels of disaggregation to ensure the most appropriate comparability within the limitations of data availability (e.g., plain line

renewals were assessed at a job-by-job level) and were adjusted for the structural factors that could cause costs to vary between regions. An additional benefit of the methodology applied was the identification of the principal cost drivers underpinning each main cost area.

Based on the analysis of the costs categories covered and cost drivers and structural factors identified the study concludes that the annual savings if all regions achieved second best or BDP would be 11%-21% of the total operating, maintenance and renewals costs. This is before allowing for any improvements to Network Rail's best practices at the time.

3.2.2. Observations and recommendations for future studies

With particular reference to possible future studies, we note:

- The consultants experienced difficulties obtaining appropriately detailed data for the study for a number of cost areas. Future studies would benefit from greater preparation of information requirements.
- The methodology applied for this study appears to be reasonable given the data constraints and the difficulty in benchmarking activities whose costs can be significantly impacted by variations in underlying structural factors.
- With the additional information on maintenance activities that should now be available, future studies could consider the development of a multi-factor model to account for the variety of factors driving these costs. Coverage of the remaining 28% of total maintenance costs could also be considered, if the necessary data are available.
- Future studies should consider whether the identified cost drivers for operating staff costs still apply following Network Rail's re-organisation of its activities, and whether the cost function has been stable over time. In particular, it might be useful to consider whether models with multiple outputs and exogenous factors might be appropriate, if reliable time-series data are available.
- If possible, future study could be expanded to incorporate signalling staff costs which were excluded from this study.
- Extension of the analysis to include whole-life cost trade-offs between the different cost categories could be considered. For example, spending more on renewals is likely to lead to a lower maintenance requirement.
- A future regional benchmarking study could also examine whether the spread of Network Rail's efficiency across regions has decreased, and by how much, i.e., Network Rail's effectiveness in learning from and applying its own BDP.
- Future studies might look to include more detailed consideration of the time period over which savings can be made than was included within the scope of this study.

3.3. Process benchmarking

3.3.1. Approach

The process-benchmarking review focused on identifying Network Rail's major operating expenditure line items and comparing these to appropriate external benchmarks from other industries (e.g., Meta Group Worldwide Benchmark for IT costs). For certain rail specific functions (e.g., for major stations) where external benchmarks were not available, internal benchmarking of performance was used instead.

The overall coverage of the study was equal to c. £166m of expenditure in 2003/04, representing 26% of the total controllable operating expenditure. The main cost categories benchmarked were: HR, finance, IT, legal, corporate affairs, property and major stations.

Overall, Network Rail's controllable OPEX was found to be between 16% and 23% greater than the efficient level in the areas covered by the benchmarks.

3.3.2. Observations and recommendations for future studies

With particular reference to possible future studies, we note:

- The methodology applied for this study appears to be reasonable given the data constraints and the difficulty in benchmarking certain cost categories.
- Future studies could look to investigate other benchmarking methods to increase the extent of coverage of the cost base. In particular, specific studies on the whole HR function (including corporate HR), PLC adjustments, Safety and Technical expenditure should provide ORR with a deeper understanding of the controllable operating cost base and the future efficiency potential.

3.4. Review of Network Rail's Supply Chain

3.4.1. Approach

The supply-chain review set out to assess whether:

- Network Rail's supply chain capability is consistent with best practice in other sectors;
- Network Rail's estimates of the scope for future efficiency savings are sufficiently robust and challenging in light of the potential cost savings that it should be able to achieve through applying best practice in its supply chain.

The review was conducted in three phases:

- the first phase focused on creating 'a generic, cross-industry review of supply chain best practices';
- the second phase focused on assessing Network Rail's supply chain capability against the best practices identified during the first phase; and

- the third phase quantified and profiled the potential efficiency savings that Network Rail could achieve through applying best practice in its supply chain.

Network Rail's supply chain was disaggregated into six sectors: maintenance; track renewals, electrification and fixed plant; signalling and telecoms; structures and operational property; the National Logistics Unit ("NLU"); and professional services. The procurement process was divided into three main stages: strategy and planning; sourcing and contracting; and delivery and execution. Potential efficiency savings were then assessed for each of the three stages, for each of the six market sectors.

3.4.2. Observations and recommendations for future studies

With particular reference to possible future studies, we note:

- The consultants experienced difficulties obtaining appropriate data for the study. Future studies would benefit from greater preparation of information requirements.
- Future studies would benefit from an explicit assessment of the proportion of the cost base covered by the analysis.
- Each section presents a lucid diagnosis of the issues and summary figures for the savings, but the rationale for the savings (and their timings) is not shown, nor any of the calculations. Greater transparency would be helpful here.
- The initiatives (either existing or new recommendations) required to deliver the cost savings are not specified, making it difficult to assess whether Network Rail has carried them out. Future studies would benefit from greater specificity in the published record of recommended initiatives and savings from each.
- The analysis applies an "overlap factor" of 0.7 for combining savings from three categories when applied to particular market spend. This could be tested in future studies.
- Savings from NLU and Professional Services were identified in the report but not included in the total. This was done by Accenture to avoid confusion as expenditure for the NLU and Professional Services are included in the expenditures for each of the main market sectors in Network Rail's March 2003 Business Plan.
- Consideration of implementation costs or offsetting cost rises was explicitly excluded. Where possible, it would be helpful to include these within the scope of a future study.
- Future studies could include overseas railways' approaches to supply chain management in the best practice pool.

3.5. International benchmarking

3.5.1. Approach

As there is no direct comparator for Network Rail within Great Britain, international benchmarking was considered as a potential additional source of useful cost-comparative data. Oftel faces a similar problem to ORR in benchmarking BT and has also used international comparisons to estimate relative inefficiency.

The international-benchmarking study considered the identification and potential application to Network Rail of international best practices in the engineering processes of maintenance, renewal and management of track infrastructure.

The approach taken in the study was to identify and contact suitable comparators and, following several meetings, to identify relevant best practices in track maintenance and renewal processes. Comparators provided their own view of which engineering practices they believed they performed particularly well. These were then compared against current Network Rail practices. Once the data was gathered and analysed, further qualification and clarification was sought from comparators to ensure comparability with Network Rail.

3.4.2. Observations and recommendations for future studies

With particular reference to possible future studies, we note:

- The timeframes for international studies of this nature are often relatively long and reliant, to a large extent, on the goodwill of the other railway infrastructure managers. Information from several potential participants was not available for this study due to the timescale of the project. Any future studies would need to take account of the timescales and relationships required.
- With sufficient time and preparation, a future international benchmarking study could look to assess the efficiency of different companies in undertaking specific activities as well as the processes and policies determining which activities are undertaken.
- If the data were available, process-level international benchmarking analysis could be complemented by a multi-factor analysis (such as Data Envelopment Analysis ("DEA") or econometrics) to control for differences in country-specific operating conditions and multiple output measures.

4. NETWORK RAIL'S EFFICIENCY RECORD IN CP3

4.1. Progress versus efficiency targets

This section reviews Network Rail's progress during CP3 to date towards the targeted reduction in unit costs of 31%. The end point of CP3 (in efficiency terms) forms the platform for future efficiency trends and is therefore relevant to estimating the potential for further efficiency gains in CP4 and beyond.

Network Rail is predicting to achieve the efficiency targets set by the ORR in ACR2003.

"… We are improving our cost control, bringing in projects to time and under budget, maintaining our infrastructure better, more effectively, and delivering the first year's contribution to the overall 31% CP3 efficiency target required as part of the ACR 2003 …"

Network Rail Annual Return, July 2005

"… For the remainder of Control Period 3, we are planning further savings of five percent per annum which is consistent with the improvements assumed in the 2003 Access Charges Review conclusions …"

Network Rail Business Plan, March 2005

In 2004/05, Network Rail appears to have managed to reach above target efficiency in each of the three components. These figures have been agreed by ORR in their Annual Assessment 2005. It should be noted that Network Rail is also making significant progress in improving operational performance.

4.1.1 Operating costs

Network Rail has measured efficiency improvements in controllable opex by comparing their total controllable operating costs in 2004/05 with the level assumed by the ORR in the ACR2003 determination. The predicted cost in the ACR2003, in 2004/05 prices and including the targeted 8% unit cost efficiency was £1,018m. Network Rail's actual operating costs for the 2004/05 period are £934m, which shows an 8% variance from the ORR predicted value. Network Rail is therefore stating to have achieved around a 16% efficiency increase in controllable opex, saving around £110m.[1]

4.1.2 Maintenance

Efficiency improvements in maintenance have also been measured by comparing Network Rail's total expenditure in 2004/05 with the level assumed by the ORR in the ACR2003 determination, which again includes the 8% unit cost efficiency target. Network Rail's expenditure amounts to £1,271m, against the ACR 2003 determination of £1,296m (2004/05 prices). The comparison shows Network Rail

[1] Data from Network Rail Annual Return, July 2005, p169

expenditure to be 2% lower than predicted, giving an efficiency increase of 10% in 2004/05.[2]

This measure of efficiency does not take account of changes in traffic, which is clearly a major cost driver. Network Rail has proposed that costs per ETM be used to monitor efficiency over time. However, the process for recording changes in ETMs over the year robustly are only currently being established and therefore no specific adjustment for the increase in traffic has been made. Network Rail suggests that the true improvement in maintenance efficiency is therefore higher than stated above. Maintenance unit cost measures are being developed, along with improving the calculation of ETMs. These new measures will be introduced to analyse maintenance efficiency from 2005/06 onwards.

Network Rail has also noted that there has been an improvement in the quality of the maintenance work undertaken, evidence for which is shown in the performance and asset serviceability measures.

Network Rail plan to keep improving maintenance efficiency by 8% per annum throughout the rest of CP3, achieving the ACR2003 target. Beyond the end of CP3 Network Rail have assumed that a further annual efficiency improvement of 2% will be achieved.

4.1.3 Renewals

Unit cost indices[3]

Where sufficient data is available unit cost indices have been used by Network Rail to estimate the percentage change from 2003/04. These indicate that the reductions in unit cost have been 5% for plain line track and 2.7% for S&C, giving a total weighted reduction of 4.7% for track. For civils the reduction in unit cost indices is estimated to be 14%. This gives an expenditure-weighted average reduction in unit costs of 8% for two areas of renewals (track and civils).

Network Rail is currently implementing a Cost Analysis Framework to consistently capture cost data across the company which will allow trends in actual unit costs to be tracked.

Variance analysis[3]

Network Rail use budget variance analysis to assess efficiency improvements where unit cost information is not available. Annual budgets for each project or programme are determined on the basis of meeting efficiency improvements. Any changes in the project budget over the year are then classified as scope, deferral or unit cost changes. Considering the activity efficiency savings only, Network Rail estimated that the following percentages savings were achieved; 6% for track, 7% for Electrification and Plant, 8% for Railway Estates, 12% for Civils and for Telecoms, and 14% for signalling. This averages to a total efficiency improvement for renewals of approximately 9%.

[2] Data from Network Rail Annual Return, July 2005, p170
[3] Data from Network Rail Annual Return, July 2005, p171-172

Taking both of these methods into account Network Rail state that for renewals the efficiency increase is 'broadly in line' with the regulators target of 8%. It is stated that more accurate values will be achieved by using a much more extensive unit cost framework that will be implemented in 2005/06.

Network Rail state that their overall renewals expenditure will be consistent with the ACR2003 determination, apart from signalling and telecoms. This is due to a deferral of work from CP3 into CP4 to reflect a more efficient delivery profile. Network Rail notes that there is also the possibility that further efficiency savings not currently included can be introduced as a result of the possessions review. These savings could affect CP3 and CP4 efficiency achievements.

It should be noted that aspects of Network Rail's analysis have not been accepted by ORR. In particular, in the 2005 Annual Assessment, ORR considers that the activity efficiency measures capture some changes in scope as well, so may overstate the pure unit cost efficiency.

4.2 Progress versus initiatives from ACR2003

The work carried out during ACR2003 set out a range of efficiency initiatives that Network Rail could adopt to underpin the achievement of the 31% efficiency improvement target. We have attempted to assess whether Network Rail has, so far, implemented these initiatives from the available summarised information.

Within the context of Network Rail's prediction of achieving the CP3 target, any evidence that efficiency initiatives from ACR2003 are not being implemented could potentially be interpreted to mean that Network Rail is achieving the target by other means and that further efficiency gains remain to be made by implementing the initiatives from ACR2003 beyond CP3. Subsequent to this work, Network Rail may reveal that it has been implementing those initiatives but has not reported such, or it may in some cases demonstrate that the savings to be made from those initiatives was in fact limited. The provision of such evidence falls to Network Rail during the coming PR2008 process.

We have reviewed the studies carried out as part of ACR2003 and listed 45 efficiency-related initiatives that were developed during that work. At this early stage in the control period, we would expect to find limited evidence that these initiatives had been completed. However, we have reviewed Network Rail's publications and relevant trade press for evidence that these initiatives are being pursued. We then discussed the findings with technical experts within ORR who were able to add their perspective based on their regular monitoring activities of Network Rail.

The efficiency initiatives have been allocated into four categories, depending on the information available regarding the progress status of each:

- **'Being pursued and likely to produce full benefits in CP3'**, relates to the efficiency initiatives that Network Rail have already targeted and on which there has been a considerable progress.
  - The initiatives listed in this category are expected to completely generate the efficiency benefit by the end of CP3 with no further efficiency gains in CP4.
  - Fourteen of the initiatives identified in ACR2003 are in this category, showing that Network Rail have made considerable progress in several areas, most notably by bringing maintenance in-house and by introducing integrated control centres.
- Initiatives deemed '**no longer relevant due to bringing maintenance activities in house**' are those initiatives that have been addressed or superseded when Network Rail took maintenance activities in house.
  - There is one initiative in this category.
- Initiatives are placed under **'insufficient evidence'** when there is not enough, or any evidence that Network Rail is currently or has plans of addressing them in the near future.
  - Fourteen initiatives are currently in this category.
- '**Being pursued, but unlikely to see the full benefits by the end of CP3'** refers to those initiatives that Network Rail have already identified and developed plans for but that are going to produce full benefit in CP4 and CP5.
  - There are sixteen initiatives that Network Rail will see future benefits from including a standardised structure and procedures, the increasing use of technology, bringing some renewals activities in-house and working on a better possessions regime.

Figures A.1 to A.4 in Appendix A summarise our findings regarding the status of each of the 45 efficiency initiatives. This is an initial view based on a review of published documentation and has not been discussed with Network Rail (as specified within the ORR's brief for this project).

Overall, the evidence currently available regarding efficiency initiatives suggests that Network Rail has made considerable progress on the initiatives highlighted in ACR2003, and that there will remain significant opportunities for Network Rail to continue to improve efficiency beyond the end of CP3 by completing these initiatives.

5. EFFICIENCY RECORDS IN OTHER REGULATED SECTORS

5.1. Overview

In the absence of direct assessments of Network Rail's relative efficiency and its potential for frontier shift, the performance in other sectors of the economy may give an indication of the level of performance that could be expected from Network Rail in CP4. These comparisons provide high level sense checks of the sort of range of performance that Network Rail might be able to achieve going forward, but would need to be more accurately assessed using more direct analysis at a later date.

Section 5.2 sets out an analysis of actual unit cost trends since privatisation. Section 5.3 examines trends in total factor productivity ("TFP") in comparator sectors and those observed in academic studies of privatised industries. These TFP estimates are then converted to real unit operating expenditure ("RUOE") and real unit total cost ("RUTC") equivalents and, in Section 5.4, an estimate is made of how much of this saving might be due to frontier shift as opposed to catch-up. Section 5.5 examines other regulators' assumptions regarding the rate of frontier shift as well as derivations from RUOE trends.

In order to estimate cost reduction targets for Network Rail, this study uses evidence on RUOE trends (which include both operating and maintenance expenditure, and consist of both catch-up and frontier shift), while estimates of TFP growth are used to identify frontier shift. The TFP benchmarks are converted into both RUOE and RUTC benchmarks to identify the frontier shift for operations, maintenance and renewals costs.

The appendices describe the methodology and approach used and comment on the limitations of the analysis.

5.2. Actual real unit cost reductions since privatisation

This study aims to provide benchmarks for Network Rail's operating, maintenance and renewals expenditure, in the absence of more direct analysis. However, careful interpretation of cost trend comparisons between sectors is required because:

- Cost trends and, in particular, the catch-up element incorporated within them, are heavily dependent on the initial relative inefficiency of the company;
- Capital expenditure trends are more complex since they tend to go through cycles depending on asset age and condition.

Further details on the issues relating to cost trend comparisons are set out in Appendix B.

For each industry, costs are defined as "operating costs"; however, in all cases, with the exception of the water and sewerage industry, they include the cash element of maintenance expenditure. Unfortunately, data on renewals is not readily available on a consistent basis. In the remainder of this section, reductions in costs are referred to

as RUOE, which include the non-capitalised elements of maintenance in order to make a more direct comparison with Network Rail.

This section therefore examines real unit operating cost reduction trends in the UK network utility sectors. The main objective of this analysis is to estimate the cost trends in industries that are deemed to provide services comparable to those of the infrastructure services for the UK rail network, in order to use them as benchmarks for Network Rail's future productivity performance. The choice of the comparator industries was based on two criteria:

- The nature of their work should match that of Network Rail – i.e. the provision of network infrastructure services. This criterion is significant because network industries share similar types of activities and certain characteristics, such as increasing returns to scale and density, and the long-term effects of past investment on current efficiency levels;
- The industry must be subject to incentive based economic regulation.

Based on the above, the industries discussed in this paper are:

- Water and sewerage;
- Electricity (transmission and distribution);
- Telecommunications (BT).[4]

There are physical differences between the type of activities undertaken by Network Rail and those of these comparators. This means that it is not possible not to compare the efficient level of costs between these comparators. However, the remit of this analysis is to determine a benchmark range of potential cost reduction trends in the absence of more direct assessments, including that of Network Rail's relative efficiency.

Figure 5.1 below shows an indication of the trends that have occurred in reductions in costs since privatisation.[5] Further details of the estimates by industry are available in Appendix C.

The analysis of trends in growth rates is undertaken using the average of each annual growth rate, rather than a compound annual growth rate approach, in order to minimise the sensitivity to the start and end points of the available data and to help identify where atypical performance may exist. The observed RUOE reduction figures in each industry are adjusted for volume growth according to the approach described

[4] An additional possible candidate to be included in the list above would have been the gas industry. However, the gas transportation and distribution industry was excluded from the analysis because since 1996 it has undergone extensive restructuring activity, and consistent data covering the whole period from privatisation is not available.

[5] The analysis provides two types of RUOE change estimate for the industries examined. For all industries, the average RUOE change, defined as the average value of the annual RUOE changes, is calculated. For multi-company industries, such as water and sewerage and electricity distribution, the weighted average RUOE change is also reported, which is defined as the annual percentage difference of the aggregated industry-wide RUOE (in turn, defined as the sum of costs divided by the sum of outputs in a single year). In all cases, a positive value represents productivity growth (ie, a reduction in costs per unit of output), while a negative value signifies productivity regression (ie, an increase in costs per unit of output).

in Appendix D in order to segregate the effect of efficiency improvement from the impact of the economies of scale. As the measure reported controls for changes in volume, any unit efficiency gains from changes in volume of outputs would be over and above the measures reported here.

An issue relevant to the rail context is whether the volume of inputs may also be reduced in order to reduce total expenditure. The analysis presented in this section relates to changes in unit costs achieved by companies over time. As the majority of changes in scope are likely to be from renewals, for which there is no direct evidence of performance in the figures reported here, changes in the volume (or scope) of renewals activity which Network Rail may be able to achieve would be expected to be over and above the trend in underlying costs presented in this section.

Figure 5.1 Summary of trends in actual real unit cost reductions of UK regulated companies

	Period	Volume-adjusted RUOE (average % per annum)
Water industry controlling for quality enhancement	1992/93–2003/04	2.5
Sewerage industry controlling for quality enhancement	1992/93–2003/04	2.6
Electricity distribution	1990/91–2000/01	3.8
NGC	1990/91–2001/02	5.7
BT, using call volumes	1996/97–2003/04	10.3
BT, using exchange lines	1996/97–2003/04	3.8
Other consultants' studies[1]	Various	2.7–6.9
Range (controlling for enhancement)		**2.5–10.3**
Range (excluding outliers)		**2.5-5.7**

Note: [1] Other consultants' studies exclude gas transportation and distribution due to restructuring and lack of robust data.

Some of these industries have been privatised for more than ten years and may be in a steady state of cost reductions compared with the period immediately after privatisation where larger cost reductions are likely to have been expected. However, whilst this pattern of cost reductions is intuitively expected, the actual cost reduction patterns tend to be more complex since they are also driven by the 'carrots' and 'sticks' (i.e. the strength of the incentives and the size of the cost reductions targets) set by the regulators.

Thus, the real actual unit cost reductions (defined as operating costs which include cash maintenance expenditure for all industries except water and sewerage which is OPEX only) for industries comparable to Network Rail range from 2.5% to 10.3% pa,

or between 2.5% and 5.7% pa when excluding outliers.[6] Clearly, these cost reduction rates vary considerably, which is likely to be due in part to different starting levels of inefficiency and the large rates of catch-up that followed, differences in technological advances, and industry-specific events.

The range of cost reductions found in this study are broadly consistent with those found by consultants undertaking similar exercises for other regulators, such as Europe Economics on behalf of Ofwat in establishing a benchmark for the water industry:

"… The evidence from analysis of UK regulated firms suggest that savings of the order of 3 per cent to 5 per cent per annum in real operating expenditure have been achieved since privatisation …"

'Scope for efficiency improvement in the Water and Sewerage Industries: Final Report', Europe Economics, March 2003

Similarly, Frontier Economics found, on behalf of Postcomm in establishing a benchmark for Royal Mail:

"… On balance we believe that this evidence is consistent with medium-term unit cost reductions relative to RPI of between 2% and 7% per year, for a constant level of service quality cost (and including capital inputs) …"

'The Impact of Liberalisation on Efficiency: Prepared for Postcomm', Frontier Economics, January 2002

Finally, CEPA undertook a similar exercise on behalf of Ofgem in 2003 using a similar set of comparators and concluded for UK distribution network operators:

"…We expect operating efficiency (the PFP measure), to be in the range 2.0-5.0%…"

'Productivity Improvements in Distribution Network Operators: Final Report', Cambridge Economic Policy Associates, November 2003

The analysis in this report covers at least the time period examined in previous studies on efficiency published by consultants and, where possible, is updated with the latest available data. Nevertheless, for completeness, the estimates derived from the consultants' studies referred to above are shown in Appendix C.

None of the comparator industries highlighted have experienced a cost shock of the order of magnitude that Network Rail faced following Hatfield and during administration, when costs rose rapidly as a large amount of activity was undertaken in a short period of time. This might suggest that Network Rail might not be in a similar position to other privatised companies. One way of making a meaningful comparison between Network Rail and the other regulated privatised utilities might be to examine the efficiency gains made by other regulated network utilities by time period.

To obtain a picture of the dynamic productivity improvements over time, the results from Figure 5.1 have been segregated by comparable industries per control period and

[6] It is likely that exchange lines represents a more appropriate cost driver for BT than call volumes and would be more similar to track length as a cost driver for Network Rail.

per year periods since privatisation. The analysis looks at both years since privatisation and individual control periods as it not clear which effect is more important - the effect of a periodic review and the changing incentives and targets which potentially lead to additional improvements in performance or the removal of inefficiencies post- privatisation and the likely decreasing pattern of this element over time. Differing numbers of years for the control periods for BT and NGC and the limited availability of data for some industries means analysis of control periods and years since privatisation gives differing results. However, it should be noted that by examining shorter time periods the analysis is more susceptible to atypical performance/events.

Figure 5.2 shows the rates of real unit cost reduction (defined as above) achieved by the UK regulated utilities identified in Figure 5.1, by control period. There were insufficient observations to go beyond the third control period.

Figure 5.2 Summary of actual real unit cost reductions (volume adjusted) of UK regulated companies by control period (% pa)

	Range	Average
First control period	-3.8–5.2	1.9
Second control period	3.0–12.8	6.5
Third control period	-1.5–13.2	5.2

According to Figure 5.2, in the second regulatory period, companies operating in the regulated industries in the UK have, on average, achieved reductions in RUOE of 6.5% pa (with a range of 3.0% to 12.8%), adjusted for economies of scale. During the next control period, average efficiency improvement was 5.2% in annual terms (with a range of –1.5% to 13.2%), adjusted for economies of scale. Again, the ranges are quite broad due, in part, to different starting levels of inefficiency. In fact the ranges are broader than those in Figure 5.1 due to the shorter time periods under examination.

Figure 5.3 shows the rates of RUOE reductions by number of years since privatisation.

Figure 5.3 Summary of actual real unit cost reductions (volume adjusted) of UK regulated companies by number of years since privatisation (% pa)

Years since privatisation	Range	Average
1–5	1.5–6.7	3.9
6–10	3.7–4.5	4.3
11–15	-1.5–9.6	2.9

According to Figure 5.3, in the period 6–10 years since privatisation UK regulated industries were able to achieve average unit cost reductions of 4.3% pa (with a range of 3.7% to 4.5%). In the next five-year period, the rate of RUOE reductions was on average 2.9% pa (with a range of –1.5% to 9.6%). Again, the performance varies significantly.[7]

This analysis shows that in the first control period/5 years post privatisation the efficiency gains might be less than can be expected later on. This may be due to a lack of understanding of the cost structure of the industry and focussing on ensuring the serviceability of the asset base before significant cost reductions can be achieved. The period post Hatfield and during administration may have had a similar emphasis on network safety and serviceability and hence led to the large cost increases seen in this period (with less management focus on efficiency improvements). Therefore information regarding the cost reduction trends in control periods 2 to 3 and years 6 to 15 years post privatisation may provide a better indication of the potential for efficiency improvements in CP4 and CP5 for Network Rail.

To estimate what rates of unit cost reduction might be expected from Network Rail in CP4, the average of control period 2 and years 6 to 10 is taken giving an estimate of 5.4% per annum and the average of control period 3 and years 11 to 15 gives an average of 4.1% per annum as a benchmark for CP5.

This is consistent with evidence that there is a decreasing rate of improvement over time, once the initial level of inefficiency has been established. However, it is also worth noting there is more uncertainty surrounding estimates for CP5. Figure 5.4 summarises results of the analysis of direct RUOE measures of efficiency improvements achieved by regulated industries.

[7] The results obtained in tables 5.2 and 5.3 differ from each other in terms of average performance improvement. These differences arise from the following:

- averaging effects from taking the average of the company for each period;
- in some cases there are fewer companies or sectors represented in these breakdowns due to data availability;
- the frequency of the price control reviews is not always 5 years;
- in some cases, even if a sector is represented, the number of years of available data does not match the full period in question.

Figure 5.4 Summary of the RUOE measures of efficiency achievement (% pa)

	Range	Average
Second control period	3.0–12.8	6.5
Years 6 to 10	3.7–4.5	4.3
CP4 Average		**5.4**
Third control period	-1.5–13.2	5.2
Years 11 to 15	-1.5–9.6	2.9
CP5 Average		**4.1**

Notes: Actual RUOE reductions are adjusted for scale effects.

It is also interesting to note that even going forward the UK regulators are still identifying potential for companies to catch-up to best practice. For example, in the price control review of the water industry in 2004 ("PR04"), equivalent on the basis above to CP6 for Network Rail, Ofwat commissioned a study to examine the potential for cost reductions for the water industry. As part of this assessment, the consultants estimated a long-run annual scope for reduction in base service OPEX and a 'privatisation effect' (which incorporated the effect of catch-up following pre-privatisation inefficiencies). This privatisation effect was estimated to be 1.25% to 3.5% p.a. It was then judged by the consultants that a proportion of this privatisation effect still remained within the industry. They estimated this effect to be 0.5%–2.5% p.a., stating that 'we think there is certainly scope for some continuation of catch-up in the next few years'.[8] Indeed, Ofwat's catch-up targets at PR04 were 1.8% p.a. for water services and 1.3% p.a. for sewerage services.[9]

The analysis provided has adjusted for significant changes in the scope of activity where possible (such as enhancement in water and sewerage and NGCs undertaking of the Transmission Services Scheme). Given the time period and data available it is the consultant's judgement that this range represents the best view of the unit cost efficiency improvements that can be derived from the available data and in the absence of more direct estimates. Consequently, the initial level of starting efficiency rather than changes in scope of activity determines where within the range would provide a target for Network Rail's cost reductions. Therefore, the achievement of the range has predominantly been via unit cost efficiency improvements rather than through changes in scope.

5.3. Total factor productivity growth analysis

In the absence of direct assessments of Network Rail's potential for cost reductions, one approach to establishing a possible benchmark range of cost reduction rates for Network Rail is to consider the efficiency improvements in the economy as a whole, and in sectors of the economy comparable to Network Rail.

[8] Europe Economics (2003), 'Scope for Efficiency Improvements in the Water and Sewerage Industries Final Report', a report for Ofwat, March.
[9] Ofwat (2004), 'Future water and sewerage charges 2005–10, Final determinations', November.

TFP growth is a widely used method of assessing productivity improvements within the economy as a whole. Unlike the single (or partial) factor measures of productivity (such as RUOE), TFP accounts for both the operating and capital inputs. This analysis considers the changes in costs observed for companies operating in competitive markets, and which are therefore assumed to be efficient in outputs, and is therefore distinct from any changes in costs that might be due to increasing efficiency in a company's scope of activities. Whilst recognising that small changes in scope may have occurred it is not possible to determine in which direction they have been and experience suggests that this is a secondary issue to the company's initial level of starting efficiency.

In order to estimate cost reduction targets for Network Rail, this study uses evidence on RUOE trends (which include both operating and maintenance expenditure, and consist of both catch-up and frontier shift), while estimates of TFP growth are used to identify frontier shift. The TFP benchmarks are converted into both RUOE and RUTC benchmarks to identify the frontier shift for operations, maintenance and renewals costs.

The approach taken here estimates expected productivity in TFP terms and, when converting to RUOE/RUTC, uses a real input price adjustment to control for expected changes in input prices due to economy-wide productivity gains, which, in perfectly competitive markets, are passed through as price reductions and captured in RPI.[10] Finally the study examines what proportion of the efficiency improvement in RUOE/RUTC terms represents frontier shift only. The first step in this approach to deriving an operating cost reduction benchmark is to establish a TFP growth rate benchmark. Two approaches are used in this study:

- Sectoral TFP growth figures;
- A review of the academic literature on TFP performance in regulated industries.

These are discussed in turn below.

5.3.1. Using UK sectoral TFP growth as a benchmark

This section examines productivity trends only. The next section (5.4) converts these productivity benchmarks to real unit operating and real unit total cost benchmarks.

5.3.1.1. Identifying sectors for comparison

The first step is to establish reasonable sectoral comparators for Network Rail. However, TFP growth analysis of the UK sectors of the economy tends not to be undertaken at a very detailed sectoral level - usually the first level of the SIC code[11] is used - or, if more disaggregated, tends to focus on the manufacturing sector. Thus,

[10] Following a similar approach to Europe Economics and Professor Nick Crafts in a paper prepared for Ofwat: 'Water and Sewerage Industries General Efficiency and Potential for Improvement', 1998.

[11] SIC codes are Standard Industrial Classifications which are a means of classifying organisations in terms of the nature of their business (eg C is Mining and Quarrying and CA is Mining and Quarrying of energy producing materials).

very close matches of sectoral TFP growth to Network Rail are not possible. Nevertheless, five potential sectoral benchmarks are worth examining:[12]

- The economy as whole;
- Market sectors (i.e. excluding the public sector, since its productivity is difficult to measure accurately and could bias the result);[13]
- Transport - this is part of Transport, Storage and Communication;
- Construction;
- Electricity, gas and water supply.

The first two benchmarks establish the overall productivity trends in the UK economy as a whole. The remaining benchmarks establish productivity trends in industries comparable to Network Rail. They represent network industries that need to operate, maintain and renew their network - companies that undertake construction work, including civil engineering; or transport companies. They may therefore be more indicative of the technology growth and thus long-term cost reduction trends that Network Rail may be able to achieve.

5.3.1.2. Identifying the time period for comparison

As discussed above, since the aim of this section is to establish a long-term annual operating cost reduction (or frontier shift) benchmark for Network Rail, any external benchmarks need to be constructed over reasonably long time periods to mitigate the impact of atypical performance. To check the sensitivity of the results to the periods examined, the TFP growth rates over three alternative periods are assessed: 1973-99, 1979-99 and 1989-99.

5.3.1.3. Results

The TFP growth estimates are taken from O'Mahony and de Boer (2002). However, it should be noted that this study only provides data up to 1999.[14] However, as a result of volume growth, TFP growth will in part be due to the impact of economies of scale. As these external benchmarks are intended to provide a benchmark for Network Rail's potential for efficiency improvements at constant volume growth, TFP growth figures are adjusted for volume growth on the basis of Equation D.1 in Appendix D**.** (The volume adjustment used is based on a conservative assumption of economies of scale of 0.9 for all sectors used by other consultants and academics.) This adjustment (and sensitivity to higher and lower assumptions) results in the TFP growth figures provided in Figure 5.5.

[12] http://www.statistics.gov.uk/methods_quality/sic.

[13] The value of output of services of the non-market sector (which includes government administration, education and health) is partly estimated by employment income with some allowance for capital consumption. The extent to which employment income has been used has also varied over time. As such, the output measure for non-market services may not be reliable. The economy-wide productivity figures may therefore be biased by the inclusion of non-market sectors. The examination of market sectors only may therefore provide a more accurate assessment of economy-wide productivity.

[14] O'Mahony, M. and de Boer, W. (2002), "Britain's Relative Productivity Performance: Updates to 1999 Final Report to DTI/Treasury/ONS", March.

Figure 5.5 Sectoral TFP growth adjusted for volume growth (average % pa)

	1989–99	1979–99	1973–99
Electricity, gas and water	3.2	2.7	2.7
Construction	0.7	1.7	1.2
Transport	2.3	3.0	2.4
Total market sectors	0.8	1.2	1.2
Total economy	0.9	1.1	1.1
Range	**0.7–3.2**	**1.1–3.0**	**1.1–2.7**
Average	**1.6**	**1.9**	**1.7**
Average using 0.8 as economies of scale	1.4	1.6	1.5
Average using 0.95 as economies of scale	1.7	2.1	1.8

Note: Volume adjustment is based on a conservative assumption of economies of scale of 0.9 unless stated.
Source: O'Mahony and de Boer (2002), op. cit.

Thus, TFP growth rates adjusted for volume growth range between 0.7% and 3.2% pa. The most direct comparators are provided by the transport sector and the network industries (electricity, gas and water). Overall, therefore, this analysis would suggest an adjusted TFP benchmark of 1–3% pa for Network Rail's productivity potential, with the most directly comparable benchmarks being 2.3% pa or higher.

Section 5.4 converts these TFP figure to cost benchmarks, and adjustments to real input prices are made which control for the productivity growth in the economy as a whole (more detail is available in Appendix E).

5.3.2. Estimates of TFP growth from academic literature on the impact of privatisation

This section summarises the academic literature on the impact of privatisation and, in particular, those studies that incorporate assessments based on TFP. The focus of the review is on the underlying TFP growth estimates rather than the conclusions on the impact of privatisation. The studies examined are listed in the bibliography and were published over the period 1992–2004; however, not all of these provide estimated efficiency performance that could be used in this study.

The academic literature reviewed considers the performance of a number of privatised companies, and may therefore provide a possible benchmark for Network Rail's long-term productivity potential. However, some care is required since large restructuring projects, high volume growth, and fast technological change may place upward bias on many of the average figures and certainly the upper bounds of the ranges.

Bearing these factors in mind, the literature reviewed here indicates a TFP growth range of 0% to 3% pa - see Figure 5.6.

Figure 5.6 Summary of academic findings on TFP growth of privatised companies (% pa)

	TFP	TFP adjusted for volume growth
Saal and Parker (2001)	0.8–2.2	n/a
Martin and Parker (1997)	0–2.8	0–3.0
Bishop and Green (1995)	1.2–2.2	n/a
Parker (1994)	1.8	n/a
Bishop and Thompson (1992)	1.9–2.4	1.6–2.2
Overall average[1]	**1.8**	**n/a**
Total range	**0–2.8**	**0–3.0**

Note: The studies examined were published over the period 1992–2004; however, not all of these provide estimated efficiency performance that could be used in this study, and the majority of the studies tend to be from the 1990s, when the impact of privatisation was of most academic interest.[1] Average across individual company results (not an average of the study averages).

5.4. Conversion of TFP to RUOE and estimating the frontier shift

Having established potential TFP benchmarks for Network Rail, these figures need to be converted into long-term cost reduction benchmarks. As explained in Appendix B.2, TFP is not directly comparable to OPEX improvements and it is therefore necessary to convert a TFP-based benchmark to a RUTC or RUOE benchmark and then to a frontier shift element. The approach used is as follows.

- First, a TFP-based productivity benchmark range needs to be established (as undertaken in sections 5.3.1 to 5.3.2);
- For an OPEX benchmark, this TFP benchmark then needs the capital element to be removed (this step is not required for a total cost benchmark). The assumption used is that the rate of capital substitution is the same as that observed in the UK economy (0.35);
- The productivity measure needs to be converted into a cost figure by accounting for forecasts for input price growth. This is based on forecasts for the UK economy, but may require adjusting for Network Rail-specific input price growth forecasts;
- The input price adjustment also requires an assumption of the labour share, calculated as 50% for Network Rail (in terms of staff cost as a proportion of operating costs);
- This provides an overall RUOE figure which requires the catch-up element to be removed. The split between frontier shift and catch-up is assumed to be 50/50 on the basis of a number of regulators' assessments (with a sensitivity of 75/25).

Figure 5.7 summarises the calculations required to translate the TFP benchmarks (as identified in Appendix C) into long-term RUOE reductions, based on the assumption that future input price growth for Network Rail is similar to that of the UK economy as a whole. Figure 5.8 shows the result of converting TFP benchmarks to RUTC reductions.

Figure 5.7 Conversion of TFP benchmarks into long-term RUOE reductions (average % pa)

	Sectoral TFP	Academic studies of TFP
Range		
TFP benchmark	0.7–3.2	0–3
Capital productivity	-0.1–2.4	-0.9–2.2
Increase in real input prices	0.9	0.9
Reduction in RUOE	0.5–2.9	-0.3–2.7
Frontier shift (50%)	**0.2–1.5**	**-0.1–1.4**
Frontier shift (75%)	**0.3–2.2**	**-0.2–2**
Average		
TFP benchmark	1.8	1.8
Capital productivity	0.9	1.0
Increase in real input prices	0.9	0.9
Reduction in RUOE	1.5	1.6
Frontier shift (50%)	**0.7**	**0.8**
Frontier shift (75%)	**1.1**	**1.2**

Figure 5.8 Conversion of TFP benchmarks into long-term RUTC reductions (average % pa)

	Sectoral TFP	Academic studies of TFP
Range		
TFP benchmark	0.7–3.2	0–3
Increase in real total input prices	0.4	0.4
Reduction in RUTC	0.3–2.8	-0.4–2.6
Frontier shift (50%)	**0.2–1.4**	**-0.2–1.3**
Frontier shift (75%)	**0.2–2.1**	**-0.3–2.0**
Average		
TFP benchmark	1.8	1.8
Increase in real total input prices	0.4	0.4
Reduction in RUTC	1.3	1.4
Frontier shift (50%)	**0.7**	**0.7**
Frontier shift (75%)	**1.0**	**1.05**

Comparison of frontier shift derived according to RUOE and RUTC shows that there is little evidence of different rates of frontier growth between total costs and operating costs, with estimated frontier shift benchmarks for Network Rail of –0.3% to 2.2% pa, with a rail specific benchmark (based on TFP growth of 2.3% to 3% pa) of around 1% to 2% per annum.

Appendix E examines how cost reduction factors can be used for price setting in an RPI–X framework.

5.5. Regulators' frontier shift targets

Figure 5.9 summarises the regulators' frontier shift targets for the companies. The Figure illustrates that regulators have set frontier shift targets of 0% to 3% pa depending on the industry, with an average of 1.4% pa.

Figure 5.9 Summary of regulators' frontier shift assumptions (average % pa)

	Frontier shift target
Ofwat (PR94) water and sewerage services	1.0
Ofwat (PR99) water and sewerage services	1.4
Ofwat (PR04) water services	0.3
Ofwat (PR04) sewerage services	0.5
Water Industry Commission for Scotland (2001)	0.9
Ofgem (DPCR3)	0
Ofgem (DPCR4)	1.5
Oftel (1997)	3
Oftel (2001)	2.8[1]
Ofcom (2005)	1.5–3[1]
Range	**0–3**
Average	**1.4**

Note: PR94, PR99 and PR04: 1994, 1999 and 2004 periodic reviews of water prices. DPCR3 and DPCR4: 1999 and 2004 electricity distribution price control reviews. [1] Estimated.
Source: Regulators' reports.

5.6. Summary

This section has investigated efficiency achievements in other regulated industries. The evidence, summarised in Figure 5.11, shows that regulated network industries have achieved cost reductions of between 2.5% and 5.7% pa, excluding outliers. Typically, regulators have set companies lower targets, acknowledging the incentive to outperform as well as uncertainty regarding the cost assessment.

None of the comparator industries highlighted have experienced a cost shock of the order of magnitude that Network Rail faced following Hatfield, when costs rose rapidly as a large amount of activity was undertaken in a short period of time.

In the first few years from privatisation there is often little focus on efficiency as regulators and companies understand the asset base and ensure the longevity of the network. The period post Hatfield and during administration may have had a similar emphasis on network safety and serviceability and hence led to the large cost increases seen in this period (with less management focus on efficiency improvements). Therefore information regarding the cost reduction trends in control periods 2 to 3 and years 6 to 15 years post privatisation may give an indication of the potential for efficiency improvements in CP4 and CP5 for Network Rail.

To estimate what rates of unit cost reduction might be expected in CP4, the average of control period 2 and years 6 to 10 is taken giving an estimate of 5.4% per annum and the average of control period 3 and years 11 to 15 gives an average of 4.1% per annum.

This is consistent with evidence that there is a decreasing rate of improvement over time, once the initial level of inefficiency has been established. It is also worth noting that there is more uncertainty surrounding estimates of CP5.

In this study TFP is used to derive a range estimates for the potential frontier shift for Network Rail. Table 5.11 indicates a range of frontier estimates of between –0.2% and 2.2% per annum. On the basis of the evidence available a rail specific benchmark might be 1% to 2% per annum (based on TFP growth benchmark of 2.3% to 3% pa), with an average frontier estimate of 1.5% pa. This is consistent with the frontier shift targets that regulators have set of between 0% and 3% pa.

Figure 5.11 Summary of potential benchmarks for efficiency improvements (% pa)

	Range	Average
RUOE reductions (volume adjusted)		
Actual achieved	2.5–10.3	
Actual achieved excluding outliers	2.5–5.7	
Second control period	3.0–12.8	6.5
Years 6 to 10	3.7–4.5	4.3
CP4 Average		**5.4**
Third control period	-1.5–13.2	5.2
Years 11 to 15	-1.5–9.6	2.9
CP5 Average		**4.1**
TFP growth		
Sectoral (TFP)	0.7–3.2	1.8
Sectoral (RUOE equivalent)	0.5–2.9	1.5
Academic evidence (TFP)	0 to 3	1.8
Academic evidence (RUOE equivalent)	-0.3–2.7	1.6
Frontier shift		
Regulator assumptions	0–3	1.4
TFP based ('50%' assumption)		
sectoral	0.2–1.5	0.7
Academic evidence	-0.1–1.4	0.8
TFP based ('75%' assumption)		
sectoral	0.3–2.2	1.1
Academic evidence	-0.2–2	1.2

The TFP-derived frontier estimates are based on constant volumes (i.e. they control for economies of scale). They do not control for companies undertaking new activities beyond their core business (such as Centrica's acquisitions) or large changes in quality (as seen in the sewerage industry). The TFP figures provided above assume that any additional scope savings beyond increases in volume are captured in the catch-up component.

The TFP and RUOE analysis undertaken here allows indirect measures of the potential for cost reductions to be implied from what has been observed in other industries. More direct, and thus more accurate, measures are available when more direct approaches are used – e.g. using consistent rail industry data over time to estimate both catch-up and frontier movement, or undertaking detailed studies of rail operations and the potential for the adoption of new technology or new operational processes.

Critically, this section has not examined Network Rail's relative efficiency and this is a key driver of the potential for future cost reductions. Thus, in order to establish a total cost reduction benchmark, the amount of catch-up available to Network Rail will need to be examined in detail.

6. EFFICIENCY ACHIEVEMENTS IN OTHER RAILWAYS

6.1. America

In 1981, the US Class I freight railroads were partially de-regulated.

With the passage of the Staggers Rail Act of 1980 and its implementation by the Interstate Commerce Commission ("ICC"), many regulatory restraints on the Class I freight railroad industry were removed, allowing the industry increased flexibility to adjust their rates and tailor services to meet shipper needs and their own revenue requirements.

However the Staggers Act did not completely deregulate railroads; in addition to retaining authority over a variety of non-rates areas, the ICC retained the authority to set maximum rates or take certain other actions if a railroad were found to have "market dominance" or to have engaged in anticompetitive behaviour.

As a result, more than 20 years after deregulation, the railroad industry's financial health has improved significantly, service to rail customers has improved while overall rates have decreased, and rail safety has improved.

In particular, evidence collated by the American Association of Railroads ("AAR") shows that these railroads have achieved significant, and long-running, improvements in productivity (measured by ton-miles per constant dollar operating expense).

- Overall rail productivity rose 178% from 1980 to 2004
- If we translate this into efficiency terms, unit operating cost per revenue ton mile decreased by more than 64% over the same period (Figure 6.1)

Figure 6.1 Post-Staggers Act Unit Operating Cost of US Class I Freight Railroad

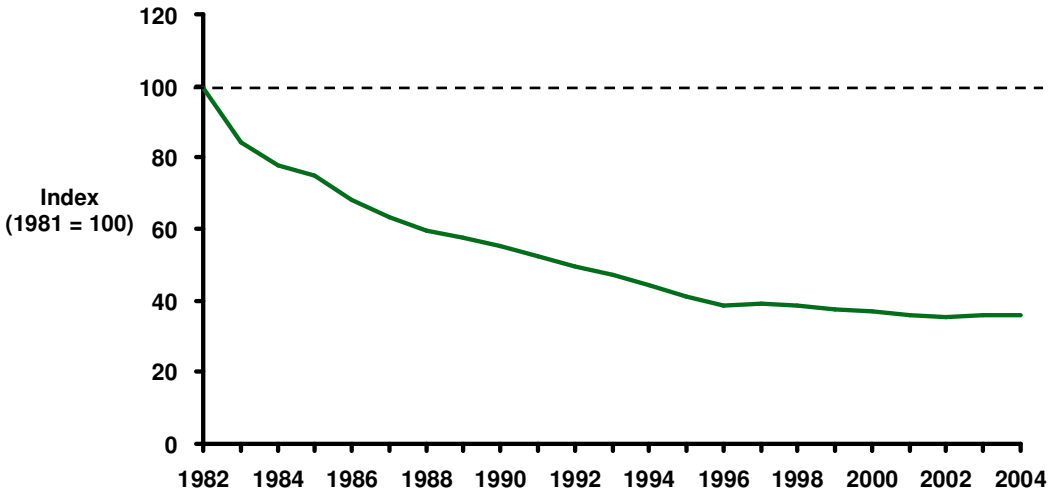


Figure 6.2 shows a summary of the efficiency gains, averaged over 5 year periods, equivalent to control periods.

Figure 6.2 Average Efficiency Gains by Control Period Equivalents

Control Period	Average efficiency gains per year in 5-year periods
1981/86 (CP1 equivalent)	7.4%
1986/91 (CP2 equivalent)	5.2%
1991/96 (CP3 equivalent)	5.8%
1996/01 (CP4 equivalent)	1.6%

In order to separate the impact on unit costs of volume growth from this calculation and isolate the efficiency gain we developed a simple model of the fixed/variable cost structure of these railroads. This leads to annual gains in productivity, adjusting for volume growth, as shown in Figure 6.3.

Figure 6.3 Average Efficiency Gains after Adjusting for Volume

Control Period	Average efficiency gains (CAGR)
1981/86 (CP1 equivalent)	7.6%
1986/91 (CP2 equivalent)	4.2%
1991/96 (CP3 equivalent)	4.5%
1996/01 (CP4 equivalent)	1.2%

As discussed in section 5, one hypothesis to inform the top end of a range of efficiency targets is that Network Rail's position at the end of CP3 is analogous to the end of CP1 in other situations. Therefore, the efficiency data in Figure 6.3 for CP2 equivalent (4.2%) and CP3 equivalent (4.5%) inform the potential efficiency gains for Network Rail in CP4 and CP5.

6.2. Australia

A number of Australian railways have been privatised or submitted to economic regulation over the past decade and we also examined the efficiency-related evidence in those cases. However, due to a range of specific factors, such as changes in industry structure or accidents, no compelling time series of data has been available to demonstrate efficiency trends.

Consequently, we do not perceive that the current study can be informed by the record of efficiency improvements in Australian railways.

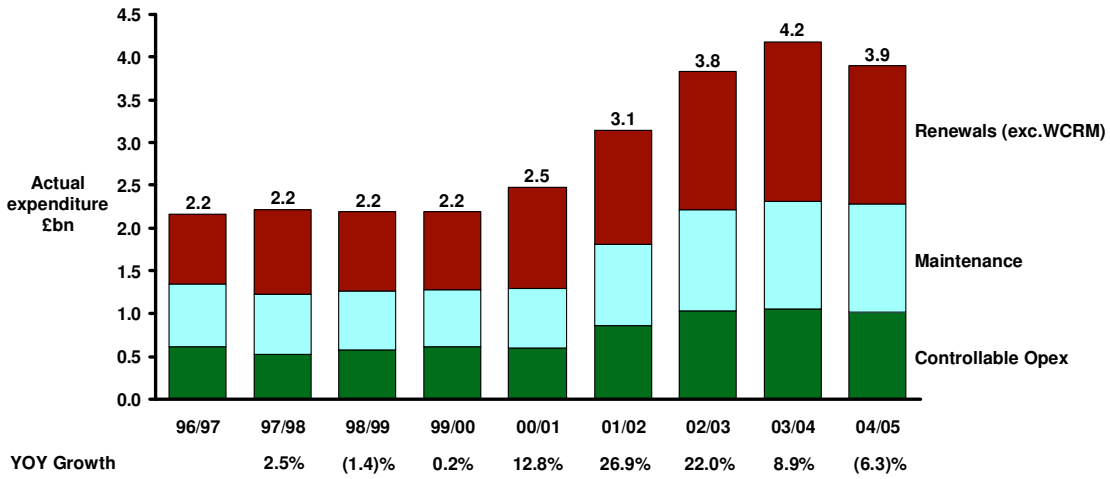
7. EFFICIENCY TRENDS IN GB RAIL

This section explores the cost trends within GB rail before Hatfield/Railway Administration and assesses whether there may plausibly be potential for additional catch-up efficiency gains after CP3 as part of a recovery from the sharp rise in costs experienced from 2001 onwards.

7.1. OMR expenditure trend

Figure 7.1 shows the trend in controllable opex, maintenance and renewals (non-WCRM) ("OMR") expenditure since 1996/97. The chart shows costs rising during 2000/01 and in each subsequent year, peaking in 2003/04. In both 2001/02 and 2002/03, costs increased by more than 20% compared with the prior year.

Figure 7.1 OMR expenditure 1996/97 to 2004/05



These cost increases could in principle be due to a combination of the following factors:

- Increased unit costs due to inefficiency,
- Increased unit costs due to changing industry priorities (e.g., emphasis on safety),
- Increased activity volumes that are justified on an on-going basis,
- Other increases in activity volumes, and
- Input cost inflation.

What remains unclear is the mix of these factors. To the extent that the cost increase was due to inefficiency or unjustified on-going activity volumes, it would indicate potential for additional catch-up efficiency gains. The calculations in this section aim to establish a plausible range for the additional catch-up after CP3.

7.2. Inefficiency in Network Rail's inheritance

Network Rail has been critical of Railtrack's record, referring in its 2003 business plan to Railtrack's "recent poor record on train performance and escalating costs".

The subject of efficiency trends in the period 2000 to 2003 is highly complex and has been studied and discussed widely. Accurate analysis is constrained by a lack of detailed data, changes in company structure, changes in reporting and the significant increase in renewals expenditure on categories where no clearly understood volume measure was defined nor reported.

We understand that the pace of the increase in activity led to increases in unit costs, as the supply industries struggled to resource the work and Railtrack/Network Rail responded to outside pressures that prioritised results (for example reductions in broken rails) rather than efficiency. It is widely perceived that cost control was poor during the time after Hatfield and during administration, and that Network Rail then took time to regain control of costs.

"… We have begun to bring costs under control …"
Ian McAllister, Network Rail 2004 Business Plan Summary, p1 (approximately 1.5 years after take-over)

In order to develop a definitive view of the scale of this potential additional catch-up the industry would need to develop a thorough understanding of the reasons for the sharp increase in costs since 2001.

7.3. Alternative projections of 2008/09 efficiency

Part of the assessment of the potential for additional efficiency gains after CP3 involves a comparison between CP3 targets and the cost position that would have been reached if Railtrack had achieved an on-going trajectory of increasing efficiency consistent with the targets set for it in CP2. We have projected efficiency in 2008/09 using two methods and a summary of these calculations is shown in Figure 7.2. The gap between the results from these two methods informs the potential for additional catch up after CP3. Only the controllable part of opex is considered throughout.

7.3.1. Method 1 for projecting 2008/09 efficiency

Method 1 starts from the 1996/97 levels of OMR (controllable opex, maintenance and renewals, which sum to £2.2bn) and makes the following adjustments:

- **Deflation:** using RPI deflators to 2003/04. Whilst rail industry inflation may differ from RPI, the calculation is not very sensitive to the choice of deflator
- **Renewals:** Adjustment to reflect changes in the volume of renewals. However, relevant activity volumes were not reported by Railtrack/Network Rail through this period. We have, therefore, taken an initial and conservative assumption that the entire increase in real expenditure was due to activity volumes, and efficiency remained constant over this period. This adds £0.9bn to estimated expenditure

- **Maintenance:** Possible adjustment to reflect activity volume changes in maintenance expenditure. However, activity volumes in maintenance were not tracked over this period by Railtrack/Network Rail. It may be that volumes increased from 2001 reflecting a backlog, but this higher volume would not be justified once the backlog was cleared. Noting that Network Rail's 2005 business plan forecasts maintenance expenditure to reduce to £0.9bn by 2008/09, in real terms similar to the low point in 1999/00, it is plausible that activity volumes will also have returned broadly to 1999/00 levels suggesting that any volume increase from 2000/01 to 2003/04 was not necessarily justified in the long run. Consequently, we have made no adjustment for increases volumes of maintenance activity that would be justifiable in the long run
- **Operating expenditure:** an initial assumption is that all real terms increases in opex represent inefficiency, although some elements of the increase may relate to changes in industry priorities or other factors
- **Efficiency targets in CP1&2:** further adjustments are made to allow for the efficiency gains to 2003/04 achieving the CP1&2 targets set by the ORR, giving a value for OMR expenditure in 2003/04 of £2.8bn at approximately 2003/04 activity volumes and target efficiency, versus actual expenditure of £4.2bn
- **Efficiency beyond 2003/04:** Another adjustment is then made for the period from 2003/04 to 2008/09 composed of the remaining CP2 target efficiency until 2005/06 and an average of the efficiency gains made by other relevant industries in comparable periods after privatisation of 4.1% p.a (see Figure 5.4). This results in notional expenditure in 2008/09 of £2.3bn at approximately 2003/04 activity levels and target efficiency.

This method results in cumulative unit cost reductions from 1996/97 to 2008/09 of approximately 32%.

For comparison, Figure 7.2 summarises the cumulative efficiency improvements achieved in the regulated industries calculated on basis of the average annual reductions in unit costs as discussed in more detail in section 5.

Figure 7.2 Cumulative efficiency improvements

	Period	Number of years	Cumulative unit cost reduction (%)
Water	1992/93-2003/04	11	24.8
Sewerage	1992/93-2003/04	11	25.8
Electricity distribution	1990/91-1999/2000	9	29.8
Electricity transmission (NGC)	1990/91-2001/02	11	50.1
BT, call volumes	1995/96-2003/04, excl 2000/01-2001/02	8	51.1
BT, exchange lines	1995/96-2003/04, excl 2000/01-2001/02	8	20.8

Figure 7.2 shows a range of 20.8% to 51.1% for cumulative long-run unit cost reductions. The 32% cumulative reduction for Railtrack/Network Rail from Method 1 above falls within this range and therefore appears plausible.

7.3.2. Method 2 for projecting 2008/09 efficiency

Method 2 is based on the 2003 determination and takes the 2003/04 actual expenditure and applies the CP3 efficiency targets taken from ACR2003 to establish total OMR expenditure of £2.9bn in 2008/09, assuming constant 2003/04 volumes (i.e., expenditure levels reduced by year on year efficiency gains but with no changes for volume). This prediction is consistent with Network Rail's recent predictions that it will achieve the CP3 targets, as discussed in Section 4. This differs from the £3.4bn OMR expenditure forecast for 2008/09 in the ORR's ACR2003 final conclusions (December 2003) because that figure includes changes in activity volumes, whereas £2.9bn is based on constant 2003/04 activity volumes.

7.3.3. Comparison between Methods 1 & 2 results

Method 1 (based on CP1 and CP2 determinations and results from other industries) suggests a potential cost base in 2008/09 of £2.4bn, whereas Method 2 (based on the CP3 determination, adjusted for activity volume to be comparable) suggests £2.9bn. The gap between the results of the two methods would require further work to explain fully.

The calculations for Methods 1 & 2 are summarised in Figure 7.3.

Figure 7.3 Alternative projections of 2008/09 efficiency

CP1 + CP2 efficiency projection (adjusted to approximate 2003/04 renewals activity levels for comparison)

	£bn 2003/04
Actual controllable OMR expenditure in 1996/97 (this figure, only, is stated in 1996/97 £)	2.2
Inflation to 2003/04 £	0.3
Adjusted to approximate 2003/04 renewals activity levels, assuming constant efficiency	0.9
Efficiency gains to 2003/04 at CP1/2 targets	(0.5)
Expenditure in 2003/04 at CP1/2 target efficiency	2.9
Efficiency gains to 2005/06 at CP2 targets	(0.2)
Efficiency gains to 2008/09 at average rate from other relevant industries of approximately 4% p.a.	(0.3)
Notional expenditure in 2008/09 (at approximate 2003/04 renewals activity levels and CP1/2 targets with continued efficiency gains to 2008/09)	**2.4**

CP3 efficiency projection (at constant 2003/04 renewals activity levels for comparison)

	£bn 2003/04
Actual controllable OMR expenditure in 2003/04	4.2
Renewals efficiency gains at CP3 targets	(0.6)
Maintenance efficiency gains at CP3 targets	(0.4)
Opex efficiency gains at CP3 targets	(0.3)
Notional expenditure in 2008/09 (at approximate 2003/04 renewals activity levels and CP3 target efficiency)	**2.9**

Given the uncertainty in a number of the assumptions involved in these calculations, we carried out sensitivity analysis in order to estimate a range for the gap between the results from Methods 1 & 2 (a gap of £0.3bn to £0.7bn around a central estimate of £0.5bn shown in Figure 7.3). This gap may represent:

- Structural changes in the efficiency of the industry resulting from changes following Hatfield and Administration;
- Changes in volume of activity not accounted for in the analysis because volume has not been well recorded by Railtrack nor Network Rail; and,
- Efficiency (i.e., further efficiency gains to be made beyond CP3 to get to the level of efficiency that was targeted in CP1&2).

This gap does not include any possible gains from economies of scale achieved as work levels increase beyond 2003/04 – this may represent a further opportunity for efficiency. Conversely, nor does it include any savings that may be achieved from bringing work volumes down after 2008/09 (i.e., scope savings).

If this gap represented entirely catch-up efficiency gains to be achieved after CP3, the additional efficiency potential would be approximately 10% to 25% of 2008/09 expected OMR costs (representing c. 2-5% unit cost reduction p.a. through CP4). Based on the data available and in the context of this preliminary study, it is plausible that a proportion of this gap could represent additional catch-up efficiency. To the extent that this gap does represent additional catch up, it would be incremental to any view of on-going efficiency improvements derived from analogy with efficiency trends in other regulated industries or other railways.

7.4. Relative performance of Scotland

7.4.1. Introduction

The devolution of responsibility to the Scottish Executive for the funding of rail infrastructure in Scotland from April 2006 means that separation of Network Rail's price control framework between England & Wales and Scotland is likely to be necessary to support ORR's regulation of separate funding and HLOS specification provided by the Department for Transport and the Scottish Executive. Consequently, ORR required this study to examine whether there is any evidence for a differential efficiency target (or preliminary range) for Scotland versus England and Wales. This section examines the efficiency evidence available in relation to Scotland.

7.4.2. Recent Unit Cost Data

Network Rail is developing a unit cost framework but to date has provided the ORR with only limited unit cost data. Figure 7.4 shows a summary of recent track renewals unit cost data for Scotland versus the national average.

Figure 7.4 2003/04 Unit rates nationally and in Scotland

	Unit Rate (£/m)		Delta
	National	Scotland	
Major Items			
Re-rail both rails	(229)	(270)	18%
Steel sleeper relay and re-rail	(476)	(463)	-3%
Reballast – ABC	(442)	(373)	-16%
Re-rail, resleeper, reballast – ABC (all sleeper types)	(773)	(623)	-19%
Re-rail, resleeper, reballast – Trax (all sleeper types)	(731)	(625)	-15%
Re-rail, resleeper, reballast, formation – Trax (all sleeper types)	(760)	(829)	9%
Drainage	(289)	(159)	-45%
Other –GCC only			
Re-rail – one rail only	(177)	(206)	16%
Other			
Steel sleeper only	(476)	(525)	10%
Re-rail, ballast – Trax	(618)	(618)	0%
Reballast – Trax	(617)	(581)	-6%
Resleeper, reballast – ABC (all sleeper types)	(420)	(550)	31%
Resleeper, reballast – Trax (all sleeper types)	(661)	(711)	7%
Reballast, formation – Trax	(902)	(533)	-41%
Resleeper, reballast, formation – Trax (all sleeper types)	(893)	(864)	-3%

The data does not show any distinct pattern in the unit costs for Scotland versus other regions.

7.4.3. Regional Benchmarking results

L.E.K.'s Regional Benchmarking study for ACR2003 (see section 4) derived normalised comparisons of unit costs in 2002/03 by region. Overall, for Scotland BDP cost was 24% below the business plan forecast for 2003/04 which is slightly above the average gap across all regions and the third largest gap across the six regions.

For Opex, Scotland was the closest region to BDP. For Maintenance Scotland achieved varied results, with the second worst score in track maintenance, but third best for S&T maintenance. For total renewals cost per region, Scotland had the second lowest spend, average cost per track km and cost per route km for total renewals and plain line renewals costs. However, it had the highest cost per train km, cost per million gross tonne km and cost per million equivalent gross tonne km.

7.4.4. Conclusion

Given Scotland's mixed performance in both recent track renewals unit cost data from Network Rail and the normalised unit costs presented in Regional Benchmarking, it is difficult to draw conclusions on relative efficiency for Scotland. In any event, at this early stage in CP3 it would be difficult to draw conclusions regarding relative efficiency for Scotland at the end of CP3, without further investigation.

Consequently, at this stage we do not suggest a differential range for the efficiency targets for Scotland.

8. CONCLUSIONS ON PRELIMINARY EFFICIENCY TARGETS FOR CP4 AND CP5

This section summarises the results of our investigation into the potential range for efficiency targets for Network Rail in CP4 and CP5. Our conclusions can be summarised as follows:

- Network Rail's 2005 business plan predicts that the company will, by the end of CP3, achieve 31% efficiency savings; ORR's final determination in ACR2003 was for a 31% reduction in unit costs.
- We have reviewed Network Rail's published statements since ACR2003 for evidence of the achievement of the various unit cost efficiency initiatives identified in ACR2003. Whilst it is clear that Network Rail is making rapid progress in reducing its unit costs, the evidence at present means that we can not conclude that Network Rail will have entirely completed substantially all of these initiatives during CP3, and indeed a number of those initiatives are not mentioned in Network Rail's publications since ACR2003. Consequently this suggests there will be further opportunity for catch-up efficiency gains in CP4 and beyond
- We have examined the trends in efficiency gains (including frontier and catch-up) in other industries
  - In investigating the top end of the range for Network Rail, these analyses have been based on the hypothesis that the sharp increase in costs that followed Hatfield and Railway Administration have effectively "reset" the industry to the relatively high level of inefficiency typically observed pre-privatisation
  - As a consequence, the period currently under examination (CP4 and CP5) is considered similar (in terms of efficiency gain potential) to second or third regulatory periods in other industries or situations
- Findings from other industries
  - Following privatisation, a range of industries have achieved significant unit cost efficiency gains. Over the long run these unit cost reductions have cumulated to between 20% and 50%
  - These gains are often measured and analysed in terms of Reductions in Unit Operating Expenditure ("RUOE"), which would be equivalent to Network Rail's operating and maintenance costs
  - Long run trends in RUOE and Total Factor Productivity (including capex) are similar, from which we infer that renewal efficiency changes are unlikely to be materially different from those achieved for operating and maintenance costs
  - On average over a time period analogous to Network Rail's CP4 (years 6-10 from privatisation or a second control period), other regulated industries have on average achieved 5.4% p.a. efficiency gains

  - There is no evidence that reductions of scope (i.e., activity volume) have contributed significantly to the achievement of these cost reductions
  - Frontier efficiency gains across a range of industries comparable to Network Rail appear to be in the range of 1-2% p.a.

- During the period 1986 to 1991 (equivalent to a second regulatory period), US Class I freight railroads achieved 4.2% p.a. unit cost efficiency gains after adjusting for volume growth (which increases to 4.5% between 1991 and 1996 or a CP3 equivalent period)
- We have also attempted to assess the level of additional catch-up that might be implied by the sharp rise in Railtrack / Network Rail's costs since 2000. To do this, we have compared 2008/09 OMR notional expenditures assuming full achievement of ACR2003 CP3 efficiency targets with what expenditure in 2008/09 would have been if the targeted efficiency gains in CP1 and CP2 were achieved (built up from 1996/97 OMR cost base but keeping constant activity levels).
  - Even after achieving the targeted efficiency gains in CP3, Network Rail may not yet have caught up with the CP1 & 2 efficiency trajectory
  - High level analysis suggests this cost gap could be 10% to 25% of notional 2008/09 OMR spend, a proportion of which is plausibly additional catch-up, i.e., over and above the rate achieved in other industries
- There may be additional efficiency gains from scope reduction, but no evidence exists at this stage to allow us to quantify this. It is interesting to note Network Rail's significant renewals underspend so far in CP3 and out-performance against Asset Stewardship Index and train delay targets as reported in the ORR's assessment of 2004/05. In light of this positive trend, the ORR and Network Rail may wish to reassess (as part of PR2008) the target level of activity required to achieve a given sustainable level of asset condition.
- In light of Network Rail's rapid progress in improving the condition of the network there appears to be need for a dialogue about the appropriate level of asset condition targets and their definition as there may also be additional potential efficiency gains to be obtained from examining the standard of specification for work carried out on the network. However, this would have implications for quality standards (e.g., performance and safety) which need to be considered carefully.

Based on this evidence, a plausible range of potential efficiency gains in CP4 is between 2% and 8% p.a.

At this stage, looking beyond CP4 necessarily involves even greater uncertainty. However, we would judge that the lower bound of an expected range would consist of frontier shift plus some remaining catch-up at least as the result of long term efficiency initiatives being fully realised. As an upper end of the range, we have referred to the achievements of other industries (in periods of time analogous to a

third control period under the reset hypothesis) and included a small amount of the additional catch-up estimated to be achievable from the end of CP3 onwards that could not be fully captured in CP4. Therefore, in CP5, a plausible range for the efficiency target would be 1.5% to 5% p.a.

These figures represent real annual efficiency gains and are therefore net of general, economy-wide, inflation and specific, industry input-cost, inflation.

The ORR is required to apply an efficiency target separately to Scotland versus England and Wales. At this stage, there is insufficient data to conclude that Scotland will achieve a different relative efficiency to England and Wales by the end of CP3. Consequently, we do not suggest a differential target for Scotland.

The efficiency range applies to unit cost efficiency, and therefore excludes any scope or quality changes. To the extent that scope is an issue at next review, should focus on bottom-up review.

9. SUGGESTED EFFICIENCY-RELATED WORK PROGRAMME FOR PR2008

This section contain an assessment of the key areas of work that should be undertaken in PR2008 to support the regulatory determination on efficiency.

9.1. Network Rail's planned expenditure for 2008/09

Figure 9.1 summarises Network Rail projection for OMR cost in 2008/09 in the 2005 business plan.

Figure 9.1 Network Rail's predicted OMR expenditure in 2008/09

	2004/05 £m
Operating expenditure	1,004
Of which, controllable	**754**
Maintenance	**928**
Renewals (non-WCRM)	
Track	676
Other	1,616
Total renewals (non-WCRM)	**2,292**
Total OMR expenditure (Controllable operating expenditure, maintenance and non-WCRM renewals)	**3,974**

Figure 9.1 shows that Network Rail will be spending approximately £4bn in 2008/09. The significant sums being spent on each of O, M and R suggest that ORR will need to focus its work programme on all three areas. Moreover, track will account for just 30% of renewals and so analyses of renewals efficiency will need to extend beyond track into a range of other asset classes.

9.2. Potential approaches to unit cost efficiency analysis in PR2008

This section sets out a number of complimentary approaches to identifying the scope for unit cost efficiency gains beyond CP3.

9.2.1. Regional unit cost benchmarking

As in ACR2003, we would suggest the ORR compares the regions within Network Rail to identify internal best practice. In addition, by using time series data (which is likely to be available by then) the ORR could increase the number of observations as well as identifying the rate of catch-up and frontier shift achieved. This would

potentially give differential results for catch-up and frontier shift for Scotland, but is data-dependent.

9.2.2. Signaller review

Signaller cost was excluded from regional benchmarking in 2003 because it had recently been reviewed by consultants for Network Rail. Unless a similar situation again prevailed, we would suggest that signaller costs were review in PR2008. This would involve benchmarking of processes and tools against other industries that involve rostering larger staff contingents (train crew would be an obvious example amongst others). Further work could include a bottom-up challenge to the efficiency of rosters on a sample basis.

9.2.3. International benchmarking

Comparisons with other railways under different management structures may indicate the potential for efficiency gains from adopting new practices. Comparators need to be chosen for their similar networks, economic environment and remit.

In order to mitigate some of the comparability problems with international comparisons it is useful to examine both process level benchmarks of unit costs and models which allow for multiple inputs and outputs:

- Process level benchmarking analysis will give a good indication of the unit cost savings that can be achieved at a fine degree of detail and allows direct comparability in terms of the activity undertaken. This could involve, for instance, identifying specific maintenance or renewal activities that are common and comparing costs (or norms) for those activities across a number of railways.;
- A multi-factor analysis (such as DEA or econometrics) will control for differences in country specific operating conditions and remits to ensure the target set using process level modelling is an achievable one (i.e. Network Rail is not being set a target which is cherry-picked from different international comparators) as well as allowing for multiple inputs and outputs.

To be successful, this work should be carried out over a long time period (potentially 2 years) in order to allow the other railways to participate without the need for significant short-term resourcing on their part.

9.2.4. Process benchmarking

As in ACR2003, PR2008 should include benchmarking of non-engineering functions such as IT, Finance and HR with comparators from the UK. In addition, time series data may be available allowing for investigation of catch-up and frontier trends.

9.2.5. Technology review

This approach would involve identifying emerging technologies and their potential to deliver frontier movements in efficiency.

9.2.6. Input price inflation

PR2008 should include an update on L.E.K.'s 2003 study on price inflation in Network Rail's principal input costs.

9.3. Potential approach to scope efficiency

Addressing a similar question to the review of Network Rail's bottom-up business plan conducted by L.E.K., Halcrow and TTCI in ACR2003, this workstream would challenge Network Rail's plans regarding volume of renewal activity.

However, we would expect that as CP3 progresses, Network Rail will significantly improve its asset management processes from policy and strategy through data acquisition to analysis and whole-life costing. As a consequence, in PR2008, the ORR ought to be able to approach a workbank review by assessing Network Rail's processes relative to established norms of good asset management practice. Should this comparison be favourable, this may limit the need for engineering-based site visits and review of paper filing, as was necessary in ACR2003, to challenge Network Rail's proposed value of renewals.

9.4. Possessions review

During ACR2003, the issue of more efficient engineering access was assessed, but the results were not widely nor early enough understood to be included in the regulatory settlement. The ORR along with ATOC and Network Rail is currently conducting a review of possessions efficiency and the results of that review should be fed into the PR2008 process. We would expect that significant additional efficiencies can be identified through this review.

APPENDICES

A. EFFICIENCY INITIATIVES AND NETWORK RAIL'S PROGRESS

As noted in section 4.2, this is an initial view based on a review of published documentation and has not been discussed with Network Rail (as specified within the ORR's brief for this project).

Figure A.1 Being pursued and likely to produce full benefits by the end of CP3

O/M/R	Efficiency Initiative	Network Rail's progress
Regional Benchmarking Report		
O	*Legacy structures and procedures:* non standardised procedures, practices and uses of technology across regions results in legacy structure and sizing variations.	National standards have been set. A new functional structure based on 18 areas has been put in place, enabling Network Rail to define more clearly and consistently across the whole network what is done, when it is done and how it is done.
O	*Co-location of TOC:* reduce interfacing effort for control staff by co-locating TOC and /or contract staff within the control room.	Evidence has been seen of the well-functioning an integrated control room. There are currently seven around the country, with more being created.
M	*Contract structure:* adoption of alternative structures which incentive contractors to minimise unit costs.	For track this is no longer relevant as maintenance activities have been brought in house. For other specialised contracts reverse auctions have been used in some cases to drive prices down. All suppliers go through a quality audit in order to verify that they are of the sufficient quality.
M	*Plant rates:* reduce costs by establishing similar rates for similar items of plant across regions by more visible and consistent contract negotiation.	'With track maintenance taken in-house, the contractors have to an extent become ROSCOs (rolling stock leasing companies) for track machines, with Network Rail as customer - although the contractors still need the plant themselves for their track renewal contracts. David Balcomb who runs the plant arm of Carillion says 'Whereas before we were working for an internal customer, now we are working for an external one too-and when he says he wants that machine there on the night , we'd better make sure we have it there!' MODERN RAILWAYS SEPT 04
M	*Subcontract labour usage:* reduce subcontractor percentages possibly by inserting terms to limit subcontract labour usage with contracts.	Network Rail has reduced their reliance on labour only subcontractors with more effective planning and recruitment of permanent employees.

M	*Overhead and profit rates:* Determine and reduce overheads and profit rates agreed with contractors.	Covered by in house maintenance

Figure A.1 Continued

O/M/R	Efficiency Initiative	Network Rail's progress
Regional Benchmarking Report		
M	*Logistics outsourcing:* Use 3rd party logistics provision as system efficiency provides overall cost reduction	The National Delivery service is responsible for track maintenance materials including heavy plant now, as well as all heavy track materials.
M	*Materials management:* improve materials management, possibly using central purchasing.	The National Delivery service is now responsible for the supply of all bulk materials in support of maintenance activities and uses central purchasing. A single national procurement contract has been tendered for the supply of other maintenance materials.
R	*In house vs contractor management:* reducing outsourcing of site management increases efficiency.	Network Rail, is now involved in the management, monitoring and day-to-day supervision of track renewal contracts.
R	*Contractor pricing:* certain specific initiatives reduce prices.	Amanda Henderson report to be provided by ORR
R	*Working method:* efficient practices in contracts.	Amanda Henderson report to be provided by ORR
Review of Network Rail's Supply Chain		
M	*Contracting:* improve negotiation processes and capability	Reverse auctions are a positive initiative. Network Rail are using the most appropriate source of contracts.
R	*Sourcing and contracting:* optimise positions in contractor negotiations, attack cost drivers and develop competitive supply market.	New framework contracts developed for asset renewals, which progressively increase the level of competitiveness when tendering. [The Henderson report] templated 16 activities and unit cost targets.
ORR Identified		
O	*Integrating franchises*	Reduces the number of TOCs to liaise with therefore simplifying the interface with TOCs

Figure A.2 No longer relevant due the inclusion of maintenance activities in house

O/M/R	Efficiency Initiative
Regional Benchmarking Report	
O	*Region structure and contract management:* reduce complexity of regional structures and rationalise contractual arrangements to reduce asset management headcount.

Figure A.3 Insufficient Evidence

O/M/R	Efficiency Initiative
Regional Benchmarking Report	
O	*Contingency staffing:* Rationalisation of shift patterns or some redundancies to reduce the current overstaffing at night or off-peak.
O	*Rostering patterns:* Variations in overtime culture, for example self-rostering, across regions can impact costs. Network Rail is in the process of replacing manual rostering with computerised rostering, which will also enable the rationalisation of rostering clerks.
O	*Scale of control rooms:* single control rooms reduce minimum staffing levels and workload. However this would require more time and investment; extending some control rooms or building new ones, testing and technology implementation work and staff training programs.
O	*TOC relationship:* Wide variations in the 'aggressiveness' of some TOCs in challenging initial delay attribution results in increased commercial account headcount to deal with the situation.
O	*Geographic distribution of staff:* some regions have dedicated delay staff in signal boxes, meaning resources cannot be pooled when major incidents occur.
O	*TOC timetable specification quality:* TOCs should produce a timetable of appropriate quality so Network Rail train planning staff do not have to start from scratch. The train planning function could be centralised at HQ level in order to improve efficiency across the whole network. (POSSIBLE EVIDENCE OF THE SECOND PART OCCURING)
M	*Joint S&T and Rapid Response teams:* joint teams for planned maintenance work and response to incidents might enable better labour utilisation.
M	*Sharing resources between adjacent areas:* contractors should achieve synergies especially in management and supervision when serving adjacent areas.

Figure A.3 Continued

O/M/R	Efficiency Initiative
Regional Benchmarking Report	
M	*Depot locations:* optimise staff costs, response time and local overheads by adjusting depot locations. A separate project would be required to establish the benefits of depot optimisation as significant investment would be involved.
M	*Rapid response (allocation of teams to incidents):* allocation of a particular team to incident improved to ensure travel time and total cost minimised.
R	*Non-core possession pattern:* multiple, short, non-disruptive weeknight possessions for non-core work are potentially inefficient. Undertaking follow-up work within the core possession is more cost effective.
R	*Optimised resourcing:* monitor target costs to ensure efficient levels of resource. This is apparently planned, but as yet there is no evidence.
Review of Network Rail's Supply Chain	
M	*Synergies:* exploit potential synergies with track renewals.
R	*Materials management:* Change materials management process – procure materials centrally?

Figure A.4 Being pursued, but unlikely to see the full benefits by the end of CP3

O/M/R	Efficiency Initiative	Network Rail's progress
Regional Benchmarking Report		
O	*Legacy structure and procedures:* different regions have different workloads not translating to corresponding variations in headcount , implying that some regions are able to accomplish significantly more with a given staffing level.	Network Rail has implemented a templated structure in 18 areas. There is evidence of good progress at the top end of the organisation, but there is more work to be done towards the bottom end of the workforce where many areas are still to be standardised. This is estimated to take a minimum of a further 2 to 3 years.
O	*Technology:* small scale local technology improvements influence the number of staff required, large scale systems integration would increase efficiency across the whole network.	Network Rail is investing in Information Management systems, which will produce improvements in this area. However this work is ongoing and will continue into CP4, therefore there is no evidence they will reach the frontier by the end of CP3.
O	*Staff expertise:* improvements required in recruitment, training and retention of staff.	There is currently a foundation degree course based at Sheffield Hallum University and Network Rail are also funding a three year apprentice program at Gosport College to train 200 apprentices a year. A competence management program is also run. Due to the length of these schemes improvements will be seen throughout CP4 and into CP5.
M	*Contractor culture:* different cultures and management working practices amongst various contractors impacts effectiveness of the partnership approach.	Network Rail are reporting a strong team spirit building since maintenance activities were brought in house. Achieving this objective is also linked to the apprentice training schemes and skills base and the benefits of these take longer to be seen. However improvements in working practices can be shown currently as infrastructure failure is down by 10% and is still reducing despite traffic increases.
M	*Contractor and Network Rail planning:* aborted possessions and short notice alterations can result in partial or full write-offs of the committed labour and plant. The quality and thoroughness of planning should be improved so access can be obtained. Planning could also be done further in advance to reduce premium rates being paid for plant equipment.	The PL5 Change Programme is addressing the whole issue of poor possession planning. Evolution 1 has been issued for consultation and will lead to greater stability at an earlier stage. Evolutions 2 and 3 will improve the planning processes at TT-70 and TT-60 respectively.

Figure A.4 Continued

O/M/R	Efficiency Initiative	Network Rail's progress
Regional Benchmarking Report		
M	*Efficient engineering access:* possessions are shorter than optimal due to difficulties negotiating with TOCs. Look to change possessions and plan possessions in advance to give TOCs prior notice and reduce costs incurred.	The possessions review is challenging every aspect of possessions including pre-planning, take-up and hand back, improving efficiency of tasks undertaken and current constraints such as safety regulations. Metrics will be developed to show the current situation and to monitor progress as the different initiatives are implemented. Regulation changes may also be required as a result of the review.
M	*Productivity norms:* productivity and unit cost norms vary between areas.	Network Rail have established a project team to raise the productivity of the maintenance workforce. The team is focussed particularly on training to improve skills and improve planning processes that will help maximise productive time within possessions. Network Rail are also currently working on capturing the correct detail of data required for unit costs.
Review of Network Rail's Supply Chain		
M	*Strategy and planning:* demand profiling and management of changing requirements – difficulty in accurately specifying work that will be required under maintenance contracts.	Network Rail is beginning to address the long term planning process. They hope to plan the 2006 Business Plan much more reliably and from the top down, rather than the bottom up, as previously done. However much more work is needed on top down strategies.
M	*Use of Access:* insufficient contract management in planning and the efficient use of access. Reduce the time plant and resources are kept on standby, increase cost control and cost management on contracts.	The possessions review is challenging every aspect of possessions including pre-planning, take-up and hand back, improving efficiency of tasks undertaken and current constraints such as safety regulations. Metrics will be developed to show the current situation and to monitor progress as the different initiatives are implemented. Regulation changes may also be required as a result of the review.
R	*Strategy and planning:* longer term planning, use better planning data, reduce required amount of changes to plan and do more work on the early design/scope of the work.	The Engineering Support Centre has been set up to process and manage the condition data collected by infrastructure measurement vehicles. A renewals investment panel has been created to review all renewal schemes, ensuring a greater focus on getting the correct specification for renewal projects and their effective delivery.

Figure A.4 Continued

O/M/R	Efficiency Initiative	Network Rail's progress
Review of Network Rail's Supply Chain		
R	*Risk:* reduce the amount of risk contractors build in, add more clarity and consistency in risk allocations.	The Investment Management System programme introduces new systems to support improved project delivery, which will also provide more effective risk management. This is still a large area for improvement and there is still much more to be gained from this in CP4.
R	*Contractor monitoring:* supplier performance management and development. Contractors are not monitored and have no incentive to reduce costs.	For track renewals are now in house so full benefits are received here. Signalling design is being brought in house and bringing S&C in house is also being investigated. More work is being done in these areas so the full benefits will not be achieved until beyond CP3.
R	*Internal performance management:* improve internal performance management process.	There is some evidence of area level KPIs being cascaded down, but it is an ongoing process.
R	*Delivery and execution:* new technology or innovative working practices.	Network Rail is using Six Sigma analysis techniques to identify maintenance improvements. Increasing amounts of automated inspection is being undertaken. Network Rail is also investing in high output renewals systems. The benefits from these are currently limited by possessions lengths, but there is still potential to maximise these further.
Benchmarking of Opex		
O	*Financial Management:* identified inefficiency.	WCRM are ahead of Network Rail corporate, who are beginning to introduce people to improve this. A platform should be established by the end of CP3 which will introduce further improvements in CP4.
Other		
M	*Technology*	Six Sigma techniques introduced to identify maintenance improvements. Network Rail are investing in new technology , in particular a New Measurement Train to give better detail about track items. Ultrasonic inspection is also being trialled. In 2/3 years this will be a significant advantage as headcount reductions can occur as the amount of manual inspection can be reduced.

B. METHODOLOGY AND GENERAL ISSUES

Several approaches can be taken to establish a benchmark for Network Rail's potential for cost reductions. This report focuses on using the performance of other companies or sectors, given by productivity and efficiency measures, as possible benchmarks.

To establish a reasonable benchmark for Network Rail's long-term potential for cost reductions, it is necessary to understand what the productivity and efficiency measures relate to, and the limitations of possible comparisons of these measures between companies or industries.

B.1. Measuring productivity and efficiency: partial measures

The production process of any company at a given point in time, *t*, can be simplified using measures of capital (K_t), labour (L_t) and raw material inputs (M_t) to produce output (Y_t). Alternatively, output can be expressed in terms of value added (VA_t) – i.e. how much value the firm adds through its production process (such information is available at the sectoral level from National Accounts).

This production process can then be expressed as a production function:

$$Y_t = f(K_t, L_t, M_t) \text{ or } VA = f(K_t, L_t) \qquad \text{Equation B.1}$$

The aim of a productivity or efficiency measure is to quantify the efficiency of this production process.

B.1.1. Partial productivity measures

Some of the most widely used measures of the efficiency of this production process are partial productivity indicators. A partial productivity indicator at time *t* (P_t) is a ratio of the outputs produced at time *t* (Y_t) to the inputs used in time *t* (I_t) to produce those outputs, as given by Equation B.2.

$$P_t = \frac{Y_t}{I_t} \qquad \text{Equation B.2}$$

The growth in this ratio over time can be interpreted as an indicator of efficiency gains. Therefore, efficiency improvements can be monitored through a change in the productivity measure. If the productivity measure increases, it can be inferred that there has been technical progress and/or the use of current inputs has become more efficient. In other words, higher levels of output can be provided without using additional inputs, or the same levels of output can be achieved using lower input levels.

Single factor productivity is the simplest and most intuitive measure of productivity. In Equation B.2, I_t would be replaced with the particular input of interest (e.g. labour, capital or raw materials). One of the most widely used partial productivity measures is

output per employee, or labour productivity (LP_t), and is perhaps most directly comparable to operating cost reductions.

$$LP_t = \frac{Y_t}{L_t}$$

Equation B.3

B.1.2 Unit cost measures

Equations B.2 and B.3 are measures of technical efficiency - the ability of a company to produce the required output using the smallest amount of physical input. However, the efficiency of the production process can also be measured by examining overall (cost) efficiency, which measures the company's ability to produce a given amount of output while incurring the lowest possible cost.

In the case of partial measures for overall cost efficiency, OP_t, Equation B.4 is used:

$$OP_t = \frac{C_t}{Y_t}$$

Equation B.4

where C_t represents the cost of one factor input (eg, operating costs, maintenance or renewals). This indicator is also referred to as a unit cost, since it indicates the expenditure required to produce a single unit of output. Alternatively, total unit costs can be examined equivalent to operations, maintenance and renewals.

When costs relate to operations and are expressed in real terms – i.e. after input price growth is controlled for - the ratio provided is commonly referred to as real unit operating expenditure (RUOE).[15] It is this measure that is used in the cost comparisons in Appendix C.

B.2. Total factor productivity

The use of single factor productivity measures can lead to bias since not all factors of production are taken into account – i.e. they provide only a partial picture. To mitigate this potential bias, an alternative approach that considers all factor inputs can be used, referred to as total factor productivity (TFP). Starting from Equation B.1, it is necessary to specify some functional form, and the Cobb–Douglas production function is one such form that is often used (Equation B.5):

$$Y_t = K_t^{\alpha} L_t^{\beta} M_t^{\gamma} \text{ or } VA_t = K_t^{\delta} L_t^{\varepsilon}$$

Equation B.5

where α, β and γ (δ and ε) are weighting factors - usually the share of each input in total costs,[16] in which case $\alpha + \beta + \gamma = 1$ ($\delta + \varepsilon = 1$). This implies that the returns to scale are assumed to be constant, and that relative changes in factor costs are taken

[15] Current input prices are translated into real input prices using a cost deflator index, the most common being a consumer or retail price index.

[16] Ideally, these weights should represent the elasticity of substitution for each input factor, but they are usually chosen to be the share of each input in total costs or revenue.

into account. From this, TFP can be constructed as shown in Equation B.6 (this represents the total factor equivalent of Equation B.2):

$$TFP_t = \frac{Y_t}{K_t^{\alpha} L_t^{\beta} M_t^{\gamma}} \quad \text{or} \quad TFP_t = \frac{VA_t}{K_t^{\delta} L_t^{\varepsilon}}$$

Equation B.6

In this measure, the denominator can be interpreted as the potential output available from these inputs; the productivity measure is thus the ratio of actual-to-expected output.

Where there are multiple outputs, Y_t would need to represent them all. The TFP measures used in this study are based on whole economy sectors. Thus the output measure used is value added, and, as such, accounts for multiple outputs (i.e. the right-hand version of Equation B.6 is the basis of the TFP measures used in this study).

TFP is therefore not directly comparable to operating cost improvements because it:

- Incorporates all inputs into the production process (including capital), while operating costs do not consider the capital input;
- Is an output-based measure and would need to be adjusted to account for input prices in order to convert to a cost-based measure.

Having obtained a TFP benchmark, it is then necessary to convert this into a RUOE benchmark. Section 5.3 also examines how much of that RUOE might be attributed to a frontier shift.

B.3. Establishing a long-run cost reduction benchmark from RUOE and TFP: general issues

Both RUOE trends and TFP trends incorporate two effects.

- *Catch-up to best practice* - cutting costs by improving practices within an organisation through the adoption of current technology or working practices. If a firm is inefficient, it has greater scope to improve and 'catch up' to the market leader. This implies that the observed rates of efficiency improvement are dependent on the relative initial efficiency of the companies in the industry. In Network Rail's case, since it is the only operator in its industry, catch-up may be improving to achieve internal benchmarks (e.g. regional) and/or improving to achieve international or functional benchmarks.
- *Frontier shift or long-term cost reductions* - cost improvements achieved by adopting technology or working practices yet to be developed.[17]

[17] In addition to establishing how inefficient a regulated company is compared with its peers, and thus how much regulated companies can catch up to their peers, UK regulators consider what the potential for best practice to improve is. The reason for this additional cost-reduction target is that even the most efficient companies in the industry are expected to be able to improve their performance going forward based on implementing new management practices and new technological developments. As such, this additional element represents the long-term minimum industry-wide potential for cost reductions - i.e. it represents the rate at which the efficiency frontier shifts over time.

Most of the external benchmarks used in this report incorporate both catch-up and frontier shift. This report attempts to estimate the total scope for cost savings (catch-up and frontier) using RUOE from the information available. Estimates of TFP are used to help determine what frontier shift may be possible.

The appropriateness of TFP-based benchmarks for the purpose of total cost reduction will be highly dependent on Network Rail's potential for catch-up to best practice. Regulatory approaches used to incorporate catch-up potential in TFP-based assessments have taken a TFP-based assessment of long-term cost reduction and used an estimation of a 'privatisation effect', together with a judgement on how much of this 'privatisation effect' remains in the industry in question. These estimates tend to be based, in turn, on comparisons of RUOE trends. Given that RUOE comparisons are undertaken in Appendix B, TFP-based assessments are undertaken in this section to provide frontier shift benchmarks only.

The technical approach to this problem is to use Malmquist indices.

B.4. Comparisons across industries: general issues

This report identifies external benchmarks based on comparisons with industries at company or industry level. Such comparisons only make sense when examining cost reduction trends, or trends in productivity (rather than comparisons of relative efficiency levels), since companies in different industries will undertake a number of various functions (implying inconsistency across the units of comparison at the aggregate level).

Such comparisons have the potential to identify reasonable benchmarks for future annual cost reductions. However, these methods require careful use to ensure like-for-like comparisons. The issues to consider are set out below, together with an explanation of how they are mitigated, to some extent, in this study (for further details, see Appendix D).

- *Comparability of the industries* - when comparing productivity performance between industries, it is important to recognise that some industries have the potential to achieve large productivity growth through rapid technological development (e.g. the telecommunications industry). In other sectors (e.g. water and sewerage), the rate of technological change is less pronounced, and therefore productivity gains relating to technological development are expected to be less significant in the short-to-medium term.
  - when examining RUOE, this study focuses on privatised regulated industries. This is mainly due to the readily available wealth of information and academic studies on these industries, rather than the comparability between them and Network Rail. However, the companies examined are regulated, operate a network infrastructure, provide a public service and often have a nationwide presence.
  - the TFP performance of other sectors comparable to Network Rail and composite sectors (based on Network Rail's functions) is also examined.

- *The impact of atypical performance and exogenous factors* - focusing on short time periods or only one company can result in extreme (high or low) estimates of efficiency improvement due to atypical conditions. In this study, efficiency performances over reasonably long time periods are examined, focusing on the average performance of several companies (where more than one exists in the industry). The exception to this is the examination of price control periods and years since privatisation, where the impact is noted in the main text.

- *The business cycle* - business cycles are periodic swings in an economy's pace of demand and production activity, characterised by alternating phases of growth and recession. Compared with the long-run trend, TFP growth tends to be lower during recessionary periods (for example, since companies tend not to shed labour immediately in order to maintain capacity at the expense of reductions in productivity), and higher during growth periods as this excess capacity is used. Thus, TFP growth comparisons are made over a complete business cycle to avoid misrepresenting the impact of recessionary or growth periods.

- *The regulatory cycle* - for the productivity analysis of privatised (regulated) industries, the effects of privatisation and the regulatory cycle (and the incentives present at the time) are likely to overshadow the effects of the business cycle. Where consistent data is available, the whole time period from privatisation to the present is therefore examined, alongside the regulatory periods. In particular, evidence is collected on the performance of privatised industries in the second regulatory review period. This is done to help examine performance of regulated companies in the same situation as Network Rail (i.e. after one price control review where the regulator and the company have understood the industry and the data and are in a position to make confident judgements about the potential for cost reductions).

- *The comparability of volume growth and the impact of economies of scale* - in this study, the observed RUOE reduction figures and TFP growth figures are adjusted using estimates of economies of scale in each industry.

- *The comparability of input price growth (e.g. wages)* - as a benchmark, historical cost reductions may need to be adjusted if future input price growth is estimated to be significantly out of line with the RPI. It is assumed that there is no significant difference in wage pressure across the utility industries examined when comparing RUOE trends. However, when using TFP benchmarks, the expected input price growth pressure was assumed to be equal to that of the economy as a whole. Further work may be required to understand fully the potential input price growth in rail.

Issues that have not been controlled for include the following.

- *The controllability of costs* - different industries may have different proportions of non-controllable costs. Companies with very high proportions of non-controllable costs will have less potential to reduce their total costs. In this study, it is assumed that the comparator companies have similar proportions of controllable costs.

- *The comparability of quality-of-service performance* - significant changes in quality of inputs and outputs over time may hinder comparisons. For example, if investment is increased (or more people are employed) to produce the same amount of a good, but to a higher standard, productivity will appear to have fallen. However, it is difficult to adjust for such differences, as the impact on costs will need to be estimated. Instead, the assumption in this study is that the benchmarks used are reasonable, as most of the industries examined have maintained or improved their quality of service over the periods examined, which should be consistent with Network Rail's operating objectives. In the case of some industries with extensive quality-enhancement programmes (i.e. the water and sewerage industry), some assessment of this impact is provided.
- *The comparability of the initial efficiency positions* - the potential for future cost reductions is highly dependent on the initial efficiency position of a company. An inefficient company has greater potential for cost reductions than an efficient one, other things being equal. The use of Malmquist indices is the most direct way to account for this factor, and academic literature using this approach has been examined in this study. For other comparisons, more ad hoc, and thus less robust, adjustments are used.
- *The strength of the incentives* - it is also apparent that greater cost reductions can be achieved when the regulatory incentives are stronger.
- *Substitution between factor inputs* - an issue specific to partial productivity and efficiency measures is that increases in the metric cannot be identified solely as efficiency improvements, since *changes in the choice of input mix* will have an influence. For example, if a firm replaces much of its workforce with an improved information technology system, per-capita output will increase significantly, although productive efficiency could fall when both inputs are considered. A similar problem arises from outsourcing, in that the labour productivity measure could increase substantially, concealing the growth in input costs. The trade-off between operating expenditure (OPEX) and capital expenditure (CAPEX) can be both operational as well as the result of changes in accounting policy. The approach used in this study is to assume that, when using RUOE as a basis for the benchmark for Network Rail's operating cost reduction, capital substitution is of a similar order of magnitude across the regulated utilities.

B.5. Summary

As discussed above, there are several issues with using external efficiency and productivity trends as potential benchmarks, and subjective steps are often required to provide a benchmark. Thus, several approaches are examined in this study in an attempt to derive a consistent overall benchmark for Network Rail.

C. ACTUAL AND TARGET REAL UNIT COST REDUCTIONS FOR UK REGULATED COMPANIES

Network Rail's potential cost reductions can be compared with the real unit cost reduction trends achieved in other sectors and, in particular, the UK regulated sector. Indeed, an examination of the trends in RUOE of companies in other industries has been used as part of the regulatory consultation process in most UK regulated industries.

C.1. Interpretation

With some minimal adjustments to aid comparability, a high-level range of historical performances is provided as an indication of the rates of performance improvement that can be achieved. However, these figures do not take into account exogenous factors, and careful interpretation is therefore required.

More generally, differences in RUOE trends can be due to the following factors:

- strength of the incentives, including ownership structure;
- comparability of input price growth (e.g. wages) and input mix;
- comparability of the initial efficiency positions;
- atypical performance;
- comparability of the industries and the potential for technological development;
- comparability of volume growth and the impact of economies of scale;
- regulatory cycle and, to a lesser extent, the business cycle;
- controllability of costs;
- comparability of quality-of-service performance;
- consistency of the measures.

C.2. Actual real unit cost reductions in UK regulated companies

This section examines the real unit cost reductions achieved in a number of privatised regulated industries.

C.2.1 Water

The water and sewerage industry in England and Wales comprises privatised water and sewerage companies ("WASC"s) and water-only companies ("WOC"s). [18]

[18] At privatisation, there were ten WASCs and 22 WOCs, and while the number of WASCs has remained constant over time, the number of WOCs has decreased to 12 due to mergers and acquisitions in the industry. The RUOE changes presented below are based on a balanced panel—ie, for the purposes of the analysis, the

Operating cost and volume data is available for all these companies from 1992/93 onwards on a consistent basis from the June Returns (submitted each year to the regulator by the water companies and made publicly available by Ofwat the following October). The latest available June Returns provide data on 2003/04 - the 2005 June Returns have not yet been published.

This data provides the operating costs split between water services and sewerage services as well as providing a split of operating and maintenance costs. Figure C.1 summarises the unit operating costs for water services, averaged across the individual water companies' performance, over the period 1992/93 to 2003/04

Figure C.1 Annual average RUOE reductions for water services (%)

	Average RUOE reductions	Average RUOE reductions adjusted for scale	Weighted average RUOE reductions	Weighted average RUOE reductions adjusted for scale
1994/95–1999/2000	1.9	1.9	2.3	2.3
1999/2000–2003/04	1.9	1.9	1.9	1.9
1992/93–2003/04	2.0	2.0	2.0	2.0

Note: OPEX excludes depreciation, uncontrollable costs (local authority rates, Environmental Agency charges, etc) and exceptional items.
Source: Ofwat June and July Returns, various years.

The analysis shows average RUOE reductions in water services of around 2% pa.[19] The average RUOE also changes little between regulatory periods.

Due to the large increase in quality required by Ofwat and the Environment Agency the above Figure may underestimate the achieved cost reductions in water industry. To control for the increase in quality and knock-on effects of a large capital programme, enhancement expenditure has been removed in Figure C.2 below.

data was adjusted to create the composite companies that are currently active in the industry. Thus, for example, although data on Anglian and Hartlepool is available separately prior to 2001, it is the composite company, Anglian & Hartlepool, which is used to assess the RUOE change from the starting point of the analysis.

[19] The average RUOE reduction changes little when adjusted for returns to scale, due to output levels remaining roughly constant throughout the period examined and the analysis assuming only relatively small returns to scale (0.96), based on an overall water service model reported in Competition Commission (2000), 'Mid Kent Water Plc: A Report on the References under Sections 12 and 14 of the Water Industry Act 1991', p. 267.

Figure C.2 Annual average RUOE reductions for water services, enhancement expenditure excluded (%)

	Average RUOE reductions	Average RUOE reductions adjusted for scale	Weighted average RUOE reductions	Weighted average RUOE reductions adjusted for scale
1994/95–1999/2000	2.9	3.0	4.6	4.4
1999/2000–2003/04	1.5	1.4	0.5	0.5
1992/93–2003/04	2.4	2.4	2.5	2.5

Source: Ofwat June and July Returns, various years.

According to Figure C.2 average annual reductions in RUOE when the quality enhancement programme is controlled for, are estimated at around 2.5% with the range 1.0–10.1% pa on a weighted basis adjusting for scale effects.

Separate data on maintenance (and where necessary renewals) which is not capitalised is available from the June Returns. Where the other industries include cash maintenance in their operating expenditure, the data is separated out for water and sewerage.

Figure C.3 Annual average real unit maintenance cost reductions for water services (%)

	Average RUOE reductions	Average RUOE reductions adjusted for scale	Weighted average RUOE reductions	Weighted average RUOE reductions adjusted for scale
1994/95–1999/2000	-8.5	-8.5	-5.4	-10.4
1999/2000–2003/04	-1.1	-1.1	4.8	4.8
1992/93–2003/04	-4.7	-4.7	-0.3	-2.1

Source: Ofwat June and July Returns, various years.

Figure C.3 shows that unit maintenance expenditure has increased since privatisation. This is likely to be due to the reclassification of operating costs to capital costs and maintenance, and the lack of historical investment in the network, and may not be typical of maintenance expenditure trends in privatised network utilities.

C.2.2 Sewerage

Figure C.4 summarises the unit operating costs for sewerage services, averaged across the individual companies' performance, over the period 1992/93 to 2003/04.

Figure C.4 Annual average RUOE reductions for sewerage services (%)

	Average RUOE reductions	Average RUOE reductions adjusted for scale	Weighted average RUOE reductions	Weighted average RUOE reductions adjusted for scale
1994/95–1999/2000	-0.7	-0.7	-1.7	-0.8
1999/2000–2003/04	-3.1	-3.1	-1.7	-1.7
1992/93–2003/04	-1.4	-1.4	-1.0	-0.7

Source: Ofwat June and July Returns, various years.

The analysis shows average RUOE increases in sewerage services of around 0.5–3.1% pa, with a weighted average increase of 0.8% pa, adjusted for scale.[20]

Results reported in Figure C.5 below account for expenditure incurred to achieve the quality increase required by Ofwat and the Environment Agency.

Figure C.5 Annual average RUOE reductions for sewerage services, enhancement expenditure excluded (%)

	Average RUOE reductions	Average RUOE reductions adjusted for scale	Weighted average RUOE reductions	Weighted average RUOE reductions adjusted for scale
1994/95–1999/2000	5.8	5.8	5.4	5.4
1999/2000–2003/04	-2.1	-2.1	-1.3	-1.5
1992/93–2003/04	2.3	2.3	2.3	2.6

Source: Ofwat June and July Returns, various years.

The analysis that accounts for enhancement expenditure shows output-weighted average RUOE reductions in sewerage services of around 2.3% pa and 2.6% pa, adjusted for scale. The range of estimates is -4.6% to 8.0% on a weighted basis adjusting for economies of scale.

[20] The average RUOE reduction changes little when adjusted for returns to scale, due to output levels remaining roughly constant throughout the period examined and the analysis assuming only relatively small returns to scale (0.96).

Separate data on maintenance (and where necessary renewals) which is not capitalised is available from June Returns. Where the other industries include cash maintenance in their operating expenditure, the data is separated out for sewerage.

Figure C.6 Annual average real unit maintenance cost reductions for sewerage services (%)

	Average RUOE reductions	Average RUOE reductions adjusted for scale	Weighted average RUOE reductions	Weighted average RUOE reductions adjusted for scale
1994/95–1999/2000	-11.8	-11.8	-8.9	-8.9
1999/2000–2003/04	-7.2	-7.2	-4.7	-4.9
1992/93–2003/04	-5.4	-5.4	-1.6	-1.9

Source: Ofwat June and July Returns, various years.

Figure C.6 shows that trends in unit maintenance expenditure have increased since privatisation. This is likely to be due to the reclassification of operating costs to capital costs and maintenance, and the lack of historical investment in the network, and may not be typical of maintenance expenditure trends in privatised network utilities.

C.2.3. Electricity distribution

In contrast to the water industry, there is no central source for cost and volume data over time for the electricity distribution companies. The following discussion is therefore based on cost data (including operating costs and maintenance) collated from 14 individual company regulatory accounts over the period 1990/91 to 2000/2001, and other sources for the output measures. Moreover, due to this non-centralisation of data, the cost information is not consistent over time. As discussed in Section 5.2.2, these inconsistencies include the significant costs that were removed from distribution in DPCR3 and allocated to supply (changes in capitalisation policies and accounting have also affected the figures).

According to Ofgem's 'Electricity Distribution Price Control Review: Initial proposals', June 2004, 145/04 definition of operating expenditure is the following:

- Operating expenditure - this covers the day to day costs of running the network such as repairs and maintenance and generally most staff and overhead costs.

The RUOE reductions presented in Figure C.7 are based on total operating costs, as reported in the companies' regulatory accounts.[21]

[21] This cost measure includes depreciation, which is a proxy of CAPEX and, as such, should be excluded from the analysis; however, the use of depreciation was deemed necessary due to the wide range of capitalisation policies adopted by the distribution companies.

Figure C.7 Annual average RUOE reductions for electricity distribution services (%)

	Average RUOE reductions	Average RUOE reductions adjusted for scale	Weighted average RUOE reductions	Weighted average RUOE reductions adjusted for scale
1990/91–1994/95	1.2	0.9	2.0	1.8
1994/95–1999/2000	5.3	4.8	5.8	5.4
1990/91–2000/01	5	4.7	5.7	5.3
1990/91–1999/2000	3.4	3.1	4.1	3.8

Note: The operating expenditure figures include depreciation and uncontrollable costs (eg, National Grid Company rates) but exclude exceptional items.
Source: Company regulatory accounts and Electricity Association (various), *Electricity Industry Review*.

The large RUOE reductions for the last period of the analysis, 1999/2000–2000/01, suggest that this period may be not typical of performance. This large reduction could be explained by the following changes that took place in this period.

- During DPCR3, some costs were reallocated from the electricity distribution businesses to electricity supply. On average, these reallocations resulted in a reduction of approximately 8% in the companies' total allowed revenues.
- In DPCR3, Ofgem determined that there was scope for large efficiency gains to be achieved in the industry, and therefore set relatively high targets for some companies.
- Companies had a strong incentive to make their efficiency savings as soon as possible during the price control periods.[22]

For the above reasons, the 1999/2000–2000/01 period should be removed from the estimation of RUOE reductions, since the industry cannot be considered to be in a stable state, which is a necessary condition for establishing a long-term cost reduction benchmark.

The figures adjusted for scale suggest an annual average RUOE reduction benchmark of approximately 3.1% on an unweighted basis and 3.8% on a weighted basis.[23] The range of estimates is -2.5% to 10% per annum on a weighted basis adjusting for economies of scale.

[22] Ofgem did not introduce a rolling OPEX mechanism—this time dependency of incentives and the consequent front-loaded profile in cost reduction can also be seen in Figure B.7 over the previous regulatory period, 1994/95 to 1999/2000.
[23] Owing to 1.4% annual volume growth for the period since privatisation, adjustments for the scale effects are required. This analysis uses a scale elasticity estimate of 0.7, consistent with the findings of the study by Burns, P. and Weyman-Jones, T.G. (1994), 'The Performance of the Electricity Distribution Business: England and Wales 1971–1993', Centre for the Study of Regulated Industries, Chartered Institute of Public Finance and Accountancy, May.

C.2.4. Electricity transmission

The transmission business in England and Wales is carried out by the National Grid Company (NGC). Data has been provided directly by NGC, but it was unable to obtain an update of this data in the timeframe of the current study. Electricity transmission saw a significant decrease in RUOE from 1990/91 to 2000/01, a period that is also characterised by increasing output volumes (with an estimated average annual growth of 1.3%). In 1998, operating costs rose sharply due to NGC taking over the operations and management of the Transmission Services Scheme, which was previously the responsibility of the Electricity Pool of England and Wales.

According to Ofgem's 'Transmission Price Control Review: Initial Consultation', July 2005, 54/03, controllable operating costs can be broken down into two categories (p.37):

- Direct or field activities - these include inspection, maintenance and repair of network assets;
- Indirect activities - including services which support field activities (e.g. asset management, network design) and also more general support services and overheads (e.g. finance. HR, IT and corporate costs).

According to Ofgem, CAPEX is incurred for one of two distinct reasons (p.34):

- The installation of new assets;
- The replacement or refurbishment assets.

Therefore, in regulatory accounts, renewals expenditures are capitalised and not included in this measure.

Figure C.8 reports the RUOE reductions based on two measures of operating cost: including and excluding rates (i.e. uncontrollable costs).

Figure C.8 Annual average RUOE reductions for NGC (%)

	Excluding rates		Including rates	
	RUOE reductions	RUOE reductions adjusted for scale	RUOE reductions	RUOE reductions adjusted for scale
1990/91–1996/97	7.1	6.8	5.6	5.4
1996/97–2000/01	5.9	5.5	4.9	4.6
1990/91–2001/02	6.0	5.7	4.9	4.6

Note: Operating costs are total operating costs minus depreciation and Transmission System Scheme/Balancing Services Incentive Scheme charges. Output is units of electricity transmitted, adjusted for weather.
Source: NGC.

The annual average RUOE reductions for NGC during the period 1990/91–2001/02 are estimated at 6.0% when controllable costs are used, and 4.9% when operating costs include rates.

When adjusted for economies of scale, the annual average RUOE reductions achieved by NGC are 5.7% for controllable operating expenditure and 4.6% when rates are included.

C.2.5. BT

Although BT was privatised in 1984, due to changes in regulatory accounting guidelines, consistent data is only available from the 1996 reporting year onward.

In terms of establishing a general long-term productivity trend benchmark, because BT is in the communications industry and because of the technology-led characteristics of the sector, BT's historical performance may provide a comparable benchmark for Network Rail. However, the high rates of cost reductions exhibited by BT may also be due to competitive pressures and the significant restructuring that the company has undergone.

In assessing the degree of comparability with Network Rail, BT's financial statements, (Current Cost Financial Statements for BT Network, 2004) were examined. The modelled costs include both operating and maintenance expenditure.

Figure C.9 summarises BT's performance over the period 1995/96–2003/04.

Figure C.9 Annual average RUOE reductions for BT (%)

	Average RUOE reductions		Average RUOE reductions adjusted for scale	
	Call volume	Exchange line (no. of connections)	Call volume	Exchange line (no. of connections)
1995/96–2003/2004	8.1	-0.7	7.3	-0.7
1995/96–2003/2004 excluding 2001/02[1]	11.0	3.9	10.3	3.8
1995/96–2001/02	10.9	3.5	10.1	3.4
2002/2003–2003/04	11.3	4.7	10.9	4.9

Note: RUOE includes access, network and retail OPEX. [1] The productivity change estimate over the whole period may be biased downwards because, during 2001/02, the costs pertaining to network and access assets increased significantly, mainly owing to company restructuring and the adoption of new activities that increased costs (eg, BT Retail Narrowband Access).
Source: BT regulatory accounts; Oftel Market Information.

There are two critical issues when using BT's RUOE reductions as possible benchmarks for Network Rail.

- The large output growth experienced by BT during the timeframe (approximately 10% per annum in terms of call volume, but less than 1% per annum in terms of exchange lines) will bias the unadjusted RUOE figures upwards. As a result, the productivity measure needs to be corrected for the effects of scale economies. The analysis assumes that BT's elasticity of scale is equal to 0.9, which is a very conservative assumption when call volume is used as an output.
- The choice of the output measure with which to calculate RUOE is critical - the difference between the call volume and the line-based measure is significant.

Exchange line-based RUOE figures may give a more representative view of the cost savings achieved;[24] however, using call volumes as a scale driver may highlight the upper-end of a range of savings that could be expected to be achieved.

C.2.6 Other regulated sectors

RUOE reduction of UK regulated companies has been used as part of the regulatory consultation process in most of the UK regulated industries. Thus, additional benchmarks are available from these secondary sources. A review of the estimates of the productivity growth in the UK regulated sectors obtained by other consulting companies, particularly Frontier Economics (2002),[25] CEPA (2003),[26] and Europe Economics (2003) is provided below.[27]

[24] Many cost studies of telecommunications companies find lines to be the key cost driver rather than call volumes. For example, In its most recent study for Ofcom, Nera suggested that lines are the more suitable output measure: 'Switched lines have been a strong cost driver over the whole period, although they have a slightly stronger influence after 1999. Since 1999, leased lines have become a more significant cost driver. The reverse is true for switch minutes, which were only significant in the first three years of our model. In more recent periods, variations in the volume of switch minutes appear to have had much less impact on costs.' Nera (2005), 'The Comparative Efficiency of BT in 2003: A Report for Ofcom', March.

[25] Frontier Economics (2002), 'The Impact of Liberalisation on Efficiency: Prepared for Postcomm', January.

[26] Cambridge Economic Policy Associates (2003), 'Productivity Improvements in Distribution Network Operators: Final Report', November.

[27] Europe Economics (2003), 'Scope for Efficiency Improvement in the Water and Sewerage Industries: Final Report' March.

Figure C.10 Productivity growth estimates according to Frontier Economics (2002)

	Measure	Period	Average	Range
British Gas	RUOE, '000 meters	1992/93–1995/96	5.9	
British Gas	RUOE, TWh gas throughput	1986/87–1995/96	7.5	
BT	RUOE, call minute	1992/93–1998/99	4.8	
BT	RUOE, exchange connections	1983/84–1998/99	0.7	
Electricity distribution	RUOE	1990/91–1997/98	6.5	2.6–10.4
Electricity distribution*	Productivity growth (excl. capital inputs)	1990–1998	9.0	
NGC	RUOE	1990/01–1997/98	6.80	
Sewerage	Total base service operating expenditure	1992/93–1997/98	1.9	
Sewerage*	RUOE	1992/93–1999/00	1.9	
Transco	RUOE, '000 meters	1995/96–1997/98	16.9	
Transco	RUOE, TWh gas throughput	1995/96–1997/98	16.4	
Water	Total base service operating expenditure	1992/93–1997/98	3.7	
Water*	RUOE	1992/93–1999/00	2.1	
Average (RUOE only)			**6.9**	**0.7–16.9**

Source: ORR/Europe Economics (2000), 'Analysis of Responses to Review of 'Railtrack Efficiency', July, except (*) Frontier Economics (2002) estimates.

Figure C.11 Productivity growth estimates according to CEPA (2003)

	Measure	Period	Average	Range
BT	PFP, OPEX only, volume-adjusted, trend	1997/98–2001/02	11.9	
Electricity distribution	PFP, OPEX only, volume-adjusted, trend	1996/97–2001/02, excluding 2000/01	5.8	
NGC	PFP, OPEX only, volume-adjusted, trend	1990/91–2001/02	4.9	
Railtrack	PFP, OPEX only, volume-adjusted, trend	1995/96–2001/02	5.9	
Sewerage	PFP, OPEX only, volume-adjusted, trend	1994/95–2001/02	0.9	
Water	PFP, OPEX only, volume-adjusted, trend	1994/95–2001/02	1.7	
Average			**5.2**	**0.9–11.9**

Source: CEPA (2003), op. cit.

Figure C.12 Productivity growth estimates according to Europe Economics (2003)

	Measure	Period	Average	Range
BT	RUOE, call minute, OLS trend	1993–2002	1.9	
BT	RUOE, exchange lines, OLS trend	1988–2002	-1.1	
Electricity wires network	RUOE, volume adjusted, OLS trend	1991–2001	5.3	-0.4–10.4
Railtrack	RUOE, passenger numbers, OLS trend	1995–2002	4.8	
Railtrack	RUOE, route length, OLS trend	1995–2002	0.0	
Sewerage	RUOE, base service adjustement, OLS trend	1993–2002	4.4	2.3–6.5
Water	RUOE, base service adjustement, OLS trend	1993–2002	3.6	1.5–6.1
Average			**2.7**	**-1.1–53**

Source: Europe Economics (2003), op. cit.

According to these consulting companies, average productivity growth achieved in the UK privatised industries lies in the range 2.7–6.9% pa.

This is also consistent with LECG's analysis of the average RUOE reduction of 4.1% pa, achieved by UK regulated sectors during the period since privatisation. Indeed, in its assessment LECG concluded:

"… the results historically achieved in other regulated sectors, in conjunction with the more one-off gains generally achieved in the first 5 to 10 years of price controls suggest that annual unit cost savings (in RUOE terms) of between 3% and 4% have typically been achievable in firms that are moving to an efficient frontier after an extended period of public ownership and absence of price pressure"[28]

[28] LECG (2005), op. cit.

D. COMPARISONS OF PRODUCTIVITY AND EFFICIENCY MEASURES: ISSUES

As discussed in Appendices B and C, several factors affect a measure of productivity or efficiency. The implications of these for this study and the approaches used in the study to mitigate, to some extent, the impact of these issues on the reasonableness of their use as comparisons for Network Rail are explored below.

D.1. Volume effects

Volume effects arise where there are variable returns to scale in the production process, and they have an impact on how the productivity measures should be interpreted. Increasing returns to scale imply that, as the scale of production increases, output grows by proportionally more than the corresponding increase in the inputs. For instance, an expansion in output will automatically lead to a rise in TFP. In this case, the apparent improvement in the productivity measure is *not* being driven by any underlying technical or dynamic efficiency improvements, but rather by the growth in the inputs, and it is a direct result of the way in which the standard measures of productivity are calculated.

If the extent of the economies of scale is known, this effect is reasonably straightforward to extract from the total movement in productivity, and is adjusted for in this study. For example, the relationship between a standard TFP measure and technical change, when volume effects exist, is shown in the following equation:

$$\hat{A} = \hat{TFP} + (1 - 1/\varepsilon_{CQ})\hat{N} \qquad \text{Equation D.1}$$

where $\hat{A}$ is defined as true frontier shift, $\hat{TFP}$ as the growth in the TFP, ε_{CQ} is the elasticity of costs with respect to output, which captures the extent of the economies of scale, and $\hat{N}$ is the weighted growth in inputs.

When there are increasing returns, the cost elasticity is less than 1 – i.e. costs rise by less than the increase in output - and the standard measure of TFP grows faster than the actual technical change as inputs increase.

The cause of this problem could be attributed to the methodology underlying the measurement of TFP. In more detail, the standard weights used for the inputs in the measurement of TFP growth are the share of the total costs represented by each input, which naturally sum to 1. This assumes that, if all the inputs increase, the output increases equiproportionately. However, when inputs increase, their proportionate impact on output is, in fact, greater than 1 (assuming that increasing economies of scale hold). Hence, rather than adjusting the overall TFP measure to extract $\hat{A}$, the true frontier shift (as shown above), the weights could be adjusted to reflect the economies of scale. In general, according to standard TFP methodology, input weights are assumed to sum to 1, and scale effects are assessed afterwards.

The correction for non-constant returns of scale is slightly different for the case of RUOE, although Equation B.1 provides a reasonably good estimation as well. For this

analysis, the returns-to-scale correction adjusts the RUOE of the first year of each time period examined, using Equation D.2:

$$RUOE_{t-1}^{corrected} = C_{t-1}^{real} \times (1 + \Delta G_{t-1,t} \times \varepsilon_{CQ}) / O_t \qquad \text{Equation D.2}$$

where C is real costs, $\Delta G_{t-1,t}$ is the change in output levels in the period examined, ε_{CQ} is the elasticity of costs with respect to output and O is output level.

D.2. Business cycle

The aim of this study is to identify a steady-state, long-term benchmark for Network Rail's operating cost reductions. In order to derive a reasonable benchmark, it is important to consider the impact of the business cycle on observed performance.

It is commonly observed that firms alter the utilisation rate of inputs rather than the actual level employed. Adjustment costs could make it more costly to lay off workers or to mothball plant than to use these inputs less intensively during recessions and more intensively during booms. A pro-cyclical pattern is induced in productivity, since the same inputs appear to produce less in periods of recession and more in booms; if the utilisation rate is not considered, this is ascribed to changes in efficiency. Either a control for factor utilisation should be included in a productivity analysis, or any period examined should reflect a full business-cycle movement, so that the cyclical effect disappears from the average (assuming that the utilisation pattern is symmetric).

In most productivity studies, performance over a complete cycle is examined. Alternatively, utilisation rates could be employed to adjust the level of the inputs used in the analysis. For example, one way to control partly for the business-cycle effects in the labour force is to use hours of work or full-time equivalents (FTEs), rather than number of employees. For the TFP section, which is based on O'Mahony (2002), the effects of business cycles on labour productivity are partly controlled for using hours of work. Similarly, unit cost measures partly adjust for this by considering the cost of labour rather than headcount. If there were a shift towards more part-time workers without changing the total number of employees, and such an adjustment were not made, efficiency improvements would be understated.

A further option is to use productivity averages over a full business cycle. This is the approach adopted in this study when examining TFP in other sectors. The average figures produced over the period examined should be free from the influence of cyclical effects since the positive productivity biases in boom years should be cancelled out by the negative biases in the downturns.

For the comparisons using regulated industries, this effect is less significant, as these industries are less susceptible to the business cycle. Most of the utility industries have seen positive or near-zero volume growth over the periods examined. In addition, long time periods and full regulatory periods are examined to minimise the impact of time-dependent regulatory incentives. Finally, operating costs are used which account for changes in the mix of part-/full-time staff, for example.

D.3. Atypical performance and exogenous factors

Using the change in productivity over time as a benchmark for future performance assumes that the past performance of a company is a sensible yardstick of future performance. Therefore, if there are likely to be substantial *changes in the operating environment* of part of the business or changes in *exogenous factors*, this technique could be less appropriate. For example, some companies have achieved substantial productivity gains over a given period owing to, for example, the abolition of restrictive practices.

Thus, if the productivity measure is being used in setting targets for future performance, it is important to know whether past gains have been achieved because of strong product growth, rapid catch-up to a world leader, or as a result of exogenous factors. Whether equivalent gains will be feasible in the future will depend on whether the underlying conditions are likely to persist. Where possible, these factors are taken into account.

The approach used in this study is to exclude, as far as possible, periods materially affected by exogenous factors. For example, periods excluded could be those affected by cost reallocations out of the regulated part of the business; significant sectoral restructuring (such as mergers); and higher costs due to the wider scope of activity of the regulated company, as required by the regulator. It is not possible to account for all exogenous factors under such an approach. Alternatively, econometric modelling, or similar techniques, could be used - such an approach could be feasible for the US dataset, for example.

E. USING THE COST REDUCTION FACTOR IN AN RPI–X FRAMEWORK

This section discusses the mechanics of the RPI–X setting, as well as the decomposition of the X factor, but abstracts away from the other building blocks of depreciation and allowed returns and how regulators often reprofile these elements to ensure reasonable financial performance of the regulated companies, and thus focuses on X purely in terms of cost reductions.

The RPI–X framework is based on the *assumption* that changes in the final price of a service are related to the growth in the cost of the inputs and to the improvement in efficiency in delivering the service. The inputs include a reasonable return on the capital invested in the process. This basic relationship can be considered to hold for any specific sector and for the whole economy. The relationship can be formally written as:

$$\hat{P}_{OW} = \hat{P}_{IR} - T\hat{F}P_R \qquad \text{Equation E.1}$$

$$\hat{P}_{OG} = \hat{P}_{IG} - T\hat{F}P_G \qquad \text{Equation E.2}$$

where P_O is the output price of the service, P_I is a weighted sum of the unit cost of the inputs, *TFP* denotes unit productivity improvement, *R* denotes the rail sector, *G* denotes the general economy and carets (^) indicate growth rates.

Equation E.1 states that the change in the price of rail reflects changes in the costs of the inputs (fuel, materials, labour and capital), minus the change in average industry efficiency. Therefore, productivity can be thought of as showing how, over time, more output can be produced with the same inputs. Output prices fall by the extent of these improvements. Equation E.2 is analogous for the economy as a whole.

Subtracting Equation E.2 from Equation E.1 gives:

$$\begin{aligned}\hat{P}_{OR} &= \hat{P}_{0G} + \left(\hat{P}_{IR} - \hat{P}_{IG}\right) - \left(T\hat{F}P_R - T\hat{F}P_G\right) \\ &= \hat{P}_{0G} - \left[\left(\hat{P}_{IG} - \hat{P}_{IR}\right) + \left(T\hat{F}P_R - T\hat{F}P_G\right)\right]\end{aligned} \qquad \text{Equation E.3}$$

Overall, Equation E.3 describes how prices in the rail sector change over time. The regulator would want to limit these according to a given RPI–X control. Equation E.3 can be used to indicate what the chosen X factor implies. Changes in the final price of the rail services can be divided into two parts:

$$\hat{P}_{OG} \text{ and } \left(\hat{P}_{IG} - \hat{P}_{IR}\right) + \left(T\hat{F}P_R - T\hat{F}P_G\right) \qquad \text{Equation E.4}$$

and these two parts can be seen to correspond to the RPI and the X factor respectively.

From Equation E.2, $\hat{P}_{OG}$ corresponds to output prices in the economy as a whole. Thus, it can be assumed that $\hat{P}_{OG} = RPI$, because the RPI is the chosen measure of the

increases in final prices in the overall economy. The second component corresponds to the X factor, so

$$X = \left(\hat{P}_{IG} - \hat{P}_{IR}\right) + \left(T\hat{F}P_R - T\hat{F}P_G\right) \qquad \text{Equation E.5}$$

It follows that, *if* RPI reflects average productivity gains, this X factor itself has two parts:

- *differential in input costs* - the first part indicates that the greater the gap is between growth in input costs in the general economy and in the rail industry, the larger (more negative) the X factor will be. In other words, if input-cost growth in the rail sector is found to be greater than that in the economy as a whole, the X factor should be reduced accordingly;
- *differential in TFP* - the second part reflects the fact that the X factor is larger, to the extent that technological progress is faster in the rail industry than in the economy as a whole.

The analysis *assumes* perfectly competitive markets, implying that the prices of the inputs are set outside the firm's control - these input prices include wage rates and the costs of raw materials. Therefore, the first term in the X factor is supposed to capture any differences that result simply from a *different input structure*. For example, a rail company will have a different mix of skilled and unskilled workers from that in the overall economy, affecting the average cost of labour. A rail company will also be more exposed to construction price risks. Where input costs in the rail industry grow at a similar rate to costs in the overall economy, the first term is zero. In this case, the X factor represents only the technical progress in the rail industry that is in excess of such progress in the rest of the economy.