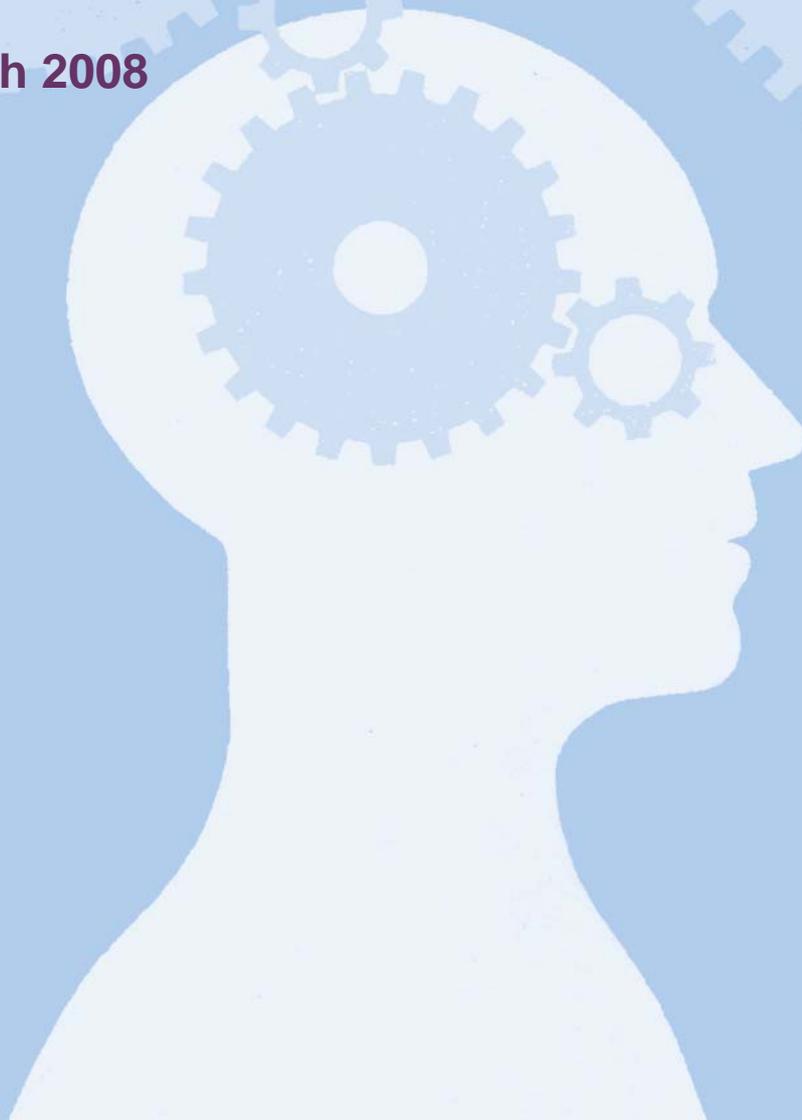


What is Network Rail's likely scope for frontier shift in enhancement expenditure over CP4?

**Prepared for
Office of Rail Regulation**

March 27th 2008



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What is Network Rail's likely scope for
frontier shift in enhancement over CP4?

Executive summary

This study examines the likely future efficiency gains achievable by Network Rail in its proposed capital enhancement programme for the price control period from 2009/10 to 2014/15 (Control Period 4, CP4). Enhancement expenditure is defined as expenditure related to activities that aim to improve a company's asset capacity or capability, while future efficiency gains, otherwise referred to as 'frontier-shift efficiencies', are driven mainly by technological or process changes whose effects may not be directly observable today, but could be reasonably expected to occur in CP4.

Capital enhancement expenditure forms a large part of Network Rail's total expenditure, and is therefore crucial to the Office of Rail Regulation (ORR) in understanding the economic and efficient levels of investment needed in this area, which in turn feed through into track access charges. For CP4, Network Rail has put forward in its Strategic Business Plan a projected expenditure of approximately £9.6 billion, although the actual allowed expenditure is subject to the ORR's approval.

In assessing the scope for efficiency gains, two general approaches are available, either direct or indirect. Direct approaches to estimating frontier shift are usually based on the decomposition of an aggregate productivity measure (into catch-up, frontier shift and possibly other components, such as scale of operations) derived from a direct examination of the industry and its participants. There are a number of techniques that produce such indices and allow their decomposition using a panel dataset—most notably by constructing Malmquist indices within a data envelopment analysis (DEA) framework and panel data analysis within an econometric framework. However, since the relevant data on direct comparators was not available for this study, the option of directly estimating the scope for frontier shift in the rail infrastructure industry was not available.

This study focuses instead on indirect methods of estimation of the likely productivity growth potential for Network Rail. Such methods are usually based on identifying a set of industries and/or companies that are comparable with the assessed company, examining the rate of efficiency improvement for the comparators, and finally constructing an aggregate scope for productivity improvement for the assessed company based on this evidence.

Oxera has examined two sources of evidence relating to frontier shift in enhancement:

- approaches and estimates derived by other regulators in network industries; and
- economy-wide productivity growth estimates that can be used to construct a benchmark for Network Rail.

Most of the regulated companies in the utilities and transport sector undertake significant capital investments. Some regulators specifically separate such investment into maintenance and enhancement. Where this separation is not explicit, it can be applied ex post in some regulated industries, depending on the nature of the project. Therefore, there is significant relevant literature on the cost-effectiveness and cost efficiency of large capital enhancement projects, motivated mainly by regulators undertaking price control reviews.

The review of other regulators' approaches reveals that, although only a few examine frontier shift in enhancement expenditure, most of the estimates produced could be used as guidelines to the ORR in setting a frontier-shift target for Network Rail. Industries that might be more relevant in this context include water and sewerage, gas distribution and the London Underground. These industries carry out enhancement activities that are similar in nature to those undertaken by Network Rail, face similar conditions in their respective input markets,

and the frontier-shift estimates proposed by their regulators extend to approximately the same timeframe as CP4. The following table summarises the frontier-shift estimates used by those regulators.

Summary of frontier-shift estimates used by other regulators

Sector	Price control period	Frontier-shift estimate (%)
Water and sewerage	2005–10	2.5–3
Gas distribution	2007–13	1.2–1.8
Overall range		1.2–3
London Underground	2010–17	3–4 ¹

Note: The water and sewerage sector estimate assumes real input price growth of 1–1.5%. The gas distribution sector estimate is net of the ‘comparative competition’ effect. ¹ For London Underground the figure reported relates to overall productivity growth and is included as evidence from the nearest comparator to Network Rail. Source: Oxera analysis.

The second source of evidence is the productivity performance of the UK economy, and particularly that of sectors of the economy that undertake activities comparable to those carried out by Network Rail in delivering its enhancement programme. The study uses the latest available information on UK productivity growth, sourced from EU KLEMS, a pan-European productivity measurement project, to construct a composite benchmark that incorporates information from all the sectors of the economy deemed to be comparable to Network Rail. Similar approaches to the productivity benchmark have been used extensively by other regulators in the past, including the ORR. Many of the frontier-shift estimates in other regulated sectors are derived using similar indirect measures of productivity.

Such an analysis requires a number of issues to be addressed. If possible, the period of the analysis should be over full business cycles to avoid introducing bias in the productivity growth estimates used. The activities that Network Rail undertakes in its enhancement programme are mapped to comparator industries, in order to create a composite benchmark. If economies of scale are present in the industries that make up the composite benchmark, their effects are calculated and removed from the productivity growth estimate. Finally, assumptions are required in order to decompose the productivity growth estimate into frontier-shift and catch-up efficiencies.

Due to the complexity of the issues involved, extensive sensitivity analysis was carried out in order to test the robustness of the central estimates and to derive a range of possible results. The results of the sensitivity analysis reveal that the estimates are relatively stable, regardless of the assumptions used to construct them, as the following table demonstrates.

Range estimates for frontier shift in rail infrastructure enhancement

	Range (%)
100% of TFP growth is due to frontier shift	1.2–1.8
75% of TFP growth is due to frontier shift	0.9–1.4

Source: Oxera analysis.

Overall, both sources of evidence provide a fairly consistent estimate of the potential for frontier-shift efficiency in a regulated infrastructure company. The results of the analysis are summarised in the table below.

Summary of frontier-shift estimates presented in this study (%)

Source of evidence	Frontier-shift estimate
Other regulators' approaches	1.2–3
TFP growth analysis	0.9–1.8

Note: The values presented relate solely to frontier shift, and therefore do not include the effect of real input price growth.

Source: Oxera analysis.

The above evidence is based on indirect measures of productivity growth and is therefore reliant on the assumptions used. Although the sensitivity analysis revealed that changes in these assumptions do not lead to a significant change in the range of results, the use of more direct measures could help to increase the level of confidence in any possible cost-reduction target. These measures could include using consistent rail industry data over time to estimate both catch-up and frontier shift, or undertaking detailed studies of rail operations and the potential for the adoption of new technology or new operational processes.

Contents

1	Introduction	1
2	Network Rail’s enhancement activity	3
3	Evidence from other regulators	5
3.1	Ofwat—water and sewerage in England and Wales	7
3.2	WIC—water and sewerage in Scotland	7
3.3	Ofgem: electricity and gas transmission	8
3.4	Ofgem: electricity distribution	8
3.5	Ofgem: gas distribution	9
3.6	The CAA and the Competition Commission	10
3.7	PPP Arbiter	11
3.8	Ofcom	12
3.9	Highways Agency	12
4	Comparability with rail	13
4.1	Relevance of comparator industries	14
4.2	Comparability of input price growth and regulatory business cycles	14
4.3	Summary	15
5	Total factor productivity analysis	17
5.2	Constructing the composite benchmark	19
5.3	Decomposing the productivity growth estimates	24
6	Risk	27
7	Conclusions	29
A2.1	Relevance to Network Rail	33
A2.2	Overview	33
A2.3	Major projects	33
A2.4	Maintenance contracts	34
A2.5	Risk	35
A2.6	External reviews	36

List of tables

Table 2.1	Network Rail’s proposed CP4 enhancement programme	4
Table 2.2	Summary of GRIP stages, project definition and cost estimates	4
Table 3.1	CAPEX performance assessment: evidence from other regulators	5
Table 3.2	Ofgem’s forecasts of annual real input price growth (%)	10
Table 4.1	Timeframe for which the frontier-shift estimates of other regulators are calculated	14
Table 4.2	The effects of real input price growth on expected real cost reductions	15
Table 4.3	Summary of frontier-shift estimates	16
Table 5.1	Activity mapping for enhancement	22

Table 5.2	TFP annual growth benchmarks (% change)	22
Table 5.4	TFP growth using alternative weights and industries for the composite benchmark (% pa)	24
Table 5.5	Range estimates for frontier shift in rail infrastructure enhancement	26
Table 7.1	Summary of frontier-shift estimates presented in this study (%)	29
Table A.2.1	Reasons for cost increases	37

List of figures

Figure 2.1	Network Rail's proposed CP4 enhancement programme	3
Figure 5.1	Real value-added growth in the UK economy	19
Figure 5.2	Average annual TFP growth in the selected sectors	21
Figure 6.1	Stylised GRIP process for a hypothetical project	27
Figure 6.2	Distribution of enhancement projects by GRIP stage	28

1 Introduction

Network Rail's Strategic Business Plan¹ suggests that capital enhancement expenditure will form a large part of the company's total expenditure during its forthcoming control period from 2009/10 to 2014/15 (CP4).² It is therefore crucial for the Office of Rail Regulation (ORR) to develop an understanding of the economic and efficient levels of investment in this area. To this end, the ORR has commissioned Oxera to assess the scope for applying a frontier-shift efficiency component to Network Rail's proposed CP4 enhancement programme. Frontier shift is defined as the change in the production frontier due to technological or process changes which results in cost reductions or increased output that may not be directly observable today, but can be reasonably assumed to occur in the future.

Estimating frontier shift is subject to more uncertainty than catch-up³ since it is attempting to predict the future, while the scope for the latter can be based on current information. Given the lack of information on future changes in technology, the regulator has to rely on historical information, but needs to consider whether the future is likely to be different in some way. If the regulator is confident that past trends can be used as a guide to future productivity improvements, a historical performance-based estimate for the scope for future efficiency savings can be derived by two approaches, either direct or indirect.

The direct approach to estimating frontier shift is usually based on the decomposition of an aggregate productivity measure (into catch-up, frontier shift and possibly other components, such as scale of operations) derived from a direct examination of the industry's historical performance. There are a number of techniques that produce such indices and allow their decomposition using a panel dataset—most notably by constructing Malmquist indices within a data envelopment analysis (DEA) framework and panel data analysis within an econometric framework. A direct method of estimation could be based on comparisons of past performance in completed Network Rail enhancement projects. However, the necessary information is not available at a sufficiently detailed level of granulation (discrete, standardised activities with costs fully allocated in each activity).

The aim of the enhancement expenditure proposed by Network Rail is to improve the capacity or capability of the network. These investments are typically project-based and often complex, one-off engineering exercises. The nature of enhancement expenditure and lack of direct comparators render the use of direct methods of estimation infeasible; the focus therefore here is on indirect methods of estimating frontier shift.

This report examines two main sources of evidence to assess the scope for frontier shift in Network Rail's enhancement activities:

- targets set by other regulators of infrastructure companies;
- productivity growth observed in comparable sectors of the economy where competition exists.

All regulated industries engage in enhancement activity—that is, work that improves their assets' capacity or capability. Therefore, almost all regulators undertake some form of assessment to ascertain whether the investment proposed in a company's business plan is necessary to deliver the desired outcomes and is delivered in an efficient and economic way.

¹ Network Rail (2007), 'Strategic Business Plan: Control Period 4', October.

² Network Rail put forward almost 900 enhancement projects totalling £9,630m (2006/07 prices) in expenditure over CP4, which is a significant increase over historical levels of expenditure.

³ Catch-up is defined as the gap between a firm's current performance and existing best practice.

To this end, most regulators examine each company's business plan to identify the major proposed investments, and solicit the help of experts to form a view of the reasonableness of the projects' proposed costs (similar to the Steer-Davies-Gleave and Arup work commissioned by the ORR). In most cases, these assessments make no mention of any frontier-shift-related efficiencies, although a number of regulators have in the past estimated such a component for operating expenditure (OPEX).

With regard to the second source of evidence, the analysis makes use of total factor productivity (TFP) growth estimates, sourced externally, to inform the likely rate of productivity improvement that is achievable by Network Rail. TFP growth is the most widely used method of assessing productivity improvements over time within the economy as a whole. 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). The TFP measures used in this study are based, indirectly, on total costs, since they assess performance as a measure of value-added, and are therefore suitable for the estimation of a performance improvement trend in rail infrastructure enhancement, which contains both labour and capital elements. In general, TFP measures are the preferred measures of growth, compared with partial productivity measures such as labour productivity, despite the added methodological difficulties required to estimate them.

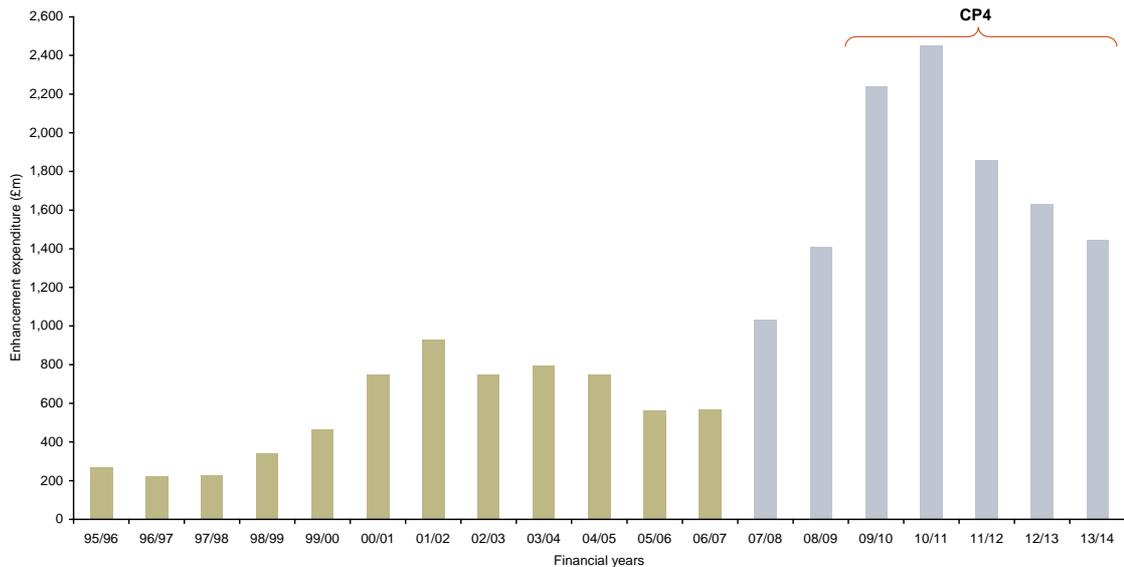
The analysis used in this report is based on identifying a set of industries that are comparable with Network Rail, assessing the rate of efficiency improvement for the comparators, and finally constructing an aggregate scope for productivity improvement for Network Rail based on this evidence.⁴

⁴ The 2005 study by Oxera and LEK makes use of such indirect measures. Oxera and LEK (2005), 'Assessing Network Rail's Scope for Efficiency Gains over CP4 and Beyond: A Preliminary Study', December 12th.

2 Network Rail's enhancement activity

During CP4, Network Rail plans to deliver significantly greater volumes of enhancement activity compared with previous levels—the enhancement activity in this period is projected to account for almost 31% of total CP4 costs. Figure 2.1 demonstrates the growth in activity by comparing the proposed CP4 programme with enhancement projects undertaken in previous years.

Figure 2.1 Network Rail's proposed CP4 enhancement programme



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

The principal reasons for the proposed increase in enhancement activity are, according to Network Rail, increasing demands for additional capacity on the network and the requirement to reach the objectives specified by the DfT and set out in the High Level Output Specification. To achieve these objectives, Network Rail put forward almost 900 projects, including those that it believes to provide value-added but that are not specified in the HLOS. These total £8,353m (2006/07 prices) in expenditure over CP4. In addition, Network Rail states that approximately £1,276m (2006/07 prices) in additional expenditure is required in order to cover the Transport Scotland HLOS, Transport Innovation Fund (TIF)-related projects and other third-party projects. Table 2.1 details the CP4 enhancement expenditure breakdown.

Table 2.1 Network Rail's proposed CP4 enhancement programme

Type of project	CP4 total (£m) (2006/07 prices)	Description
DfT	8,353	Includes specified projects, projects required to deliver the HLOS outputs, plus options to deliver further outputs
Transport Scotland	380	Transport Scotland HLOS-specified projects and project development funding
TIF	117	Projects funded from TIF
Third-party	779	Projects funded by third parties (eg, Olympics 2012)
CP4 total	9,630	

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

The actual level of expenditure required is not certain at this point. According to Network Rail, the overall cost included in the plan is based on the point estimate cost of these projects, including an overall portfolio level of contingency based on having an 80% level of confidence of delivering the portfolio within the estimated cost. The main reason for this uncertainty relates to the forward-looking nature of such projections, compounded by the loose specification of costs and required outputs for many projects.

According to project management theory, projects in their early stages are considered to carry more risk. As the project progresses, risk decreases as the specifics of the project become apparent. Network Rail attempts to quantify the development stage of a project using an approach developed to manage investment schemes, set out in the Guide to Railway Investment Projects (GRIP). The definition and confidence level of the cost estimates in each stage are detailed in Table 2.2.

Table 2.2 Summary of GRIP stages, project definition and cost estimates

GRIP	Stage	Definition	Cost estimate	Confidence level
1	Output definition	Development remit	High level based on previous rates or estimate templates	± 40%
2	Pre-feasibility	Functional specification and high-level option assessment	Based on unit rates or estimate templates	± 30%
3	Option selection	Project design specification and option selection report	Based on unit rates or estimate templates	± 20%
4	Single option development	Reference design	Based on unit rates or resource-based rates	± 15%
5	Detailed design	Detailed design	Based on unit rates or resource-based rates	± 10%
6	Construction, testing and commissioning			
7	Scheme handback			
8	Project close-out			

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

According to Network Rail, the cost estimates presented in Table 2.1 are inclusive of efficiencies achieved to date, but no further scope for efficiency (either catch-up or frontier shift) is included. In addition, Network Rail specifically states that its projected cost pressures resulting from increased input prices have been accounted for and included in its projections.

3 Evidence from other regulators

This section examines the practices of other regulators with respect to capital expenditure (CAPEX) efficiency,⁵ with the emphasis placed on whether a separate estimate for frontier shift was applied to enhancement expenditure, and, if so, how this was derived.

Not all regulators separate costs into operations, maintenance and renewals (OM&R) and enhancement, but most carry out an assessment exercise of companies' expenditure. Oxera, together with LEK, has produced a report for the ORR on such issues—namely on assessing the scope for efficiency savings in OM&R—which was based on a TFP approach, real unit operating expenditure (RUOE) reductions and historical trends, using other regulated industries as comparators.⁶

Oxera's research found that, although most regulators examine the scope for efficiency in CAPEX, only a few adopt a frontier-shift component specifically for capital enhancement. Table 3.1 summarises Oxera's findings.

Table 3.1 CAPEX performance assessment: evidence from other regulators

Regulator	Enhancement as discrete cost category?	Approach to CAPEX-related efficiency measurement (catch-up and frontier shift)	Frontier-shift component for enhancement?
Water			
Ofwat	Yes	Cost base approach: bottom-up analysis using unit costs (capital enhancement)—catch-up component TFP productivity growth benchmarks used to derive frontier shift	Aggregate productivity improvement estimate using TFP-based approaches. Enhancement frontier shift is 50% more challenging than maintenance expenditure targets. (Total scope is 7.4% for water and 8.8% for sewerage over the five-year price control period. Note that Ofwat sets targets based on 50% of the total scope)
Water Industry Commission for Scotland (WIC)	Yes	Cost base approach: bottom-up analysis using unit costs (capital enhancement)—catch-up component TFP productivity growth benchmarks used to derive frontier shift	Like Ofwat, WIC sets targets at 3.7% for water and 4.4% for sewerage for the whole price control period, based on 50% of the total scope for frontier shift, as assessed by Ofwat
Electricity			
Ofgem			
Transmission	No (although enhancement-type CAPEX can be derived)	Assessment of planning processes, companies' forecasts, analysis of unit costs, and ex post bottom-up modelling of allowances—catch-up component	No

⁵ Since most regulated utilities allocate enhancement expenditure to CAPEX.

⁶ Oxera and LEK (2005), op. cit.

Regulator	Enhancement as discrete cost category?	Approach to CAPEX-related efficiency measurement (catch-up and frontier shift)	Frontier-shift component for enhancement?
Distribution	No (although enhancement-type CAPEX can be derived)	Bottom-up analysis using unit cost approach (all CAPEX) and sliding-scale incentive mechanism—catch-up component	No
Gas			
Ofgem			
Transmission	No (although enhancement-type CAPEX can be derived)	Assessment of planning processes, companies' forecasts, analysis of unit costs, and ex post bottom-up modelling of allowances—catch-up component	No
Distribution	No (although enhancement-type CAPEX can be derived)	Business plan analysis, top-down benchmarking, comparisons of unit costs and sliding-scale incentive mechanism—catch-up component TFP productivity growth benchmarks used to derive frontier shift	1.5% ongoing productivity improvement for two types of enhancement-related CAPEX
Airports			
CAA	Yes	Business plan analysis and consultation with airlines, unit cost in individual projects—catch-up component	No
London Underground			
Public-Private Partnership Arbitrator	No	None officially adopted, but consultant's study on likely productivity improvements is available—catch-up and frontier-shift components	No, but the report estimated the scope for productivity improvement on aggregate activities (both OPEX and CAPEX) to be 3–4% per year
Telecoms			
Ofcom (formerly Oftel)	No	Parametric and non-parametric analysis using international comparators, OPEX and total costs (2003 review, last retail price control review)—catch-up component	No frontier shift component adopted, but consultant's study estimated average productivity gains for total costs of 1.5% per year
Roads			
Highways Agency	No, although some investment initiatives can be classified as enhancement	High-level assessment, qualitative benchmarks and engineering assessments of discrete projects—catch-up component	No

Source: Oxera analysis.

The following sections provide some more detail on the other relevant regulators' approaches to the assessment of capital enhancement.

3.1 Ofwat—water and sewerage in England and Wales⁷

The total efficiency improvement factor used by Ofwat consists of two components:

- a catch-up component, which shows the extent to which each company should improve its efficiency to reach the best-performing companies in the industry;
- a continuing efficiency improvement factor, which refers to frontier shift.

Ofwat's approach to frontier shift (also referred to as the scope for continuing efficiency improvements) is based on an assessment of general economic productivity trends. When assessing productivity trends, Ofwat recognised that performance improvement in the water and sewerage industry was greater than in the economy as a whole. The continuing efficiency improvement was estimated according to TFP growth analysis and real unit cost assessment.

The regulator takes a view that the scope for continuing efficiency improvements is *greater* for capital projects than for operating costs due to several factors, such as the ongoing nature of the large capital programme, synergies available within the environmental and water quality programmes, and the history of companies becoming more efficient. Ofwat also noted that the majority of the capital projects are sewerage-related and the frontier-shift estimates are somewhat higher than for water services. Ofwat's approach is such that only part of the scope for continuing efficiency improvement is included in the price limits. For all expenditure categories (including capital maintenance), 50% of the estimated scope for ongoing efficiency (ie, frontier shift) is included in the price limits; the remainder acts as an additional incentive mechanism for companies to outperform the regulator's assumptions.

Specifically in the case of capital enhancement, Ofwat was of the view that there is greater scope for efficiency in the areas of planning and implementing new projects, compared with the more repetitive work associated with capital maintenance. Therefore, it chose to set 50% more *challenging* targets than for capital maintenance. Ofwat considers that the historical trend of substantial outperformance of previous regulatory assumptions supports the adoption of higher targets. The regulator also notes that an apparent systematic bias in overestimating the cost of enhancements does not appear to have been corrected thus far.

Ofwat's view with regard to frontier shift for capital enhancement would imply that a reduction of 7.4% in unit costs for water services, and 8.8% for sewerage services, over the period 2005–10, is feasible. This translates into annual reductions of 1.4% and 1.7% respectively. These assumptions include the effects of real input price growth. However, it should again be noted that only half of the scope for continuing improvement was included in the price limits, in line with Ofwat's approach to incentives, so the annual reduction targets are set at 0.7% and 0.9% respectively.

3.2 WIC—water and sewerage in Scotland

At the last strategic review, WIC followed the methodology used by Ofwat to assess CAPEX efficiency. WIC worked closely with the Reporter, the Scottish Environment Protection Agency (SEPA) and the Drinking Water Quality Regulator (DWQR) to ensure that investment would improve compliance with water quality or environmental discharge standards. Like Ofwat, WIC made separate assessments of efficiency for capital maintenance and capital enhancement investment. It used Ofwat's cost-based approach to benchmark Scottish Water's relative efficiency in delivering capital enhancement projects, taking into account special factors relating to the industry in Scotland, such as geography, population settlement patterns and public ownership. WIC compared the standard costs submitted by Scottish

⁷ Ofwat (2004), 'Future Water and Sewerage Charges 2005–2010: Final Determinations', October.

Water with the basket of standard costs submitted to Ofwat by the water and sewerage companies in England and Wales. Over a four-year regulatory cycle, WIC required Scottish Water to close 75% of its cost base efficiency gap, and applied an additional reduction of 4% over the period to match 'continuing improvement' (equivalent to Ofwat's expectations in the price limit of the improvement achievable by leading companies).⁸ This continuing improvement component corresponds to frontier shift and is equivalent to that used by Ofwat in its assessment of water and sewerage companies in England and Wales.

3.3 Ofgem: electricity and gas transmission⁹

Ofgem does not explicitly distinguish capital enhancement from overall CAPEX; rather, it assesses overall CAPEX for gas and electricity transmission. However, there is a clear distinction between load-related and non-load-related CAPEX; load-related expenditure is due to increases in demand and new customer connections. Therefore, part of the total CAPEX (that which is classified as load-related) can be classified as enhancement expenditure.

Ofgem uses a two-stage procedure to assess CAPEX: historical CAPEX is first examined, followed by forecast expenditure. The two types of assessment include an analysis of unit cost and bottom-up modelling of allowances. The assessment methodology is based on the gap relative to current best practice, and no separate frontier-shift component is estimated. However, the scope for continuing efficiency improvements is examined in the case of OPEX, and Ofgem sets the OPEX frontier shift at 1.5% per year.

3.4 Ofgem: electricity distribution¹⁰

For electricity distribution, as in the case of transmission, the regulator assesses total CAPEX. Similarly, CAPEX is classified as either load-related or non-load-related. Load-related expenditure is required to increase the capacity and capability of the network, so that it can accommodate greater demand, and can thus be considered similar to enhancement expenditure.

Ofgem uses companies' submitted business plans to construct a bottom-up model to assess forecast CAPEX. The assessment is based on a case-by-case unit cost approach for all CAPEX, and does not assume frontier shift-related cost reductions. This bottom-up approach was used in conjunction with Ofgem's sliding-scale incentive mechanism.

The sliding-scale mechanism, now referred to as the Information Quality Incentive (IQI), was developed for the fourth distribution price control review (DPCR4). Rather than being presented with a 'take-it or appeal it' regulatory decision, the mechanism allows companies to choose from a range of low CAPEX allowances with high incentive rates, or high expenditure allowances coupled with low incentive rates. In theory, the varying incentive rate offers companies greater financial incentives to submit business plans that represent their true expenditure requirements. The reward received by companies is greatest when companies choose an option that represents the expenditure level they expect to incur over the regulatory period.¹¹ However, in order for the regulator to set a baseline CAPEX allowance, an assessment of each company's projected expenditure is necessary. In other words, the purpose of the sliding-scale mechanism is to strengthen the companies'

⁸ WIC (2005), 'The Strategic Review of Charges 2006–10: The Final Determination', November, section 4, p. 193.

⁹ Ofgem (2006), 'Transmission Price Control Review: Final Proposals', December.

¹⁰ Ofgem (2004), 'Electricity Distribution Price Control Review: Final Proposals', November.

¹¹ Oxera (2007), 'Assessing Approaches to Expenditure and Incentives', October, Chapter 2, Appendix 1.

incentives to deliver the projected CAPEX, not to replace the regulator's assessment of CAPEX.

3.5 Ofgem: gas distribution¹²

In gas distribution, Ofgem exercises ex post and ex ante assessments of CAPEX, which include a detailed examination of unit costs, business plan analysis and top-down benchmarking using regression analysis. The analysis uses the cost disaggregation available through the regulatory accounting guidelines and examines each category of CAPEX separately. CAPEX categories in Ofgem's regulatory accounting guidelines are based on the principle of activity costing for both OPEX and CAPEX. In the case of CAPEX, they provide the following disaggregation.¹³

- 1) **Local transmission and storage (LTS) capacity CAPEX**—this relates to all expenditure required to expand the local transmission system and storage capacity.
- 2) **Connections CAPEX**—expenditure associated with connections to new houses, new connections to existing houses and connections to non-domestic customers. Overall, this category of CAPEX is related to increases in demand or alteration of demand patterns and taking ownership of pipes laid by others.
- 3) **Mains reinforcement**—expenditure driven by the requirement to meet demand and specified operating pressure, and reinforcement activity associated with consumer requests.
- 4) **Governors (pressure regulators)**—this type of CAPEX is associated with new governor installation driven by general demand growth, replacement of governors to increase capacity due to general demand growth, replacement of distinct or service governor installations due to obsolescence, and replacement of governors due to compliance with risk policy and economic reasons (replacement versus repair).
- 5) **Other operational CAPEX**—expenditure driven by procurement of land, buildings, plant and equipment.
- 6) **Non-operational CAPEX**—including system operations, IS CAPEX, XORSERVE, vehicles, telecoms and office, security, furniture and fittings, and tools and equipment.

Although Ofgem does not identify enhancement expenditure separately, some of the activities listed above relate to enhancing the capacity and/or the capability of the network, and can thus be classified as capital enhancement expenditure, namely:

- LTS capacity;
- connections;
- mains reinforcement;
- governors.

For two of the above activity areas—connections and mains reinforcement—Ofgem estimates a scope of ongoing productivity improvement equal to 1.5% per annum. This figure appears to be based on the scope for frontier shift for OPEX, estimated to be 2.5% per year based on an analysis of productivity trends (TFP growth) in related industries. This in turn comprises 1.4% per year estimated outperformance of the gas distribution industry relative to the economy and scope for further cost reductions of 1.1% per year related to the recent introduction of comparative competition in the sector; this was estimated by Ofgem in the

¹² Ofgem (2007), 'Gas Distribution Price Control Review: Final Proposals Document', December.

¹³ PB Power (2007), 'PB Power Reports for Gas Distribution Price Control Reviews: Capex and Repex', March.

assessment of the effect of the sale of the gas distribution networks. The OPEX estimate does not, however, include input price growth effects, which have changed significantly over the course of the price control review consultation, as shown in Table 3.2.

Table 3.2 Ofgem’s forecasts of annual real input price growth (%)

Input	Initial Proposals	Final Proposals
Contract labour	2	2.5
Direct labour	1	1.5
Materials	1	3
Other	0	0
Total OPEX real input price growth¹	0.9	1.3–1.7

Note: ¹ The total effect of the Final Proposals input price growth assumptions is Oxera's estimate.
 Source: Ofgem (2007), 'Gas Distribution Price Control Review Initial Proposals', May. Ofgem (2007), 'Gas Distribution Price Control Review: Initial Proposals', May 29th. Ofgem (2007), 'Gas Distribution Price Control Review: Final Proposals', December 3rd.

The overall effect of the assumptions in the Initial Proposals, according to Ofgem’s calculations, is 0.9% real growth in input prices for total OPEX. Ofgem does not explicitly state the overall effect of the assumptions in its Final Proposals and therefore the 1.3–1.7% range presented in Table 3.2 is an estimate of the overall effect, based on Oxera calculations.

It is not entirely clear how Ofgem moves from the overall productivity growth estimate (ie, the 2.5% per year) to the CAPEX-specific rate of cost reductions due to productivity growth (ie, the 1.5% per year). It is, however, likely that the latter is derived after adjusting the former for the effect of input price growth.

3.6 The CAA and the Competition Commission

The CAA’s approach to CAPEX relied heavily on ‘constructive engagement’ between the airlines and BAA. That process involved consideration not only of the projects to be carried out, but also the commissioning by the International Air Transport Association (IATA) of a review from the construction consultants, Currie & Brown, of BAA’s costs of delivering projects.¹⁴ The CAA itself also commissioned Scott Wilson to review whether BAA’s proposed capital investment plan (CIP) is appropriate and reasonable.¹⁵ Consideration has been given to the overall strategy for facility planning and the estimation of CAPEX on a project-by-project basis. For each project, assessments were made of:

- the relevant unit costs for the works;
- the treatment of project-specific costs;
- the indirect costs and allowances for risks.

Benchmarking studies were undertaken by both BAA¹⁶ and external consultants to identify best practice and to examine whether the CIP represented value for money when benchmarked against similar BAA projects, as well as projects external to BAA. Comparisons were sought for base costs. Project-specific costs were excluded and dealt with separately.

¹⁴ Currie & Brown (2006), 'Heathrow Airport Capital Investment Programme: CAPEX Efficiency Workstream—Facility Benchmarking', February.

¹⁵ Scott Wilson (2006), 'CAA’s Initial Price Control Proposals for Heathrow, Gatwick and Stansted Airports: Supporting Paper X—Advice to CAA on BAA’s Capital Investment Plan at Stansted Airport', December.

¹⁶ Competition Commission (2002), 'BAA plc: A Report on the Economic Regulation of the London Airports Companies (Heathrow Airport Ltd, Gatwick Airport Ltd and Stansted Airport Ltd).

Indirect costs were included although they varied considerably and it was difficult to establish benchmarks.

In the most recent price control review, the CAA suggested that there was scope for 'catch-up' efficiency savings in OPEX of 1% per year. It also considered that there might be additional scope for OPEX frontier-shift savings of between 0.5% and 1.5% per year, in line with the range shown in recent reviews by other regulators. However, the CAA was of the view that BAA had already demonstrated strong productivity improvements in recent years and that there was therefore limited scope for efficiency improvements beyond that captured in the RPI. To that end, the CAA proposed an overall efficiency improvement target of 1% per annum, which was the result of the catch-up analysis and included no frontier shift.

For CAPEX, the regulator assessed BAA's efficiency by applying bottom-up benchmarking analysis to capital investment projects. The benchmarks represented current best practice and therefore related to catch-up efficiency. No estimate for CAPEX frontier shift was specified.

The Competition Commission endorsed the overall methodology for assessing operating costs and CAPEX, and agreed with the CAA that no frontier shift should be applied.¹⁷

3.7 PPP Arbiter

The PPP Arbiter commissioned two reports from consultancies to examine the issue of performance assessment of the infrastructure companies which manage the maintenance and enhancement of the London Underground services (infracos),¹⁸ one of which suggested that the Arbiter should seek to identify trends in costs and productivity.¹⁹ In addition to the comparators, the Arbiter should be able to make use of non-industry-specific indicators of trends in cost efficiency, physical productivity measures and input prices.

Similarly, the second report considered the distinction between catch-up and frontier-shift gains important and relevant to the analysis, because:

if there was evidence ... to suggest that the frontier shift gains achievable by a particular firm or industry were likely to be significantly higher or lower than those achievable by other privatised utilities, then it might no longer be valid to carry out simple comparisons of total efficiency improvements.²⁰

Using TFP analysis and evidence from the LEK and Oxera study,²¹ NERA found that: 'the frontier shift gains available to the Infracos are likely to be broadly comparable with those of privatised utilities'.²² Based on the RUOE reductions of the privatised utilities, NERA's view was that a reasonable range of aggregate efficiency improvements for the Infracos would be 3–4% per annum for total costs. NERA's report did not make explicit reference to capital enhancement expenditure.

¹⁷ Competition Commission (2007), 'BAA Ltd: A Report on the Economic Regulation of the London Airports Companies (Heathrow Airport Ltd and Gatwick Airport Ltd)', September 28th.

¹⁸ NERA (2006), 'High Level Efficiency Estimates for the Second Review Period', March.

¹⁹ CEPA (2003), 'Report to the London Underground PPP Arbiter: Approaches to Benchmarking Infraco Efficiency and Performance', July, Annex 4.

²⁰ NERA (2006), 'High Level Efficiency Estimates for the Second Review Period: Report for the Office of the PPP Arbiter', March, p. 15.

²¹ LEK and Oxera (2005), 'Assessing Network Rail's Scope for Efficiency Gains Over CP4 and Beyond: A Preliminary Study', December.

²² NERA (2006), 'High Level Efficiency Estimates for the Second Review Period: Report for the Office of the PPP Arbiter', March, p. 19.

3.8 Ofcom

Ofcom approaches the cost efficiency of BT's wholesale line rental (WLR) from a unit cost perspective.²³ The assumption about the level of efficiency gains that BT could achieve in the current regulatory period was based on an ex post assessment of productivity improvements during 1999/00–2004/05 for US local exchange carriers. The assessment examined both operating and total costs. Ofcom did not set any explicit capital enhancement efficiency improvement targets. After consultation, Ofcom and BT agreed on ongoing efficiency improvements of 1.5% per year for operating costs. However, it is not clear from the regulatory documents whether this figure should be regarded as catch-up, frontier shift, or both.

The study produced by Ofcom's consultants²⁴ examining cost trends in the telecoms industry, found a decrease of 1.5% in real total costs per annum. Given that these estimates are derived from econometric stochastic frontier analysis models, these trends implicitly measure the average productivity improvement in the industry.

3.9 Highways Agency

The Highways Agency's target for efficiency in 2007–08 is set out in its business plan. It has agreed with the DfT to deliver efficiency improvements in roads procurement equal to around 3.1% of total Agency annual expenditure. This estimate is based on current best practice and does not include any cost reductions due to frontier shift. (See Appendix 2 for a more detailed discussion of the Highways Agency's performance measurement practices.)

²³ Ofcom (2006), 'Wholesale Line Rental: Reviewing and Setting Charge Ceilings for WLR Services', January.

²⁴ NERA (2005), 'The comparative efficiency of BT', March.

4 Comparability with rail

The research carried out in the previous section revealed that the majority of regulators examined did not make any explicit provisions for a frontier-shift component in capital-related expenditure in their respective industries. The industries where a frontier-shift component for enhancement expenditure was estimated were:

- the water and sewerage industry (England & Wales, Ofwat; and Scotland, WIC);
- the gas distribution industry.

In the telecoms industry, Ofcom’s consultants estimated the trend in total cost reduction of the industry (OPEX and CAPEX), which, due to the nature of their analysis, can be taken to represent frontier shift.

Additionally, the PPP Arbiter published a report on the total scope for productivity improvements for the infracos.²⁵ Although the report does not attempt to disaggregate its estimate into catch-up and frontier shift, this section includes the findings of the report, given that the infracos undertake activities that are the most similar to those undertaken by Network Rail.

In all circumstances, except for the telecoms industry, the frontier-shift component was estimated using a TFP-based methodology, similar to that used in this study. For the telecoms and London Underground, the frontier-shift component was not estimated solely for capital-related expenditure, but rather for total controllable expenditure. For the water industry, WIC has applied Ofwat’s final estimates on the scope for improving efficiency. Therefore, the discussion in this section does not deal with WIC’s methodology separately, as the methodology and final estimates are identical to those used by Ofwat.

The aim of this section is to examine whether the frontier-shift estimates used by the regulators described above, can be used to inform the ORR’s views on the extent of any likely frontier shift in Network Rail’s capital enhancement programme in CP4. As such, two significant issues need to be considered:

- the relevance of the comparator industries examined;
- the comparability of input price growth and regulatory business cycles.

Other issues relating to the comparability of the benchmark industries include:

- the comparability of the initial efficiency positions—the focus of this study is frontier shift, which is independent of starting efficiency positions;
- adjustments for atypical performance—for most of the comparator industries examined, this issue is not applicable, since the impact of any atypical event is already accounted for in the regulators’ assessments. For the gas distribution industry, the frontier-shift estimate proposed by Ofgem includes an estimate for a ‘comparative competition effect’, which could be considered unique and relevant only for the gas distribution industry in the current price control period. Ofgem adopted the view that, due to the recent structural separation of the networks and the introduction of new parties, incentives would be strengthened, and thus the rate of productivity growth in the industry would

²⁵ NERA (2006), ‘High Level Efficiency Estimates for the Second Review Period: Report for the Office of the PPP Arbiter’, March, p. 19.

accelerate. The overall effect was estimated to be scope for cost reductions of an additional 1.1% per year.

4.1 Relevance of comparator industries

The majority of the regulated utility companies manage a physical network of pipes or cables, and thus most of the capital-related projects undertaken in these industries are relatively similar. The major exception is the airports sector, which could include the construction of major infrastructure, such as terminals and runways. Network Rail falls somewhere in between—it has characteristics similar to physical network industries, since a major part of its remit is the maintenance and enhancement of rail infrastructure, while at the same time it undertakes major infrastructure projects similar to the airports sector, such as Thameslink and major station modernisations. The closest comparators to Network Rail are the infracos which manage the maintenance and enhancement of the London Underground services, although they are not responsible for signalling.

Several factors suggest that the telecoms industry is not a robust comparator for rail infrastructure, the most pertinent being the rapid pace of technological change, which substantially reduces the useful life of investment. The nature of the capital enhancement work is also quite different in telecoms, since the majority of the service enhancements are related to terminal and switching equipment, and not to work on the physical network. (The exception is the under-grounding of high-capacity fibre-optic lines, but, even here, a large part of the expenditure for the increased capacity is for terminal and exchange expansion.)

With regard to risk, all industries examined are capital-intensive, and as such face similar risks to the rail infrastructure industry, and indeed to most infrastructure projects across the economy. The major differentiating factor in the rail infrastructure sector is that any capital-related work is likely to cause greater disruption to existing operations than similar work carried out by other network industries. This is largely due to greater interdependencies among the services using a rail network compared with a pipes-or-lines network. Therefore, the ramifications of any disruption would be more complex and have a greater impact. To avoid or mitigate the effect of the likely disruption to the network, work is usually undertaken at restricted times (eg, at night and over the weekend), and even small disturbances in the work programme can have significant effects on completion times and project costs.

4.2 Comparability of input price growth and regulatory business cycles

The discussion in the previous section demonstrated that the nature of capital-related work carried out in the comparator industries (water, gas distribution and the infracos) is similar in general terms to the work undertaken by Network Rail. The frontier-shift estimates produced by those regulators cover timeframes similar to that of CP4. Table 4.1 illustrates.

Table 4.1 Timeframe for which the frontier-shift estimates of other regulators are calculated

Sector	Price control	Timeframe
Water	Periodic review 2004	2005–10
Sewerage	Periodic review 2004	2005–10
Gas distribution	Gas distribution price control review	2007–13
London Underground (relates to total scope for productivity improvement)	Second review period	2010–17 ¹

Note: ¹ Taken from a report published in March 2006.
Source: Oxera analysis.

Frontier-shift estimates should reflect the long-term cost-reduction opportunities of an industry due to technical or process change, and thus the timeframe in which they are applied should have little bearing. However, given that frontier shift is a forward-looking measure and difficult to estimate accurately, examining price control periods of the comparator industries with similar timeframes to the CP4 provides more confidence in the comparability of the estimates.

The comparability of input price growth is important for this study mainly because the estimates available from Ofwat are for efficiency-related cost-reduction targets and not frontier shift per se. These targets are derived by adjusting the frontier shift by the effects of real input price growth—ie, price growth above or below the RPI. The issue would not be significant if not for Ofwat’s estimates, given that frontier shift represents the productivity improvement expected to be achieved over a period, assuming that prices remain constant. Therefore, for the ORR to move from a frontier-shift estimate to a cost-reduction target, the estimate would need to be adjusted for the Network Rail-specific real input price growth in enhancement activities.

With regard to the effects of input price growth, all regulators are of the view that the regulated companies in their respective industries will face increasing pressure in the price of their inputs. For the gas distribution industry and London Underground, where forecasts are available, real price growth effects are similar, as Table 4.2 demonstrates.

Ofgem provides information on all the components used to construct its ‘ongoing productivity improvement’ estimate for the gas distribution industry, and as such the effects of input price growth can be easily corrected for. The same is the case for the infraco-specific estimate; NERA estimated real input price growth during the second review period of approximately 1–1.5% per year. For the water and sewerage industry, Ofwat does not provide information on its assumptions on input price growth in its final determinations, but it does explicitly state that these are taken into account.

Table 4.2 The effects of real input price growth on expected real cost reductions

	Water	Sewerage	Gas distribution (net of the ‘comparative competition effect’)	London Underground
Frontier shift estimate (except London Underground) ¹	n/a	n/a	1.2–1.8	3–4
Input price growth effects	n/a	n/a	1.3–1.6	1–1.5
Expected real cost reductions	1.4	1.7	0–0.2	1.5–3

Note: ¹ The figure reported for London Underground relates to overall productivity growth.
Source: Oxera analysis.

As previously mentioned, Ofwat did not make its input price growth assumptions public. However, if it is assumed that they are similar to the forecasts for London Underground and the gas distribution industry, the productivity growth assumption for the water and sewerage industry could be easily calculated (see section 4.3 below).

4.3 Summary

Frontier-shift estimates for capital enhancement work expenditure are available for a limited number of regulated industries—namely, the water and sewerage industry, gas distribution, telecoms and London Underground. However, with exception of the telecoms industry, which faces a rapid pace of technological change, these regulated industries appear to be sensible comparators for Network Rail, given that their main activities are in many ways similar.

In addition, the timeframe relating to the available external frontier estimates overlaps with the period of CP4, further increasing the usefulness of these estimates.

For the gas distribution industry and London Underground, estimates are available for both cost-reduction targets and productivity growth. Given that the focus of this study is to provide an estimate of the likely technological change in the rail infrastructure enhancement, it is the productivity growth estimates that are more relevant. These are not available for the water and sewerage industry. However, if it is assumed that input price growth is similar across the comparator industries, which seems reasonable given that the real price growth forecasts for gas distribution, London Underground and Network Rail are all in the same range, a productivity growth estimate for water and sewerage could be calculated, by adding the real input price growth assumption to the cost-reduction targets. Assuming a real input price growth range of 1–1.5%, water and sewerage productivity growth is estimated to be approximately 2.5–3% (see Table 4.3).

Table 4.3 Summary of frontier-shift estimates

Sector	Price control period	Frontier shift estimate¹ (%)
Water and sewerage	2005–10	2.5–3
Gas distribution	2007–13	1.2–1.8
Overall range		1.2–3
London Underground	2010–17	3–4

Note: The water and sewerage sector estimate assumes real input price growth of 1–1.5%. The gas distribution sector estimate is net of the ‘comparative competition’ effect. ¹ For London Underground the figure reported relates to overall productivity growth, and is included as evidence from the nearest comparator to Network Rail. Source: Oxera analysis.

The overall range of the continuing productivity improvements used by other regulators is 1.2–4% per year. However, the upper limit of this range is informed by the London Underground estimate, which relates to the overall scope for improvements and not just frontier shift. Since this estimate could include some element of catch-up, a more conservative range estimate would be 1.2–3% per year.

As noted earlier, the above estimates relate to frontier shift and would need to be adjusted for the effects of real input price growth in Network Rail’s enhancement activities to be used as cost-reduction targets.

5 Total factor productivity analysis

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

This analysis makes use of TFP growth estimates. 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). The TFP measures used in this study are based, indirectly, on total costs, since they assess performance as a measure of value-added, and are therefore suitable for the estimation of a performance improvement trend in rail infrastructure enhancement, which contains both labour and capital elements. In general, TFP measures are often the preferred measures of growth, compared with partial productivity measures such as labour productivity, despite the added methodological difficulties required to estimate them.

Historical comparisons of TFP growth rates for UK industry sectors provide useful information about the future potential for productivity improvements more generally. Indeed, UK regulators have used comparisons of TFP growth rates to provide high-level cost-reduction targets, and to address general issues in constructing the composite benchmark.

The first step in the TFP-based analysis is to establish a benchmark for the TFP growth rate. The approach used in this study is based on the assumption that the productivity performance trend of a particular organisation can be informed by a weighted average of past performance trends of a number of other related 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 deemed contribution of that sector to the rail infrastructure industry's activities.

Such comparisons have the potential to identify reasonable benchmarks for future annual efficiency gains. However, these methods require careful use to ensure like-for-like comparisons. The issues to consider are set out below, together with an explanation of how they are mitigated in this study.

- **Comparability of the industries**—when comparing productivity performance between industries, it is important to recognise that some industries (eg, telecoms) have the potential to achieve comparatively large productivity growth through rapid technological development. In other sectors (eg, electricity, gas and water supply), the rate of technological change is less pronounced, and therefore productivity gains relating to technological development are expected to be less significant in the short to medium term. 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 to those carried out in enhancing the rail infrastructure. Section 5.3 provides more detail on this topic.
- **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.

- **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, for example, tend not to shed labour immediately in order to maintain capacity at the expense of reductions in productivity), and higher during growth periods as this excess capacity is used. Thus, TFP growth comparisons are made over a complete business cycle to avoid misrepresenting the impact of recessionary or growth periods. See section 5.3 for more detail.
- **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, the estimation of scale effects is a complicated issue for most industries, and reliable evidence might not be available. See section 5.3 for more detail.
- **The comparability of input price growth (eg, wages)**—different industries use different input mixes and therefore face different price effects. In this study, the estimates were derived after adjusting for input price effects using industry-specific input price growth indices, thus ensuring like-for-like comparisons for the TFP growth estimates.
- **Substitution between factor inputs**—an issue specific to partial productivity and efficiency measures is that increases in the metric cannot be identified solely as efficiency improvements, since *changes in the choice of input mix* will have an influence. For example, if a firm replaces much of its workforce with an improved information technology system, output per head 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 enhancement activities are similar to the industries that comprise the composite benchmark. Given that these activities use a mix of capital and labour inputs similar to Network Rail’s enhancement activities, it could be argued that further adjusting the productivity growth estimates for substitution could be excessive.

5.1.1 Data

The dataset used comes from the EU KLEMS project, a consortium of various 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.²⁶ In this case, only the UK-specific data was used. The dataset employs 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 where productivity growth data is available are detailed in Appendix 3.

²⁶ EU KLEMS Project, ‘Productivity in the European Union: A Comparative Industry Approach’, <http://www.euklems.net/>.

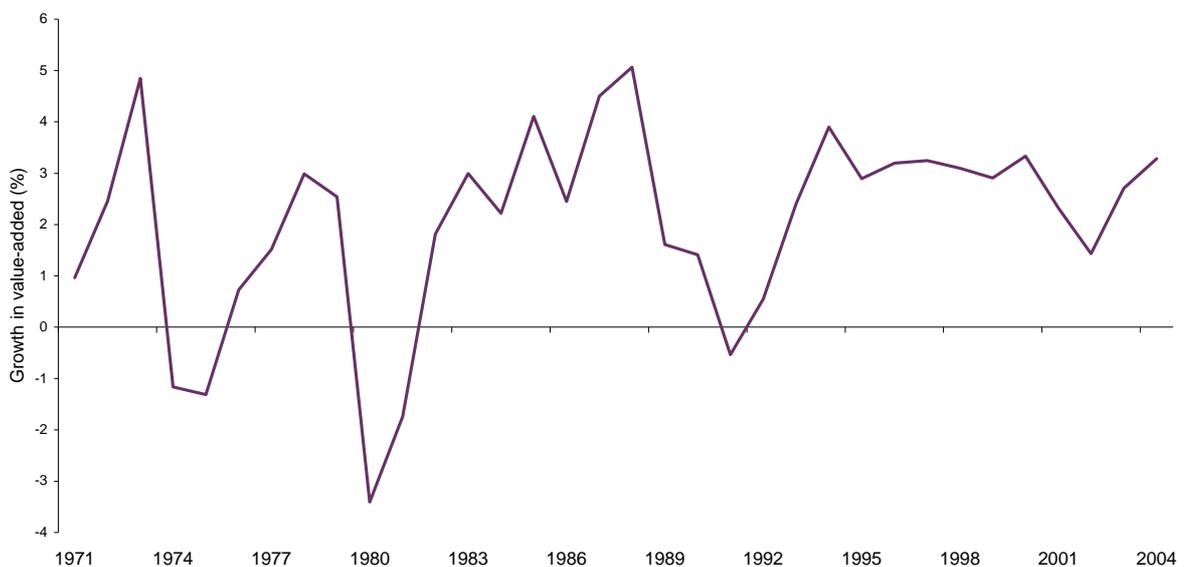
5.2 Constructing the composite benchmark

5.2.1 Identifying the time period for comparison

The aim of this study is to establish a frontier-shift benchmark for enhancement activities carried out by 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).

The first issue to consider is the appropriate timeframe over which the TFP growth rates are to be taken. Possible periods to examine should be over at least one business cycle (see previous section for discussion). 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 (see Figure 5.1.)

Figure 5.1 Real value-added growth in the UK economy



Source: EU KLEMS.

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.
- After 1980, growth in value-added became relatively 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 and the UK economy has enjoyed a period of stable growth since the end of the available data.
- Overall, the data suggests that the UK economy has experienced two possible full business cycles: one could be seen spanning 1981 to 1992, and an alternative covering 1990–2002 or possibly 2004. These cycles overlap due to the uncertain nature of the exact start and end points of business cycles.

To summarise, the 1981 to 2004 period appears to cover two whole business cycles and includes the more recent information on productivity growth; at the same time, it is long enough to allow the averaging-out of any atypical performance. All these features suggest

that the analysis should focus on this period. However, the TFP growth benchmarks would also be created based on the full dataset (ie, 1970–2004), as well as the more limited 1990–2004 period to check the sensitivity of the results.

5.2.2 Identifying sectors for comparison

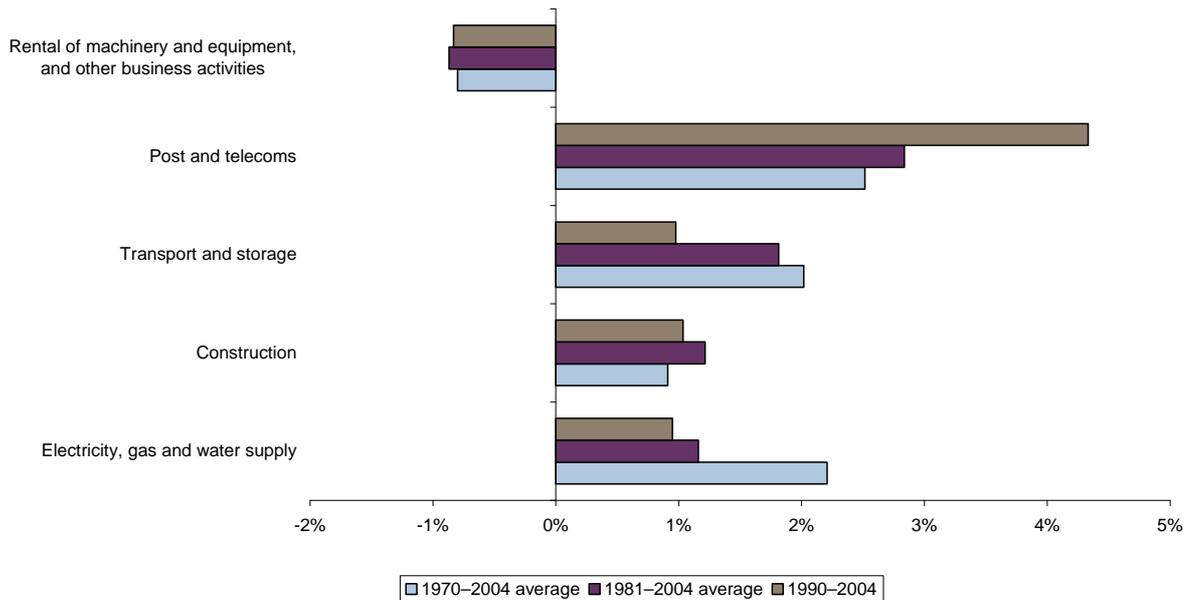
The first step is to establish reasonable sectoral comparators for Network Rail. However, TFP growth analysis of the UK sectors of the economy tends not to be undertaken at a very detailed sectoral level—usually the first level of the SIC code is used—or, if more disaggregated, tends to focus on the manufacturing sector. Thus, very close matches of sectoral TFP growth to Network Rail are not possible. Nevertheless, a number of sectoral estimates are worth examining:²⁷

- the economy as a whole;
- electricity, gas and water supply—comprising all activities related to the production and distribution of electricity and the collection, purification and distribution of water;
- transport and storage—comprising activities related to providing passenger or freight transport, supporting activities such as terminal and parking facilities, cargo handling, storage, etc, and renting of transport equipment with driver or operator;
- construction—comprising all activities related to site preparation, civil engineering, building installation, building completion, and renting of construction or demolition equipment with operator;
- post and telecoms—comprising post and courier activities and telecoms (transmission of sound, images, data or other information via cables, broadcasting, relay or satellite);
- renting of machinery and equipment and other business activities—the classification for other business activities includes legal, accounting, book-keeping 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.

The first estimate establishes the overall productivity trends in the UK economy as a whole. The other sectors detailed above undertake activities that could be considered comparable to those undertaken by a rail infrastructure company, and therefore could be 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.

²⁷ http://www.statistics.gov.uk/methods_quality/sic.

Figure 5.2 Average annual TFP growth in the selected sectors



Source: EU KLEMS and Oxera analysis.

Selecting the weights to create the virtual comparator can be done in a number of ways. In previous studies the asset types have been mapped to industries according to the nature of the activity undertaken. This approach assumes that in producing outputs the virtual comparator undertakes activities similar to those in a variety of different industries (see mapping of possible comparators in the table below).

The mappings to activities are based on the following assumptions.

- Enhancement activities for track, signalling and electrification and plant assets are similar to the activities undertaken by utility companies and those relating to the transport and storage sector. An equal weighting has been applied to those sectors to form the composite benchmark.
- Structure and operational property assets include structures such as bridges, tunnels and earthworks, as well as Network Rail-managed and franchised stations and maintenance depots. Therefore, the majority of the enhancement work undertaken in this asset category is likely to be directly related to construction.
- For telecoms assets, the direct comparator is assumed to be the post and telecoms sector. For other activities, the more general business activities sector was adopted as the suitable comparator.

An alternative approach, suggested following discussion with ORR, is to allocate comparators to the asset types according to which SIC category the asset-related costs would be recorded in. Using this assumption, all enhancement expenditure for the specific asset types 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. While this approach acknowledges that the outputs of the activity undertaken by Network Rail largely relate to construction, it does have a potential drawback in that Network Rail's past performance already contributes to the construction sector. The strict reliance on the construction sector for the creation of the composite benchmark may introduce an element of circularity, in that the benchmark is based partly on Network Rail's own performance

depending on the degree of influence Network Rail has on that sector. This mapping, suggests a composite benchmark that is 94% construction and 6% business activities.

Table 5.1 presents a breakdown of enhancement expenditure into activities determined by asset type, and the two approaches for mapping those activities to relevant industries.

Table 5.1 Activity mapping for enhancement

Enhancement asset types	Weights (%) ¹	Possible comparators	Alternative comparators
Track	22	Transport and storage; electricity, gas and water supply	Construction
Signalling	28	Transport and storage; electricity, gas and water supply	Construction
Structures	7	Construction	Construction
Operational property	19	Construction	Construction
Electrification and Plant	16	Transport and storage; electricity, gas and water supply	Construction
Telecoms	2	Post and telecoms	Construction
Other	6	Renting of machinery and equipment and other business activities	Renting of machinery and equipment and other business activities

Note: ¹The weights used to develop the model are based on 2003/04 costs.
Sources of data: Oxera analysis of LEK (2007), 'Input Price Trends Report', August 3rd.

5.2.3

Results

The TFP performance of the composite benchmarks is presented in Table 5.2. The TFP growth for the total economy is also presented for comparison purposes. For a discussion on how a TFP measure can be converted into a cost-reduction target using the RPI – X framework, see Appendix 1.

Table 5.2 TFP annual growth benchmarks (% change)

Period of analysis	1981–2004
Economy wide TFP	0.7
Composite benchmark (using possible comparators)	2.0
Composite benchmark (using alternative comparators)	1.8

Source: Oxera analysis.

As discussed at the start of this section, the composite benchmarks would need to be adjusted in the presence of economies of scale in the comparator industries. However, the analysis made no adjustment for scale effects for a number of reasons.

- The electricity, gas and water supply sector, which has a significant weight in the composite benchmark, is largely made up of companies that manage a network, such as utility companies, which can in theory benefit from economies of scale, since, 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 usually entails additional investment in order to expand the network capacity. In this instance, the marginal cost of supplying additional output can be substantial. The evidence regarding the existence of economies of scale in network industries from the academic literature is sometimes contradictory.

- In the water and sewerage sector, Ofwat has commissioned a number of reports examining the issue over the years. Its most recent report 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.²⁸ It should also be noted that Ofwat makes extensive use of unit cost models in its comparative efficiency analysis, which make 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 for OPEX (see, for example, Burns and Weyman-Jones, 1996).²⁹ However, in its CAPEX assessment, Ofgem makes use of unit cost models, which make the explicit assumption of constant returns to scale.
- In the telecoms industry (excluding postal services), evidence from a long data period for the telecoms sector in Australia³⁰ suggests the existence of constant economies of scale; the model parameters estimated by NERA³¹ also imply constant returns to scale.
- Evidence on scale economies in the other industries that make up the composite benchmark is even scarcer.
 - For the transport and storage sector, the extent of the activities that this industry classification covers does not allow the formulation of an inclusive measure of scale economies. Nevertheless, some recent articles suggest that there is no evidence of scale economies in areas such as local public transport³² and air transport.³³
 - In the construction sector, very few academic studies have examined the issue. However, given the large fragmentation of the sector,³⁴ it could be assumed that any economies of scale are exhausted in a relatively small scale of operations.

The previous Oxera/LEK study on the scope for efficiency improvements in Network Rail used the assumption that the scale elasticity in the comparator sectors was 0.9.³⁵ The effects of adopting such an assumption using more recent data are estimated in the sensitivity analysis below (see section 5.2.4).

5.2.4 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;

²⁸ Stone and Webster (2004), 'Investigation into Evidence for Economies of Scale in the Water and Sewerage Industry in England and Wales', January.

²⁹ 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.

³⁰ Bloch, H., Madden, G. and Savage, S.J. (2001), 'Economies of Scale and Scope in Australian Telecommunications', *Review of Industrial Organization*, **18**:2, March.

³¹ NERA (2005), 'The Comparative Efficiency of BT in 2003: A Report for Ofcom', March.

³² Farsi, M., Fetz, A. and Filippini, M. (2006), 'Economies of Scale and Scope in Local Public Transportation', *Journal of Transport Economics and Policy*, **41**:3, 345–61.

³³ Basso, L.J. and Jara-Díaz, S.R. (2006), 'Calculation of Economies of Spatial Scope from Transport Cost Functions with Aggregate Output with an Application to the Airline Industry', *Journal of Transport Economics and Policy*, **39**:1, 25–52.

³⁴ McCloughan, P. (2004), 'Construction Sector Concentration: Evidence from Britain', *Construction Management & Economics*, **22**:9, pp. 979–90.

³⁵ Oxera and LEK (2005), op. cit.

- 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.

Table 5.4 presents the productivity performance of four alternative composite benchmarks:

- the initial composite benchmark constructed using the weights in Table 5.1 above;
- excluding the transport and storage sector—given that this sector is mostly 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, resulting in the construction sector having a more significant contribution to the composite variable (60% now, was 25% in the initial benchmark);
- only construction and business activities (6%)—this composite variable is composed of 94% construction and 6% business activities, as per the ORR’s guidance;
- only construction and business activities (20%)—this composite variable is composed of 80% construction and 20% business activities. According to the ORR, Network Rail’s project management activities are usually 5–10% of the project’s total costs. This composite benchmark was created to test for the impact of a substantial increase in activity in this particular area.

Table 5.4 TFP growth using alternative weights and industries for the composite benchmark (% pa)

	Initial benchmark	Excluding the transport and storage sector	Only construction and business activities (6%)	Only construction and business activities (20%)
Base-case results	2.0	1.8	1.8	1.5
Expanding the period (1970–2004)	1.9	1.6	1.1	0.9
Reducing the period (1990–2004)	1.5	1.5	1.5	1.2
Assuming 0.9 elasticity of scale	1.7	1.5	1.5	1.2
Range	1.5–2.0	1.5–1.8	1.1–1.8	0.9–1.2

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 1.1–1.8%, derived after removing the highest and the lowest estimates of the sensitivity analysis.

5.3 Decomposing the productivity growth estimates

In general, cost reductions are achieved through:

- **catch-up to best practice**—by adopting current technology or working practices;
- **frontier shift or long-term cost reductions**—by adopting technology or working practices yet to be developed.

As the aim of this study is to provide estimates for the likely scope of frontier shift in enhancement expenditure that could be achieved by Network Rail over the CP4 period, the

question of how the benchmark TFP growth estimate should be decomposed into catch-up and frontier shift is critical for this analysis. However, the decomposition of a productivity index into various sources of productivity is a data-intensive exercise requiring company-level data in order to be attempted using first principles. Since the analysis 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. Nevertheless, a number of points can be made regarding the likely composition of the TFP growth benchmark.

- The methodology adopted 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 at the efficiency 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.³⁶ Even so, the proposition that growth accounting 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 some assumptions. For example, it could be assumed that adjustment costs and cyclical effects are averaged out given that the analysis adopts a sufficiently long timeframe; that the aggregate sectors operate under constant elasticity of scale; and that 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 neither assumption is supported by 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 view of the competitive nature of the industries that make up the composite benchmark. An academic study that examined the overall productivity performance of the UK economy found that, on average, 75% of the economy-wide TFP growth, which includes the contribution from non-market sectors, is due to frontier shift.³⁷ The relevant percentage for the composite benchmark would approach 100%, the closer real-life markets came to meeting the conditions required for competitive markets and efficient producer behaviour.

In light of the above, the frontier shift for rail infrastructure enhancement could be 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 because 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 the 2005 Oxera/LEK study for the ORR.

Table 5.5 shows the impact of these assumptions.

³⁶ OECD (2001), 'Measuring Productivity: Measurement of Aggregate and Industry-level Productivity Growth'.

³⁷ 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, 66–83.

Table 5.5 Range estimates for frontier shift in rail infrastructure enhancement

% of TFP growth due to frontier shift	Range (%)
100%	1.2–1.8
75%	0.9–1.4

Source: Oxera analysis.

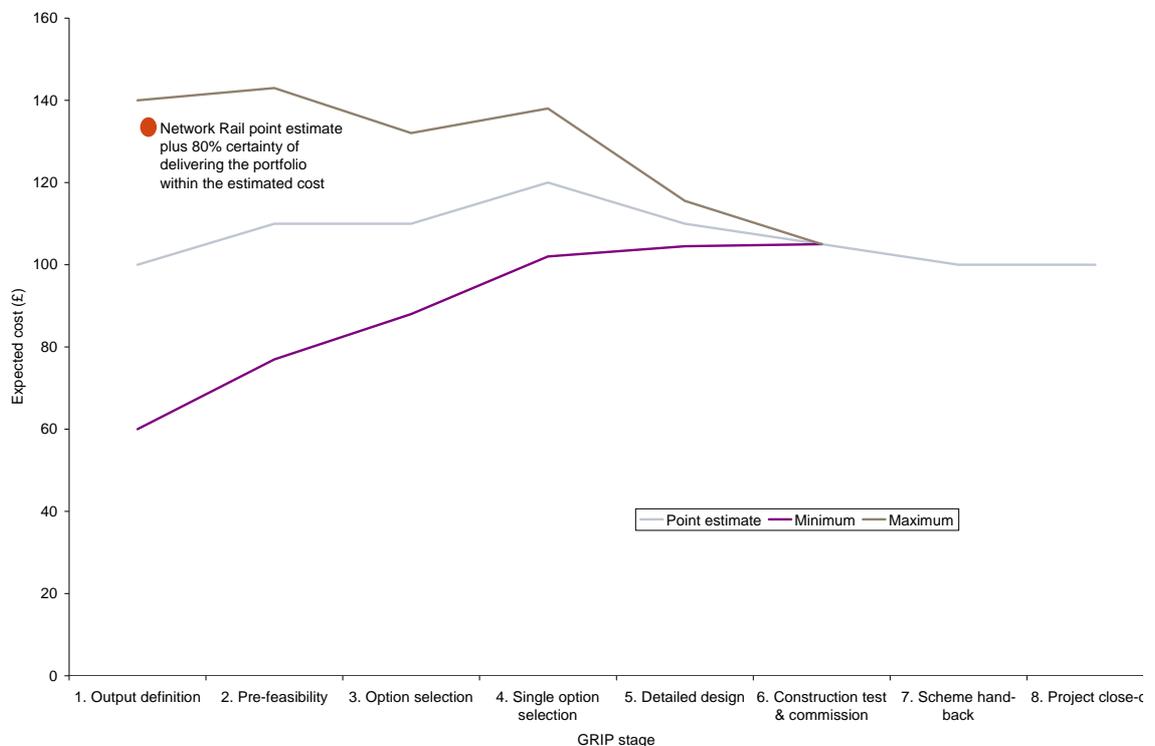
In conclusion, the analysis undertaken in this section results in indirect measures of the potential for cost reductions, estimated by observed productivity growth in other industries. More direct, and thus more accurate, measures are available when more direct approaches are used—eg, using consistent rail industry data over time to estimate both catch-up and frontier shift, or undertaking detailed studies of rail operations and the potential for the adoption of new technology or new operational processes.

6 Risk

There is considerable uncertainty surrounding the actual cost of undertaking enhancement projects, particularly where an enhancement of a particular type is being undertaken for the first time, or when the feasibility of a project is unclear at the inception.

To mitigate the risks associated with delivering such projects, Network Rail has developed an approach to managing investment schemes, set out in the Guide to Railway Investment Projects (GRIP). The GRIP process covers the investment life cycle from inception through to the post-implementation realisation of benefits. At the start of the process, the costs (and benefits) of a project are uncertain and, as such, the relative risk of the project is quite high. As a project goes through its life cycle, the uncertainty surrounding the actual cost (and associated benefits) decreases until a firm view of the costs and benefits is formed. See Figure 6.1 for a stylised illustration of how the expected costs might evolve.

Figure 6.1 Stylised GRIP process for a hypothetical project

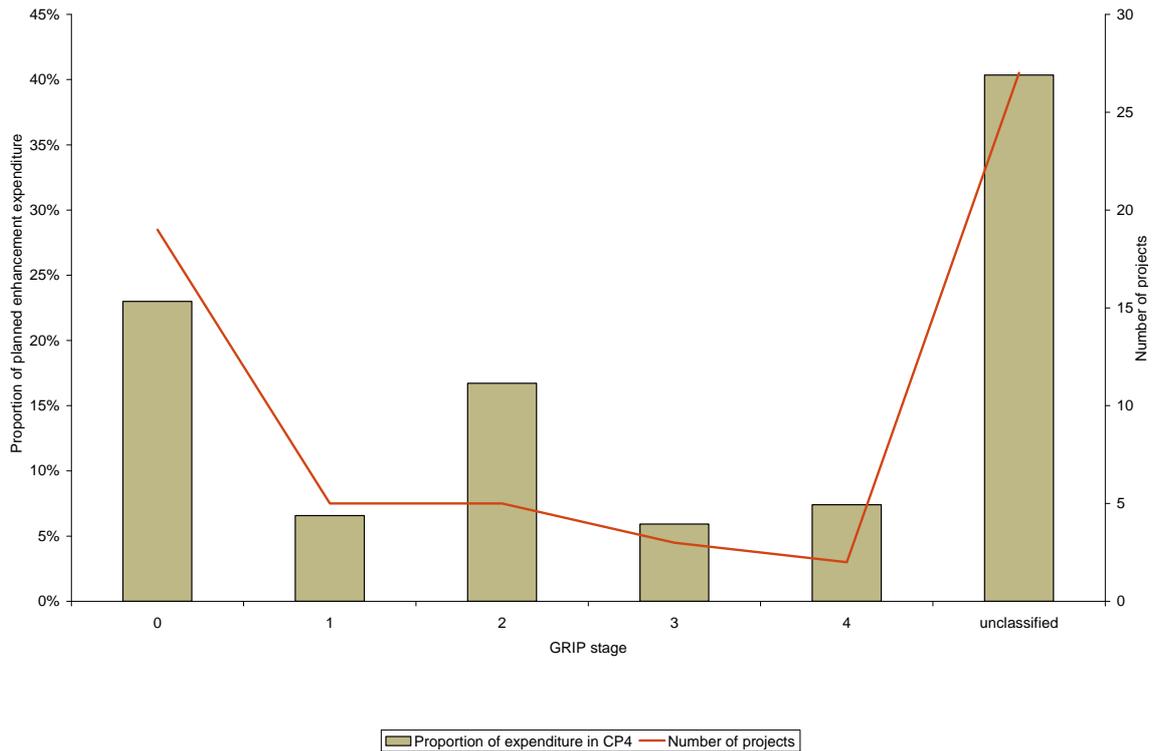


Source: Oxera analysis.

According to the GRIP, projects in their early stages are considered to carry more risk. As the project progresses, risk decreases as the specifics of the project become apparent and more is known about the nature of the project. Therefore, more rapid cost reductions might be expected, as risk and complexity decreases.

Examining the distribution of Network Rail's projects by GRIP stage shows that many of the projects are either unclassified or in the early stages of the GRIP process, as shown in Figure 6.2.

Figure 6.2 Distribution of enhancement projects by GRIP stage



Source: ORR (supporting information to Network Rail’s Strategic Business Plan).

- This large number of projects that are unclassified or in the early GRIP stages suggests that there is considerable uncertainty regarding the actual cost of the enhancements being proposed by Network Rail. There are several hypotheses for how this might affect the rate of frontier shift in enhancement expenditure. Adopting new technology and management practices will allow Network Rail to plan more effectively and reduce the amount of uncertainty in the early GRIP stages. This reduced uncertainty should lead to lower actual costs as projects that should be stopped are less likely to be accepted.
- Having more projects in the early GRIP stages means that there is more scope for frontier shift, as there is more time remaining in the project for the effect of new technologies to be realised and the direction of expected costs influenced. A project in the early planning phases has more chance of adopting new technology or management practices than one where a contract is about to be signed.
- Typically, the earlier GRIP stages involve more planning activities, and the later phases have a heavier weight on delivery and implementation. The scope for frontier shift may differ in these categories. However, without detailed information on what the comparator industries for these activities are, it is difficult to say which is likely to have greater scope for frontier shift.

7 Conclusions

Enhancement activity in rail infrastructure is expected to increase significantly in CP4, with total projected expenditure estimated at approximately £9.6 billion over the period, according to Network Rail's Strategic Business Plan, although Network Rail's assessment is subject to review by the ORR, which will set the final expenditure allowance and efficiency assumptions. Given the level of the projected investment, the ORR has placed emphasis on assessing whether the proposed projects would deliver the required outputs in an efficient and economical manner. This report aims to provide guidance on one component of the overall assessment, that relating to the scope of cost reductions that would be likely to be available to Network Rail due to frontier shift.

Oxera has examined two sources of evidence relating to frontier shift in enhancement:

- approaches and estimates derived by other regulators in network industries;
- economy-wide productivity growth estimates that can be used to construct a benchmark for Network Rail.

The review of other regulators' approaches revealed that although only a few examine frontier shift in enhancement expenditure, most of the estimates produced could be used as guidelines to the ORR in setting a frontier-shift target for Network Rail. The more relevant industries include water and sewerage, gas distribution and the London Underground. These carry out enhancement activities that are similar in nature to those undertaken by Network Rail, face similar conditions in their respective input markets, and the frontier-shift estimates proposed by their regulators extend to approximately the same timeframe as CP4.

The second source of evidence is the productivity performance of the UK economy, and particularly that of sectors of the economy that undertake activities comparable to those carried out by Network Rail in delivering its enhancement programme. The study uses the latest available information on UK productivity growth, sourced from EU KLEMS, to construct a composite benchmark that incorporates information from sectors of the economy deemed comparable to Network Rail. Similar approaches to the productivity benchmark have been used extensively by other regulators in the past, including the ORR—indeed, most of the frontier-shift estimates in other regulated sectors are derived using similar indirect measures of productivity.

The results of the analysis are summarised in Table 7.1.

Table 7.1 Summary of frontier-shift estimates presented in this study (%)

Source of evidence	Frontier-shift estimate
Other regulators' approaches	1.2–3
TFP growth analysis	0.9–1.8

Note: The values presented above relate solely to frontier shift and therefore do not include the effect of real input price growth.

Source: Oxera analysis.

The above evidence is based on indirect measures of productivity growth—namely, on assessments undertaken in other regulated industries or measures estimated directly using economy-wide indicators. As such, they incorporate some degree of subjectivity and are dependent on a number of assumptions. Although the sensitivity analysis revealed that changes in assumptions do not necessarily lead to a wide range of results, the use of more direct measures could help to increase the level of confidence in any possible cost reduction

target. These measures could include using consistent rail industry data over time to estimate both catch-up and frontier shift, or undertaking detailed studies of rail operations and the potential for the adoption of new technology or new operational processes.

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:

$$\hat{P}_{0R} = \hat{P}_{IR} - \hat{TFP}_R \quad (\text{Equation A1.1})$$

$$\hat{P}_{0G} = \hat{P}_{IG} - \hat{TFP}_G \quad (\text{Equation A1.2})$$

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 A1.1 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 A1.2 is analogous for the economy as a whole.

Subtracting Equation A1.2 from Equation A1.1 gives:

$$\begin{aligned} \hat{P}_{0R} &= \hat{P}_{0G} + (\hat{P}_{IR} - \hat{P}_{IG}) - (\hat{TFP}_R - \hat{TFP}_G) \\ &= \hat{P}_{0G} - [(\hat{P}_{IG} - \hat{P}_{IR}) + (\hat{TFP}_R - \hat{TFP}_G)] \end{aligned} \quad (\text{Equation A1.3})$$

Overall, Equation A1.3 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 A1.3 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:

$$\hat{P}_{0G} \text{ and } (\hat{P}_{IG} - \hat{P}_{IR}) + (\hat{TFP}_R - \hat{TFP}_G) \quad (\text{Equation A1.4})$$

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

From Equation A1.2, \hat{P}_{0G} corresponds to output prices in the economy as a whole. It can therefore be assumed that $\hat{P}_{0G} = \text{RPI}$, 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:

$$X = (\hat{P}_{IG} - \hat{P}_{IR}) + (\hat{TFP}_R - \hat{TFP}_G) \quad (\text{Equation A1.5})$$

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.

A2 Evidence from a comparator: the Highways Agency

A2.1 Relevance to Network Rail

Given Network Rail's domestic monopoly of rail infrastructure and the nature of rail, it can be difficult to make comparisons between Network Rail and other companies. However, the Highways Agency is a large domestic transport infrastructure agency, and, as such, its treatment of enhancement expenditure and approach to frontier shift may be of relevance for comparisons with Network Rail.

This analysis of the Highways Agency is of relevance as a potential comparator to Network Rail, in terms of targets for efficiency gains, the methodology for measuring this, and recommendations for achieving it. The Agency appears to be aiming to achieve efficiency gains in the region of 3.1% of total costs over 2007–08. However, these relate mostly to catch-up, given that the benchmarks used are relative to current best practice.

Network Rail may also wish to consider the methodology used by the Highways Agency for performance assessment of major projects and some of the indicators examined. The outcomes of two reviews of the Agency have given recommendations about how performance could be improved, particularly in terms of cost control and risk management.

A2.2 Overview

The roles and responsibilities of the Highways Agency, as set out in its framework document, include the following.³⁸

- Operation and stewardship of the strategic road network, including day-to-day and whole-life maintenance.
- Managing traffic, tackling congestion, providing information to road users and improving safety and journey reliability on the strategic road network.
- Delivering the programme agreed with the Secretary of State for additions and enhancements to the strategic road network.

The Highway's Agency's target for efficiency in 2007–08, as set out in its business plan, is to:

Deliver efficiency improvements in roads procurement through adding value to service delivery of £200m in 2007–08.³⁹

The Agency's total voted budget for 2007–08 is £6.47 billion, so the intended efficiency improvements are equal to around 3.1% of total Agency expenditure.

A2.3 Major projects

The Major Projects Directorate is responsible for the delivery of major schemes, defined as those valued at more than £5m each. This includes the Targeted Programme of

³⁸ Highways Agency (2005), 'Framework Document', November.

³⁹ Highways Agency Business Plan 2007–08.

Improvements, an £11 billion portfolio of major road improvement schemes aimed at combating some of the most pressing infrastructure problems. These projects are often significant schemes, such as motorway widening, extensions and junction improvements. They are therefore more likely to be of relevance to rail than the more minor schemes undertaken on the road network by the Agency and local transport authorities.

A2.3.1 Toolkit for performance measurement of major projects

The Highways Agency's Performance Measurement Policy Team has issued a toolkit for the performance measurement of major projects.⁴⁰ Designed to be used as a consistent method of performance measurement by those involved in delivering the Agency's contracts, the toolkit measures performance in eight areas: product, service, right first time, cost, time, safety, team culture and client performance.

Each of these areas is broken down into more specific performance indicators and scored on a scale of 1–10, with guidelines about the qualitative requirements needed to obtain each score. For example, the second performance indicator under the product category is preliminary design (including but not limited to):

- 1:2,500 layout drawings;
- approach to whole-life cost;
- stage 1 safety audit;
- departures from standards;
- geo-technical study and surveys.

Performance data is used by the Highways Agency to inform the process of selecting suppliers and to help deliver improved performance of suppliers. The Highways Agency looks for suppliers that demonstrate best performance and strong and improving capabilities. If a supplier's performance falls below acceptable standards, a consideration is made of whether that supplier should be restricted from future tendering opportunities.

These measures are assessed by both the project leader and the supplier, who must each keep records of evidence to support their proposed scores. Project leaders and suppliers engage in monthly progress meetings. Performance data is recorded and stored on an electronic database for future reference.

A2.4 Maintenance contracts

Maintenance contracts are those covering the day-to-day maintenance and management of the trunk road and motorway network. The current operational contracts for managing agents and managing agent contractors were implemented in 2001. The Highways Agency has produced an area performance indicator (API) handbook that details the measurement system developed.⁴¹ The aim of the measurement framework is to have:

A framework that measures the performance and capability of the Highways Agency and its supply chain partners, and drives continual improvement.

The indicators are either monthly or annual. Specific targets are not listed in the API handbook. The 14 indicators are:

- API 1 Response to emergency indicators;
- API 2 Response to Category 1 defects;
- API 3 Customer satisfaction;

⁴⁰ Highways Agency (2006), 'Motivating Success: A Toolkit for Performance Measurement of Major Projects'.

⁴¹ Highways Agency (2007), 'Area Performance Indicator Handbook', March.

- API 4 Environmental amenity index;
- API 5 Site (workplace safety);
- API 6 Predictability of discrete schemes (time);
- API 7 Predictability of discrete schemes (cost);
- API 8 Predictability of resource (accruals) forecasting;
- API 9 Winter maintenance;
- API 10 Defect free work;
- API 11 Road traffic accidents at roadworks;
- API 12 Street lighting outages;
- API 13 Network availability;
- API 14 Third-party claims.

Examples of their measurement include the percentage increase in the predicted scheme cost at different stages of the scheme (API 7 CP01), number of complaints received (API 3 CS02), and percentage of category 1 defects made safe or repaired within the 24-hour response time.

A2.5 Risk

The Highways Agency's approach to risk is set out in its Procurement Strategy document and is detailed below.

The HA has sought to improve the certainty of out-turn prices on certain contracts by the transfer of most risks to the contractor. This has been successful in improving certainty of price and time but it may not necessarily deliver best value as it comes at the price of a risk premium. A fair allocation of risks requires that risks are identified prior to the establishment of a contract. In addition, tenderers need to be able to assess the potential consequence of a risk and to be able to include an appropriate risk allowance in the price bid. It is unlikely that a client will get best value if tenderers have had to rely on guesswork if they have had inadequate information or if they will not be in a position to manage the risk. The outcome will be that the tenderers will either guess too high or too low, neither of which scenarios will result in best value. The client will either pay too much or the quality of the product or service may be threatened by commercial pressure.

In theory, best value is achieved by the client paying for appropriate risk management measures together with the costs of dealing with the consequences of only those risks that actually occur. However, the contractor and the supply chain are more likely to contribute to the effective and efficient management of risks if they have fair and reasonable incentives. The judgement required by a client is how much to pay for the transfer of a risk, and at what level it is judged better value to retain the risk and to pay any consequential costs. The HA will accept risks where suppliers are prepared to work in partnership to manage the risks and control the consequences.⁴²

One aspect of the external review (the Nichols review) was to consider the Highways Agency's approach to risk management.⁴³ In terms of project cost estimates, it describes the present twofold approach to risk allowances as follows.

- A HARM risk allowance, based on 'risk events', which may or may not happen—for example, ground conditions may be found to be worse than expected. Aspects of uncertainty that cannot easily be treated as events tend to be ignored—for example, ambiguity associated with early project definition. Prior to Office of Government Commerce (OGC) Gateway 2, total HARM allowance was large, averaging 35% in a range of 20–90%. By OGC Gateway 3b, total HARM allowance had dropped to 5%.

⁴² Highways Agency (2001), 'Procurement Strategy'.

⁴³ Nichols, M. (2007), 'Review of Highways Agency Major Roads Programme', March.

- An optimism bias, recommended in the Treasury’s Green Book 2003, to allow for the tendency for project estimates to be exceeded, has also been applied since 2003. This is a 45% increase in estimate plus a HARM allowance for normal/non-controversial schemes and a 65% uplift for non-standard schemes. As this is intended to cater for average cost overruns on projects, the potential outcome for any particular scheme could be in a much wider range—eg, of 10–150% in practice (depending on the level of HARM allowance). The optimum bias allowance drops to 5% at OGC Gateway 3a, and to 3% by start of construction.

The Nichols review recommended the following changes to the Highways Agency’s risk management:⁴⁴

- a radical review of requirements for risk management at project, programme and strategic levels;
- in light of the review, adopting an improved best-practice approach for project risk management adapted to the Highways Agency’s requirements;
- appointing a senior risk adviser—not to manage risk, but to develop and embed the improved process into the mainstream project and programme management, and to provide ongoing support;
- undertaking a training programme in risk management for all staff in the projects area up to and including senior management.

The applicability of these recommendations for the Highways Agency’s risk management to Network Rail’s practices may be worth consideration by the ORR.

A2.6 External reviews

A2.6.1 Nichols review

The Nichols review mainly considered (what was then) the Targeted Programme of Improvements, for which individual schemes that entered the programme were showing large cost increases. Specifically, there was concern about the Highways Agency’s ability to estimate the costs of the programme and the revisions made to this—specifically, an increase from £9.4 billion to £11.8 billion between April 2005 and October 2006. The review recommended that the programme be replaced with three groupings of schemes. Since the review, the Targeted Programme of Improvements has been re-classified as the major schemes programme, and the Highways Agency is moving to a new monitoring and control system for this.⁴⁵

A Highways Agency-commissioned document analysed the 13 schemes, with the largest cost increases between their entry into the Targeted Programme of Improvements and the July 2006 budget. The report found the breakdown of underlying causes for the cost increases to be that presented in Table A.2.1.

⁴⁴ Nichols, M. (2007), ‘Review of Highways Agency Major Roads Programme’, March.

⁴⁵ <http://www.highways.gov.uk/roads/2644.aspx>.

Table A.2.1 Reasons for cost increases

Reason for cost increase	% of cost increase
Inflation to Q1 2005	26
Inflation from Q1 2005	26
Inaccurate estimating	15
Project definition	15
Risk	7
Time delays (including inflation)	5
Land	3
Time delays (excluding inflation)	2
Statutory undertakers ¹	1

Note ¹ Companies and agencies with legal rights to carry out certain development and highways works.
Source: Highways Agency (2006), 'Major Projects Targeted Programme of Improvements: Report on Preliminary Analysis of Significant Reasons for Cost Increases', October.

The Nichols review assessed each of these underlying causes and recommended that changes in responsibility, accountability and contingency allowances be made to the Highways Agency's current approach. The review also suggested that early experiences of the adoption of early contractor involvement appeared to show that schemes were being adopted on time and on budget once construction had begun.

A2.6.2 National Audit Office review

In 2003 the National Audit Office assessed the Highways Agency's performance in maintaining England's strategic road network.⁴⁶ It found that measurement of the network condition and the Agency's performance could be further improved. In particular, there was an average overspend of 27%, the Agency did not always choose the best value-for-money projects, and it sometimes sacrificed dynamic efficiency to ensure that in-year budgets were met.

Some of the report's key findings are set out below.

In 2001–02, the Agency spent £502 million on maintenance of the 8,900 kilometres that it manages directly, over £56,000 per kilometre ...

...However, the Agency does not differentiate between roads requiring reconstruction because they have reached the end of their natural lives and those that require reconstruction due to untimely maintenance. Such information would allow the Agency to assess whether it had eliminated reconstruction work that could have been avoided if more timely maintenance had been carried out ...

... The Agency could go further to strengthen cost control ... Unit costs of capital maintenance work have increased sharply in real terms over recent years, partly reflecting higher than general inflation in the construction industry but also the adoption of higher quality and more durable treatments, greater night time working and more expensive techniques. Controlling in-year spending on capital maintenance projects is a priority. ... However, cost control was much less effective over projects' lifetimes, where we found an average overspend of 27 per cent and which involved the Agency delaying new projects in order to keep spending within in-year budgets ...

⁴⁶ National Audit Office (2003), 'Maintaining England's Motorways and Trunk Roads', March.

A3 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, textile , leather and footwear	17t19
Wood and of wood and cork	20
Pulp, paper, 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
Renting of machinery 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

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