Oxera

Network Rail's scope for efficiency gains in CP4

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Executive summary

At the 2003 access charges review, the Office of Rail Regulation (ORR) set a target for Network Rail to reduce the unit costs of its controllable operating, maintenance and renewal (OM&R) expenditure by an average of 31% over the five years of control period 3 (CP3).

The purpose of this study is to provide an assessment of efficiency gains achievable by Network Rail in OM&R expenditure, which is intended to inform the 2008 periodic review. The assessment of these values will form an input into the ORR's determination of Network Rail's revenue allowance in CP4, and hence affects the access charges on the rail network.

This study draws on existing materials only, and has been undertaken without any engagement with Network Rail. It is designed to complement other efficiency studies and analysis that the ORR is carrying out. To estimate the likely range of possible efficiency improvements for Network Rail, this report uses two pieces of evidence on productivity from the regulated utility sectors and from firms operating in competitive markets.

Evidence from other regulated sectors

Historical reductions in unit costs achieved by other network utility companies can be used to provide a benchmark range of possible future cost reductions for Network Rail. This study updates the analysis presented in the LEK/Oxera 2005 report,[1] and it makes it more specific to Network Rail's situation, taking into account the data made publicly available since the publication of that report, most of which dates to 2007.

A common measure of efficiency change in the comparator industries is reductions in real unit operating expenditure (RUOE). In the absence of direct comparators, examining RUOE trends enables comparisons of trends in efficiency with similar price-regulated industries and companies which own, maintain and renew network infrastructure. Historical RUOE reductions achieved by similar network utility companies could be used as a benchmark range of possible future cost reductions for Network Rail. The unit cost reductions of selected companies/industries can then be used as a benchmark for possible cost reductions achievable by Network Rail once appropriate adjustments have been made to ensure comparability. The reductions in RUOE have been summarised in a variety of ways to give a potential range of estimates of the scope for the efficiency improvement for Network Rail in CP4. The table below shows that the central range of estimates from the industry average RUOE reductions (4–6% per year) is corroborated by the data summarised in several different ways.

[1] LEK and Oxera (2005), 'Assessing Network Rail's Scope for Efficiency Gains over CP4 and Beyond: A Preliminary Study', December 12th.

Results of OPEX RUOE analysis (average % per year)

	Range of estimates
Industry average annual RUOE (central range)	4.0–6.2
'Reset' hypothesis	
By control period	6.8
By years since privatisation	5.2
Distribution	
At a company level	–2.6 to 7.0
At a industry level	–0.5 to 8.1
Trend analysis	4.2 to 8.1

Note: Operating expenditure (OPEX) from the comparator industries refers to operating costs plus those maintenance costs which are not capitalised.
Source: Oxera analysis.

The evidence from the industry-level analysis of OPEX unit cost trends suggests a central range of 4–6.2% per year.

Network Rail's operating costs increased significantly after the Hatfield derailment and during administration.[2] The 'reset' hypothesis assumes that the sharp increase in costs that followed Hatfield and the period of administration have effectively reset the industry to a position typically observed around privatisation. Other consultants' studies have estimated Network Rail's current relative inefficiency. Information on the cost reduction trends in the second price control period and 6–10 years after privatisation in other sectors may therefore provide a more appropriate indication of the potential for efficiency improvements in CP4 for Network Rail. The reset hypothesis suggests a range of average cost reduction of 5–7% per year.

Evidence from competitive markets

Additional evidence on Network Rail's potential for cost reductions in the absence of direct comparators is based on the productivity improvements in sectors of the economy comparable to Network Rail. The approach used is based on the assumption that the productivity performance of a particular industry can be represented by a weighted average of the performance of a number of other industries, known as a 'virtual comparator'. Estimates of productivity trends for the rail infrastructure industry are inferred by weighting the estimates for each comparator sector by the contribution of that sector to the rail infrastructure industry's activities. The results of the analysis (shown in the table below) on EU KLEMS data[3] show what level of performance might be expected from a company carrying out activities similar to those undertaken by Network Rail but operating in a competitive environment.

[2] Following a material change in the financial circumstances of the company, Railtrack was placed in special railway administration in 2002. Network Rail subsequently took over the company in 2002.

[3] EU KLEMS is a project run by a consortium of academic institutes including the University of Groningen and the National Institute of Economic and Social Research (NIESR), which aims to provide productivity growth estimates for a large number of EU countries.

Total factor productivity growth benchmarks for Network Rail (% per year)

	OPEX	Maintenance	Renewals	OM&R
Estimated total factor productivity (TFP) growth	1.0	2.1	2.1	1.9
75% from frontier shift	0.75	1.6	1.6	1.4

Note: Figures exclude any adjustment for the effect of input price growth.
Source: Oxera analysis.

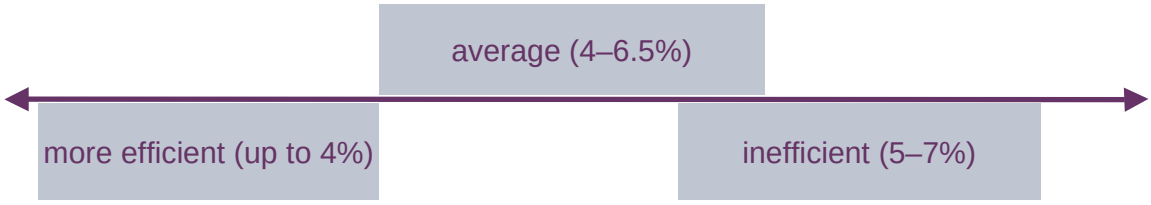
As these estimates come from firms operating in competitive markets over long time horizons, theory would suggest that their performance represents that of an efficient firm (ie, they do not include an element of catch-up). This assumes that all firms are operating efficiently and productivity growth is seen from advances in new technology and management practice. In reality, there may be transition costs and structural inefficiencies that have an impact on this estimate. A more conservative view, based on academic evidence, is that, on average, 75% of economy-wide productivity gains are the result of pure frontier shift. This implies that frontier shift in OM&R could be around 1.4% per year.

The analysis of unit cost reductions uses data mainly relating to operating and maintenance costs. As such, it is unclear that direct inference can be made about renewals expenditure. However, the analysis of TFP according to the activities undertaken in each cost category suggests that firms in competitive markets make very similar productivity gains in renewals as they do from maintenance.

Possible range of efficiency targets

According to the above analysis, the possible efficiency targets based on suitable comparators for Network Rail are illustrated below.

Possible efficiency targets for Network Rail (% per year)



Source: Oxera.

The actual target depends on the judgement of the ORR on the current efficiency level of Network Rail. Network Rail's own analysis, set out in its Strategic Business Plan, might be reasonable if it is currently 'efficient' and close to the best practice. However, evidence suggests that there is still a significant gap to best practice.[4] The reset hypothesis also indicates that firms in their second control period can still make significant cost savings.

[4] See, for example, the analysis in ORR (2008), 'Update on the Framework for Setting Outputs and Access Charges and Strategic Business Plan Assessment', February, p. 113.

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1 Introduction

Network Rail is in the third regulatory control period (CP3) since privatisation of the rail industry. The current regulatory settlement, established by the Office of Rail Regulation (ORR) during the 2003 Access Charges Review (ACR), covers the period from April 2004 to March 2009, and followed Network Rail's acquisition of Railtrack and the re-establishment of stable funding for the industry following the Hatfield derailment. The ORR made an assumption that Network Rail could reduce the unit costs of its controllable operating, maintenance and renewal (OM&R) expenditures by an average of 31% over the five-year control period.

In 2008, the ORR will complete the periodic review for CP4, covering 2009/10 to 2013/14. In 2005, it commissioned Oxera and LEK to provide an initial estimate of the range of efficiency improvements in OM&R that Network Rail might be able to achieve over the course of CP4 and CP5.[5] Since Network Rail is the only company in the industry, the consultants made indirect comparisons to assess potential unit cost savings. Drawing on evidence from other regulated utilities and other railways, the consultants arrived at a range of 2–8% per year.

Network Rail responded to this study in a supporting document[6] for its 2007 Strategic Business Plan.[7] It noted that: 'any such top-down approach should be treated with caution due to the many assumptions inherent and implicit in the method.' Attempting 'to refine' the maximum plausible range of 2–8% per year, based on 'internal Network Rail knowledge and specific data which can be provided to ORR' and 'new information now available', Network Rail concluded that a 'reasonable and appropriate range for efficiency target-setting based on this top-down methodology is 2–3.2% per year'.[8]

1.1 Objectives

This study provides an assessment of the efficiency gains achievable by Network Rail in OM&R expenditure, which is intended to inform the ORR's judgements on efficiency in the 2008 periodic review. The assessment of these values will form an input into the ORR's determination of Network Rail's revenue allowance in CP4, and hence affects the access charges on the rail network.

This study draws on existing materials only, and has been undertaken without any engagement with Network Rail. It is intended to complement other efficiency studies and analysis that the ORR is carrying out.

The ORR and Network Rail have already undertaken studies examining direct bottom-up evidence on Network Rail's performance. Given this previous work, the performance in other sectors of the economy and other regulated industries may provide an indication and useful cross-check of the level of performance that could be expected from Network Rail in CP4 and CP5. These comparisons provide high-level sense-checks of the range of performance that Network Rail might be able to achieve going forward. This study is therefore intended to focus on top-down estimates of Network Rail performance, adding to the evidence base on which the ORR can make its determination.

[5] LEK and Oxera (2005), 'Assessing Network Rail's Scope for Efficiency Gains over CP4 and Beyond: A Preliminary Study', December 12th.

[6] Network Rail (2007), 'Strategic Business Plan: Supporting Document—Response to LEK/Oxera Study', October.

[7] Network Rail (2007), 'Strategic Business Plan: Control Period 4', October.

[8] Network Rail (2007), 'Strategic Business Plan: Supporting Document—Response to LEK/Oxera Study', October, p. 17.

1.2 Methodology

This study focuses on indirect measures of efficiency by examining economy-wide productivity trends and rates achieved by other regulated industries. The methodology and datasets used, including details of the assumptions made, are described in subsequent sections of the report. Given that the actual point estimate of efficiency achievable by Network Rail will depend on how close it currently is to best practice, only a range of potential efficiency estimates can be provided.

1.2.1 Evidence from comparator companies

Historical reductions in unit costs achieved by other network utility companies can be used to provide a benchmark range of possible future cost reductions for Network Rail. This study updates the analysis presented in the 2005 report, taking into account the data made publicly available since the publication of that report, most of which dates to 2007.

The analysis of indirect evidence presented in this report is based on like-for-like comparison not only across sectors, but also over time. Therefore, the comparability of the historical performances is important, and the following approach has been adopted to ensure that any comparisons drawn are robust.

– The analysis focuses on privatised (and price-regulated) network industries/companies, since these are regarded as the companies outside the rail industry whose characteristics most closely match those of a rail infrastructure company, including capital intensity, and the operation and maintenance of a geographically diverse network.

– Placing a focus on regulated network industries might suggest that the rates of technical progress in each industry should be similar. However, technology-intensive industries, such as telecoms, may be expected to have faster technical progress than the other utility industries, and may be expected to be able to reduce their unit costs more quickly.

– The relevant periods for assessment were selected taking into account the cyclical nature of productivity performance, the time elapsed since privatisation, and the relevant regulatory periods.

– Where possible, the unit cost reductions were adjusted for inflation, the impact of economies of scale, changes in accounting standards, and changes in the nature of outputs.

– In industries where several companies operate, the results are averaged across the group of companies in order to mitigate the impact of atypical performance (due to favourable or unfavourable exogenous factors).

1.2.2 Evidence from economy-wide productivity

Total factor productivity (TFP) measures, based on total costs, were employed as a benchmark for OM&R costs. Total factor productivity (TFP) growth is a commonly used method of assessing productivity improvements over time within the economy. Unlike other partial methods of productivity growth, TFP measures include all input factors in the production process—namely, labour, capital and intermediate input (usually related to materials) prices. In contrast to the 2005 study, a new dataset on TFP has been used for this study. The dataset comes from the project by EU KLEMS,[9] a consortium of academic institutes including the University of Groningen and the National Institute of Economic and Social Research (NIESR), which aims to provide productivity growth estimates for a large

[9] EU KLEMS, 'Productivity in the European Union: A Comparative Industry Approach', http://www.euklems.net/.

number of EU countries. In this instance, only the UK-specific data was used. The dataset uses Standard Industry Classification (SIC) and contains information on productivity growth estimates for a large number of industries from 1970 to 2004. TFP was compared over a complete business cycle to avoid misrepresentation of the impact of recessionary or growth periods.

Evidence on economy-wide productivity may provide an important benchmark for the regulator. It addresses the question of what efficiency might be achievable in a fully competitive market.

To undertake TFP analysis, some important assumptions were made. It might be argued that TFP-based estimates are sensitive to these assumptions. To mitigate this, Oxera conducted sensitivity analysis on the assumptions to ensure that the estimate for potential efficiency gains is as robust as possible.

RUOE is a partial measure of productivity focusing on the operating cost (ie, those costs not capitalised) performance of the business, whereas TFP looks at the total cost of the business. The ROUE estimates provide evidence on the overall scope, catch-up and frontier shift for possible efficiency improvements. Changes in TFP observed from economy-wide productivity in *competitive* markets are likely to have much lower levels of structural inefficiency (catch-up) than those from regulated natural monopolies due to the competitive nature of those markets.

1.3 Structure of the report

This report is organised as follows. Section 2 summarises Network Rail's assessment of the scope for efficiency savings in the CP4, as described in its Strategic Business Plan. Section 3 considers Network Rail's and LECG's critique of the LEK/Oxera 2005 study, and their adjustments to the models. The section also outlines Oxera's response to Network Rail's critique.

Section 4 examines the efficiency improvement achievements observed in other regulated industries in the UK, and section 5 considers comparable evidence from competitive industries of the economy as a whole. Section 6 summarises the findings of the analysis in this report and synthesises these into a recommended range of efficiency improvements that could be expected for CP4 and CP5.

2 Network Rail's Strategic Business Plan

The efficiency targets that Network Rail will be seeking to achieve over CP4 are explained in Chapter 5 of its Strategic Business Plan.[10] The analysis of potential efficiency improvements is largely based on assessments of specific efficiency initiatives identified by Network Rail. Bottom-up assessments have been undertaken to identify the detailed schemes and initiatives to be pursued in order to deliver future efficiency savings. In addition, Network Rail is suggesting an element of stretch for initiatives that are likely to be identified during the course of CP4. Network Rail also includes an estimate of the effect of input price inflation in setting its overall target.

Network Rail examines plausible efficiency targets using a top-down approach. This approach was based on a review of the analysis by the ORR's consultants and consideration of other regulators' targets set in recent price reviews. This assessment was then used to cross-check the bottom-up initiatives. Network Rail reviewed a range of top-down studies, including the ORR's initial assessment of the potential catch-up and frontier shift. Having considered alternative efficiency assumptions, Network Rail concluded that, in most areas, it would be able to achieve underlying efficiency savings of 5% per year in the first two years, falling to 2% per year in the final year of CP4. Without adjustment for the effect of rising input prices, the central estimate was 2.4% per year over the course of CP4.

See Appendix 1 for a summary of Network Rail's Strategic Business Plan (2007) and the studies on Network Rail's efficiency.

2.1 Conclusions from Network Rail's Strategic Business Plan

Network Rail assumed that it would be able to achieve underlying efficiency savings in most areas of 5% in the first two years, falling to 2% in the final year of CP4. In some areas (eg, signalling costs), Network Rail regarded such large savings to be unrealistic and assumed a lower rate. It also assumed increases in input prices that have been accounted for based on an independent report prepared by LEK for Network Rail.[11] LEK suggested that Network Rail's expenditure portfolio was likely to be affected by input price inflation in excess of RPI. Annual average projected efficiency gains and input price changes are summarised in Table 2.1. Network Rail concluded that, excluding the effect of rising input prices, its overall costs would fall by 2.4% per year during CP4, a result that was broadly 'consistent with the company's top-down analysis', and 'similar to targets set in recent reviews by other regulators'.[12]

[10] Network Rail (2007), 'Strategic Business Plan: Control Period 4', October.

[11] Network Rail (2007), 'Network Rail Strategic Business Plan: Response to LEK/Oxera study', October.

[12] Network Rail (2007), 'Strategic Business Plan: Control Period 4', October, p. 117.

Table 2.1 Network Rail's view of CP4 efficiency and input prices (% per year)

	Efficiency	Input prices	Net impact
Controllable operating expenditure (OPEX)	3.52	1.62	1.48
Maintenance	3.52	1.32	2.44
Renewals	3.52	0.7	2.96

Note: Figures given are annual averages.
Source: Based on Network Rail (2007), 'Strategic Business Plan: Control Period 4', October, Figure 5.24, p. 117.

3 Response to critiques of LEK/Oxera (2005)

3.1 Network Rail's critique

The initial range of 2–8% annual efficiency gains estimated by the ORR for Network Rail in CP4 was based on Oxera and LEK (2005). Network Rail issued a response to this study as one of the supporting documents to its Strategic Business Plan.

LEK/Oxera (2005) used a 'top-down' approach, focusing on efficiency in terms of catch-up and frontier shift. Network Rail accepted that this approach has some value, but expressed some concerns over its application:

> Network Rail believes that the analytical framework established by this study is very helpful for top-down assessment of the range of plausible efficiency targets for the next control period (noting however our concerns with placing reliance on top-down assessments).[13]

Network Rail's response document used new information (internal company knowledge and data) to build on the methodology in the LEK/Oxera (2005). The analysis conducted by Network Rail suggests that the appropriate range for efficiency improvements is 2–3.2% per year.

3.1.1 Network Rail's adjustments to the LEK/Oxera methodology

The main changes by Network Rail to the LEK/Oxera methodology were as follows.

- Adjustments to the estimation of long-term efficiency trends in other industries. According to Network Rail the specific issues are:
  - the efficiency gains of National Grid Company (NGC) were due to volume growth and are therefore not an appropriate comparison to Network Rail;
  - renewals expenditures were not included in the consultants' comparison based on real unit operating expenditure (RUOE);
  - making these adjustments implied a maximum cost reduction of 2.6% per year from long-term efficiency trends.
- An adjustment made to OM&R to reflect an improved understanding of the level of justified expenditure increases since the Hatfield derailment. This adjustment reduces the efficiency savings based on historical trends to a maximum of 0.6% per year. The adjustment is based on a review of historical expenditure by Network Rail.

Taken together, these two adjustments provide the upper end of Network Rail's estimated range of 3.2% per year.

3.1.2 Critique of approach

Network Rail put forward a critique of the LEK/Oxera (2005) efficiency estimates based on evidence from other industries. These are detailed below together with a response to each concern (see Table 3.1).

[13] Network Rail (2007), 'Network Rail Strategic Business Plan: Response to LEK/Oxera study', October, p. 6.

Table 3.1 Responses to Network Rail's critique

Network Rail critique	Response
There are significant structural differences between Network Rail and the industries taken to be analogous to Network Rail that were used for comparison	The comparators are all large regulated infrastructure companies operating, maintaining and renewing a network monopoly. There is also regulatory precedent for using this approach, with similar comparisons having been undertaken in numerous regulated infrastructure sectors (see, for example, studies undertaken by Ofgem and Ofwat[1])
NGC is not comparable to Network Rail as the efficiencies achieved by NGC were due to a large, industry-specific, increase in volumes	The latest data shows that NGC no longer has the greatest reductions, and economy-of-scale adjustments are made to control for volume changes
The removal of NGC significantly reduces the potential efficiency gains	NGC could be considered a robust comparator as a national network operator with no retail business
Analyses of other industries are based on different time periods which may reflect different macroeconomic conditions	The analysis examines data over the business cycle, limiting the effect of macroeconomic factors
RUOE measures are not appropriate for assessing renewals	Evidence from economy-wide productivity shows that productivity in maintenance is similar to that of renewals. RUOE analysis of renewals could be based on disaggregated data if available; however, there was insufficient evidence to draw robust conclusions on renewals. Direct benchmarking evidence from LEK shows that a 2.5% annual average catch-up to an internally set frontier on renewals is possible, while evidence from the study undertaken using the International Union of Railways (UIC) 'lasting infrastructure cost benchmarking' (LICB) dataset suggests a higher number[2]
The high-level approach provides no link to how savings are achieved on the ground	RPI – X regulation provides incentives for Network Rail to innovate and identify efficiency gains. It is not the purpose of this type of study to identify specific initiatives

Notes: [1] CEPA (2003), 'Productivity Improvements in Distribution Network Operators, November, p. 36; Europe Economics (2003), 'Scope for Efficiency Improvements in the Water and Sewerage Industries', March, Appendix.
[2] ORR (2008), 'Update on the Framework for Setting Outputs and Access Charges and Strategic Business Plan Assessment', February, p. 113.
Source: Oxera.

3.2 LECG's critique

LECG has provided a critique of LEK/Oxera (2005), which identified a preliminary range of possible efficiency improvements from 2% to 8% per year.[14] LECG states that 'it is rare for identified potential efficiency targets to exceed 5% annually'.

Neither the 2005 report nor this report recommends a particular target, but both set out the evidence on achieved performance for the ORR to be able to make informed decisions.

The purpose of LEK/Oxera (2005) was to define a range of possible efficiency improvements, and the evidence shows that several regulated firms have achieved annual efficiency savings of greater than 5% per year (such as Scottish Water and Network Rail itself). Several other reports for regulators have observed performance of greater than 5% annually, as identified by the summary of consultants' reports in LECG's report for

[14] LECG (2008), 'Assessing Network Rail's Scope for Efficiency Gains', report prepared for Network Rail, April 3rd.

Postcomm.[15] LECG's own historical analysis of trends in other regulated sectors indicates that electricity distribution, electricity transmission, gas transportation & distribution and Railtrack have all achieved over 5% annual RUOE reductions with a maximum of 8.8%.[16]

3.2.1 Double-counting of scope for efficiency improvements

LEK/Oxera sets out a preliminary range of possible savings. This range was used to identify the possible *maximum* and *minimum* savings Network Rail might be able to achieve over CP4. As such, no judgement was made on the likelihood of either scenario occurring.

LECG's critique that the top of the range (8%) double-counts catch-up savings is inaccurate. The top of the range was calculated from a combination of possible frontier-shift and catch-up efficiencies from observed performance. The range is not calculated using the 5.4% figure identified using the 'reset hypothesis' analysis as claimed by LECG, but is derived from the performance of the comparator set plus the extra additional savings identified to return Network Rail to its previous performance.

This is calculated using the range of savings observed from other industries across all periods—ie, 2.5–5.7% per year (which is consistent with the savings that the ORR expected of 3–5% per year before the Hatfield derailment[17]), plus a 'plausible proportion' of the incremental savings identified in section 7 of LEK/Oxera (2005), which would reverse the expenditure increase observed following Hatfield (2%–5% per year). This *maximum* estimate does rely on a proportion of those savings being incremental to the average savings made in other network utilities, as stated in LEK/Oxera (2005) and identified by LECG.

Possible data errors

The differences between Oxera's 2003 and 2005 studies relate to adjustments made to ensure that the data is consistent over time and the most up-to-date version is used, since regulators often revise their data over time to ensure accuracy. The analysis presented in this report takes account of data as it has become available and makes further adjustments to ensure that the comparisons over time are on a like-for-like basis.

3.2.2 Implied pace of change

LECG argues that the significant efficiency savings made in CP3 are above the norm and make such savings unlikely in CP4.

Reset hypothesis

Evidence from other network industries suggests that the largest efficiency savings are made during the second price control period (see Table 4.3). Network Rail's achievement of large efficiency savings in the first control period does not necessarily preclude efficiency savings of a similar magnitude being made again. The main driver of potential efficiency savings is the starting level of relative inefficiency of the firm. LEK/Oxera (2005) makes no assumption about the relative efficiency of Network Rail compared with best practice, but sets out a range of possible efficiency improvements. The exact scope for future efficiency savings will depend on Network Rail's relative efficiency.

Performance similar to Network Rail's 5.7% per year has been achieved by other regulated companies such as Scottish Water and NGC. See above for a more detailed discussion on achieved RUOE savings.

[15] LECG (2006), 'Future Efficient Costs of Royal Mail's Regulated Mail Activities: Top Down Final Conclusions', January 23rd, Table 6.
[16] LECG (2005), 'Future Efficient Costs of Royal Mail's Regulated Mail Activities', August 2nd, Table 244.
[17] ORR (2000), 'The Periodic Review Of Railtrack's Access Charges: Final Conclusions—Volume I', July, p. 33.

Efficiency incentives

LECG suggests not using the upper end of the range to ensure that the price control incentivises Network Rail to outperform the target. The choice of target within the range is made by the ORR, taking into account evidence from all the efficiency studies undertaken.

3.2.3 Comparator analysis

Inclusion of BT

BT was included because it operates, maintains and renews a national network, and is price regulated in a similar way to Network Rail. The analysis focused on the wholesale part of the business to make the comparison as like-for-like as possible. The efficiency performance of BT, as demonstrated over the more recent period examined, is within the preliminary range of possible efficiency savings identified.

Other efficiency studies for regulators have included BT as a comparator in their assessments, including Ofwat and Ofgem.[18] LECG also uses BT as a comparator in its report to Postcomm regarding the efficiency position of Royal Mail.[19]

Exclusion of Royal Mail

Royal Mail did not meet the criteria for inclusion since it does not own, operate and maintain a network in the same way as the other comparators. In addition, it may not be a good comparator for Network Rail since it has a different cost structure, being a more labour-intensive business. Labour accounts for 60–70% of Royal Mail's costs, compared with 40–45% for Network Rail[20].

According to LECG (Table 257), the majority of Royal Mail's expenditure finances activities which have distributive trades and/or manufacturing as their closest nature of work comparator (approximately 70%). This suggests that the nature of activities undertaken by Royal Mail is markedly different from that of Network Rail.

Exclusion of BAA

BAA was excluded because it did not meet the criteria of owning, operating or maintaining a network. While an interesting sensitivity, LECG's use of BAA as a comparator is problematic given the significant increases in security costs in the first regulatory period.[21] The data to delineate depreciation and security costs from the total OPEX is not readily available; it was therefore impossible to ensure data consistency and make a like-for-like comparison between the comparators.

3.2.4 Impact of proposed service reliability improvements

There is no quantitative evidence to suggest that improvements in efficiency come at the cost of improvements in quality of service. In a number of cases companies have managed to achieve significant efficiency gains at the same time as increasing quality levels.

LECG's analysis (Table 13) suggests that the only company in the LEK/Oxera comparator set with declining quality performance was BT. The quality measure used by LECG relates to the retail arm of the business, which is not included as a comparator as the RUOE

[18] Europe Economics (2003), 'Scope for Efficiency Improvements in the Water and Sewerage Industries', March, Appendix 3; CEPA (2003), 'Productivity Improvements in Distribution Network Operators, November, p. 36.

[19] LECG (2005), 'Future Efficient Costs of Royal Mail's Regulated Mail Activities', August 2nd, Table 244.

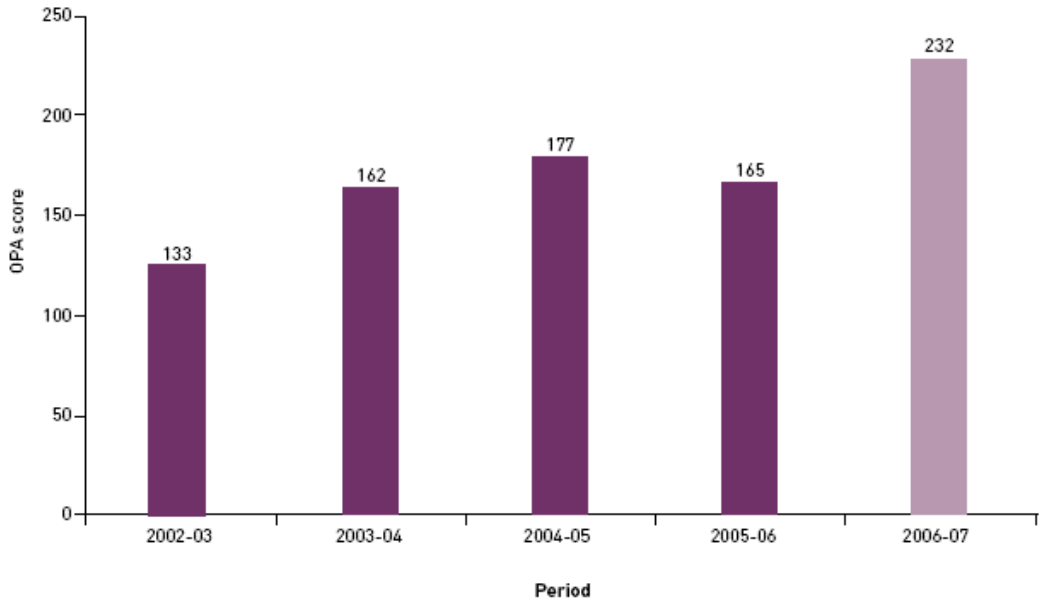
[20] Royal Mail Group Limited (2007), 'Regulatory Financial Statements 2006–2007'; Network Rail Limited (2007), 'Annual Report and Accounts 2007', June 18th.

[21] LECG excludes the period from 2001 due to the significant increase in security costs. However, according to CAA (1991), security costs increased very significantly during Q1 due to stricter government standards. *CAA (1991), 'Economic Regulation of BAA South East Airports 1992–1997',* the Civil Aviation Authority, November, p. 30.

calculation was based on the wholesale business to ensure a like-for-like comparison with Network Rail. The more relevant quality measure for the wholesale business is faults per line, on which BT has *improved* performance while making one of the largest cost savings in our sample.

Another example of improving quality and making significant efficiency gains, from this study, is the performance of Scottish Water, which has achieved savings of between 8% and 14% per year while also increasing the quality of service to its customers, as shown in Figure 3.1.

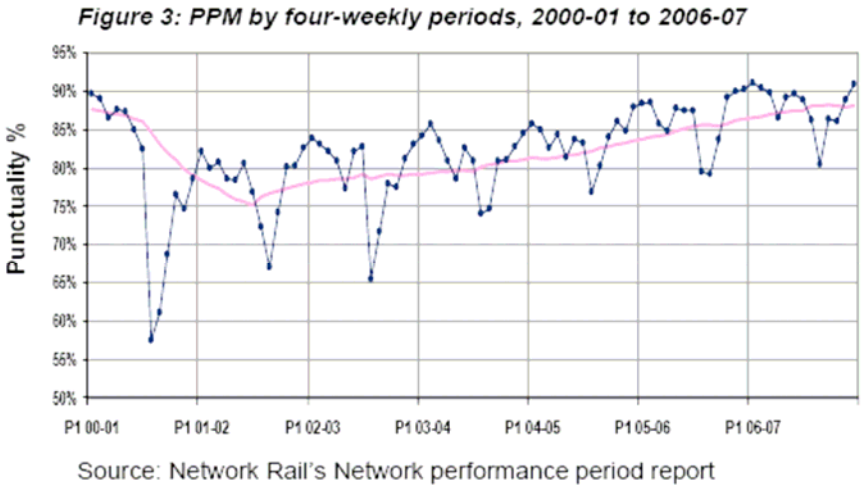
Figure 3.1 Quality performance indicator for Scottish Water

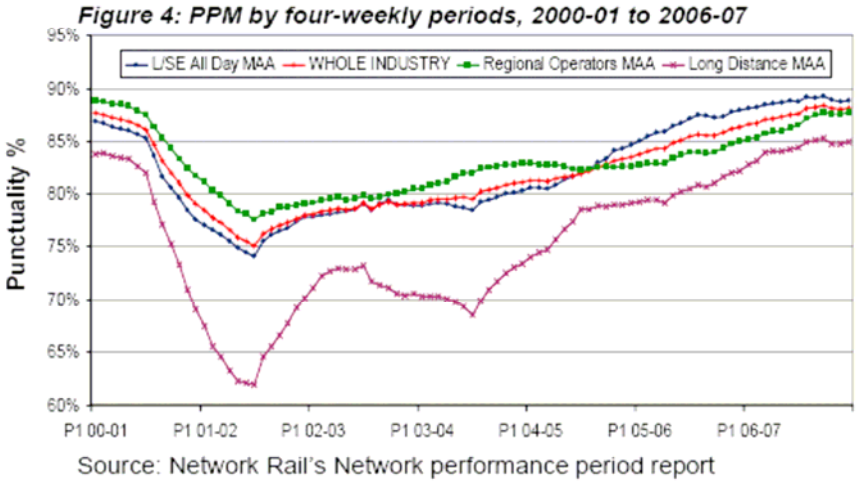


Source: WIC (2007), 'Customer Service Report 2006–2007', Water Industry Commission for Scotland, p. 3.

Network Rail itself has made significant cost reductions over CP3 while also improving its service performance, as shown from the public performance measure (PPM) in Figure 3.2.

Figure 3.2 Public Performance Measure for Network Rail





Source: ORR (2007), 'Annual Assessment of Network Rail 2006–07', September, p. 18.

3.2.5 TFP evidence and frontier shift

LECG notes that the TFP data used in the 2005 study ends in 1999, and suggests that the more up-to-date EU KLEMS dataset be used. The EU KLEMS data was not available when the 2005 study was undertaken. However, it was used in this updated study.

4 Evidence from other regulated sectors

When assessing the efficiency of a regulated company, it is preferable to look at direct evidence on its performance relative to a benchmark. However, since Network Rail is the only infrastructure operator of its type in the UK, it does not have any direct comparators in the same way as regional monopolies such as electricity distribution and water companies have. This makes direct analysis of Network Rail's relative efficiency and performance more difficult, but not impossible, with the use international comparisons or comparisons between Network Rail's regions as a possible method. Examining the historical performance of other similar regulated infrastructure companies also provides estimates of the expected efficiency gains that could be achievable by Network Rail. Although indirect, this analysis provides an important input to considerations about how Network Rail's efficiency might evolve over time.

This analysis updates LEK/Oxera (2005) with the latest available data on the performance of UK regulated utilities, and provides a range of possible rates of improvement based on the historical performance of these comparators. Network Rail's actual ability to make efficiency gains within this range will depend on its starting level of efficiency, the operating environment over the next control period, and the efforts of Network Rail management during CP4.

The analysis presented below identifies a range of efficiency gains estimated across a group of selected comparators. To identify a likely range for performance improvement for Network Rail, four approaches are used to summarise the data:

– industry average RUOE;
– performance since privatisation;
– trend analysis;
– distribution analysis.

The methodology and dataset used, including details of the assumptions made, are detailed below.

4.1 Methodology

A common measure of efficiency change in the comparator industries is reductions in RUOE. Historical RUOE reductions achieved by other similar network utility companies could be used as a benchmark range of possible future cost reductions for Network Rail. Costs for all industries, except gas distribution, are inclusive of the cash maintenance elements.[22] The data available for comparator industries relating to renewals expenditure is insufficient to draw robust conclusions.

Indirect measures of the potential for efficiency improvements are usually based on comparisons with a set of industries and/or companies. [23] The unit costs are calculated by dividing a measure of expenditure by a measure of output. Reductions in unit costs are calculated for each year for which data is available for each of the comparator companies. The unit cost reductions of the selected companies/industries are then used as a benchmark for possible cost reductions achievable by Network Rail. In the absence of direct comparators, the comparison with the selected industries/companies is an appropriate

[22] Those elements of maintenance which are not capitalised.
[23] LEK/Oxera (2005) made use of such indirect measures.

approach to identifying a possible range of future efficiency savings for Network Rail because the comparators all operate, maintain and renew a price-regulated network.

4.1.1 Adjustments to ensure comparability

For the comparisons to be meaningful, it is important that they are on a like-for-like basis. The following approach was taken to ensure that the comparisons made are reliable and robust.

- The analysis uses data from largely privatised (regulated) network industries. These are the companies outside the rail infrastructure industry but whose characteristics are closest to those of a privatised rail infrastructure company.
- The focus on regulated network industries suggests that the rates of technical progress in each industry should be similar. However, technology-intensive industries such as telecommunications are expected to have faster technical progress than other utility industries, and are expected to be able to reduce their RUOE more quickly.
- The relevant period for assessment was selected taking into consideration the time elapsed since privatisation and the relevant regulatory periods.
- The RUOE reductions, as mentioned above, were adjusted for volume growth and the impact of economies of scale.

The analysis uses the cost and output data for each company. The data was then cleaned and adjusted where necessary to ensure consistency of information across companies and industries over time where possible. The data used for each company is described in Appendix 1.

Cost data

Financial statements reporting standards give companies flexibility in the way they report their costs. Therefore, in order to ensure comparability, the modelled costs excluded depreciation and agency costs, as some companies report costs net of these items to focus on controllable operating costs. Uncontrollable costs were excluded since they are not costs on which a company can easily make efficiency savings.

To make the comparisons over time, it was necessary to adjust the cost data to take account of inflation. The RPI was used to construct an inflation index, taking the 1992/93 financial year average as the base year.

To calculate the unit costs, the main scale drivers in each industry were used as the cost driver. Cost and cost driver data was matched as closely as possible such that when there were changes in the outputs of the business, these were reflected in the cost data.

The percentage reductions in unit costs are calculated using the following formula:

$$\Delta RUOE_t = ((\text{unit cost}_t/\text{unit cost}_{t-1}) - 1)*100$$

where unit cost_t is the current unit cost at year t, and unit cost_{t-1} is the unit cost in the previous year.

Adjusting for economies of scale

The unit cost calculation assumes that costs change in the same proportion to volumes (ie, constant returns to scale). However, most natural monopolies exist because they are characterised by economies of scale. To account for economies of scale, Oxera used industry studies and academic papers, as well as precedents, to identify appropriate estimates of economies of scale for each industry. The cost elasticity for a given industry is

assumed to be constant over time. RUOE is corrected for economies of scale using the following formula:

$$RUOE_{t-1}^{corrected} = Unit\ cost_{t-1}^{Real} \times (1 + \triangle Output_{t-1,t} \times \varepsilon) / Output_t$$

where $\triangle Output_{t-1,t}$ is the change in output from (t – 1) to t; ε is the cost elasticity; and $output_t$ is output in the current year.

Industry average annual RUOE reduction

For all the industries examined, the average RUOE change is defined as the average value of the annual RUOE changes. In the case of industries with more than one company, such as the water and sewerage sector in England and Wales (E&W) and electricity distribution industries, the weighted average RUOE change is used. The weighted average RUOE is defined as the sum of expenditure divided by the sum of outputs for each year.

The average of annual changes is used, instead of the annual compound growth rate (ACGR), in order to minimise the sensitivity of the results to start and end points, and to identify biases from atypical performance.

LEK/Oxera (2005) examined data up to 2003/04 at the latest, depending on the industry. More recent data has since become available. In addition to the industries chosen for the previous study, gas distribution and Scottish Water have been added to the comparator set. The E&W water and sewerage sector and the gas distribution industry also report maintenance expenditure separately.

Due to concerns about cost allocation, the estimation of separate RUOE reductions for operating, maintenance, and renewal expenditure was considered insufficiently robust for some industries. However, it was possible to make a similar separation (namely, OPEX versus capital maintenance) in the E&W water and sewerage industry, as well as in the gas distribution sector.[24]

Years since privatisation and number of control periods

The reductions in RUOE can be examined by summarising the annual RUOE estimates by the number of years since privatisation and by control periods. This approach may help in providing a more relevant benchmark compared with average annual RUOE reductions over the entire time period for which data is available. This method groups together RUOE estimates within a particular control period and specific time periods since privatisation. A range of possible efficiency targets for Network Rail can be drawn from RUOE reductions that are associated with the relevant control period or specific time period since privatisation.

Although the comparison may be more relevant to Network Rail's current situation using a shorter time period, this does make the analysis more sensitive to business cycle effects or atypical performance. A shorter time period increases the risk that the result observed is biased by either atypical performance by one firm in that period or economy-wide circumstances (such as recession or rapid economic growth) related to the business cycle, which influence the performance of the comparator.

Distribution and trend analysis

Trend and distribution analysis was undertaken in addition to examining RUOE results. The trend analysis uses the computed unit costs at the company level. An index of unit costs is

[24] Oxera also investigated the possibility of using the data available from Ofgem to disaggregate OPEX and CAPEX similar to the split undertaken in the water industry in order to identify in the split between operations, maintenance and renewals, and to provide evidence on the potential for efficiency improvement in functions undertaken by company headquarters. However, the only data available is forecast costs and outputs for gas distribution networks which were not suitable for drawing robust conclusions, due to the lack of observations.

calculated for this analysis. In the final stage, the trend is fitted to the natural logarithm of the index using the ordinary least squares (OLS) regression technique. The estimated trend coefficient can be interpreted as the annual percentage reduction in unit costs.

The distribution analysis examines the distribution of RUOE estimates at both the company and industry level by fitting a normal distribution to the observed reductions in RUOE. The analysis highlights the upper and lower quartiles as suggested ranges for possible RUOE reductions.

In addition, Oxera attempted to identify the split between operating, maintenance and renewal activities, using available evidence related to the costs of the headquarters or overheads to determine whether a separate target could be identified. However, due to data issues, this approach was not considered reliable and was excluded from the analysis.

4.2 Results

This section of the report summarises the reductions in RUOE to obtain a range of possible cost reduction benchmarks for Network Rail. It examines a range of estimates for indirect costs such as HR, IT, legal, and overheads. Renewals data is not readily available for the majority of industries reviewed as part of this study, with the exception of the gas distribution industry and E&W water and sewerage. This data is not sufficient to draw conclusions with respect to the potential efficiency saving for renewals expenditure.

4.2.1 Data and assumptions

Using public domain data and the methodology outlined above, Oxera estimated RUOE reductions for the following industries:

– E&W water and sewerage;
– Scottish Water (water and sewerage);
– electricity distribution;
– gas distribution;
– electricity transmission;
– telecommunications (BT).

These regulated network utilities could be regarded as comparable to Network Rail since the provision of network services involves similar types of activity and exhibits common characteristics. Utility companies in the comparator industries are exposed to similar incentives as Network Rail, since these industries are also subject to economic regulation.

Oxera recognises that there are physical differences between these comparator industries and rail infrastructure services. In addition, none of the comparator industries has experienced a cost shock similar to that faced by Network Rail following the Hatfield derailment, when costs rose rapidly as a large amount of activity was undertaken in a short period of time. In the absence of a more direct assessment, the range of comparator industries is used to provide an indicator of potential cost reduction trends. Appendix 2 provides a more detailed discussion of the comparator industries, including an explanation of atypical performance. Atypical performance may be induced by external factors such as changes in industry structure or in regulatory accounting policy, which could make two subsequent years incomparable and bias the results. Where such issues arose, the reduction in RUOE from those two years was excluded.

When making comparisons and interpreting the results, it is important to bear in mind that achieved or expected cost efficiencies in different industries are strongly dependent on the initial level of relative efficiency of the company.

4.2.2 RUOE and maintenance RUOE over entire period

Table 4.1 shows the average annual reductions in OPEX and maintenance unit costs of the comparator industries.[25]

Following the methodology set out above, costs and volumes were collected and cleaned for each company in the RUOE analysis (see Appendix 1 for more detail). For all industries, except gas distribution, OPEX is inclusive of the cash (ie, non-capitalised) maintenance elements. In the case of the E&W water and sewerage industry and Scottish Water, capital maintenance costs also include renewals expenditure. The data available does not give a clean split between operations, maintenance and renewals. The OPEX RUOE figures contain all operating and some maintenance expenditure, whereas maintenance RUOE includes capital maintenance and renewals, where possible. Further breakdown is infeasible given the available information.

Table 4.1 RUOE results over entire period (average % change per year)

	Period	OPEX RUOE	Maintenance RUOE
E&W water industry	1992/93–2006/07	1.8	–3.4
E&W sewerage industry	1992/93–2006/07	1.7	–4.5
Scottish Water (water)	2002/03–2005/06	8.8	2.9
Scottish Water (sewerage)	2002/03–2005/06	14.3	0.4
Electricity distribution	1990/91–2006/07	4.0	
Gas distribution[1]	2008/09–2012/13	2.3[1]	0.9
NGC	1990/91–2006/07	4.9	
BT, using call minutes	1996/97–2006/07	6.2	
BT, using exchange lines	1996/97–2006/07	4.8	
Range		**1.7 to 14.3**	**–4.5 to 2.9**
Central range		**4.0 to 6.2**	**0.4 to 0.9**

Note: [1] The gas distribution average RUOE reduction is –0.6 % per year and –0.3% per year for mains renewals and services renewals respectively.
Source: Oxera analysis.

Deriving the central range

Due to the recent changes in the structure of gas distribution in the UK, the RUOE trend for gas distribution is estimated based on Ofgem's projection of unit costs for the next price control period, since this was the only publicly available data. Historical data is used for all the other industries.

The actual and forecast reductions in real unit costs vary from 1.7% to 14.3% per year. The E&W water and sewerage industry is at the lower end of the range, showing cost reductions of less than 2% per year. Traditionally, this sector has been associated with a slow rate of technological progress compared with other industries, and its low growth makes it an outlier compared with the rest of the industries examined.

In contrast, Scottish Water achieved significant cost reductions in both water (8.8% per year) and sewerage (14.3% per year). Unlike water and sewerage companies in E&W, Scottish Water is a public corporation and has been subject to regulation only since 2002/03. The short period of regulation, merging of three water companies, and treatment of private finance initiative contracts might result in inconsistent data over time, which is acknowledged by the company and by the industry regulator, the Water Industry Commission for Scotland.

[25] Time periods vary across industries due to variation in periods for which reliable data is available.

The gas distribution industry, even though it is in the first regulatory period for the current industry structure, showed limited cost reductions. However, as it is based on forecast data, the result may not be comparable to other industries.

For the above reasons, Oxera excluded gas distribution and the E&W water and sewerage sectors, as well as Scottish Water, to reach a central range of a reduction in the unit costs of 4.0–6.2% per year.

4.2.3 RUOE results by time passed since privatisation

The scope for future cost reductions depends on the starting level of inefficiency of the company. Privatisation and subsequent regulation could provide incentives for companies to remove structural inefficiency. Continued improvement, better information and strengthening incentives may mean that further efficiency gains are more difficult to achieve, suggesting that newly privatised industries may exhibit greater potential for cost reductions than industries which have been regulated for longer. One way of testing this hypothesis is to examine the efficiency gains made by different industries over different periods of time since privatisation.

The reductions in RUOE are grouped by individual control periods and number of years since privatisation. Both splits are considered since it is not clear whether years since privatisation or the number of control periods has a greater impact on incentives to improve efficiency. The results are summarised in Tables 4.2 and 4.3. While this analysis provides further insights, it is worth noting that figures based on shorter time periods are more sensitive to atypical performance and events.

Table 4.2 OPEX RUOE by control period (average % change per year)

Control period	Range[1]	Average
First	–3.7 to 8.8	2.2
Second	4.5 to 12.8	6.8
Third	–1.7 to 15.9	6.3
Fourth	–4.9 to 14.7	3.4
Fifth	–6.6 to 11.6	2.6
Sixth	–9.6 to 4.3	–2.6

Note: For gas distribution, 2008/09–2012/13 is treated as the first control period, after National Grid Gas (NGG) sold four of its eight gas distribution networks in 2005. [1]Ranges for the control periods are calculated as minimum and maximum of RUOE estimates across all industries over the relevant control period. The figures differ from ones stated in Table 4.1 due to averaging.
Source: Oxera analysis.

Network Rail's operating costs increased significantly after the Hatfield derailment and during the period of administration,[26] when there may have been an emphasis on network safety and serviceability and less management focus on efficiency improvements. Therefore, information on the cost reduction trends in the second control period and 6–10 years after privatisation may provide a more accurate indication of the potential for efficiency improvements in CP4 for Network Rail.

The 'reset' hypothesis assumes that the sharp increase in costs that followed Hatfield and the period of administration may have reset the industry to a relatively high level of inefficiency, similar to that observed pre-privatisation.

[26] Following a material change in the financial circumstances of the company, Railtrack was placed in special railway administration in 2002. Network Rail subsequently took over the company.

In the first control period, there may be a limited understanding of the industry cost structures, together with a greater focus on security of supply and ensuring the serviceability of the asset base, before significant cost reductions can be achieved. As shown in the table above, average observed efficiency gains are moderate (2.2% per year). Network Rail could be considered to be in the second price control period (the highlighted row) following the cost shock of the Hatfield derailment and a change of status. Typically in the second control period, regulators and the firm have a good understanding of the asset base and stronger efficiency incentives can be set. On average, regulated utilities achieved a cost reduction of 6.8% per year, with a range of 4.5–12.8%. The magnitude of cost saving tends to decline over subsequent control periods as the potential for reducing costs decreases.

Table 4.3 OPEX RUOE results by number of years since privatisation (average % change per year)

Years since privatisation	Range	Average
1–5	0.6 to 8.8	4.3
6–10	4.5 to 6.3	5.2
11–15	–1.7 to 14.7	5.2
15+	–6.6 to 3.7	–1.5

Source: Oxera analysis.

Table 4.3 also shows the trend in efficiency gains over time. (Under the reset hypothesis, Network Rail could be considered to be in the 6–10-year period, as highlighted). During the period, regulated industries were able to achieve cost reductions of 5.2% per year, with a reasonably narrow range of 4.5–6.3%. Again, most efficiency gains are realised some years after privatisation and then tend to diminish.

4.2.4 Distribution of RUOE results

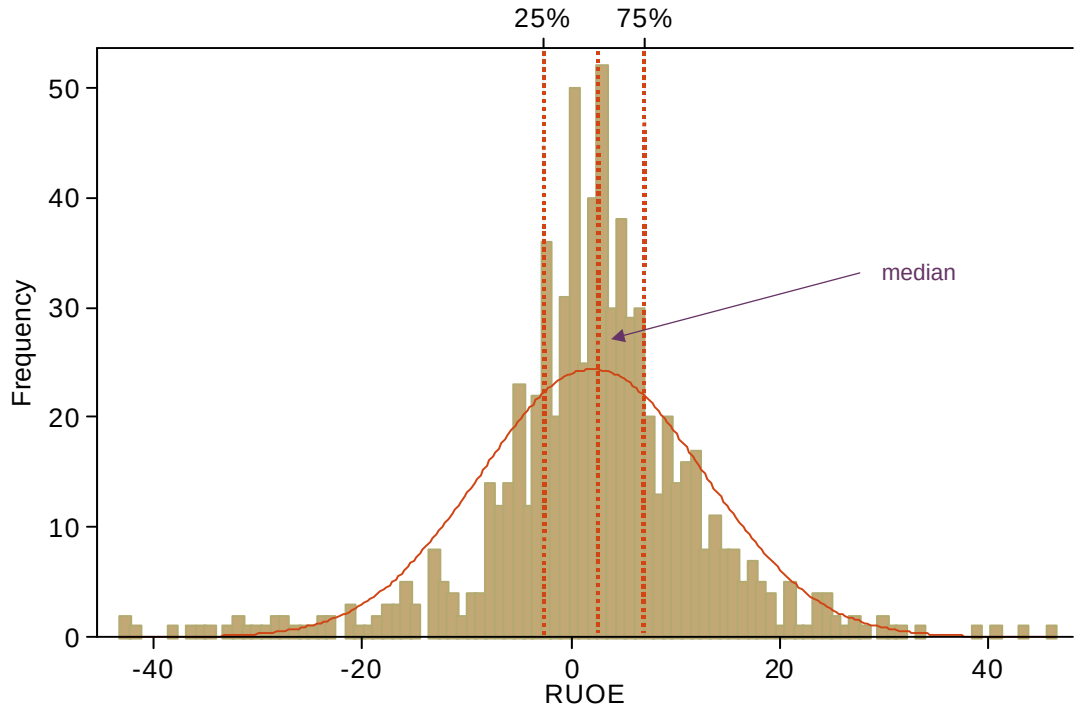
An alternative summary of the RUOE results can be seen by analysing the distribution of individual RUOE changes. This also provides a more visually intuitive explanation of the results. The following analysis uses annual RUOE reductions at the individual company and industry levels across the sectors selected for the current study.

Company level

The first part of the analysis looks at the distribution of year-on-year RUOE estimates at the company level—ie, an observation is a reduction in RUOE for a company at a certain point in time (this gives 745 observations.)

An inter-quartile range is used to indicate where the majority of the data lies in the distribution analysis. The inter-quartile range shows a range of efficiency improvements that are likely to be achievable. Figure 4.1 presents the distribution of RUOE reductions at the company level.

Figure 4.1 Distribution of RUOE results at the company level



Source: Oxera analysis.

The dashed lines represent the 25th and 75th percentiles. The figure excludes very large changes in RUOE which were assessed to be outliers.[27]

These results are summarised in Table 4.4.

Table 4.4 Distribution of RUOE results at the company level (% per year)

Mean	Median	25th percentile	75th percentile
1.35	2.31	–2.59	7.02

Source: Oxera analysis.

As the mean is significantly lower than the median, this may suggest that the mean is biased to the left by RUOE estimates for companies from an industry with similar performance and which have a greater representation in the sample (such as the water and sewerage companies). If an industry with a low rate of productivity growth, such as water and sewerage, has a large weight in the sample, it may bias the results.

Industry level

Examining the distribution of RUOE estimates at the industry level removes the potential bias arising when one industry has a greater number of firms. Given the bias in the results of the company-level analysis, the results at the industry level can provide a more reliable estimate. In this dataset, an observation is represented by an RUOE reduction for an *industry* at a certain point in time (the total number of observations in this case is 86.)

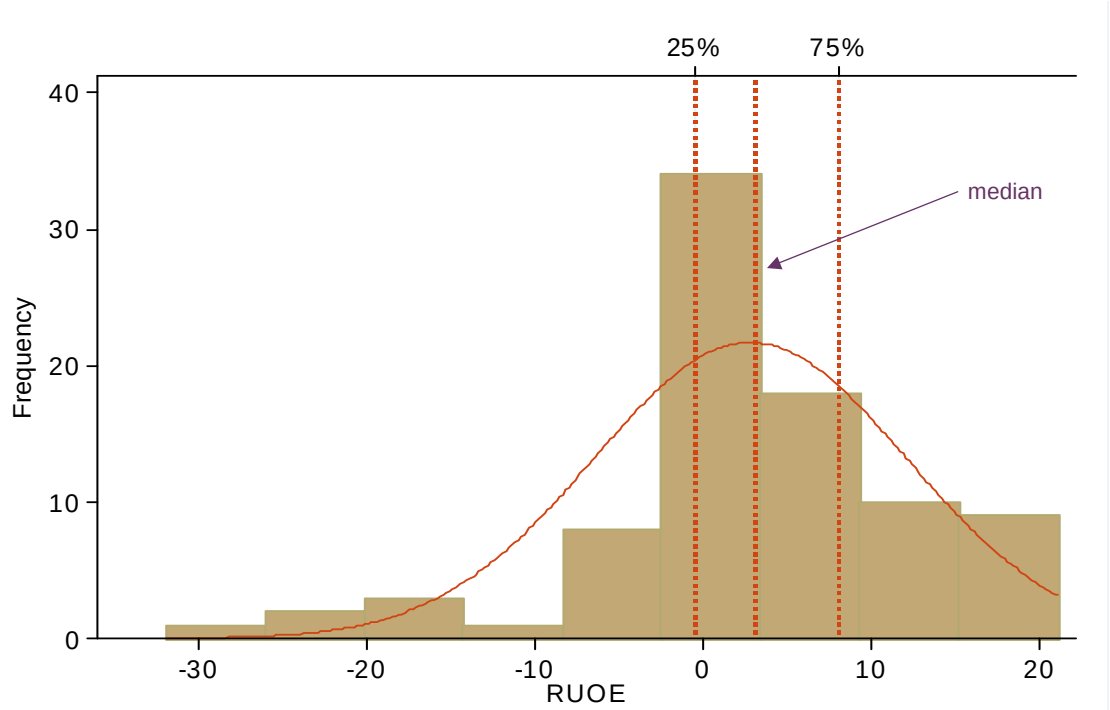
The industry-level analysis has fewer data points, but uses aggregated RUOE reductions, which could be seen as being more relevant from the comparative analysis perspective.

[27] RUOE estimates with an absolute value of greater than 50% were excluded as outliers.

Aggregated RUOE estimates give equal weight to each industry included in the sample, which may mitigate the potential bias at the company level.

Figure 4.2 and Table 4.5 present the results of the RUOE distribution analysis at the industry level.

Figure 4.2 Distribution of RUOE results at the industry level



Source: Oxera analysis.

Table 4.5 Distribution of RUOE at the industry level (% per year)

Mean	Median	25th percentile	75th percentile
2.82	2.85	–0.45	8.12

Source: Oxera analysis.

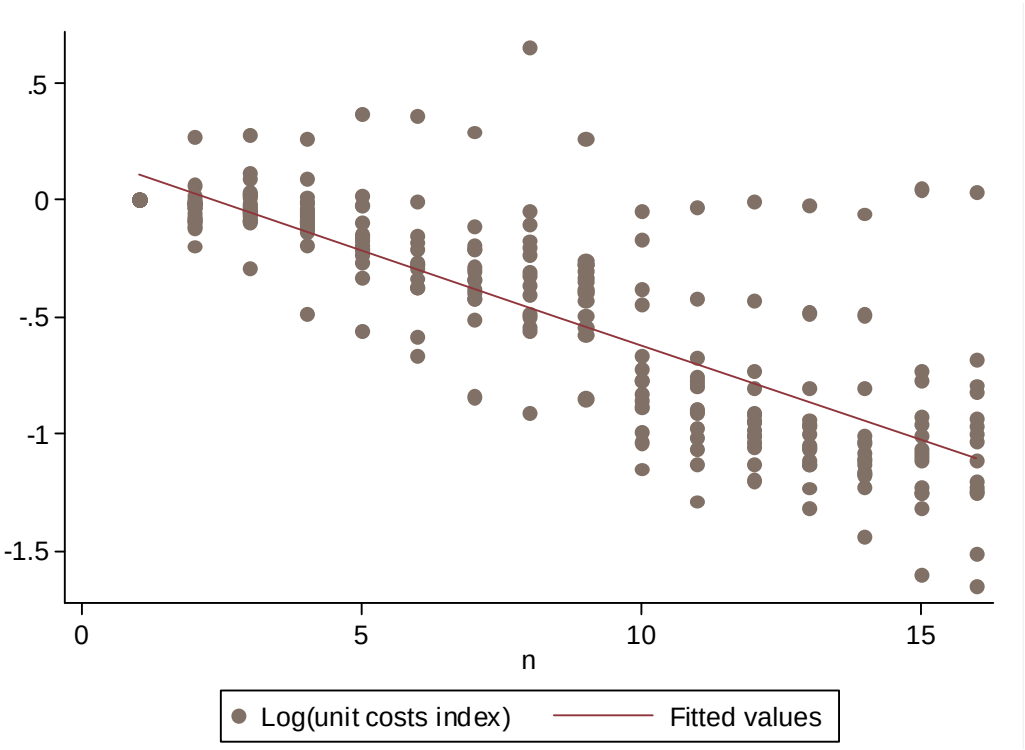
4.2.5 Trend analysis

An alternative approach that may provide additional insight is to estimate the trend in average annual reductions in unit costs at the company level. This approach examines how the unit costs have evolved over time. In particular, it provides an estimate of the marginal effect of an extra year on RUOE reductions.

The effect of an extra year was calculated by constructing a unit cost index for each company. This avoids the problem of not being able to take the logarithm of negative RUOE changes. A trend variable is created for each company, starting at the point when reliable operational data becomes available for the company.

Figure 4.3 illustrates the relationship between the trend and the logarithmic index of unit costs.

Figure 4.3 Fitted trend on logarithm of unit cost index



Source: Oxera analysis.

The results of the trend analysis are presented in Table 4.6.

Table 4.6 Unit cost estimated trends (average % change per year)

	All industries	All industries excluding outlier industries[1]
Reduction in unit costs	4.2	8.1

Note: [1] E&W water and sewerage and telecommunications.
Source: Oxera analysis.

The figures in the table represent a range of estimates that depend on the assumption regarding Network Rail's starting efficiency. A reduction in unit costs of 4.2% per year is estimated using the available observations. However, the explanatory power of the regression is relatively low. The fit of the model in terms of explanatory power and confidence interval increases with the exclusion of outlier industries, such as E&W water and sewerage and telecommunications. Excluding outliers increases the estimated unit cost trend to 8.1% per year.

4.3 Conclusions on RUOE analysis

The reductions in RUOE have been summarised in a variety of ways to give a potential range of estimates of the scope for Network Rail's efficiency improvement in CP4. Table 4.7 shows that the central range of estimates from the industry average RUOE reductions (4–6% per year) is corroborated by the data summarised in several different ways.

Table 4.7 Result of unit costs analysis (average % per year)

	Range of estimates
Industry average annual RUOE (central range)	4.0–6.2
Reset hypothesis	
By control period	6.8
By years since privatisation	5.2
Distribution	
At a company level	–2.6 to 7.0
At a industry level	–0.5 to 8.1
Trend analysis	4.2 to 8.1

Source: Oxera analysis.

5 Evidence from total factor productivity

Additional evidence on Network Rail's potential for cost reductions in the absence of direct comparators could be based on the productivity improvements in the economy as a whole, and in sectors of the economy that are comparable with Network Rail.

TFP growth is the most widely used method of assessing productivity improvements over time within the economy as a whole. Regulators in the UK have frequently made use of TFP growth comparisons to provide high-level cost reduction targets. Unlike other partial methods of productivity growth, TFP measures are constructed by accounting for all input factors in the production process—namely, labour, capital, and intermediate input prices (usually related to materials). TFP measures are based, indirectly, on total costs (since they assess performance as a measure of value-added) and can be used to assess the performance of the OM&R functions. TFP measures are often considered to be a superior estimate of growth, despite the added methodological difficulties required to estimate TFP.

In general, productivity growth can be decomposed into two main components:

– **catch-up to best practice**—improvements achieved by adopting current technology or working practices;
– **frontier shift or long-term cost reductions**—improvements likely to be achieved in the future by adopting technology or working practices yet to be developed.

The benchmarks derived from a TFP growth analysis include the effects of both components, and thus represent a measure of the scope of total productivity improvement. However, since the TFP benchmarks are derived from sectors that operate in competitive markets, it is likely that the impact of the catch-up component would be limited and that the majority of the productivity improvement benchmark would be due to frontier shift. A more detailed discussion on the issue of decomposition is provided in section 5.5.

The first step is to establish a TFP growth rate benchmark. The approach taken in this study is based on the assumption that the productivity performance of a particular industry can be represented by a weighted average of the performance of a number of other industries. This amalgamation is referred to as a 'virtual comparator' and is constructed using economy-wide productivity data. Therefore, estimates of productivity trends for the rail infrastructure industry are inferred by weighting the estimates for each comparator sector by the assumed contribution of that sector to the rail infrastructure industry's activities.

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 addressed in this study.

– **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 (eg, the telecommunications industry). In other sectors (eg, electricity, gas and water supply), the rate of technological change is slower, and therefore productivity gains relating to technological development are expected to be less significant in the short to medium term. For this study, the industries used to construct the virtual comparator display relatively stable productivity improvement trends, and the criteria used for their selection are based solely on the similarity of the activities undertaken by the industries and rail infrastructure. Section 5.3 provides more detail on this.

– **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 industries. In section 4, where shorter time periods are examined, averages over companies and industries are used to mitigate this impact.

– **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 (as companies tend, for example, 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 complete business cycles to avoid misrepresenting the impact of recessionary or growth periods.

– **The comparability of volume growth and the impact of economies of scale**. Volume effects arise in areas where there are variable returns to scale in the production process, and they have an impact on how the above productivity measures should be interpreted. Increasing returns to scale imply that, as the scale of production increases, output increases by proportionally more than the corresponding increase in the inputs. If the extent of the economies of scale is known, this effect is reasonably straightforward to extract from the total movement in productivity; however, reliable evidence is not always available.

– **The comparability of input price growth (eg, wages)**. Different industries use different input mixes and therefore face different price effects. In this study, the TFP estimates that were used to construct the composite benchmark were derived after adjusting for input price effects using industry-specific historical input price growth indices, thereby ensuring like-for-like comparisons for the TFP growth estimates. The estimates of productivity growth do not include the effects of Network Rail's future real input price growth.

– **Substitution between factor inputs**. An issue specific to partial productivity and efficiency measures is that increases in the partial measure 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, output per person 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 OPEX and CAPEX can be both operational as well as the result of changes in accounting policy. This study assumes that the effects of factor substitution in maintenance and renewals activities are similar to the industries that comprise the composite benchmark. Given that these activities use a balanced mix of capital and labour inputs, it could be argued that further adjusting the productivity growth estimates for substitution could be excessive. Operational costs, however, predominantly comprise of labour costs. Therefore, the scope for productivity gains could be greater than those derived from the performance of the composite benchmark. As such, an adjustment for capital substitution effects could be appropriate for this cost category (see section 5.3).

5.1.1 Data

The dataset is that used by EU KLEMS, a consortium of academic institutes including the University of Groningen and the National Institute of Economic and Social Research

(NIESR), which aims to provide productivity growth estimates for EU member states. [28] Only the UK-specific data was used in this study. The dataset uses Standard Industry Classification (SIC) and contains information on productivity growth estimates for a large number of industries from 1970 to 2004. However, the level of aggregation is quite high, with most estimates available for only the first level of SIC—industries where a more detailed disaggregation is available tend to be sub-sectors of manufacturing. The industries for which productivity growth data is available are detailed in Appendix 3.

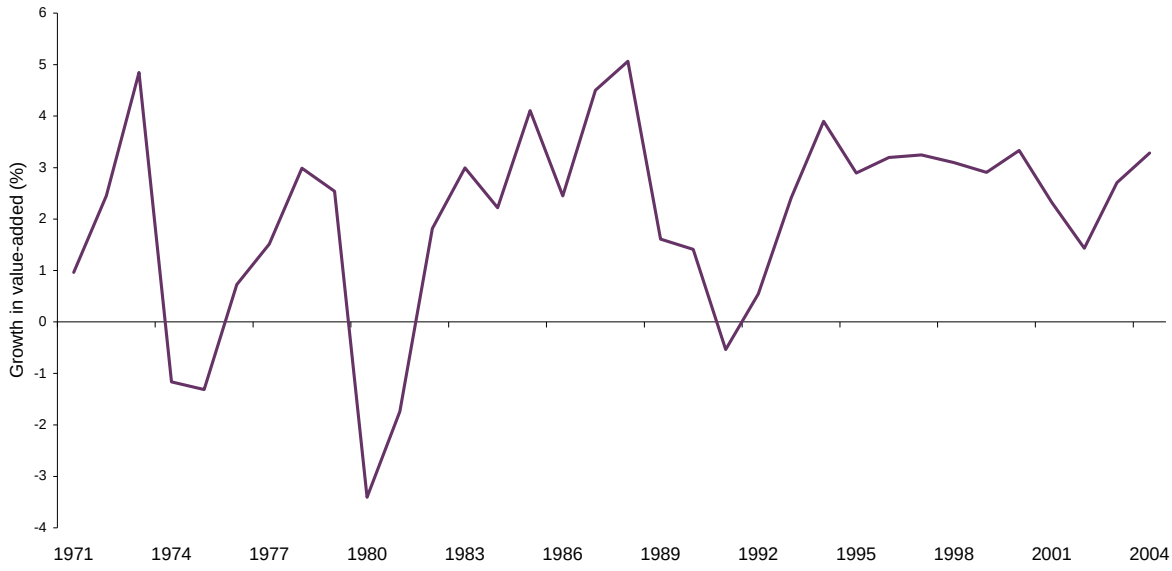
5.2 Constructing the composite benchmark

5.2.1 Identifying the time period for comparison

The aim of this study is to establish a long-term annual operating cost reduction benchmark for Network Rail. As such, any external benchmarks need to be constructed over reasonably long time periods to mitigate the impact of atypical performance (eg, a two- or three-year period of major organisational change, or the impact of a period of recession).

Possible periods to examine should be over at least one business cycle (see above). As business cycles are characterised by alternating phases of growth and recession, the most straightforward way to assess the duration of a business cycle is to plot the growth of output over time, as shown in Figure 5.1.

Figure 5.1 Real value-added growth in the UK economy



Source: EU KLEMS.

The first issue to consider is the appropriate timeframe over which the TFP growth rates are to be taken. Figure 5.1 shows the following.

– The 1970–80 period was characterised by sharp fluctuations in the level of value-added. During this period the UK experienced two major oil crises and severe disruptions to economic activity due to industrial action.

[28] EU KLEMS, 'Productivity in the European Union: A Comparative Industry Approach', http://www.euklems.net/.

– After 1980, growth in value-added become more stable. There appears to be a strong upward trend in value-added up to 1988–89, followed by a short period of declining growth. This trend was reversed in 1992–93.

– Overall, the data suggests that there were two full business cycles during the period of the EU KLEMS project: one spanning 1981–92, and the latest covering 1990–2002 or possibly up to 2004.

Thus, the 1981–2004 period covers two whole business cycles, and includes the more recent information on productivity growth. At the same time, it is sufficiently long for atypical performance to be averaged out. These features all suggest that the analysis should focus on this period. However, the TFP growth benchmarks are also created based on the full dataset (ie, 1970–2004) as well as the more limited 1990–2004 period, in order to check the sensitivity of the results.

5.2.2 Identifying sectors for comparison

TFP growth analysis of the UK sectors of the economy tends not to be undertaken at a particularly detailed sectoral level—usually the first level of the SIC code is used—or, if more disaggregated, tends to focus on the manufacturing sector. Thus, very close matches of sectoral TFP growth to Network Rail are not possible. Even if greater disaggregation were available there would be an endogeneity issue since the results would be highly influenced by Network Rail's own performance. Nevertheless, some sectoral estimates can be examined:[29]

– the economy as whole;

– electricity, gas and water supply—activities related to the production and distribution of electricity, and the collection, treatment and distribution of water;

– transport and storage—activities related to the provision of passenger or freight transport, supporting activities such as terminal and parking facilities, cargo handling, storage, etc, and rental of transport equipment with a driver or operator;

– construction—activities related to site preparation, civil engineering, building installation and completion, and rental of construction or demolition equipment with an operator;

– post and telecommunications—activities related to post, courier, and telecommunications (eg, transmission of sound, images, data or other information via cables, broadcasting, relay or satellite);

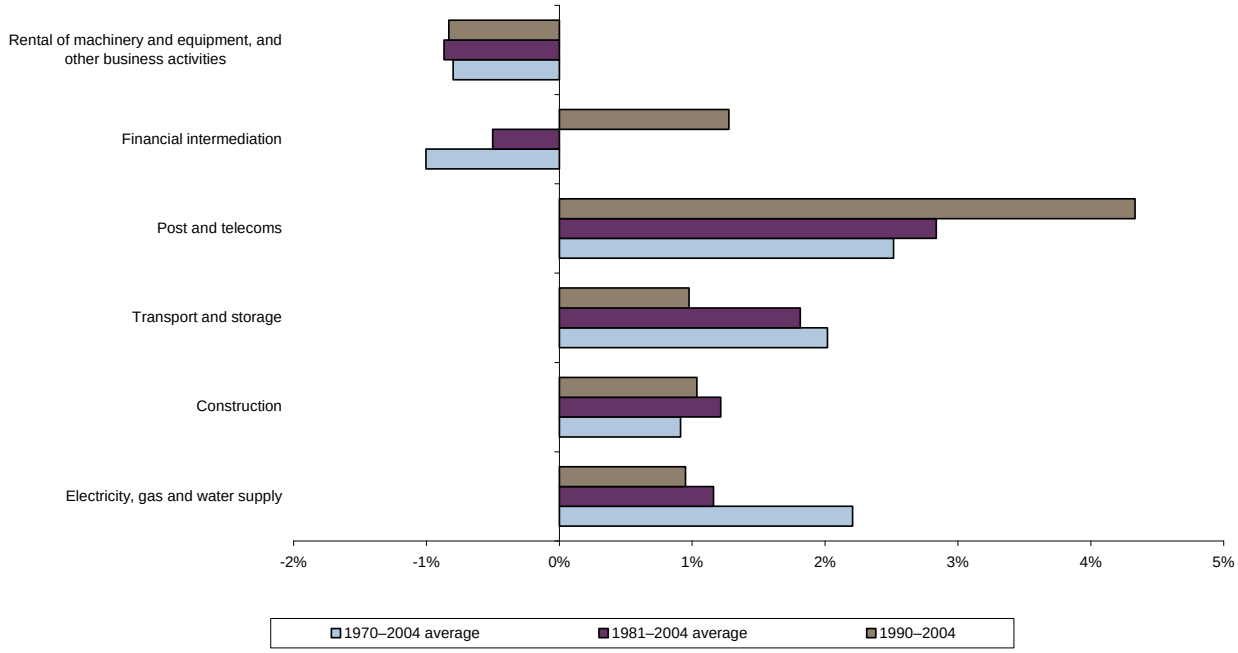
– rental of machinery and equipment and other business activities—the classification for other business activities includes legal, accounting, bookkeeping and auditing activities; tax consultancy; market research and public opinion polling; business and management consultancy; architectural and engineering activities and related technical consultancy; labour recruitment and provision of personnel; technical testing and analysis; advertising; investigation and security activities; industrial cleaning and miscellaneous business activities not classified elsewhere;

– financial intermediation—activities related to monetary intermediation (banks, building societies and other institutions); insurance and pension funding, except compulsory social security; activities auxiliary to insurance and pension funding; and activities auxiliary to financial intermediation.

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

The first estimate establishes the overall productivity trends in the UK economy as a whole. The other sectors undertake activities that could be considered comparable to those undertaken by a rail infrastructure company, and could therefore be more indicative of the technology growth and thus long-term cost reduction trends that Network Rail may be able to achieve. Figure 5.2 presents the average annual TFP in the above-mentioned sectors.

Figure 5.2 Average annual TFP growth in the selected sectors



Source: EU KLEMS and Oxera analysis.

Table 5.1 provides a breakdown of OM&R into activities, and maps those activities onto relevant industries.

Table 5.1 Activity mapping for OM&R

Weights for OPEX	%	Possible comparators
Total operations and customer services	43	Electricity, gas and water supply Rental of machinery and equipment and other business activities
Total other functions	19	Electricity, gas and water supply Rental of machinery and equipment and other business activities
Total corporate services	15	Rental of machinery and equipment and other business activities
Total group activities (insurance and pensions)	23	Financial intermediation
Weights for maintenance	**%**	**Possible comparators**
Track	36	Transport and storage Electricity, gas and water supply
Signals	11	Transport and storage Electricity, gas and water supply
E&P	5	Transport and storage Electricity, gas and water supply
Telecoms	6	Post and telecommunications
Maintenance—other	5	Transport and storage Electricity, gas and water supply
Overheads	23	Transport and storage Electricity, gas and water supply
Engineering	6	Rental of machinery and equipment and other business activities
NDS	5	Transport and storage
Other	4	Transport and storage Electricity, gas and water supply Rental of machinery and equipment and other business activities
Weights for renewals	**%**	**Possible comparators**
Track	29.9	Transport and storage Electricity, gas and water supply
Signalling	20.8	Transport and storage Electricity, gas and water supply
Civils	17.0	Construction
Operational property	12.6	Construction
Telecoms	7.4	Post and telecommunications
Electrification	4.0	Transport and storage Electricity, gas and water supply
Plant and machinery	3.1	Electricity, gas and water supply
IT and other	5.1	Rental of machinery and equipment and other business activities

Note: The weights used to develop the model are based on total Network Rail projected CP4 costs. Numbers may not sum to 100% due to rounding.
Sources: Maintenance cost data: Network Rail (2007), 'Strategic Business Plan—Supporting document, Maintenance Efficiency Model', October. Operating cost data Network Rail (2007), 'Strategic Business Plan—Supporting Document, Opex Efficiency', October. Renewals cost data: Network Rail (2007), 'Strategic Business Plan—Control Period 4', October.

The mappings onto activities are based on the following assumptions.

– Network Rail's operating functions are similar to those undertaken by other network utilities providing operations and customer services, as well as corporate activities. There is also an element of professional services in these activities, and thus 'Rental of machinery and equipment and other business activities' was also included in the benchmarks. Total group activities relate mostly to insurance and pensions expenditure, and therefore the most relevant comparator is the 'Financial intermediation sector'.

– Maintenance costs are allocated by function and could also be considered comparable to the maintenance functions undertaken by other network utilities. Due to the rail-specific nature of this cost element, the 'Transport and storage' sector has also been included in the benchmarks, which is consistent with LEK/Oxera (2005). For the engineering-related expenditure, the 'Other business activities' sector was used, which includes engineering professional services. For NDS (ie, the costs related to running network infrastructure trains), the 'Transport and storage sector' is used as the relevant comparator.

– Costs for renewals are similar to costs for maintenance as regards their allocation between activities. The 'Construction' sector is used as a benchmark for Network Rail's activities that can be clearly identified as such—namely, Civils and Operational property.

5.3 Results

The TFP benchmarks based on the composite benchmark are presented in Table 5.2. For comparison purposes, the TFP growth for the total economy is also shown.

Table 5.2 TFP growth benchmarks, 1981–2004 (% per year)

	OPEX	Maintenance	Renewals	OM&R
Economy wide TFP	0.7	0.7	0.7	0.7
(1) Composite benchmark	0.5	2.1	2.1	1.8
(2) Economy-of-scale effect	0.0	0.0	0.0	0.0
(3) Capital substitution effects	0.5	0.0	0.0	0.1
Estimated TFP growth (1) + (2) + (3)	**1.0**	**2.1**	**2.1**	**1.9**

Source: Oxera analysis.

As discussed above, the composite benchmark can be adjusted in a number of ways to ensure like-for-like comparison with the rail infrastructure industry. The most pertinent adjustments relate to the effects of economies of scale and capital substitution.

With regard to the impact of economies of scale, the analysis made no adjustments for the following reasons.

– Companies that manage a network, such as utility companies, can, in theory, display economies of scale. This is because when there is excess capacity, the cost of supplying an additional unit of output over the network is usually quite small. However, when capacity is constrained, increasing the output can entail additional investment in order to increase the network capacity. In this case, the marginal cost of supplying additional output can be substantial.

– Due to the complexities of network economics, the estimation of scale effects is not straightforward. Hence, reliable estimates of returns to scale over different network capacities are difficult to identify in the literature, and what evidence is available is sometimes contradictory.

– A recent report for Ofwat suggests that the larger water and sewerage companies display diseconomies of scale, while, for the smaller water-only companies, the hypothesis of constant returns to scale cannot be statistically rejected. [30] Ofwat makes extensive use of unit cost models in its comparative efficiency analysis, which are based on the explicit assumption of constant returns to scale.

– In the electricity distribution industry, the evidence from the academic literature suggests that significant economies of scale are present.[31] However, in its CAPEX assessment, Ofgem makes use of unit cost models, which are based on an explicit assumption of constant returns to scale.

– Evidence from a long data period for the telecommunications sector in Australia suggests the existence of constant economies of scale. [32] The model parameters estimated by NERA also imply constant returns to scale. [33]

– Evidence relating to scale economies for the other industries that make up the composite benchmark is scarce and difficult to evaluate given the high level of activity aggregation of the available industry classifications.

LEK/Oxera (2005) used the assumption that the scale elasticity in the comparator sectors was 0.9. The effects of adopting such an assumption based on the more recent data are estimated in the sensitivity analysis that follows.

With regard to the effects of capital substitution, the analysis made an adjustment for OPEX only, as discussed above. The calculation of the adjustment is based on the assumption that the rate of capital substitution for the composite benchmark is the same as that observed in the UK economy (0.35), and follows the same principles used in the 2005 study.

The productivity growth benchmarks established in this report are only one element of the analysis to establish a long-term cost reduction target for Network Rail. The other major component required is an estimate for the likely input price growth in the rail infrastructure sector. Under the RPI – X framework, revenue allowances can then be set by calculating the two major components of X, namely:

– the differential in input price growth between the general economy and the rail infrastructure sector;
– the differential in the scope for productivity growth between the general economy and the rail infrastructure sector.

Appendix 4 provides a more detailed discussion on the issue.

5.4 Sensitivity analysis

The productivity growth estimate based on the composite benchmark approach required assumptions for:

– the composition of the benchmark;
– the period of the analysis;

[30] Stone & Webster (2004), 'Investigation into Evidence for Economies of Scale in the Water and Sewerage Industry in England and Wales', January.
[31] See, for example, Burns, P. and Weyman-Jones, T.G. (1996), 'Cost Functions and Cost Efficiency in Electricity Distribution: A Stochastic Frontier Approach', *Bulletin of Economic Research*, **48**:1, January.
[32] Bloch, H., Madden, G. and Savage, S.J. (2001), 'Economies of Scale and Scope in Australian Telecommunications', *Review of Industrial Organization*, **18**:2, March.
[33] NERA (2005), 'The Comparative Efficiency of BT in 2003, A Report for Ofcom', March.

– the nature of the returns to scale in the industries that make up the composite benchmark.

To understand of the impact of these assumptions on the final estimate, this section undertakes an extensive sensitivity analysis to test the stability of the constructed estimates and reveal the extent of the uncertainties surrounding them.

With regard to the construction of the composite benchmark, the analysis examined two alternative compositions.

– **Excluding the transport and storage sector**: Given that this sector is largely influenced by companies that *use* instead of *provide* transport infrastructure, Network Rail's activities previously classified as transport and storage are classified here as construction. This impacts the maintenance and renewals benchmarks, which now have a greater reliance on the TFP growth from the construction sector.

– **Only construction and business activities**: An alternative approach to the construction of the composite benchmark, suggested following discussion with ORR, is to allocate comparators according to the SIC category in which the costs would be recorded. Using this assumption, all maintenance and renewals expenditure is mapped to the construction sector, since the relevant SIC classification is 42.12–Construction of railways and underground railways, which is part of the construction sector. All other Network Rail enhancement expenditure relates mainly to planning and project management, and could be allocated to the more general business activities sector. This results in a composite variable comprising 93% construction and 7% business activities for maintenance, and 95% construction and 5% business activities for renewals.

Additional sensitivity analysis was undertaken to examine the effects of extending and contracting the period of the analysis, applying alternative elasticity-of-scale assumptions, and adopting alternative methods for calculating the capital substitution effect. An OPEX labour productivity estimate was also calculated for comparison purposes.

Table 5.3 summarises the results of the analysis.

Table 5.3 Sensitivity analysis for the TFP growth benchmarks (% per year)

	OPEX	Maintenance	Renewals	OM&R
Base case results	1.0	2.1	2.1	1.9
Expanding the period (1970–2004)	0.8	2.2	1.9	1.8
Reducing the period (1990–2004)	1.3	1.6	1.7	1.6
Capital substitution based on Europe Economics[1]	1.5	n/a	n/a	1.7
Labour productivity	0.9	n/a	n/a	1.6
Removing transportation and storage	n/a	1.9	1.9	1.7
Only construction and business activities	n/a	1.8	1.8	1.7
Assuming 0.9 elasticity of scale	0.5	1.8	1.8	1.5
Range	**0.5–1.3**	**1.6–2.2**	**1.7–2.1**	**1.5–1.9**

Notes: [1] Based on the method used in Europe Economics (2003), 'Scope for Efficiency Improvement in the Water and Sewerage Industries: Appendices', Appendix 2, p. 26.
Source: Oxera analysis.

The results of the sensitivity analysis reveal that the estimates are relatively stable, regardless of the assumptions used to construct them. Overall, this approach results in a productivity growth estimate of approximately 1.5–1.9% per year.

5.5 Frontier and catch-up components

Decomposing a productivity index into various sources of productivity is data-intensive and requires company-level data in order to be attempted using first principles. Since the analysis in this study focuses on indirect measures of productivity growth and has no access to company-level data, a direct decomposition of the TFP growth estimate is not possible. However, a number of points can be made regarding the likely composition of the TFP growth benchmark.

– The methodology employed to create the EU KLEMS productivity growth estimates relies on the assumption of the existence of competitive markets. For the purposes of this analysis, the competitive market hypothesis directly implies that, in the long run, all firms operate on the efficient frontier. Under this hypothesis, if a firm suffers from systematic inefficiency, it would not be able to cover its cost of capital and would thus be quickly forced out of the market. If the hypothesis holds, all TFP growth is due to technological change—ie, frontier shift.

– However, empirical evidence suggests that systematic inefficiency may be present in market sectors, and measures of TFP growth can be contaminated by other factors, such as adjustment costs, economies of scale, cyclical effects, measurement errors and changes in efficiency.[34] Even so, the proposition that TFP measures, such as those used in this analysis, are equivalent to measures of technological change (defined as the inter-temporal change in the production frontier) can be supported under the assumptions that adjustment costs and cyclical effects are averaged out due to three factors: the analysis adopts a sufficiently long timeframe; the aggregate sectors operate under constant elasticity of scale; and technical and allocative inefficiency does not change over time.

The TFP growth estimates produced in this study can be equated to frontier-shift improvements only under the hypothesis of no technical inefficiency or no change in technical or allocative inefficiency over time. Although both assumptions do not conform to empirical evidence, it could be argued that, due to the long timeframe of the analysis, the contribution of improvements in technical efficiency to productivity growth would be limited in light of the competitive nature of the industries that make up the composite benchmark. Nevertheless, an academic study examining the overall productivity performance of the UK economy found that, on average, 75% of the economy-wide TFP growth is due to frontier shift.[35] This estimate is a lower bound because it includes the contribution from non-market sectors, which are less competitive than the market sectors forming the composite benchmark.

In light of the above, the frontier shift for rail infrastructure enhancement is constructed using one of the following assumptions.

– The TFP growth measures based on the composite benchmark are representative of frontier shift, due to the long timeframe of the analysis and the fact that the composite benchmark is informed by market sectors.

– The composite benchmark incorporates an element of catch-up efficiency which is similar to that observed in the whole UK economy, and only 75% of total productivity growth is due to technical change. This assumption is similar to that adopted in LEK/Oxera (2005).

[34] OECD (2001), 'Measuring Productivity: Measurement of Aggregate and Industry-level Productivity Growth'.

[35] Färe, R., Grosskopf, S., Norris, M. and Zhang, Z. (1994), 'Productivity Growth, Technical Progress, and Efficiency Change in Industrialized Countries', *The American Economic Review*, **84**:1, March, pp. 66–83.

In conclusion, the analysis undertaken in this section results in indirect measures of the potential for cost reductions, estimated by observed productivity growth in other industries. More direct, and thus more accurate, measures are available when more direct approaches are used—eg, 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.

6 Conclusions

Oxera has examined trends in performance from a range of regulated industries in the UK, which show significant cost reductions since their privatisation. The range of possible overall efficiency gains (including catch-up and frontier shift) was assessed by calculating reductions in RUOE, and the possible scope for future frontier shift is based on the TFP analysis.

The evidence from the industry-level analysis of RUOE estimates suggests a central range of 4–6.2% efficiency gains per year. Network Rail's operating costs increased significantly after the Hatfield derailment and during the period of administration, when there may have been an emphasis on network safety and serviceability and less management focus on efficiency improvements. The reset hypothesis assumes that the sharp increase in costs that followed Hatfield and the period of administration have reset the industry to a position similar to that observed around privatisation. Therefore, information on the cost reduction trends in CP2 and 6–10 years after privatisation may provide a more accurate indication of the potential for efficiency improvements in CP4 for Network Rail. The reset hypothesis suggests a range of average cost reduction of 5–7% per year.

The distribution analysis indicates a central range of 0–8% per year using the inter-quartile range; while trend analysis suggests a range of RUOE reductions of between 4% and 8% per year.

Additional evidence on Network Rail's potential for cost reductions has been gathered using data on the productivity improvements in the economy as a whole, and in sectors of the economy that are comparable to Network Rail. The results of the TFP analysis of EU KLEMS data (see Table 6.1) show what level of performance might be expected from a company carrying out similar activities to Network Rail but operating in a competitive environment.

Since these estimates come from firms operating in competitive markets over long time horizons, it could be suggested that their performance represents that of an efficient firm, and therefore that any increases in productivity are due to frontier shift. This assumes that all firms in the sectors that make up the virtual comparator are operating efficiently and thus productivity growth is due to advances in technology and management practice. In reality, there may be transition costs and structural inefficiencies which could have an impact on the productivity performance of the assessed sectors. A more conservative view, based on academic evidence, is that approximately 75% of economy-wide productivity gains arise from pure frontier shift (as shown in Table 6.1).

Table 6.1 TFP growth benchmarks (% per year)

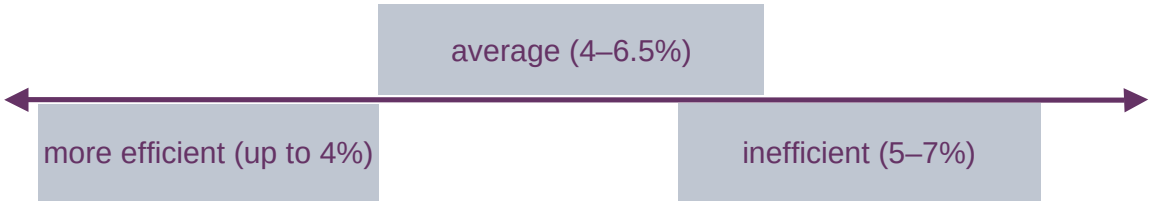
	OPEX	Maintenance	Renewals	OM&R
Estimated TFP growth	1.0	2.1	2.1	1.9
75% from frontier shift	0.75	1.6	1.6	1.4

Source: Oxera analysis.

The analysis of unit cost reductions uses data mainly relating to operating and maintenance costs. As such, it is unclear that direct inference can be made regarding renewals expenditure. However, the analysis of TFP according to the activities undertaken in each cost category suggests that firms in competitive markets make very similar productivity gains in renewals as they do in maintenance.

On the basis of the above analysis, Figure 6.1 presents possible efficiency targets for Network Rail derived from comparison with comparators relevant to Network Rail.

Figure 6.1 Possible efficiency targets for Network Rail



Source: Oxera.

The actual target depends on the current efficiency level of Network Rail. Network Rail's analysis might be reasonable if it is currently 'efficient' and close to best practice. However, evidence suggests that there is still a significant gap to best practice.[36] The reset hypothesis also indicates that firms in their second control period can still make significant cost savings.

[36] See, for example, ORR (2008), 'Update on the Framework for Setting Outputs and Access Charges and Strategic Business Plan Assessment', February, p. 113; and Network Rail and LEK (2007), 'International Benchmarking: Final Report', August.

A1 Summary of reports by Network Rail's consultants

A1.1 Network Rail Strategic Business Plan[37]

A1.1.1 Bottom-up assessments

In its Strategic Business Plan, Network Rail presented estimates of potential efficiency savings in CP4. The main part of its work was based on a bottom-up assessment of the initiatives that can be undertaken to deliver future efficiency savings. The efficiency savings are combined with stretch targets for initiatives not yet identified and taking into account the effect of rising input costs.

Efficiency improvement = identified savings + stretch – input price inflation

Efficiency plans for CP4 were developed according to specific initiatives, focusing on:

- more effective processes;
- less rework;
- improved procurement;
- asset-specific initiatives;
- achieving best practice through internal benchmarking comparisons.

To improve the value for money for customers, Network Rail planned to focus attention on three areas:

- **scope only**—undertaking activities that are necessary to deliver the outputs;
- **planning and process**—better organisation of resources;
- **price**—minimising unit costs by improving the effectiveness of the whole supply chain.

Network Rail submitted individual efficiency models and commentaries to the ORR as supporting documents to the Strategic Business Plan.

A1.1.2 Controllable OPEX

Network Rail considered that it was not 'feasible to assess the impact on operational expenditure using an activity specific modelled basis for a period some two to seven years into the future'.[38] Top-down assessment was used to inform the levels of efficiency savings from the controllable areas of OPEX. Network Rail developed specific cost profiles for certain areas of OPEX that 'cannot be assessed by the more usual types of efficiency analysis'[39] due to difficulty in identifying appropriate cost drivers, such as pension, insurance and signallers' costs.

Finance, HR and IT costs were benchmarked against external organisations. For these corporate services, external studies (undertaken by KPMG, Compass, and IPD Occupiers) identified changes for improvement.

[37] Network Rail (2007), 'Strategic Business Plan Control Period 4', October.
[38] Ibid., p. 108.
[39] Ibid.

The projection for total controllable OPEX efficiencies was 17.6% over the five-year period from 2009/10 to 2013/14, before accounting for input price inflation.[40]

A1.1.3 Maintenance

To deliver efficiency gains in maintenance, Network Rail plans to:

– improve the way it plans, manages and delivers the output;
– reduce the volume of reactive work by moving to a 'predict and prevent' approach from the existing 'find and fix' approach.

According to Network Rail these bottom-up initiatives and Network Rail's experience in CP3 suggested efficiency savings of 16.7% over five years, including a significant degree of stretch, embedded in the new approach.[41] Considering the wider top-down analysis, Network Rail included an additional 0.9% saving over five years. Therefore, Network Rail estimates that the overall efficiency savings are likely to be 17.6% by the end of CP4, before the effects of input price changes are taken into account.[42]

A1.1.4 Renewals

LEK's internal benchmarking study examined Network Rail's performance in unit cost, and identified best demonstrated practice (BDP). LEK's results suggested that, to reach first BDP, Network Rail's costs would have to be reduced by 13% over five years. Network Rail noted that, as BDP could evolve over time, it would be impractical to attain it in all cases. A second best BDP of 50–75% was suggested as a more realistic target leading to cost reductions of 9% over five years.

In its Strategic Business Plan, Network Rail expects to deliver savings in renewals of 12.5% in CP4. The degree of stretch embedded in renewals was estimated at 5.1%. As a result, Network Rail suggested an overall savings of 17.6%.

A1.2 Network Rail/LEK (2007), 'Internal Benchmarking'

Network Rail commissioned LEK to undertake an internal benchmarking study of its maintenance and renewals activities in order to understand the scope for efficiency savings. There were three planned deliverables from the project:

– benchmarking analysis—an estimation of the potential cost savings if Network Rail were to apply existing (internal) best practices across the business;
– indications of where these savings could be achieved;
– a framework for internal benchmarking that could be adopted by Network Rail in the future.

The estimates of the potential cost savings are based on 'normalised' unit cost analysis. This involves the collection of cost and volume data and the identification of structural factors (ie, of possible causes of cost differences between territories). This information is then combined to produce an analysis of unit costs after having removed the impact of the structural factors. If sample size permits, the structural factors are removed using OLS regression analysis—213 structural factors were tested in this way, of which 66 were found to have a statistically significant effect on costs.

[40] Ibid.
[41] Ibid, p. 95.
[42] Ibid, p. 95.

Due to data limitations, maintenance expenditure could not be benchmarked successfully. Renewals expenditure was benchmarked, but, again due to data limitations, only 28% (£686m) of 2006 renewals expenditure could be benchmarked.

The main conclusion from the renewals benchmarking is that, if all territories caught up to current BDP in terms of normalised unit costs, savings of 13% (2.6% per year) could be achieved. Reaching second-best practice would result in savings of 9% (1.8% per year). It is not clear how representative the 28% of renewals expenditure successfully benchmarked is. This could lead to the benchmarking findings also being unrepresentative of total possible savings for renewals.

Network Rail and LEK highlight that several other factors need to be considered when interpreting the results from the benchmarking.

– Even after normalisation, gaps between unit costs and best practice may not necessarily reflect efficiency differences—measurement error or sampling error may also explain part of the difference.

– Asset condition and management policy may vary between territories; although this is a structural factor, it could not be controlled for due to data limitations.

– The level of disaggregation and the groupings of activities chosen (eg, to territory level) affect the results depending on how that grouping reveals or averages out best practice.

– Reduction of unit cost differentials relative to internal BDP is not necessarily the most appropriate efficiency target since implementation costs may be prohibitively high or asset management considerations may justify higher-cost (higher-quality) work.

A1.3 KPMG (2006), 'Benchmarking the Finance and Human Resources Costs of Network Rail'

Network Rail commissioned KPMG to undertake a benchmark study of HR and finance functions. KPMG used a combination of benchmarking techniques to deliver a top-down assessment of both 2005/06 actual costs and 2006/07 budget/forecast costs. These techniques included:

– quantitative benchmarking against appropriate external databases and surveys;
– comparison of current performance against process benchmarks and maturity profiles;
– qualitative assessment of each department by an experienced functional specialist.

KPMG found that Network Rail's finance function is low-cost when compared with those of other large private sector organisations, with headcount and costs being mainly in the first quartile. KPMG found that, in most processes, Network Rail was close to *average* performance. In some areas of the finance function, such as tax and finance and regulatory reporting, it found that Network Rail demonstrated elements of 'leading practice' in large organisations. However, transaction processing, reporting and controls, and business decision support were areas that could be developed. KPMG estimated that an efficiency cost range of around £1.5m–£2.8m could be redirected for re-investment in improving identified shortfalls in the effectiveness of the finance function. This translates into an annual catch-up cost reduction target of 1.5–2.9%. KPMG also found that Network Rail's HR function costs are low when compared with other large private sector organisations.

A1.4 AT Kearney (2007), 'CP4 Procurement Opportunity Assessment'

Network Rail commissioned AT Kearney to assess procurement efficiency opportunities across the organisation. AT Kearney used proprietary databases and internal benchmarks to examine 78% of total procured expenditure (commodity expenditure of £1.38 billion and project expenditure of £1.24 billion).

The total identified procurement efficiencies across Network Rail were 3.3% of total expenditure (2.0% of which is project expenditure and 1.3% commodity expenditure).

– For renewals the total procurement opportunity was found to be 6.0% of total renewals expenditure over CP4. The implied annual target is therefore 1.2%. The total procurement opportunity was broken down into 4.2% from renewals project expenditure and 1.8% from renewals commodity expenditure.

– For maintenance, the identified procurement opportunity was 1.2% of total maintenance expenditure, which translates into an annual target of 0.24%.

– For OPEX, AT Kearney identified a procurement opportunity of 0.4% of total OPEX spend, implying an annual target of 0.08%.

A2 Comparator analysis

This appendix provides a detailed explanation of the data used in the analysis.

The objective of the RUOE analysis was to estimate trends in unit cost reductions across network utilities in the UK economy. The estimates of the trends are intended to be used in establishing the potential for Network Rail to make efficiency savings. The comparators have been chosen on the basis of their similarity to the UK rail network operator. Hence, the choice of the comparators should satisfy the following criteria.

– The comparators provide network infrastructure services similar to those provided by Network Rail. This criterion is necessary for the analysis, since network industries provide similar types of activity and share certain characteristics, such as economies of scale and density, and the long-term effects of past investment on current efficiency levels.

– The selected industries must be subject to economic regulation, which imposes certain efficiency incentives.

The following five industries were chosen for the analysis:

– water and sewerage (in England & Wales and Scottish Water);
– electricity transmission;
– electricity distribution;
– telecommunications; and
– gas distribution.

In addition, Oxera examined the airport industry. However, the results of the analysis of BAA's costs were not included in this study due to the lack of explanatory information regarding certain activities, without which the analysis may not be robust.

The physical nature of activities undertaken by the chosen industries is different from those provided by Network Rail. However, since direct comparison is not possible and comparator industries undertake various functions, this analysis is useful in terms of establishing a benchmark range of potential cost reduction trends.

The methods used in the analysis should ensure that the comparison is undertaken on a like-for-like basis. In particular, some industries may exhibit greater cost reduction due to the speed of technological progress (eg, the telecommunications industry) than industries such as water, where gains are realised due to the slower nature of technological progress. To mitigate these differences, the RUOE estimates were analysed over a longer time period.

A2.1 England & Wales water and sewerage

At privatisation, there were 23 water-only companies (WOCs), and ten water and sewerage companies (WASCs). From the mid-1990s to the start of 2007, a series of mergers and acquisitions reduced the total number of companies in the industry to 21. The most recent data is yet to be reflected in the reported data, meaning that data for this study is available for 12 WOCs and ten WASCs over time.

Operating data on costs and volume and different types of cost driver is available for all the companies since 1992/93. Ofwat, the industry regulator, publishes the 'June Returns' annually. All the information provided in these June Returns is collected and presented on a

consistent basis, and is seen as a reliable source of operational data. The latest available June Returns were published in December 2007 and provided data for 2006/07, where data is presented for 22 companies.

The current categorisation of the data allows for a split between water and sewerage services, and between maintenance and operating costs. In addition, Oxera collected data on indirect costs, covering, for example, 'business activities' and 'management and general', which are overheads. Cost information was not available for 'management and general' until 1995/96.

The following cost drivers were chosen for the analysis.

– Water services:

  – 'water delivered' is the cost driver for OPEX;
  – 'mains relined and renewed' is the activity cost driver for maintenance costs;
  – 'number of properties billed' is the cost driver for 'business activities' and 'management and general'.

– Sewerage services:

  – 'population connected' is the cost driver for OPEX;
  – 'total sewers renovated and replaced' is the cost driver for maintenance costs;
  – 'number of properties billed' is the cost driver for 'business activities' and 'management and general'.

OPEX excludes depreciation, uncontrollable costs such as local authority rates, Environmental Agency charges, exceptional items and third-party charges.

An atypically large change in RUOE in 2005/06 suggests that this period cannot be considered a 'normal' year for the industry, which is a necessary condition for establishing reliable estimates for long-run benchmarking purposes. This year can be considered abnormal and is excluded from the analysis for the following reason:

> reported operating expenditure no longer includes cost for recovering pension deficit. …. at the same time, companies are dealing with volatile energy costs—which have risen overall since price limits were set.[43]

Table A2.1 sets out the RUOE reduction in operating and maintenance expenditure for E&W water and sewerage.

Table A2.1 E&W water and sewerage RUOE results (average % change per year)

	Period	OPEX RUOE	Maintenance RUOE
Water	1992/93–2006/07	1.8	–3.4
Sewerage	1992/93–2006/07	1.7	–4.5

Source: Oxera analysis.

Reductions in operating costs over the period amount to around 1.8% per year. Maintenance activity shows an average increase in unit costs from 3% to 4% per year.

[43] Ofwat (2006), 'Water and Sewerage Services Unit Costs and Relative Efficiency', December, p. 3.

A2.2 Scottish Water—water and sewerage services

Water and sewerage company, Scottish Water, was created in April 2002 by merging the three former regional authorities: East, West and North of Scotland. As a publicly owned company, answerable to the Scottish Parliament, Scottish Water is subject to regulation similar to that imposed on the E&W water and sewerage industry. The Water Industry Commission for Scotland (WIC) is the regulatory body that sets the charges and reports on costs and performance. A number of other regulatory authorities are responsible for water quality, protecting public health, and environmental protection and improvement. Therefore, overall, the regulatory regime in Scotland is similar and comparable to that in E&W.

WIC follows Ofwat's approach regarding data collection. The 'Annual Reports' are similar to the June Returns of the E&W water and sewerage industry, with data disaggregated between the water and sewerage businesses, and between operating and maintenance expenditure. Operating data is available for the period from 2002 to 2006.

The following cost drivers were chosen for the analysis.

- Water services:
  - 'water delivered' is used for analysing both OPEX and maintenance costs.
- Sewerage services:
  - 'population connected' is used for analysing both OPEX and maintenance costs.

Operating costs do not include depreciation and uncontrollable costs (such as local authority rates, Scottish Environmental Protection Agency charges, exceptional items and third-party charges). In addition to these exceptions, sewerage OPEX excludes PFI costs, since they are perceived to be uncontrollable and are expensed on the basis of long-term contracts. Table A2.2 presents the results of the RUOE analysis of Scottish Water.

Table A2.2 Scottish Water RUOE results over entire period (average % change per year)

	Period	OPEX RUOE	Maintenance RUOE
Water	2002/03–2005/06	8.8	2.9
Sewerage	2002/03–2005/06	14.3	0.4

Source: Oxera calculations.

A2.3 Electricity distribution

Ofgem imposes the same type of regulation as Ofwat; however, historical data is not as readily available. All the data was collected from 14 individual company's regulatory accounts over the period from 1990/91 to 2006/07 and from other Ofgem publications. Due to changes in capitalisation policies, accounting, and the transfer of significant costs from distribution to supply, the data is not consistent over time. Nevertheless, these inconsistencies were accounted for as far as possible to make the analysis robust.

'Total unit distributed' measures the main output of the industry and is therefore reflective of the activities undertaken and hence used as a cost driver.

An abnormally large reduction in the RUOE estimate for the 1999/00–2000/01 period may be explained by the following factors:

– during the third distribution price control review (DPCR3), a significant proportion of the costs were transferred from the electricity distribution business to electricity supply;

– during the same period, the accounting standard changed from current cost accounting to historical cost accounting.

For these reasons, this period was excluded from the analysis.

The OPEX figures exclude depreciation and uncontrollable costs, such as the National Grid Electricity Transmission rates and exceptional items.

Table A2.3 Electricity distribution RUOE results (average % change per year)

	Period	OPEX RUOE
Electricity distribution	1990/91–2006/07	4.0

Source: Oxera calculations.

The results of the analysis presented in Table A2.3 show that, over the entire period, the electricity industry reduced unit costs by around 4% per year on average.

A2.4 Gas distribution

In 2005, National Grid Gas (NGG) sold four of its eight gas distribution networks (GDNs). There are currently eight GDNs, four of which are owned by NGG, with the other four belonging to three independent owners.

Historical data is unavailable for the GDNs, although Ofgem has published cost and demand forecasts for the forthcoming price control period (2008–13). Therefore, the analysis of the gas distribution industry in this study is based on this data, which makes it incomparable with the other selected sectors. For this reason, the GDNs' RUOE estimates were excluded from the final range.

The collected data is disaggregated between direct OPEX and direct maintenance. The data on indirect costs, such as HR, IT, and legal, is also available.

The main cost driver for analysis is 'annual demand forecast', which is reflective of levels of GDN activity undertaken each year.

The significant increase in maintenance cost between 2008/09 and 2009/10 results in the estimated RUOE reduction being abnormally high and cannot be described as stable—which is the necessary condition for establishing a reliable benchmark. For maintenance, the RUOE reduction between 2009/10 and 2010/11 has been excluded from the analysis.

Table A2.4 presents the results of the analysis of forecast unit costs for eight GDNs.

Table A2.4 RUOE results (average % change per year)

	Period	OPEX RUOE	Maintenance RUOE
Gas distribution	2008/09–2012/13	2.3	0.9

Source: Oxera calculations.

A2.5 Electricity transmission

National Grid Electricity Transmission (NGET), formerly known as National Grid Company (NGC), is responsible for the transmission service in E&W. The data for earlier years is not publicly available and has been provided directly by NGET. The 'Seven Year Statements' published annually by National Grid have been used for more recent years.

During the period from 1990/91 to 2000/01 NGET is characterised by a significant decrease in unit costs; the same period is also characterise by increasing output volumes. In 1998 and 2005, the operating costs rose sharply. In the former case this was due to NGET taking over the operations and management of the Transmission Services Scheme, which was previously the responsibility of the Electricity Pool of E&W. The latter is associated with a change in reporting standards in 2005:

> Under the British Electricity Trading and Transmission Arrangements (BETTA), which were introduced on 1 April 2005, National Grid, in its role as GBSO, became required to produce a single Seven Year Statement covering the whole of the Great Britain (GB) transmission system (ie, the GB SYS) on an annual basis.[44]

Operating costs are total operating costs less depreciation and Transmission System Scheme/Balancing Services Incentive Scheme charges. The output measure used is units of electricity transmitted.

The 1991/92 period is excluded due to it being an anomalous result because it is the first year after privatisation. 2002/03 is also excluded due to a change in reporting standard—NGC started to report volumes transmitted for the whole GB market (ie, E&W, and Scotland).

Table A2.5 presents the results of the RUOE analysis for NGC.

Table A2.5 RUOE results over entire period (average % change per year)

	Period	OPEX RUOE
NGC	1990/91-2006/07	4.9

Source: Oxera calculations.

A2.6 BT

BT is a telecommunications network operator providing access services to independent telecommunications operators. Due to changes in the regulatory accounting guidelines, consistent data is available only since 1996.

The costs modelled include operating and maintenance expenditure for access, network and retail parts of the business. The data was obtained from BT's regulatory accounts and Ofcom's 'Telecommunication data tables'.

During 2001/02, the costs relating to network and access assets increased significantly, mainly due to the company restructuring and adopting new activities, such as BT Retail Narrowband Access. Structural change in 2005 then led to costs falling sharply:

> Wholesale access services are now charged at third party tariff to Service Providers (SPs) and BT Retail on an equivalent basis. For year ended 31 March 2004 the charge was at cost to the Retail System Business which then charged on at third party tariff to

[44] National Grid (2007), 'Seven Year Statement', http://www.nationalgrid.com/uk/sys%5F07/.

SPs and the BT Retail Businesses and Activities. In order to implement this change for 2005 costing methodologies have been amended resulting in certain costs previously recognised in Activities within the Retail Systems Business now being attributed directly to Wholesale Services (see note 3(c)).[45]

Call volumes have fallen significantly since 2003/04, whereas the number of exchange line connections has stayed the same. This reduction in call volumes is due to switching from narrowband to broadband and from fixed lines to mobiles and voice over Internet protocol.

The RUOE reductions for 2001/02 and 2004/05 are therefore be excluded from the analysis.

Table A2.6 presents the results of the analysis using two possible cost drivers for BT's regulated business: voice calls and exchange lines.

Table A2.6 RUOE results (average % change per year)

	Period	OPEX RUOE
BT, using call minutes	1996/97–2006/07	6.2
BT, using exchange lines	1996/97–2006/07	4.8

Source: Oxera calculations.

The reductions achieved are 6.2% and 4.8% per year for voice calls and exchange lines.

[45] BT (2005), 'Current Cost Financial Statements', p.165, note 2a.

A3 List of industries included in the EU KLEMS dataset

Description	Code
Total industries	TOT
Agriculture, hunting, forestry and fishing	AtB
Mining and quarrying	C
Total manufacturing	D
Food, beverages and tobacco	15t16
Textiles, leather and footwear	17t19
Wood and products made from wood and cork	20
Pulp, paper, printing and publishing	21t22
Chemical, rubber, plastics and fuel	23t25
Coke, refined petroleum and nuclear fuel	23
Chemicals and chemical	24
Rubber and plastics	25
Other non-metallic mineral	26
Basic metals and fabricated metal	27t28
Machinery, NEC	29
Electrical and optical equipment	30t33
Transport equipment	34t35
Manufacturing NEC; recycling	36t37
Electricity, gas and water supply	E
Construction	F
Wholesale and retail trade	G
Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of fuel	50
Wholesale trade and commission trade, except of motor vehicles and motorcycles	51
Retail trade, except of motor vehicles and motorcycles; repair of household goods	52
Hotels and restaurants	H
Transport and storage, and communication	I
Transport and storage	60t63
Post and telecommunications	64
Finance, insurance, real estate and business services	JtK
Financial intermediation	J
Real estate, renting and business activities	K
Real estate activities	70
Rental of maintenance and equipment and other business activities	71t74
Community social and personal services	LtQ
Public admin and defence; compulsory social security	L
Education	M
Health and social work	N
Other community, social and personal services	O

A4 Converting productivity growth estimates into cost reduction targets under the RPI – X framework

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 economy as a whole. The relationship can be formally written as:

$$\hat{P}_{0R} = \hat{P}_{IR} - T\hat{F}P_R \qquad \text{(Equation A4.1)}$$

$$\hat{P}_{0G} = \hat{P}_{IG} - T\hat{F}P_G \qquad \text{(Equation A4.2)}$$

where P_0 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 infrastructure sector; G denotes the general economy; and caret (^) indicates growth rates.

Equation A4.1 states that the change in the price of rail infrastructure 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 A4.2 is analogous for the economy as a whole.

Subtracting Equation A4.2 from Equation A4.1 gives:

$$\begin{aligned}\hat{P}_{0R} &= \hat{P}_{0G} + \left(\hat{P}_{IR} - \hat{P}_{IG}\right) - \left(T\hat{F}P_R - T\hat{F}P_G\right) \\ &= \hat{P}_{0G} - \left[\left(\hat{P}_{IG} - \hat{P}_{IR}\right) + \left(T\hat{F}P_W - T\hat{F}P_R\right)\right]\end{aligned} \qquad \text{(Equation A4.3)}$$

Overall, Equation A4.3 describes how prices in the rail infrastructure sector change over time. The regulator would want to limit these according to a given RPI – X control. Equation A4.3 can be used to indicate what the chosen X factor implies. Changes in the final price of the rail infrastructure service can be divided into two parts:

$$\hat{P}_{0G} \text{ and } \left(\hat{P}_{IG} - \hat{P}_{IR}\right) + \left(T\hat{F}P_R - T\hat{F}P_G\right) \qquad \text{(Equation A4.4)}$$

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

From Equation A4.2, $\hat{P}_{0G}$ corresponds to output prices in the economy as a whole. It can therefore be assumed that $\hat{P}_{0G}$ = 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:

$$X = \left(\hat{P}_{IG} - \hat{P}_{IR}\right) + \left(T\hat{F}P_R - T\hat{F}P_G\right) \qquad \text{(Equation A4.5)}$$

It follows that this X factor itself has two parts.

– **Differential in input costs**—the first part indicates that the greater the gap between growth in input costs in the general economy and in the rail infrastructure industry, the larger (more negative) the X factor will be. In other words, if input cost growth in the rail infrastructure 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 to which technological progress is faster in the rail infrastructure industry than in the economy as a whole.

The analysis is set in a framework of 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 cost of raw materials. Therefore, the first term in the X factor is intended to capture any differences that result simply from a *different input structure*. For example, a rail infrastructure company could have a different mix of skilled and unskilled workers from that in the overall economy, affecting the average cost of labour. The rail infrastructure company could also be more exposed to construction price risks. Where input costs in the rail infrastructure 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 infrastructure industry that is in excess of such progress in the rest of the economy.

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