



EFFICIENCY OF HIGHWAYS ENGLAND'S OPERATING EXPENDITURE: ANALYSIS OF PRODUCTIVITY AND UNIT COST CHANGE

REPORT FOR THE OFFICE OF RAIL AND ROAD

31ST MARCH 2017

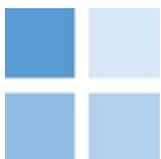
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ACRONYMS

Acronym	Full Description
CAA	Civil Aviation Authority
Capex	Capital Expenditure
CATRIN	Cost Allocation of Transport Infrastructure Cost, European transport project.
CEPA	Cambridge Economic Policy Associates, the prime contractor of this study.
CU	Catch-Up, efficiency improvements made in order to catch-up to current best practice.
DfT	Department for Transport
EU KLEMS	Database on measures of economic growth, productivity, employment creation, capital formation and technological change at the industry level for all European Union member states from 1970 onwards.
FS	Frontier Shift, ongoing efficiency achieved over time.
GO	Gross Output, measures whereby intermediate input impacts are included.
HE	Highways England
LEMS	Labour, Energy, Material, Services, a partial productivity measure which considers labour and intermediate inputs.
LEMSP	The 'residual' output growth that is not accounted for by the growth of labour and intermediate inputs (LEMS).
LP	Labour Productivity, the growth of output per unit of labour input growth.
NACE	The statistical classification of economic activities in the European Community.
NATS	National Air Traffic Services
OBR	Office of Budgetary Responsibility
Opex	Operating Expenditure
ORR	Office of Rail and Road
PFI	Private Finance Initiative, the creation of public-private partnerships through funding public infrastructure projects with private capital.
PS	Performance Specification, the objectives that Highways England must deliver.
RIS1	Road Investment Strategy 1, sets out the major strategic road network improvements Highways England is to deliver from 2015/16 to 2019/20.
RIS2	Road Investment Strategy 2, the second road investment period starting in 2020.
RUOE	Real Unit Operating Expenditure, operating expenditure divided by an indicator of output.
SR10	Spending Review 10, a review of the Highways Agency to set out its budget from 2010.
SRN	Strategic Road Network, made up of the motorways and the trunk roads in England that are Highways England's responsibility.
TFP	Total Factor Productivity, the 'residual' output growth that is not accounted for by input growth, taking into account all factors of production.
TRL	Transport Research Laboratory, a sub-contractor for this study.
VA	Value-added, a measure whereby the impacts of intermediate inputs are removed.

EXECUTIVE SUMMARY

Introduction

Highways England (HE) is responsible for operating, maintaining and improving the Strategic Road Network (SRN) in England. It was established in April 2015 as a government-owned strategic highways company, with the intention of giving it greater commercial freedom to make decisions and drive efficiencies than was possible while operating as the Highways Agency, an executive agency of the Department for Transport. At the same time, a Highways Monitor was established, which then became the Office of Rail and Road (ORR), to monitor progress in delivering a five year Road Investment Strategy (RIS) and Performance Specification (PS).

The ORR has commissioned CEPA to report on the efficiency of HE's operating expenditure (opex). The objective of this work is to assess how HE has performed against RIS1 so far and identify scope for delivering further efficiency. This report includes an analysis of HE's operating expenditure, an assessment of how these expenditures compare with suitable comparators/benchmarks, and considers the potential for further efficiencies.

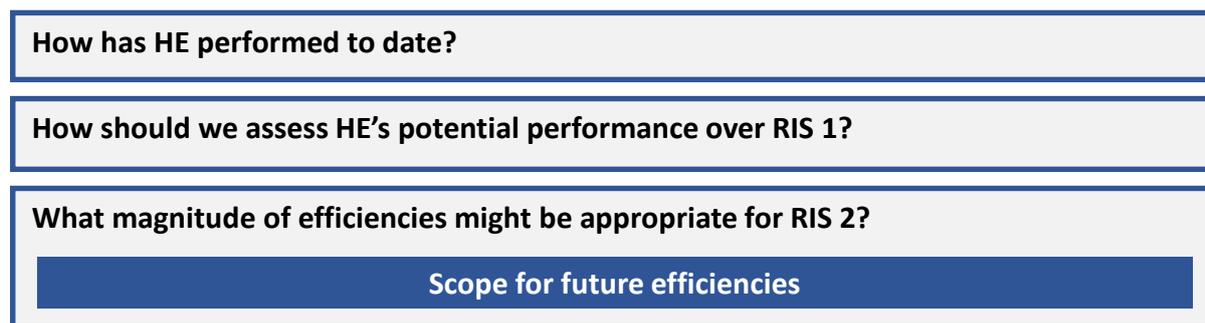
ORR's recent evaluation¹ shows Highways England to have made good progress so far on RIS1 in relation to operating performance. DfT and HE have now embarked upon a research program to develop RIS2 and ORR is tasked with assessing the levels of efficiency proposed in RIS2. The aim of RIS2 is to continue and further build upon the progress made under RIS1 but with new targets set. ORR's assessment of the proposals in RIS2 will be informed by a series of benchmarking activities, of which this report is an input.

Approach

Our approach has been to undertake a range of different analyses of operating costs, each of which offer a view of HE's cost efficiency performance to date, and indicate the potential for future savings. The components of our analysis are described in the figure below.

¹ ORR, *Annual assessment of Highways England's performance, April 2015 – March 2016*, July 2016

Figure 0.1: Analysis components



Expenditure in RIS1

HE's opex is classified in its accounts within a category it describes as "Resource Expenditure", which are the funds required by HE to operate its network, as opposed to renewing or enhancing it. For 2015/16 HE's resource expenditure budget was £1.072bn. Separately, HE receives a capital funding allowance which covers renewals and enhancements, which in 2015/16 was approximately £1.8bn. Below we provide a breakdown of HE's RIS1 resource expenditure budget for 2015/16, sourced from HE's Delivery Plan.²

Table 0.1: Breakdown of Highways England's Total Resource Expenditure

Cost area	Description	2015/16 allowance
Routine Maintenance	Day-to-day repairs of surface defects requiring early attention, winter maintenance (e.g. road gritting), maintaining road-side technology systems, vegetation management, etc.	£255m
Renewal investigations	Renewals, which includes road resurfacing, are not classified as opex. But the cost of routine inspections of the network, to establish what renewals work might be needed, is charged to resource expenditure.	£24m
General operations	Local network management schemes, other small local projects, and some technology spend.	£74m
Traffic management/customer operations	This reflects the cost of the Traffic Officer Service, including the Regional Control Centres and the National Traffic Operations Centre. Costs include pay, equipment and training for Traffic Officers and control centre staff. It includes an element of PFI costs relating to the National Roads Telecommunications Services.	£179m
Private Finance Initiative (PFI)	Service payments on PFI contracts, where sections of road are managed under long-term (30 year) concessions.	£394m

² Highways England Delivery Plan 2015-2020, Annex C.

Cost area	Description	2015/16 allowance
Support Costs	Running costs incurred by Highways England indirectly supporting the activities listed above. This includes finance, procurement, HR and IT costs. Research and Development costs are also included here, as are customer communications and third party claims.	£107m
Protocols	Costs of performing specific tasks assigned to Highways England by DfT with funding streams provided. This includes the Dart Charge, Severn River Crossing and maintaining the Historic Rail Estate.	£39m
Total resource expenditure		£1,072m

Source: Description provided by HE via email. Costs sourced from HE's Delivery Plan 2015-2020, Annex C

Over the remainder of RIS1 (up to 2019/20), HE's resource expenditure budget is broadly flat in nominal terms. Therefore, when inflation forecasts are taken into account, forecast resource expenditure declines in real terms by 12% between start and the end of RIS1 (i.e. between 2015/16 and 2019/20).³ However, we note that resource expenditure at the start of RIS1 was higher than the preceding year (2014/15). If we consider the period between 2014/15 and 2019/20, total resource expenditure is set to decline by 7.5% in real terms.

Data adjustments

We made two adjustments to the data series. First, amendments have been necessary to identify costs which HE can control; we could not expect HE to be targeted to achieve efficiencies on areas of cost that cannot be changed. The key adjustment related to controllability is to remove contracted, and therefore committed, PFI costs. Second, we have removed costs which relate to activities which are outside of HE's core role. In this category costs are associated with the British Rail estate that HE has responsibility over for historic reasons. Taking opex from 2012/13 onwards, and making the two adjustments noted above, gives us an adjusted opex measure which we refer to as '**core costs**' – which would ideally form the primary basis of our analysis.

A further issue for this project has been obtaining information in a consistent time series, because reporting structures and applicable accounting rules have altered since the organisation's status changed. As a result, it has been difficult to extend the data series back in time on a consistent basis. Despite considerable engagement with HE, we have been unable to undertake analysis of costs before 2012/13 as it included the renewals component of resource expenditure. This is because the renewals component of opex prior to 2012/13

³ Based on RPI inflation forecasts from the [Office for National Statistics](#).

included substantial items now classified as capex, and neither we nor HE have been able to offer a usable adjustment for this.

By further excluding the renewals component, which we call '**core costs – R**' (i.e. core costs minus renewals), we obtain a consistent time series and can undertake an analysis of costs over a longer time period, back to 2009/10. Inevitably this analysis is restricted to a proportion of the core opex cost base. But renewals is today fortunately a relatively small proportion, less than 2.5%, of HE's resource expenditure.

Efficiency expectations

The Cook Report⁴ (2011) has been a key driver of reform for the Strategic Road Network in England. Cook undertook an analysis of HE (when previously the Highways Agency) and made several recommendations, including the need for long term planning (to 2040) to support increased investment, improved performance, efficiency savings, and a change in company structure to become a Government-owned standalone company.

Cook identified the opportunity for HE to realise annual efficiency savings across a number of areas. Cook combined top down and bottom up evidence to recommend that HE should be able to achieve its objectives while reducing its maintenance, renewal and operating expenditure (excluding major projects and PFI) by £200m by the end of RIS1, based on expenditure of £1bn in this area, i.e. annual expenditure at the end of RIS1 is circa £800m. This corresponds to a 20% reduction in expenditure by the end of the 5 year RIS1 period, i.e. 4-5% per annum, cumulative over 5 years.

We consider in this report how HE is performing to date against the efficiency expectations set by Cook noting however, that things have changed e.g. there has been higher than anticipated traffic growth, since those expectations were set. We also note that there is a potential for a trade-off between costs and performance. For this report, we have not reviewed the changes in HE's key performance indicators. HE's performance regime changed substantially once RIS1 started. During 2010-15, HE did consciously reduce some aspects of its service as part of its opex cost reduction efforts in that period.

Analytical approach

All three analytical stages of our work draw on an analysis of Real Unit Operating Expenditure (RUOE) over time. We use this method to compare HE's unit costs to other companies/industries with similar characteristics and make an assessment of the scope for efficiency based on its performance, compared to those other companies/industries. This method is widely used by regulators as it provides an independent assessment of the scope for efficiency that does not rely on detailed benchmarking exercises, for which the regulator

⁴ Cook A., *A fresh start for the Strategic Road Network*, November 2011

may have insufficient granular data. Its use by regulators has provided evidence that the scope for efficiency savings for regulated companies tends to be largest soon after privatisation, and then diminishes over time once the 'low hanging fruit' (easy to achieve efficiencies) have been realised. Therefore, part of the analysis that we undertake is to split efficiency gains by the time period after privatisation in which they occurred.

HE is not regulated to the same degree as some other sectors, nor has it been privatised. Therefore, the comparison between HE and other regulated companies is not a perfect match – HE does not have the same incentive of seeking to generate profits for shareholders, nor does it have the ability to raise finance via capital markets.

Our analysis is based on consideration of the change in Real Unit Operating Expenditure (RUOE), which is operating expenditure divided by an indicator of output. We calculate the change in RUOE as this provides a measure of changes in unit costs over time. We calculate changes in RUOE for HE and a selection of industries with similar characteristics. This enables us to compare HE's historic performance against such industries/companies. We take into account both productivity gains and changes in input prices.

In calculating HE's RUOE, the output metric is an important decision. The main options are:

- Vehicle-km – the quantity of traffic that HE's network facilitates; or
- Lane-km – the quantity of road that HE manages, taking into account different road widths.

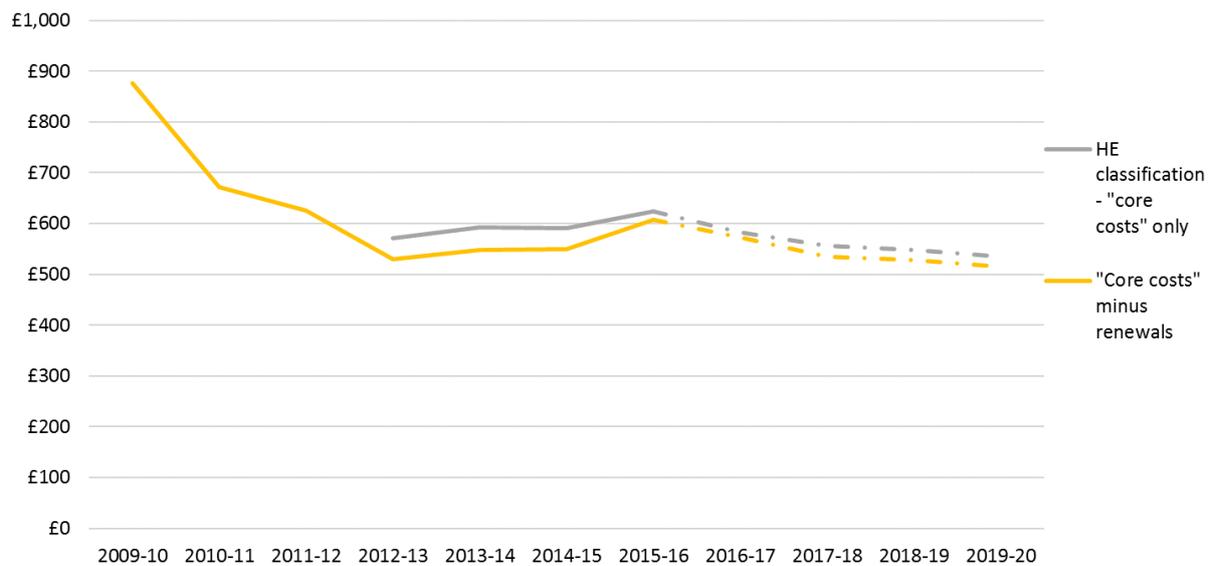
In practice we present results for both of these as there are arguments for use of each.

We also undertake an adjustment for economies of scale within our RUOE calculations, to account for opex reductions arising from output growth, rather than genuine improvements in efficiency, e.g. HE could accommodate an increased volume of traffic on its network without having to increase opex by the same proportion. The adjustment is made through the application of a cost elasticity value, specific to each industry, to the RUOE calculations.

Highways England's performance to date

The chart below shows the historic costs that we include in our efficiency analysis. It includes HE's 'core costs' for the period 2012-13 to 2015-16, and HE's 'core costs – R' for the period 2009-10 to 2015-16. (We also show forecast costs as dotted lines.)

Figure 0.2: HE resource expenditure, core costs only, 2012/13 onwards, £m (2014/15 prices)



Source: Data received directly from Highways England.

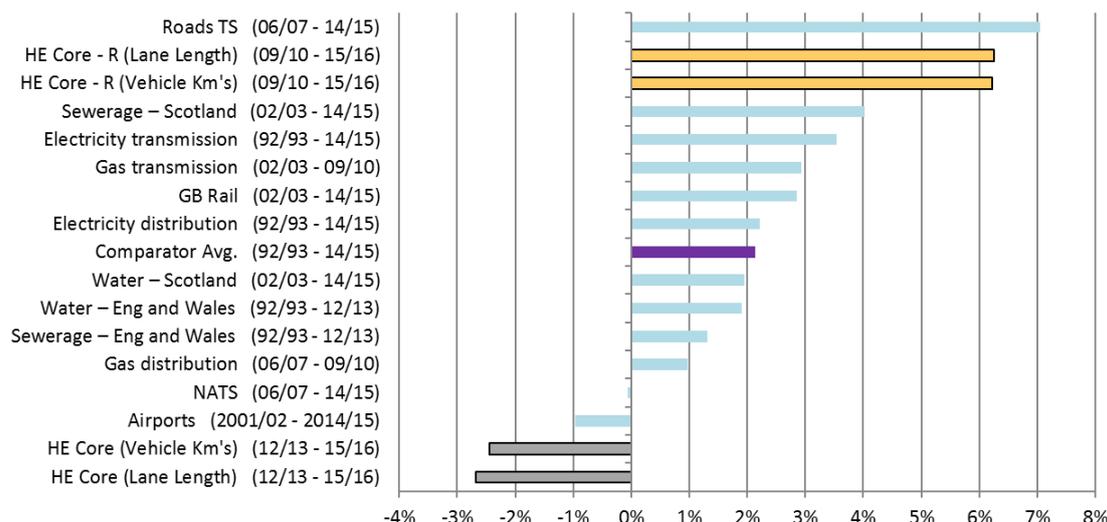
'Core costs' (and 'core costs – R') have risen since 2012-13. This is due primarily to increases in traffic management costs, support costs, and general operations. However, due to accounting changes prior to 2015/16, we cannot say in which areas these cost increases occurred.

However, by focusing on 'core costs – R', we demonstrate that costs fell significantly prior to 2012-13. From discussions with HE, we understand that the SR10 efficiency challenge (discussed in Section 2.1) drove several changes in HE's maintenance practices between 2009-10 and 2012-13, and that lower maintenance costs are the source of the observed cost reductions before 2012-13. HE has provided us with some additional explanation on this issue which suggests that HE managed to reduce its maintenance costs via a mix of efficiency gains, scope reduction, and changes to standards for maintenance activities.

Historic benchmarking of Real Unit Operating Expenditure

The following chart shows the average annual reduction in real unit operating costs for HE and our comparators. We show it as a reduction consistent with the common convention that *efficiency improvements* are shown as *positive* numbers. We calculate the average as a geometric mean, a common method for averaging percentage changes. In the chart below, HE's efficiency performance is shown based on historic data available, including the first year of RIS1. 'Core costs' (grey bars) include data for 2012/13 to 2015/16, whilst 'core costs – R' (yellow bars) include data for 2009/10 to 2015/16.

Figure 0.3: Average annual reduction in RUOE for HE and selected comparators

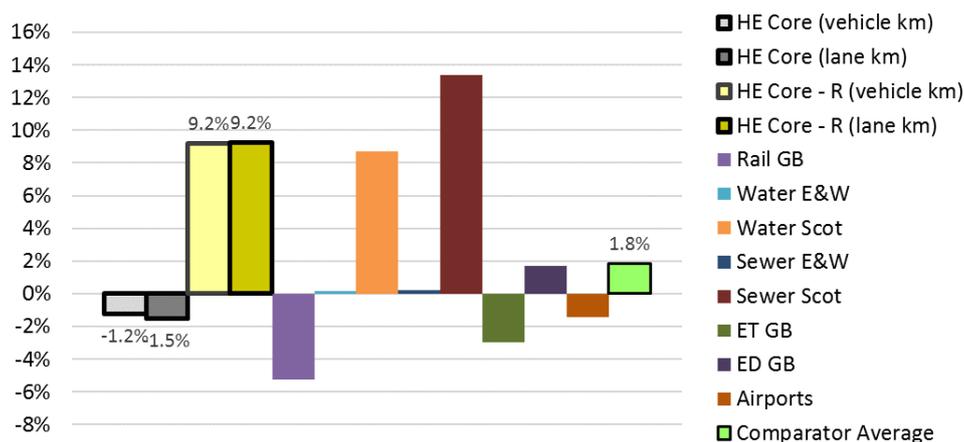


Legend: HE: Highways England, TS: Transport Scotland
 Source: CEPA Database (full details of all data sources available in A.3.1).

The chart shows that all of our chosen comparator sectors (with the exception of airports and NATS) have made efficiency gains. Focusing on ‘core costs – R’, HE has significantly increased productivity – this result is driven in particular by a large fall in maintenance costs before 2012/13. If we focus on ‘core costs’ including opex renewals, and the time period from 2012/13 onwards when this data is robust, HE appears to have become less productive, a result of its rising costs in over this period.

We also compare HE’s performance for the period immediately prior to RIS1 to provide a view of HE’s performance against comparator industries’ first control period after privatisation.

Figure 0.4: Average annual reduction in RUOE for the 1st control period for HE and comparators



Source: CEPA Database (full details of all data sources available in A.3.1).
 Note: Gas transmission/distribution and NATS are not included due to 1st control period data not being available.
 Time periods for the data included in this chart are: HE ‘core costs’ 2012/13 to 2014/15; HE ‘core costs – R’ 2009/10 to 2014/15; Rail 2002/03 – 2003/04; Water and Sewerage E&W 1993/94 – 1994/95; Water and Sewerage Scot 2003/04 – 2005/06; Electricity Transmission 1991/92 – 1992/93; Electricity Distribution 1991/92 – 1994/95; Airports – 2001/02.

HE shows evidence of significant productivity gains based on the measure of 'core costs – R'. Other comparable industries made operating productivity gains of 1.8% per annum on average during their first regulatory period after privatisation,⁵ which could be considered as a high level benchmark for HE, if HE had maintained a constant level of service provision. Based on the 'core costs' measure, and the shorter time period, HE became less productive during the period 2012/13 – 2014/15. The loss of productivity is -1.5% when lane-km is the chosen output metric, or -1.2% when vehicle-km is the metric.

However, by excluding renewals (i.e. focusing on 'core costs – R'), these results highlight significant productivity gains since 2009/10. This trend is mainly driven by a substantial reduction in maintenance costs, which is likely due to a mix of efficiency gains, some reduction in the scope, and changing standards for maintenance activities. In part, some of those scope and standards changes might have been justifiable as the expenditure was not delivering value for money or contributing effectively to the performance society requires of HE. So the distinction between what is a change in output and what is an efficiency gain is not clear, even if we could quantify it. But we would also note that after the large cost reductions in the first three years, HE's productivity appears to have fallen slightly since 2012/13.

Performance to the end of RIS1

Having reviewed HE's historic performance above, we now consider HE's projected performance, and specifically its forecast expenditure as per its current Delivery Plan. Our aim is to consider that if HE meets the budget in the Delivery Plan, whether the revised costs are likely to represent an efficient level of performance. We have chosen several benchmarks to provide a broad comparator base. These are as follows:

- **Top-down productivity metrics.** These measure the change in the value of outputs relative to the change in the cost of inputs. We assessed sectors that exhibit most similarity to the components of HE's opex.
- **Partial factor cost measures.** These calculate changes in selected input costs, relative to the value of output. As with the productivity metrics, this is undertaken for sectors that are most similar to the components of HE's opex.

⁵ Some industries, such as water and electricity distribution, show relatively small cost efficiencies in the first period post-privatisation. Unit cost performance in the water industry in this period was negatively affected in part by the need to achieve compliance with EU water quality and environmental regulations. Weak cost performance in a first regulatory period may also reflect the time taken for the companies to adjust to their new structure and learn how to take a commercial approach to cost efficiency. Slow learning is more likely where the privatisation takes place as a public offering of shares, as in these cases, rather than a trade sale to an existing commercial operator.

- **RUOE.** We review the historic efficiency performance of comparators with similar characteristics to HE.

It is important to note a key difference between the three benchmarks that we utilise. The top-down productivity metrics and partial cost measures tend to suggest lower efficiency gains for the benchmarks against which HE is compared than the RUOE metric. This is because they are based on industry data from across the whole UK economy, including many competitive markets where the scope for efficiency gains tends to be lower, whereas our data sources for RUOE are mainly companies in regulated sectors (to increase comparability with HE).

Having established a number of benchmarks, we then consider HE's forecasted resource expenditure under different scenarios.

- **Meets the budget.** HE performs in line with the RIS1 budget as per its Delivery Plan, i.e. a reduction in real costs of 9.5% over RIS1. This may not be dissimilar to the recommendations in the Cook Report, which was a reduction in real costs of 20% over RIS1, but relevant to only *certain aspects* of resource expenditure.
- **Stable in real terms.** HE performs with resource expenditure stable in real terms throughout the remainder of RIS1. Given the apparent lack of any cost efficiency savings for the period 2012/13 to 2015/16, we have also considered this cost projection as a more conservative forecast scenario.

Benchmarking of top down productivity metrics

We considered several measures of productivity for which UK-wide data is available across a number of years.

- **Total Factor Productivity (TFP):** 'Residual' output growth that is not accounted for by input growth, taking into account all factors of production. TFP is calculated using either a gross output or a value added measure – the former includes the contribution from intermediate inputs, whereas these are excluded from the latter.
- **Labour and intermediate inputs (LEMS) Productivity (LEMSP):** The abbreviation LEMS refers to Labour Energy Materials Services. LEMSP is 'Residual' output growth that is not accounted for by the growth of labour and intermediate inputs. This is calculated under both flexible and constant capital assumptions.
- **Labour Productivity (LP):** The growth of output per unit of labour input growth. Or, consistent with the explanations above, 'residual' output growth that is not accounted for by the growth of labour inputs.

We also calculate a number of variants of these measures. All data was sourced from releases of the EU KLEMS dataset. For each of these three productivity measures, we identified sectors of the UK economy which we consider (having discussed choices with ORR and HE) are the

most similar to the components of HE's opex, and used these to develop a composite index specific to HE that is matched to HE's activities.

We considered which measures would provide the best benchmark for HE's opex:

- Some intermediate inputs are included within HE's operating cost base (i.e. energy for providing signage and materials used for light maintenance), whilst the remainder are likely to sit within HE's capex base (i.e. materials and capex-related services such as construction). Therefore, we consider that both LEMS productivity and labour productivity should be taken into account when estimating the scope of efficiency.
- There is a choice between productivity with either constant capital, or with variable capital, and we think both results should be taken into account. Changes in capex are likely to be taken into account when setting opex efficiency targets, which favours using a variable capital approach. However, the relationship between capex and opex efficiencies is difficult to determine, so it is also prudent to take into account the constant capital productivity metric.

Our 'base case' estimates for LEMS and labour productivity gains with variable capital are in the range 0.6% to 0.9% per annum, i.e. outputs grow by 0.6-0.9% per annum more than inputs. These are our preferred results. If we were to take into account the 'base case', LEMS and labour productivity gains under the assumption of *constant capital*, this would widen the range of productivity gains to 0.3% (low end) to 0.9% (high end) per annum.

Applying this to HE, the implication is that a reasonably competitive company with similar activities to HE would make productivity gains at around 0.6% to 0.9% per year. Therefore, this is a reasonable proxy benchmark to apply to HE's future performance.

Benchmarking of partial factor cost measures

Our methodology for calculating these cost measures is the same as the methodology used for the top-down productivity metrics, i.e. we have used the same data sources, comparator weightings, time periods, permutations (gross output and value-added, variable and constant capital).

Consistent with our analysis for the top-down productivity metrics, our preferred results for cost efficiency are based on measures which allow for variable capital. When taking into account both LEMS and labour productivity measures, the annual productivity gains (under our base case estimates) are in the range of 0.1% to 0.9%. If we were to include constant capital, the bottom of the range would move to -0.3%. Given that the LEMS cost measure with constant capital is the only point that implies negative efficiency, this implies an efficiency target range from 0% (low end) to 0.9% (high end) per annum.

Further consideration of Real Unit Operating Expenditure

We calculate changes in RUOE above to show the level of operating efficiencies achieved by relevant comparator industries in their first control period. In this section we calculate efficiency gains for the comparators companies/sectors in their *second* price control period after privatisation because, we regard the second price control period as a proxy benchmark for RIS1. We also present efficiency gains made by companies in their *third* price control period after privatisation, as this would correspond to RIS2, and we refer to this result in our conclusions.

The average efficiency gain across the observed comparators is 3.1% for the second control period post-privatisation, and is 1.3% for the third period. Based on changes in RUOE for our comparator sectors, our benchmark for HE's efficiency gains in RIS1 is 3.1% per annum. The average efficiency gain for the third control period, 1.3%, would be applicable to any future cost efficiency targets that HE might set for RIS2 and onwards.

This 1.3% target is slightly (although only marginally) higher than the efficiency targets implied by our top down productivity measures and partial factor cost measures. This is because, as noted earlier, these latter two measures are based on industry data from across the whole UK economy, including many competitive markets where scope for efficiency gains tends to be lower. Given that HE is not (and has not been) subject to competitive pressures there may be some greater scope for catch-up efficiencies over time, as observed in other regulated industries.

Projecting the efficiency performance of Highways England

HE's current forecasts suggest that it will broadly (i.e. almost) meet the RUOE productivity benchmark implied by our analysis if it manages to reduce its 'core costs' in line with its Delivery Plan (although the precise result is somewhat sensitive to the output measure chosen to assess HE's expenditure). Based on HE's performance to date – large cost reductions up to 2012/13 but slightly rising costs since then – it is currently uncertain whether the efficiency savings in the delivery plan are likely to be met.

Setting efficiency expectations for RIS2

If HE is able to meet its Delivery Plan in RIS1, we consider that a relevant benchmark for unit cost efficiency in RIS2 could be in the region of the following:

- 1.3% per annum, as implied by the RUOE analysis for the average efficiency gain across relevant regulated networks for the third price control period post privatisation (which is broadly consistent with our analysis of top down productivity measures and partial cost factors); *plus*

- An additional annual 'catch-up' efficiency component, if it is determined that the reduction in maintenance costs prior to 2012/13 was primarily driven by scope reductions and/or changing standards, as opposed to genuine efficiencies.
- However, if HE fails to meet its Delivery Plan for RIS1, this would present a further argument for increasing the efficiency target for RIS2.

Overall our analysis suggests an efficiency target of 'at least 1.3% per annum' but with scope for adjustment based on the outcome of RIS1. This figure is broadly consistent with regulatory precedent, although we note that there is considerable variation between industries.

1. INTRODUCTION AND APPROACH

1.1. Background

Highways England (HE) is responsible for operating, maintaining and improving the Strategic Road Network (SRN) in England. It was established in April 2015 as a government-owned strategic highways company, with the intention of giving it greater commercial freedom to make decisions and drive efficiencies than was possible while operating as the Highways Agency, an executive agency of the Department for Transport. At the same time, a Highways Monitor was established, which then became the Office of Rail and Road (ORR), to monitor progress in delivering a five year Road Investment Strategy (RIS) and Performance Specification (PS). These documents set out how the Department for Transport (DfT), which funds HE, desires its funding to be spent, and specifies the performance it requires.

Highways England is currently nearly halfway through the first period Road Investment Strategy (RIS1), which runs from 2015/16 to 2019/20. The strategy details eight sectors across which Highways England is to deliver £15.2 billion of major highway improvements, in addition to its on-going operating costs (opex) of about £1 billion per year. Its performance, both in terms of outputs and cost-effectiveness, is monitored by ORR through the use of Key Performance Indicators (KPIs), other Performance Indicators (PIs), and additional less precise requirements, which are set out in the PS. One objective of RIS1 is for HE to reduce its costs of delivery so as to achieve, in effect, £1.2bn in efficiencies, in total over the five year period.

ORR's recent evaluation⁶ shows Highways England to have made good progress so far on RIS1 in relation to operating performance. DfT and HE have now embarked upon a research program to develop RIS2 and ORR is tasked with assessing the levels of efficiency proposed in RIS2. The aim of RIS2 is to continue and further build upon the progress made under RIS1 but with new targets set. ORR's assessment of the proposals in RIS2 will be informed by a series of benchmarking activities, of which this report is an input.

1.2. Objectives of this study

The ORR has commissioned CEPA to report on the efficiency of HE's operating expenditure (opex). This includes routine maintenance (such as pothole repair and gritting), investigation costs related to renewals, traffic management, customer/general operations and support costs. It also includes payments under PFI road management contracts, which are substantial.

⁶ ORR, *Annual assessment of Highways England's performance, April 2015 – March 2016*, July 2016

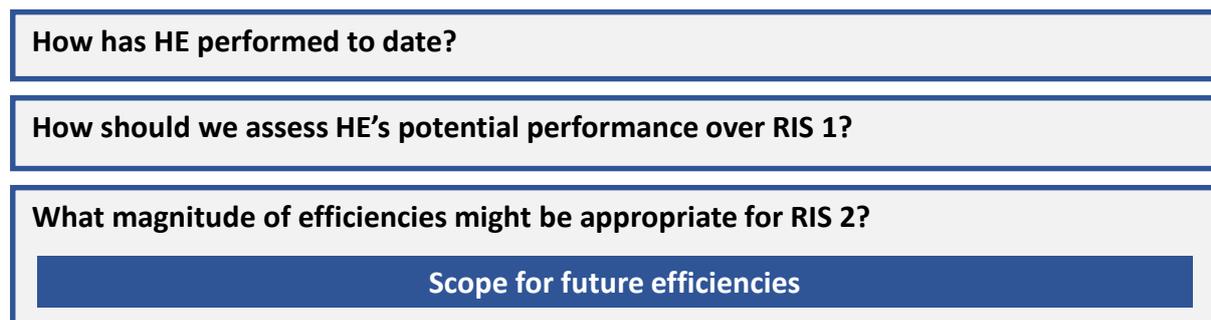
HE's opex budget is separate from its capex budget and therefore opex excludes renewals such as road resurfacing⁷ and enhancement works.

The objective of this work is to assess how HE has performed against RIS1 so far and identify scope for delivering further efficiency. This may assist in preparing RIS2 or the related PS. This report includes an analysis of HE's operating expenditure, an assessment of how these expenditures compare with suitable comparators/benchmarks, and considers the potential for further efficiencies.

1.3. Approach

Our approach has been to undertake a range of different analyses of operating costs, each of which offer a view of HE's cost efficiency performance to date, and indicate the potential for future savings. The components of our analysis are described in the figure below. These different components are discussed further in the analysis (Section 4 onwards), where our approach, results and assessment are presented. Further technical details of our approach to each component of the analysis are provided in ANNEX A.

Figure 1.1: Analysis components



Structure of the document

The document is structured as follows:

- **Section 2** provides the context to this study.
- **Section 3** gives an overview of our approach.
- **Section 4** contains our analysis of how HE has performed to date.
- **Sections 5 and 6** contain our analysis of top-down productivity and cost metrics for sectors that have similar characteristics to HE, as well as regulatory precedent.

⁷ In HE's Delivery Plan 2015-2020, its capex budget is allocated for both the *modernisation* and *maintenance* of its existing assets. However, generally when HE uses the term '*maintenance*' this refers to opex maintenance costs, rather than this maintenance component of capex. To provide clarity, sometimes we use the term '*routine maintenance*' when referring to opex maintenance costs. We consistently refer to maintenance activities within capex as '*renewals*'.

- **Section 7** presents our conclusions based on an overall review of our analysis.

The annexes contain the details underpinning our approach and analysis, as follows:

- **Annex A** contains a detailed explanation of the approach undertaken within each of the components of our analysis.
- **Annex B** contains additional results that support the analysis presented in the main body of this report.

2. CONTEXT AND KEY ISSUES

Highways England (HE), formerly the Highways Agency, is a government-owned company formed in April 2015. It is primarily responsible for the management and maintenance, as well as improvement, of all motorways and major roads in England, totalling around 4300 miles and carrying a third of all road traffic (by mileage). HE is currently halfway through its first Road Investment Strategy (RIS1), and is working to deliver the requirements of the associated Performance Specification (PS1). These documents set out a challenging and growing investment programme, alongside aims to increase performance, including delivering cost efficiencies, over the course of the 2015/16 to 2019/20 period.

2.1. Highways England's Resource Expenditure

In the following subsections we describe:

- HE's current resource expenditure in 2015/16, including an explanation of its various components.
- HE's expenditure in previous years (as the Highways Agency).
- HE's forecast expenditure for future years.
- The scope of costs that we consider when assessing cost efficiency.
- The cost trend used in our assessment, based on the scope identified.

2.1.1. Expenditure in RIS1

HE's opex is classified in its accounts within a category it describes as "Resource Expenditure", which are the funds required by HE to operate its network, as opposed to renewing or enhancing it. For 2015/16 HE's resource expenditure budget was £1.072bn. Separately, HE receives a capital funding allowance which covers renewals and enhancements, which in 2015/16 was approximately £1.8bn. Below we provide a breakdown of HE's RIS1 resource expenditure budget for 2015/16, sourced from HE's Delivery Plan.⁸

Table 2.1: Breakdown of Highways England's Total Resource Expenditure

Cost area	Description	2015/16 allowance
Routine Maintenance	Day-to-day repairs, winter maintenance (e.g. road gritting), maintaining road-side technology systems.	£255m
Renewal investigations	Renewals are classified as capex. However, the cost of routine inspections of the network, to establish what renewals work might be needed, is charged to resource expenditure.	£24m

⁸ Highways England Delivery Plan 2015-2020, Annex C.

Cost area	Description	2015/16 allowance
General operations	Local network management schemes, other small local projects, and some technology spend.	£74m
Traffic management / customer operations	This reflects the cost of the Traffic Officer Service, including the Regional Control Centres and the National Traffic Operations Centre. Costs include pay, equipment and training for Traffic Officers and control centre staff. It includes an element of PFI costs relating to the National Roads Telecommunications Services.	£179m
Private Finance Initiative (PFI)	Service payments on PFI contracts, where sections of road are managed under long-term (30 year) concessions.	£394m
Support Costs	Running costs incurred by Highways England indirectly supporting the activities listed above. This includes finance, procurement, HR and IT costs. Research and Development costs are also included here, as are customer communications and third party claims.	£107m
Protocols	Costs of performing specific tasks assigned to Highways England by DfT with funding streams provided. This includes the Dart Charge, Severn River Crossing and maintaining the Historic Rail Estate.	£39m
Total resource expenditure		£1,072m

Source: Based on description provided by HE via email. Costs sourced from HE's Delivery Plan 2015-2020, Annex C

It is important to distinguish between items which fall into Resource Expenditure and those considered capital expenditure. HE's renewals activities (e.g. road resurfacing) are today mostly categorised as capital expenditure rather than Resource Expenditure – these are sometimes referred to as 'capital maintenance' in HE's Delivery Plan. The routine maintenance activities within Resource Expenditure (noted above) items such as repair of road defects requiring early attention, as winter maintenance (salting, etc.), vegetation management, and maintaining/managing road-side technology systems (e.g. variable message signs, CCTV cameras, emergency telephones, etc.).⁹ Similarly the renewals costs counted as opex are only the investigatory and support work in planning and preparation for them.

Over the remainder of RIS1 (up to 2019/20), HE's resource expenditure budget is fairly flat in nominal terms. Therefore, when inflation forecasts are taken into account, forecast resource expenditure declines in real terms by 12% between start and the end of RIS1 (i.e. between 2015/16 and 2019/20).¹⁰ However, we note that resource expenditure for the start of RIS1 is

⁹ Highways Magazine article: <http://highwaysmagazine.co.uk/balfour-beatty-wins-8-7m-technology-maintenance-contract/>

¹⁰ Based on RPI inflation forecasts from the [Office for National Statistics](#).

higher than the preceding year (2014/15). Therefore, if we consider the period between 2014/15 and 2019/20, total resource expenditure is budgeted to decline by 7.5% in real terms.

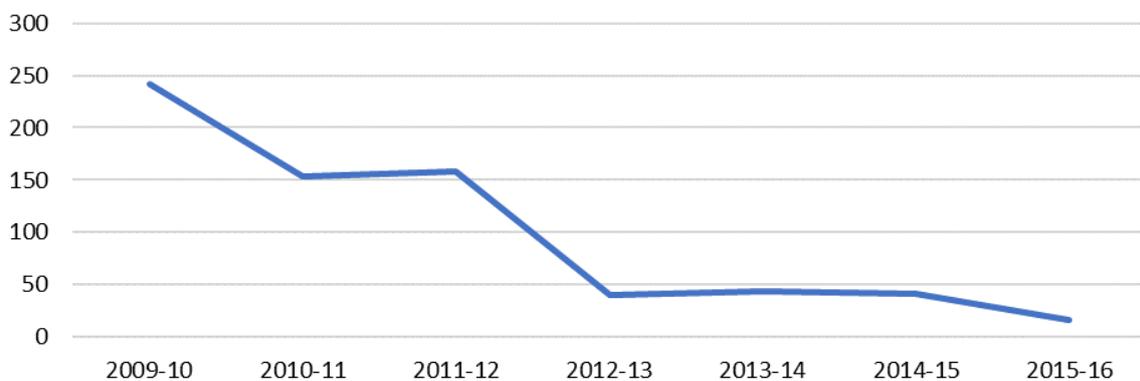
2.1.2. Expenditure in previous years

HE has provided data on its resource expenditure in previous years. However, in order to get it into a useable format, we have had to discuss and clarify several issues.

First, HE reports its costs under a different categorisation compared to that the Highways Agency used to use. After discussions with HE, we were able to take the historic trend for Highways Agency's costs and adjust it to make it more consistent with HE's current categorisation of resource expenditure for a number of years.

Second, and of greater significance in terms of magnitude, before 2012 the Highways Agency used to classify all road pavement maintenance and renewal projects below a certain value (then £100,000) as Resource Expenditure. In contrast, HE now consistently classifies maintenance or renewals as capital or operating expenditure according to *intention*, not *scale*. HE advises that this is the result of the transition to International Financial Reporting Standards in 2011/12, which impacted Highways Agency's accounting treatment (classification) of its renewals costs. This is clearly identifiable in the chart below (based on HE's classification of renewals), which shows a significant drop in renewals costs post 2011-12.

Figure 2.1: Renewals costs included in resource expenditure, £m, 2014/15 prices



Source: Data received directly from Highways England.

For the present assessment, it is important to have a consistent measure of resource expenditure over time, so that we can identify changes in costs that truly result from efficiency, as opposed to simply group or accounting classification. HE were clear on the reasons for the inconsistency shown above (i.e. the accounting changes in 2012), but after considerable engagement were not able to provide the required consistent data. Therefore, we are unable to undertake robust analysis before 2012/13 on opex if it includes the renewals component of resource expenditure. This is because the data before 2012/13 would include a major cost area now excluded from opex, which we have been unable to adjust for.

However, if we exclude the renewals component of resource expenditure, we can undertake an analysis of costs over time. From discussions with HE, this accounting classification change only occurred for renewals, and therefore no other areas of resource expenditure have been materially affected. In the following sub-sections we describe how we have undertaken additional analysis by excluding the renewals component of resource expenditure.

In summary, we have:

- Used the HE classification of data prior to RIS1, which represents an adjustment to the Highway's Agency cost data.
- Excluded data prior to 2012/13 where we have analysed a measure of resource expenditure that includes the renewals component. This ensures that the opex considered for the purposes of this study excludes all road pavement maintenance tasks that today are classified as capital expenditure.
- As a variant, excluded the renewals component of resource expenditure, in order to undertake analysis that utilises data back to 2009/10.

Finally, it is important to note that there was an efficiency challenge applied to HE's operating costs for the period 2010-2015 as part of the preceding Spending Review (SR10). The Highways Agency's Business Plan for 2012/13 indicates that the maintenance and renewals components of resource expenditure were budgeted to fall significantly during 2010-2015.¹¹ Therefore, even when the renewals component of resource expenditure is excluded from our analysis, we still take into account the change in maintenance costs during 2010-2015.

2.1.3. Scope of costs to include when assessing cost efficiency

We asked HE to provide cost data that was consistent over time. We also considered whether there were any other issues around the measure of costs that we should use when assessing cost efficiency, e.g. whether any particular components of resource expenditure should be excluded when we consider HE's cost efficiency. Following discussions with HE, we identified two key issues:

- **Controllability.** There are some categories of expenditure where HE has limited ability to influence the cost, which can be termed 'non-controllable'. The main example is long term PFI contracts which were entered into some time ago, and where the expenditure is contracted throughout the RIS period. Consistent with the Cook Report (2011), which is discussed in the following section, we consider that it is only reasonable to set an efficiency target for cost areas that are under HE's control. Therefore we remove these costs from our analysis.

¹¹ Highways Agency Business Plan 2012-13, Annex A (page 20)

- **Relevance to core activities.** HE has some categories of expenditure known as “protocols” which have been assigned to it recently, in some cases because another public body has ceased operating. Examples include railway bridges and the storage of salt for gritting. We have attempted to remove all such cost elements from consideration as they are not part of HE’s core activities.

We consider the remainder to be costs reasonably within HE’s control and relevant to HE’s core activities. For the purposes of our analysis, we refer to these costs as ‘**core costs**’ hereafter. As noted above, it is also relevant to consider a measure of opex that excludes renewals costs, in order to provide a consistent data series back to 2009/10. By taking ‘**core costs**’ and removing the renewals components of resource expenditure, we obtain an alternative measure of costs, which we refer to as ‘**core costs – R**’ hereafter (i.e. core costs minus renewals).

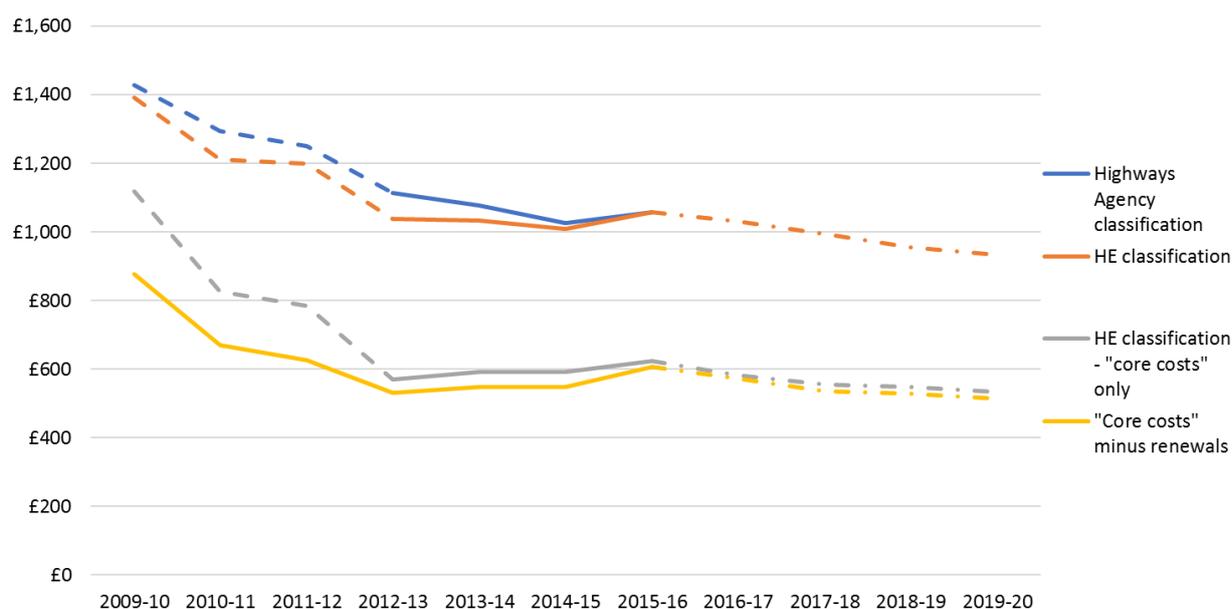
Cost area	Included within opex measure for analysis?
Routine Maintenance	Yes. We considered whether maintenance costs are uncontrollable, given that the majority of maintenance spend is under regional contracts which are only renewed every few years (on a rolling basis). However, following discussions with HE and ORR, we agreed that these are sufficiently controllable over the course of RIS1, given that contracts can be changed every few years, i.e. much more frequently than PFI.
Renewals investigations	Varies between ‘core costs’ and ‘core costs – R’ <ul style="list-style-type: none"> • ‘Core costs’: For the current year and opex forecasts, expenditure has been included in full. For previous years, we would have included these costs if an <i>adjusted</i> measure had been available, however it has not been able to collect data on a consistent accounting basis for years prior to 2012/13. Therefore, whilst we include these renewals costs within ‘core costs’, we only analyse ‘core costs’ back to 2012/13. We have not analysed ‘core costs’ in previous years to ensure the renewals resource expenditure does not include any renewals costs that would currently be classified as capex. • ‘Core costs – R’. As noted above, the renewals component of resource expenditure is excluded from ‘core costs – R’.
General Operations	Yes
Traffic Management	Yes
PFI	No – it is not controllable as contracts are very long term. It would not be reasonable to set HE an efficiency challenge for this cost area.
Support Costs	Yes
Protocol	No – protocol costs are not a core area of HE’s resource expenditure. Therefore it would not be reasonable to provide.

2.1.4. Cost trend used in our assessment

The diagram below shows the impact of the adjustments that we make in order to achieve the measures 'core costs' and 'core costs – R'. The blue line shows the data originally received from HE which corresponds to the Highways Agency's classification of costs; the orange line shows the trend after HE reclassified the Highways Agency's costs to fit with its own categorisation for resource expenditure; the grey line shows the 'core' cost trend after we have subtracted PFI and protocol costs from the HE classification of resource expenditure; and the yellow line shows core costs minus the renewals component of resource expenditure.

The trend post 2015-16 is shown as a dotted line because these are HE forecasts. With the exception of 'core costs – R', figures before 2012-13 are also shown as a dotted line because we have concerns about the reliability of renewals data for this period, as noted above. In our efficiency analysis for 'core costs' we use the figures for 2012-13 to 2015-16, and the HE forecasts. In our efficiency analysis for 'core costs – R' we use all years of available data, including HE forecasts.

Figure 2.2: HE's resource expenditure, all available years and forecast, £m (2014-15 prices)



Legend: Solid line – historic data that is consistent and reliable
Dashed line – data not comparable with 'historic data'
Dash-dot line - forecast

Source: Data received directly from Highways England

In real terms (i.e. after adjusting for inflation forecasts), core costs are budgeted to fall by 9.5% between 2014/15 and the end of RIS1. Core costs – R are forecast to fall by 6.3% over the same period.

2.2. The Cook Report

The Cook Report¹² (2011) has been a key driver of reform for the Strategic Road Network in England. Cook undertook an analysis of HE (when previously the Highways Agency) and made a number of recommendations, including the need for long term planning (to 2040) to support increased investment, improved performance, efficiency savings, and a change in company structure to become a Government-owned standalone company.

Amongst its various recommendations, Cook identified the opportunity for HE to realise annual efficiency savings across a number of areas. In particular, Cook combined top down and bottom up evidence to recommend that HE should be able to achieve its objectives while reducing its maintenance, renewal and operating expenditure (excluding major projects and PFI) by £200m by the end of RIS1, based on expenditure of £1bn in this area, i.e. annual expenditure at the end of RIS1 is circa £800m. This corresponds to a 20% reduction in expenditure by the end of the 5 year RIS1 period, i.e. 4-5% per annum, cumulative over 5 years. Cook also excluded major projects and PFI costs on the grounds that they are not sufficiently under HE's control.

Cook's recommendation was in part based on a (top down) analysis of observed efficiencies from companies operating in other regulated infrastructure sectors, e.g. rail, water and energy. Cook observed that such businesses have typically been able to achieve year-on-year cost efficiencies of c. 3–6% per annum (on average) over extended periods of time. Therefore, cumulative efficiencies of c.15–35% efficiencies should be feasible after five years.

Whilst this top-down approach means that it is hard to say exactly where Cook thought the efficiencies would come from, the recommendation was also informed by identifying scope for efficiencies in specific areas of operating costs:

- Providing greater visibility to supplier of the 'pipeline' (and funding levels) of future roads investment has the potential to generate savings of c.15–20% within HE's renewals programme.
- Developing a new model for maintenance contracting could generate savings in the region of c. 20–40%. This would involve a less bureaucratic model, with maintenance undertaken based on asset condition rather than legalistically.
- Improvements in asset management could save around 5% per annum.

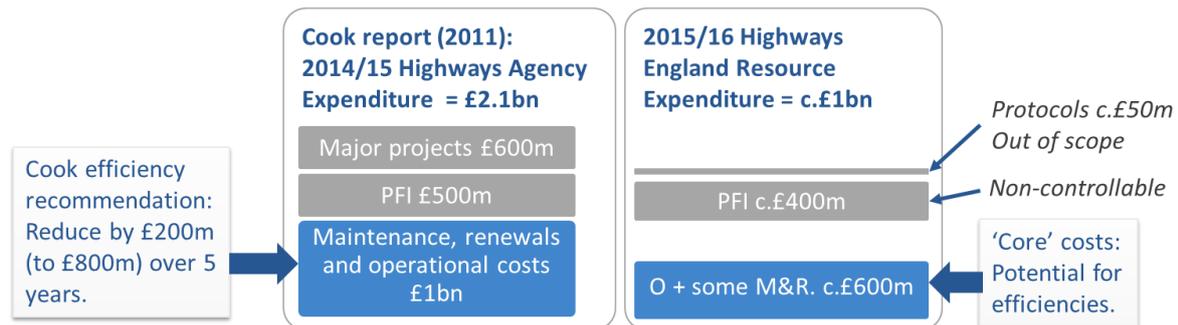
Therefore Cook's £200m savings are in fact not uniform over all the costs he considered, but some areas offer greater potential than others.

¹² Cook A., *A fresh start for the Strategic Road Network*, November 2011

2.3. Scope for efficiency savings

Cook’s recommended efficiency savings related to a broader category of expenditure than lie within our definition of core costs. In the following figure, on the left hand side, we list the categories of cost that Cook considered, distinguishing those where he recommended scope for efficiency savings (in blue), and other costs (in grey). On the right hand side we show a breakdown of HE’s resource expenditure: The ‘core’ costs are costs that are both in scope and sufficiently controllable that efficiencies are possible.

Figure 2.3: Understanding how Cook’s efficiencies might apply to HE’s resource expenditure



Legend: M = maintenance, R = renewals, O = operations.

This figure shows that the £1bn of expenditure discussed by Cook (on the left hand side) is not the same as the circa £1bn of resource expenditure in 2015/16 (on the right hand side). In particular, HE’s resource expenditure today does not include any renewals (e.g. road resurfacing) – this is currently included within HE’s capex budget. Therefore, the 20% efficiency savings applied by Cook are not *directly* applicable to HE’s current resource expenditure. Further information would be needed in order to say exactly the level of efficiency savings that Cook would propose for HE’s resource expenditure alone, and this may not be available since Cook used a top down approach.

However, we can consider Cook’s arguments for the proposed 20% saving to see whether they might apply to *some components* of HE’s resource expenditure. The first of Cook’s reasons for efficiency savings (i.e. greater visibility for renewals) is not applicable, because renewals are part of capex, not resource expenditure. The second and third reasons for savings (more efficient maintenance contracting and improved asset management) do overlap with the light maintenance and renewals inspections components of resource expenditure, although they would also be applicable to the heavier maintenance activities and renewals, which are included in capex.

In 2015-16, HE’s ‘core costs’ were £630m, of which £280m (45%) was due to maintenance and renewals costs. Therefore, if we apply a 20% efficiency challenge solely to the

maintenance and renewals components, this equates to a 9% efficiency challenge to resource expenditure in total.¹³

HE's Delivery Plan proposed a 9.5% reduction in 'core costs' over the course of RIS1.¹⁴ The estimate of Cook's efficiency challenge to total resource expenditure (9%) is broadly consistent with this. Clearly this is only an approximation, and there may well be scope for efficiency savings in other areas of resource expenditure. However, at a high level, it implies that if HE is able to meet its Delivery Plan for RIS1, it will have made efficiencies that are broadly equivalent to those proposed in the Cook Report. We consider this further later in the report.

2.4. Scope of Highways England's operating activities

The scope for efficiency is impacted by cost pressures that were not considered when Cook reported or when the business plan was developed. We understand, from discussions with HE, that it considers that there are cost pressures arising from:

- Significant traffic growth which is expected over the next couple of decades, and will increase the requirement, to some extent, for routine maintenance and traffic management. Accidents are also more prevalent as congestion increases, so there may also be greater pressure on the traffic officer service.
- Customer expectations are rising in relation to information provision (e.g. in relation to accidents and delays on motorways).
- Smart motorways are becoming more common, which requires greater signage and cameras, increased monitoring of traffic flows and potential accidents, and faster accident reaction times as the hard shoulder is not available (so traffic will build up faster without intervention).
- HE has been tasked with undertaking an ambitious £15.2 billion capital expenditure programme in RIS1. Undertaking this capital programme will involve some additional operating costs, e.g. motorway roadworks require greater traffic management. The resulting increase in network length, and installation of new services such as increasing quantities of smart motorway, will also increase the demand for services categorised as opex. On the other hand, the increasing volume of resurfacing projects completed should reduce the number of defects requiring immediate repair, classified as opex maintenance.

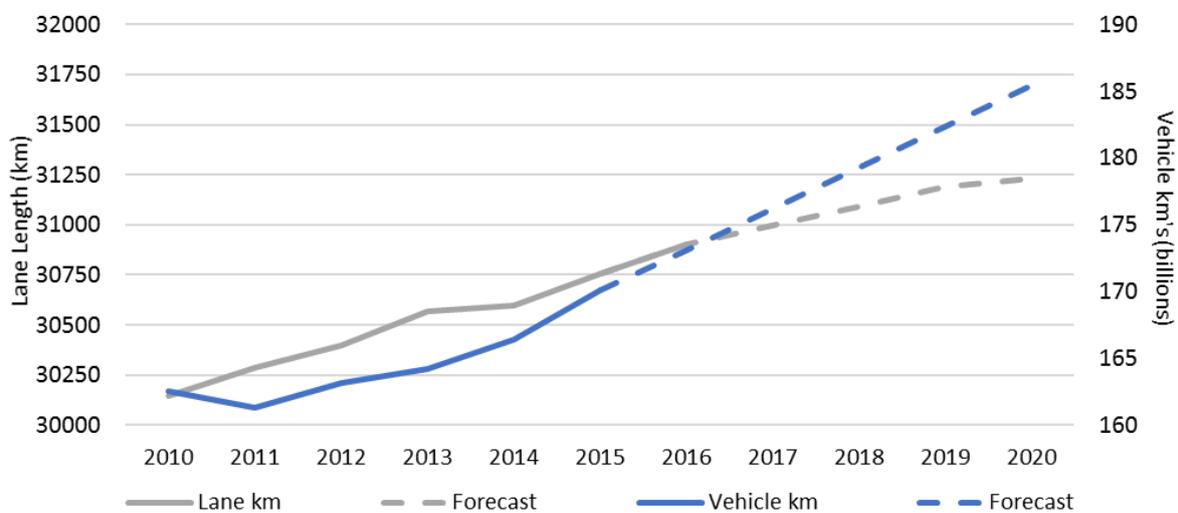
¹³ 20% (Cook efficiency challenge) × 45% (estimated proportion of resource expenditure to which Cook's efficiency challenge relates) = 9%

¹⁴ As noted in Section 2.1.1, the reduction in the budget for *total* resource expenditure is 7.5%. However, for 'core costs' only, the efficiency is larger at 9.5%.

- Since 2014, HE has started to undertake greater ‘fence-to-fence’ maintenance. Where an issue is identified that requires maintenance, HE undertakes maintenance on the entire surrounding forming the highway, i.e. from fence to fence. This means that a whole area can be repaired/maintained at once, reducing the need for HE to revisit that stretch of highway again in the near future. Whilst this approach will generate savings in the future, it requires HE to undertake a comprehensive sweep of repairs and maintenance in the short term, which may create short term cost pressures.

For reference, the recent history and forecasts increases in traffic growth and lane length are shown below. Lane length is expected to increase about 3% over the decade, whereas traffic growth is expected to be about 19%.

Figure 2.4: Evolution of lane length and vehicle kilometres of the SRN over time



Source: ¹Historic Lane Km: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/523819/road-lengths-in-great-britain-2015.zip

²Forecast Lane Km: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/424467/DSP2036-184_Highways_England_Delivery_Plan_FINAL_low_res_280415.pdf

³Historic Vehicle Km: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/523558/tra0204.xls

⁴Forecast Vehicle Km: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/411455/english-regional-plus-welsh-traffic-growth-and-speeds-forecasts-scenario-1.xlsx

However, there may also be some offsetting impacts, i.e. factors that will reduce pressure on HE’s resource budget in RIS1. In particular, the significant capital programme should reduce routine maintenance costs in the short term as road surfaces are replaced and renewed. This ‘capital substitution’ effect may reduce opex to some degree in the short term, but it may then increase again later as the new surfaces age.

2.5. Performance and cost trade-off

Another consideration is the trade-off between cost reduction and quality of service. If a company is reducing its costs, it could be achieving this either via genuine efficiency savings and/or by reducing the quality of its outputs. If expenditure is rising, this could be viewed as

inefficiency, but this might be used to deliver an improvement. This is a key reason for monitoring company performance.

HE's performance is monitored by ORR under the Performance Specification. This comprises of 8 performances areas, within which there are a small number of Key Performance Indicators (KPIs) with additional supplementary Performance Indicators (PIs). HE's main KPIs are shown below.

Figure 2.5: Four of HE's key performance targets for RIS1



Source: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/408514/ris-for-2015-16-road-period-web-version.pdf

HE's Performance Specification is relatively new, implemented in April 2015, and as such it will take time to build confidence in the metrics. More generally, a potential difficulty with some kinds of performance monitoring is that there can be a delay between a reduction in expenditure and deteriorating performance. If companies are experiencing costs pressure they may seek to delay certain activities in the knowledge that they will not face the performance consequences in the short term. As such, PIs are not necessarily a true reflection of current performance. For this report, we have not reviewed the changes in HE's KPIs, as there is not a long enough consistent series.

2.6. Summary

This chapter has identified several pieces of contextual information that inform our analysis, as well as highlighting several key issues. These are summarised below:

- There is a significant break in the data between the Highways Agency and Highways England. Different accounting approaches were used and these have proved difficult and in some cases impossible, to reconcile.
- The Cook Report proposed that a 20% reduction in HE's operating and maintenance costs was achievable over 5 years. Whilst this does not align with our definition of core costs there is some overlap, primarily for maintenance and renewals-related costs. At a high level, we estimate that Cook anticipated about a 9% reduction in operating expenditure over RIS1.

The main conclusions we draw from this part of the exercise are as follows:

- Data collection from HE was time-consuming and relatively slow, and the data prior to 2012-13 had to be excluded in our measure of 'core costs' as it did not appear to

be consistent with data from 2012-13 onwards. By excluding the renewals component of resource expenditure from 'core costs', we have been able to identify a consistent opex trend back to 2009/10 ('core costs – R'). Given these data issues, the efficiency gains and/or losses implied by HE's reported costs, particularly where HE has reclassified the Highway's Agency's data, should be considered with a degree of caution. The Highways Monitor may wish to mandate use of core costs as defined in this report for use in similar exercises.

- Some cost components of resource expenditure are not within HE's control, at least within the short term, and so it is not reasonable to subject HE to an efficiency challenge in these areas.
- However, HE's RIS1 resource expenditure budget (as per the Delivery Plan) shows a 9.5% reduction (in real terms) in 'core costs'. This appears consistent with the expectation from Cook.
- There are likely to be some emerging external cost pressures (e.g. increasing quantity of assets under management, rising traffic levels), although these may be offset to some degree by emerging opportunities for reducing opex (e.g. renewals reduce the need for maintenance).

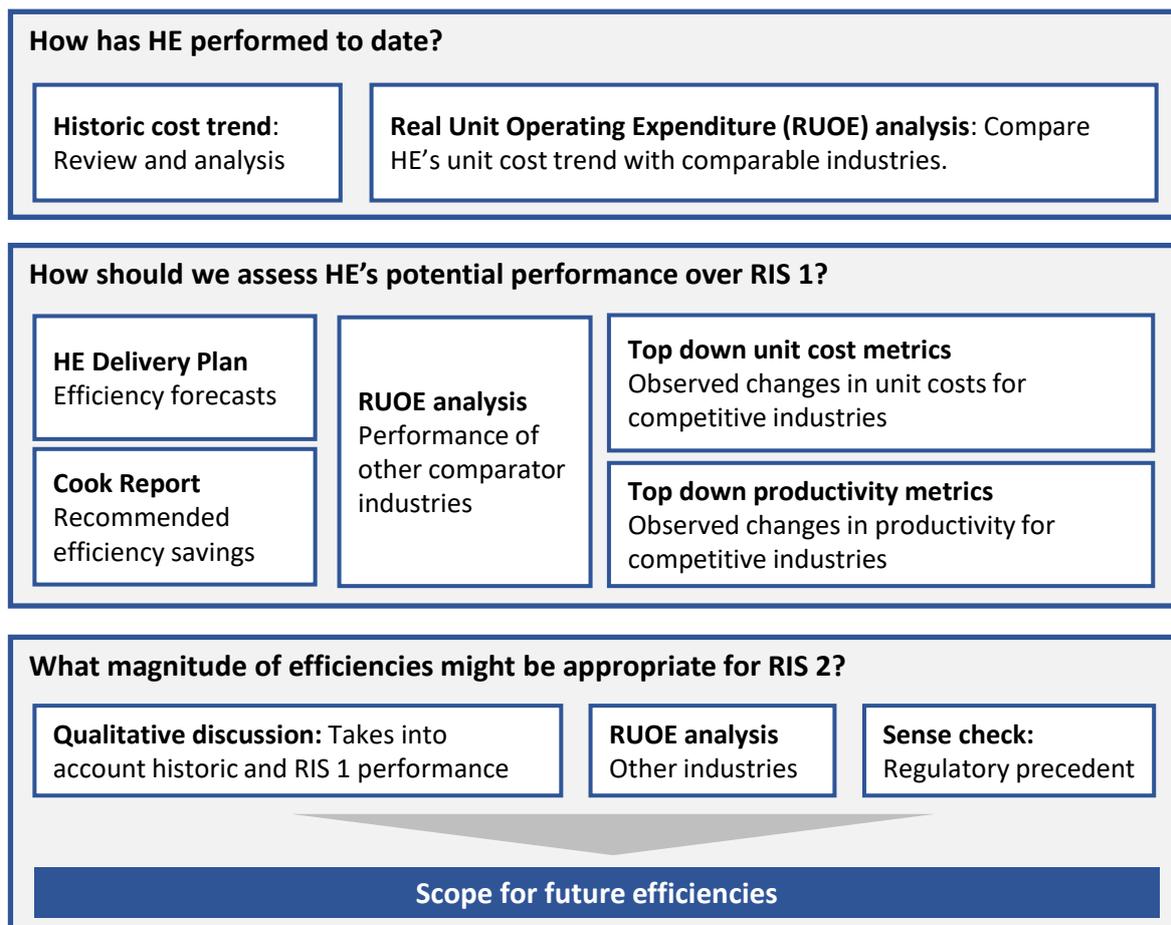
Overall, given the efficiency assumptions built into HE's future budget for resource expenditure, plus the potential cost pressures from rising passenger traffic and the considerable capital programme, RIS1 set a reasonably challenging efficiency target for HE to meet.

3. APPROACH

3.1. Overview

Having developed a reliable data set and having understood the context provided by Cook and HE's current business plan, we have used a range of different methods to assess the efficiency of HE's operating expenditure, as well as the scope for potential opex efficiency savings in the future. These are summarised in the figure below.

Figure 3.1: Approach for efficiency assessment



Further detailed explanation of our approach is included within ANNEX A.

3.2. Background

All three stages of our work rely on an analysis of Real Unit Operating Expenditure (RUOE) over time. We use this metric to benchmark HE's unit costs to other companies/industries with similar characteristics and make an assessment of the scope for efficiency based on its performance compared to those other companies/industries. This high level benchmarking method is widely used by regulators as it provides an independent assessment of the scope for efficiency that does not rely on detailed benchmarking exercises, for which the regulator may have insufficient granular data. Its use by regulators has provided evidence that scope for efficiency savings for regulated companies tends to be largest soon after privatisation, and

then diminishes over time once the ‘low hanging fruit’ (easy to achieve efficiencies) have been realised. Therefore, part of the analysis that we undertake is to split efficiency gains by the time period after privatisation in which they occurred.

HE is not regulated to the same degree as some other sectors, nor has it been privatised. Therefore, the comparison between HE and other regulated companies is not a perfect match - HE does not have the same incentive of seeking to generate profits for shareholders, nor does it have the ability to raise finance via capital markets.

However, the requirement for ORR to assess the levels of efficiency assumed in HE’s budget means that the current budget setting process, has some similarity to other regulated environments in GB (such as rail and energy). Therefore, at a high level, we can compare HE’s recent performance against regulated companies after privatisation. Since HE was under significant cost pressure between 2010 and 2015, as a result of the Government Spending Review, we consider 2010-15 to be comparable to the first period post-privatisation for other regulated networks. Following this, we take RIS1 to be comparable to the second 5-year period after privatisation.

3.3. Benchmarking of Real Unit Operating Expenditure

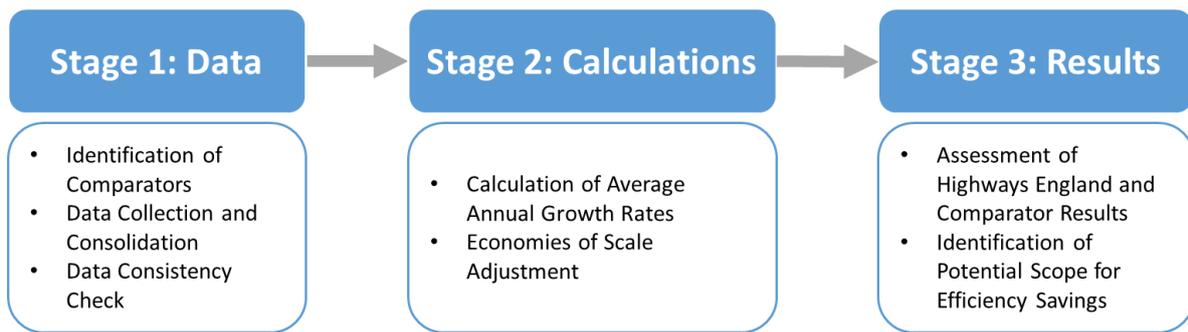
Real Unit Operating Expenditure (RUOE) is operating expenditure divided by an indicator of output. We calculate the change in RUOE as this provides a measure of changes in unit costs over time. We calculate changes in RUOE for HE and a selection of industries with similar characteristics. This enables us to compare HE’s historic performance against such industries/companies. We take into account both productivity gains and changes in input prices. For a full summary of our process in making this analysis, see annex A.3.

The change in RUOE is a proxy for cost efficiency, rather than being a precise measure. Further, in comparing its evolution with other highways networks and other industries, we need to bear in mind that each of these have some specific characteristics. For example, in comparison with other industries, the growing levels of road congestion are a cost pressure specific to road networks. However, there are enough similarities between HE and our chosen comparators to make this observation relevant at a high level, e.g. all regulated sectors face pressures to improve quality.

3.3.1. Overview of methodology

Our methodology for estimating RUOE metrics is summarised in the figure below.

Figure 3.2: Approach to the benchmarking of RUOE



Building on our previous work across various sectors, we have developed a detailed dataset of costs and output measures for a large number of companies. We identified relevant comparators for HE and then collected new data where appropriate. For a road sector comparator, we have selected Transport Scotland whom hold a similar role in terms of their road responsibility, and have the required data available. We have also selected the following comparators, as discussed in Annex A.3.2:

- rail network
- electricity distribution and transmission
- gas distribution and transmission
- water and sewerage
- airports
- air traffic control

3.3.2. Output metrics

In calculating HE's RUOE, an important decision is what output metric we should use. The main options are

- Vehicle-km – the quantity of traffic that HE's network facilitates, or
- Lane-km – the quantity of road that HE manages, taking basic account of the different widths of road.

In practice, we will present results for both of these as there are arguments for each. What we are looking for is ideally some measure of output which opex would be related to. Many of HE's opex costs are related to the quantity of road it has to manage – for example winter gritting costs. Other costs might vary with traffic – for example road damage repair. However these things are not always clear. HE has explained to us, for example, that the size of a traffic officer team for a given road section will not change for a wide range of road traffic. Also, there are opex costs which are related to the quality rather than the quantity of output. Similar issues affect the comparator industries too. Thus, we need to understand that this is a rather approximate tool and we need to be aware of the shortcomings.

3.3.3. Adjustment for economies of scale

We also undertake an adjustment for economies of scale within our RUOE calculations to account for opex reductions that may occur as a result of output growth, as oppose to genuine improvements in efficiency. For example, HE might be able to accommodate an increased volume of traffic on its network without having to increase opex by the same proportion. The adjustment was achieved through the application of a cost elasticity value, specific to each industry, to the RUOE calculations. These cost elasticities represent the percentage change in costs that would arise from a one percent increase in output.

From research on relevant literature, we have assumed the following cost elasticities for HE:

- 0.3, with respect to vehicle km. This implies that large economies of scale exist, so an increase in vehicle km would require a smaller increase in opex.
- 0.84, with respect to lane length. This implies that there are only limited economies of scale – if road length increases, opex will need to rise by a similar proportion.

Further explanation is provided in Annex A.3.

3.4. Forming conclusions

In our conclusions we take the results from the different components of our analysis and combine them in order to reach an overall view. This is not a mechanistic process – some judgement was required. In the subsequent sections we set out our findings in each area of analysis before making summary observations and drawing conclusions.

4. HIGHWAYS ENGLAND'S PERFORMANCE TO DATE

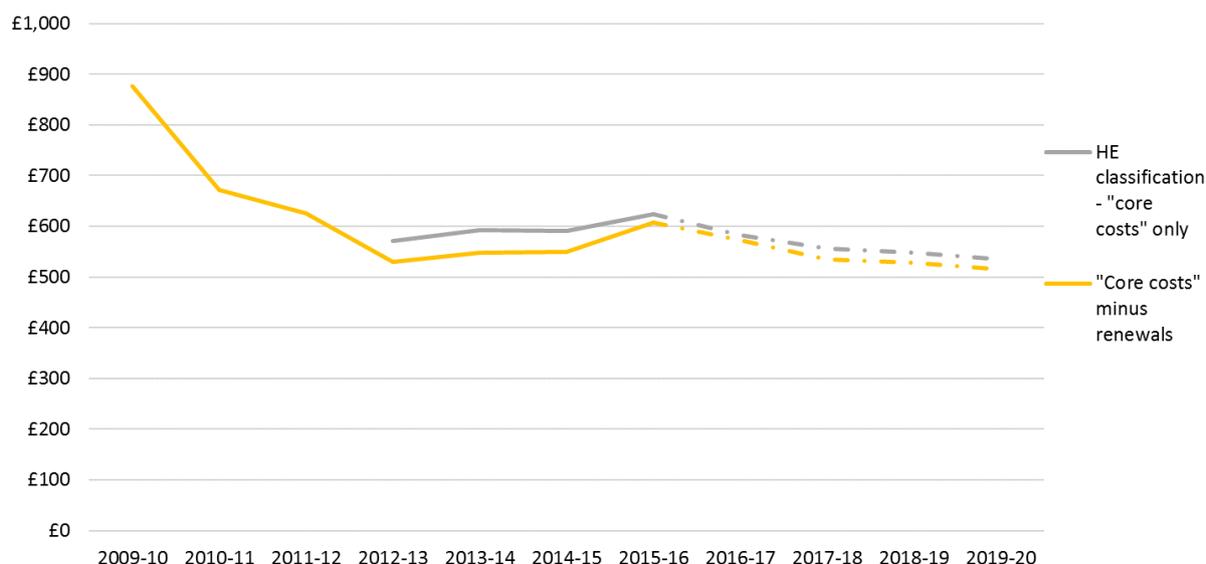
4.1. Introduction

In this section we consider how HE has performed to date in terms of its level of 'core costs'. As noted in Section 2.1, establishing a consistent opex series for HE has been challenging. In order to create a consistent time series from 2009/10 onwards we have concentrated on the narrower cost category 'core costs – R'. We are only able to analyse all 'core costs' in a consistent time series from 2012-13 to 2015-16 inclusive.

4.2. Analysis of historic costs

The chart below shows the historic costs that we include in our efficiency analysis. As noted earlier, we assess both 'core costs – R' (using all years for the period 2009-10 to 2015-16) and 'core costs' (using data from 2012/13 onwards, due to the inconsistency of renewals data prior to 2012/13). Below, we also show forecast costs as dotted lines.

Figure 4.1: HE resource expenditure, core costs only, 2012/13 onwards, £m (2014/15 prices)



Source: Data received directly from Highways England.

'Core costs' (and 'core costs – R') have risen slightly since 2012-13. This is due primarily to increases in traffic management costs, support costs, and general operations. However, there were also some changes in accounting practices prior to 2015/16, so we cannot say for sure in which specific area these cost increases occurred. HE has stated that *"figures for General Operations, Traffic Management and Support costs are split based upon apportionment of 15/16 actuals due to changes in account code structure making figures incomparable"*.¹⁵

¹⁵ Clarification received from HE in relation to their resource expenditure data.

However, by focusing on ‘core costs – R’, we demonstrate that costs fell significantly prior to 2012-13. From discussions with HE, we understand that the SR10 efficiency challenge (discussed in Section 2.1) drove several changes in HE’s maintenance practices between 2009-10 and 2012-13, and that lower maintenance costs are the source of the observed cost reduction before 2012-13.

HE has provided us with some additional explanation on this issue.¹⁶ From 2010, HE designed a new type of contract for maintenance opex, known as an Asset Support Contract (ASC). This was more focused on outcomes, rather than outputs, encouraging contractors to focus on undertaking activities which had the greatest impact on outcomes, rather than prescriptively following a list of pre-specified activities. In some cases, these contracts also changed the standards that contractors were required to achieve, e.g. reducing accident response time targets from 20 minutes to 30 minutes, or only requiring grass close alongside carriageways to be cut, as opposed to grass further away from the highway as in the past. As an example, within technology maintenance, HE switched to maintenance contracts which were “*more targeted and outcome-based*”, known as Regional Technology Maintenance Contract (RTMCs).¹⁷ Previously, contracts were more bureaucratic/legalistic.¹⁸ Overall, this suggests that HE managed to reduce its maintenance costs via a mix of pure efficiency gains (ie doing the same thing for less cost), scope reduction and changes to standards for maintenance activities. Some of these scope and standard changes may nevertheless amount to removing outputs that were not an effective use of funds in terms of the outcomes users require. Thus the distinction between an efficiency gain and a scope reduction is not clean.

4.3. Historic benchmarking of Real Unit Operating Expenditure

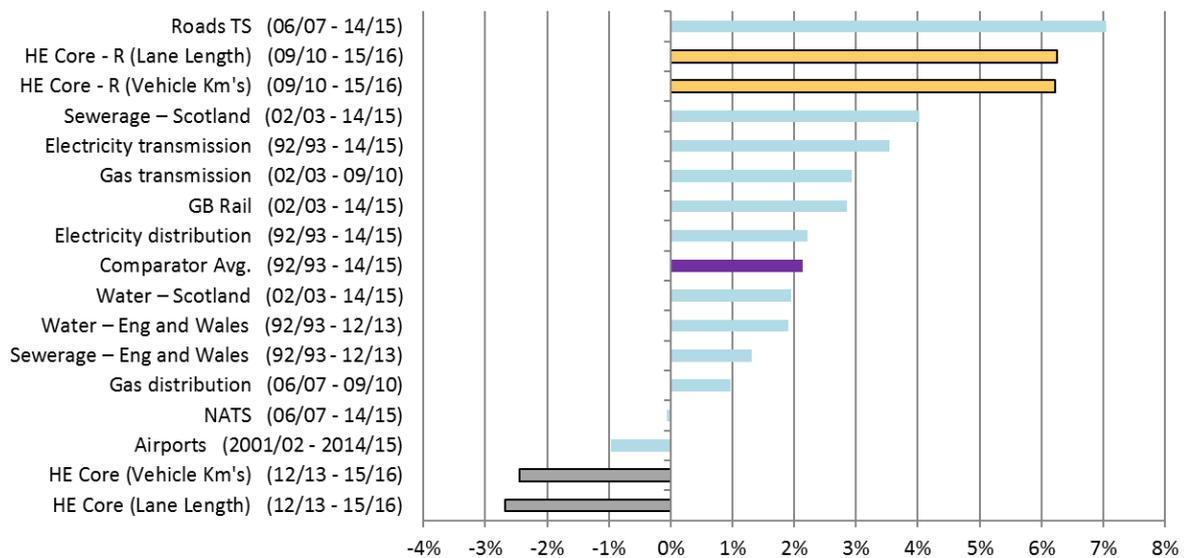
The following chart shows the average annual reduction in real unit operating costs, for HE and a number of comparators. We show it as a reduction consistent with the convention that *efficiency improvements* are shown as *positive* numbers. We have calculated the average as a geometric mean. In the chart below, HE’s efficiency performance is shown based on historic data available, including the first year of RIS1. For ‘core costs’ this includes data for 2012/13 to 2015/16, whilst for ‘core costs – R’ this includes 2009/10 to 2015/16.

¹⁶ Discussions with HE

¹⁷ Highways Agency Business Plan 2012-13, page 11.

¹⁸ Discussions with TRL

Figure 4.2: Average annual reduction in RUOE for HE and selected comparators



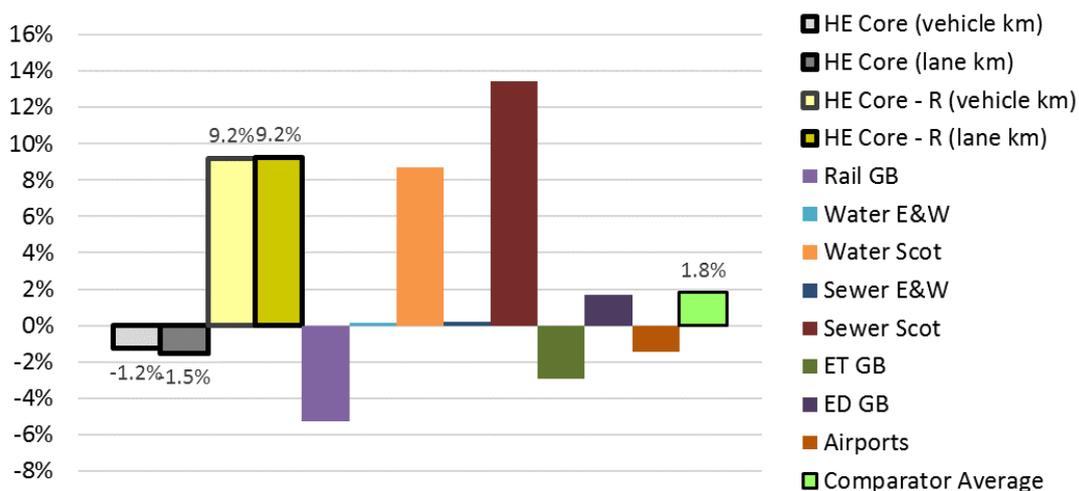
Legend: HE: Highways England, TS: Transport Scotland

Source: CEPA Database (full details of all data sources available in A.3.1).

The chart above shows that all of our chosen comparator sectors (with the exception of airports and NATS) have made efficiency gains. If we focus on 'core costs' only (and therefore only include data from 2012/13 onwards), HE has become less productive; a result of its rising costs. However, if we focus on 'core costs - R', HE has significantly increased productivity - this result is driven by the large fall in maintenance costs before 2012/13.

We can also compare HE's performance for the period immediately prior to RIS1 to provide a view of HE's performance against comparator industries' first control period after privatisation. The chart below shows this comparison.

Figure 4.3: Average annual reduction in RUOE for the 1st control period for HE and comparators



Source: CEPA Database (full details of all data sources available in A.3.1).

Note: Gas transmission/distribution and NATS are not included in this figure due to 1st control period data not being available for these comparators.

Time periods for the data in this chart are as follows: HE 'core costs' 2012/13 to 2014/15; HE 'core costs - R' 2009/10 to 2014/15; Rail 2002/03 - 2003/04; Water and Sewerage E&W 1993/94 - 1994/95; Water and Sewerage Scot 2003/04 - 2005/06; Electricity Transmission 1991/92 - 1992/93; Electricity Distribution 1991/92 - 1994/95; Airports - 2001/02.

Based on the 'core costs' measure, HE became less productive during the period 2012/13 – 2014/15. The loss of productivity is –1.5% when lane-km is the chosen output metric, or -1.2% when vehicle-km is the metric. However, HE shows evidence of significant productivity gains based on the measure of 'core costs – R'. Other comparable industries made operating productivity gains of 1.8% per annum on average during their first regulatory period post privatisation.¹⁹ This could be considered as a high level benchmark for HE, if HE had maintained a constant level of service provision.

Overall, by excluding renewals (i.e. focusing on 'core costs – R'), these results highlight that HE shows signs of significant productivity gains since 2009/10. As noted earlier, this is driven by a reduction in maintenance costs, which is likely due to a mix of efficiency gains, scope reduction and changes to standards for maintenance activities. However, without further analysis it is not possible to say which factor was the main cause. We also note that HE's productivity has fallen since 2012/13.

4.4. Efficiency savings in practice

It is important to consider the extent to which efficiency savings can be realised in practice. For example, the traffic officer service involves traffic officers physically being present at an accident or traffic event. Some efficiencies are clearly possible, e.g. improved rostering, whether to have officers driving or stationary, etc. However, after such efficiencies are realised, it becomes harder to achieve additional savings. Another example is back office (support) costs – the company has to have a finance/IT/HR department, and while some efficiencies are possible (e.g. automated software packages), it is difficult to *continuously* achieve cost savings in these areas.

As noted in Section 4.3, we could consider that annual efficiency savings of 1.8% (based on historic efficiencies observed for comparator sectors) could be considered as a benchmark for HE's 'core costs' prior to RIS1. We acknowledge that this metric is 'top-down' in nature, and does not provide an explanation for how these savings could be realised in practice. However, we have sought to mitigate for this in two ways:

- *We have compared HE to industries with similar characteristics.* We have primarily included large network industries/companies that have similar activities, e.g. for water companies, leakages can only be addressed by staff visiting the site and undertaking repairs, so there is some similarity with HE in terms of the potential for efficiency savings in relation to operating costs.
- *We use data from the early years of these industries' regulatory cycle.* As noted above, efficiency savings may fall over time, and this is particularly evident where public

¹⁹ We note that some industries, such as water and electricity distribution, show relatively small cost efficiencies in the first period post-privatisation, which reflects the time taken for the companies to adjust to their new structure and newly regulated environment.

industries/companies have been privatised and then regulated. As such, when determining an appropriate benchmark for HE, we consider how companies have performed in the period shortly after privatisation.

Whilst we attempt to make our recommendations practical to the extent possible, the remit of this report does not extend to considering in detail the practical details of implementing efficiency savings. This is an area in which HE should take the lead, and it will no doubt have considered how to practically achieve efficiency savings when preparing its Delivery Plan. However, this is also an area where ORR may wish to undertake further investigation.

4.5. Summary

Overall, our RUOE analysis indicates HE's operating efficiency has (based on 'core costs – R'), has increased with evidence of significant productivity gains by HE. These were driven by lower maintenance costs, but without further analysis it is not possible to say whether efficiency gains, scope reduction or changing to the standards of maintenance activities were the main cause. Over the shorter period since 2012/13, i.e. both 'core costs' and 'core costs – R' have risen by more than the chosen output measures (vehicle traffic or lane length), such that unit costs have also risen. We have found some indication that HE has been producing additional output in some areas, which may be impacting this. For example, since 2013/14, HE has been undertaking greater 'fence-to-fence' maintenance, as noted earlier. This is likely to have increased HE's recent costs, but should generate efficiency savings in future years.

Depending on whether we include performance prior to 2012/13, it affects how HE compares to the other industries/companies in our analysis. Therefore, without a further understanding of the drivers behind HE's lower maintenance costs prior to 2012/13, it is not possible to make a definitive statement of how HE compares against these other industries/companies.

5. HIGHWAYS ENGLAND'S POTENTIAL PERFORMANCE IN RIS1

5.1. Introduction

Having reviewed HE's historic performance in the previous chapter, we now consider HE's future projected performance, and specifically its forecast expenditure as per its Delivery Plan. We calculate a number of benchmarks for HE's future performance over RIS1. Our aim is to consider that if HE meets the budget in the Delivery Plan, whether the revised costs are likely to represent an efficient level of performance. This is important context for setting efficiency targets in RIS2, because any underperformance in RIS1 may suggest greater scope for catch-up efficiencies in RIS2.

We have chosen several benchmarks to provide a broad comparator base. These are as follows:

- **Top-down productivity metrics.** These measure the change in the volume of outputs relative to the change in the volume of inputs. We assessed sectors that exhibit most similarity to the components of HE's opex.
- **Partial factor cost measures.** These calculate changes in input costs, per value of output. As per the productivity metrics, this is undertaken for sectors that are most similar to the components of HE's opex.
- **RUOE.** We review the historic efficiency performance of comparators with similar characteristics to HE.

It is important to note a key difference between the three benchmarks that we utilise. The top-down productivity metrics and partial cost measures tend to suggest lower efficiency gains than the RUOE metric. This is because they are based on industry data from across the whole UK economy, including many competitive markets where scope for efficiency gains tends to be lower, whereas our data sources for RUOE are mainly companies in regulated sectors (to increase comparability with HE).

However, even the most efficient companies can be expected to make efficiency improvements over time - for example, by employing new technologies or working processes. We describe such companies as 'operating at the frontier of efficient performance', and the efficiency gains they make over time are known as 'frontier shift' efficiencies. Companies that are not as efficient will need to 'catch-up' to others if they themselves wish to be considered as efficient. This is referred to as 'catch-up' efficiency. These concepts are explained in more detail in Annex A.1.

Having established a number of benchmarks, we then consider HE's forecast resource expenditure under different scenarios.

- **Meets the budget.** HE performs in line with the RIS1 budget as per its Delivery Plan, i.e. a reduction in real costs of 9.5% over RIS1. As noted earlier, this may not be

dissimilar to the recommendations in the Cook Report, i.e. a reduction in real costs of 20% over RIS1, but relevant to only certain aspects of resource expenditure.

- **Stable in real terms.** HE performs, with resource expenditure, stable in real terms throughout the remainder of RIS1. Given the apparent lack of any cost efficiency savings for the period 2012/13 to 2015/16, we have also considered this cost projection as a more conservative forecast scenario.

5.2. Benchmarking of top down productivity metrics

5.2.1. Introduction

One way of examining what level of productivity changes HE should be able to achieve is to consider the overall rate of productivity growth in the economy. A potential difficulty in applying such information is that different sectors of the economy achieve different rates of improvement in productivity. We can correct for this in part by looking at sectoral rates of productivity growth, and potentially forming a weighted average aiming to reflect HE's own components of production.

We have studied three productivity metrics based on UK-wide data across a number of years. These metrics reflect different measures of productivity. Data is sourced from the EU KLEMS dataset.²⁰ As noted above in Section 5.1, the data relates mainly to competitive industries, and thus could be argued to relate mainly to 'frontier shift' efficiency.

We considered several measures of productivity for which UK-wide data is available across a number of years.

- **Total Factor Productivity (TFP):** 'Residual' output growth that is not accounted for by input growth, taking into account all factors of production. TFP is calculated using either the gross output or value added measure – the former includes the contribution from intermediate inputs, whereas these are excluded from the latter.
- **Labour and intermediate inputs (LEMS) Productivity (LEMSP):** The abbreviation LEMS refers to Labour Energy Materials Services. LEMSP is 'Residual' output growth that is not accounted for by the growth of labour and intermediate inputs. This is calculated under both flexible and constant capital assumptions.
- **Labour Productivity (LP):** The growth of output per unit of labour input growth. Or, consistent with the explanations above, 'residual' output growth that is not accounted for by the growth of labour inputs.

Further explanation of how these metrics were calculated is below and in Annex A.2.

²⁰ The EU KLEMS dataset was developed with support from the European Commission (EC), and contains various measures (economic growth, productivity, employment creation, capital formation and technological change) at the industry level for all EU member states from 1970 onwards. See: <http://www.euklems.net/>

5.2.2. Variants of the productivity metrics

We calculate each productivity metric in a number of variants. These are summarised in the table at the end of this sub-section. The variants arise from three distinctions we make when calculating them, as follows.

- **The measure of output** – either gross output or value added. Under the gross output measures of productivity, intermediate inputs are assumed to contribute to productivity growth, whereas their impact is removed in the value-added measure. These measures generally give similar results, as shown further below.
- **Capital variability** – either variable capital or constant capital. Capital is an important factor of production, however the effect of capital growth is sometimes distortionary. To mitigate that, the measures can also be calculated using a constant capital assumption. In considering the efficiency of HE’s opex, we consider both are relevant:
 - On one hand, HE’s resource expenditure budget is set at the same time as its capital budget, and DfT/ORR are likely to take into account growth of the capex budget *to some extent* when setting opex targets. Therefore there is an argument for assessing productivity benchmarks that allow for capital to vary.
 - On the other hand, the relationship between capex and opex is not always clear, and opex budgets are often set with reference to opex efficiency gains observed in other sectors. Therefore it is also relevant to develop an opex productivity benchmark for HE that holds capital constant.
- **The period of data coverage** – either using all available years of data (denoted “1”) or selected years of data (denoted “2”). The variant “1” is a fixed period. However for variant “2”, there are a number of options available, and these are used as sensitivities. We explain this in more detail in the following text.

Data coverage

The EU KLEMS database provides an extended coverage of years, and there are also several releases of the data which do not provide the same information each time.

- National productivity data has been released within the EU KLEMS database on several occasions over the last decade – in 2009, 2012 and 2016. We have used all of these sources in our analysis. We refer to these as different **data releases**.
- Within each data release, the data covers different **time periods**. The 2009 release is the largest dataset and contains data between 1970 and 2007. Given that productivity can be pro-cyclical, we believe it is appropriate to calculate changes in productivity based on complete business cycles, and thus there is an argument for selecting the average of the period rather than simply using all of the available data.

For completeness, our approach has been to calculate productivity benchmarks firstly using all of the available data (variant “1”), and secondly using our view of the most relevant data (variant “2”), but in a number of sensitivities.

- For the value-added measures, all three data releases provide useful information. In general, we consider the latest data releases to be the most accurate. However, because the 2016 release also contains the period 2006-2014, which was unusual from an economic perspective due to the global recession, we do not think it is appropriate to focus solely on the 2016 data release. Therefore, in our variant “2” metrics we have used both the 2012 and 2016 data releases, but have not included the single most recent business cycle on its own (2006-2014). For the same reason, our “**base case**” (main estimate) for value-added measures (VA), within the period options for variant “2”, is the period 1998-2014. This base case uses the most up-to-date 2016 dataset, but calculates an average across the *two* most recent business cycles.
- For the gross output measures, only the 2009 data release provides useful information, because the 2012 and 2016 releases only have value-added data. Our “**base case**” (main estimate) for gross output measures (GO), within the period options for variant “2”, is therefore the most recent business cycle available in the 2009 release, which is 1997-2006.

We summarise this in the following table.

Table 5.1: Data sources and periods used in different productivity metrics

Gross output or value added	Metrics included	Data releases used	Business cycles covered by the data release
Gross output	TFP GO LEMSP var K LEMSP con K	2009 data release	*1997-2006 (1 business cycle) 1986-2006 (2 cycles) 1978-2006 (3 cycles) 1972-2006 (4 cycles)
Value-added	TFP VA (1 and 2) LP var K (1 and 2) LP con K (1 and 2)	2016 data release	2006-2014 (1 business cycle) * 1998-2014 (2 cycles)
		2012 data release:	1997-2006 (1 business cycle) 1986-2006 (2 cycles)
		2009 data release	1997-2006 (1 business cycle) 1986-2006 (2 cycles) 1978-2006 (3 cycles) 1972-2006 (4 cycles)

Notes: * An asterisk indicates our main estimate or **base case** assumption

Bold text indicates where data has been included within a variant labelled “2”, e.g. LP VA 2.

Finally, in order to calculate a relevant benchmark for HE, we selected the most appropriate comparator sector (or multiple comparator sectors, if appropriate) within the EU KLEMS database. We employed judgement in determining the comparator sectors, so we considered

whether the comparator sectors could be varied. As such, we calculated **sensitivities** for each variant of the measures. The sensitivities use a different weighting or basket of the comparators. As noted above, we also, in some cases, used the data coverage period as a sensitivity for the variant “2” measures.

Summary of metrics

The following table summarises all the variants of the productivity metrics we calculated.

Table 5.2: An overview of the variants of productivity metrics calculated

Metric	Factors of production included	Output measure	Capital variability	Period of averaging	Acronym
Total factor productivity (TFP)	Total (Capital, Labour and intermediate inputs)	Gross output	Variable capital	All available years	TFP GO
				Value-added	All available years
				Selected years	TFP VA 2
LEMS productivity (LEMSP)	Partial (Labour and intermediate inputs)	Gross output	Variable capital	All available years	LEMSP var K 1
				Selected years	LEMSP var K 2
			Constant capital	All available years	LEMSP con K 1
				Selected years	LEMSP con K 2
Labour productivity (LP)	Partial (Labour only)	Value-added	Variable capital	All available years	LP var K 1
				Selected years	LP var K 2
			Constant capital	All available years	LP con K 1
				Selected years	LP con K 2

5.2.3. Approach

For each of these three productivity measures (in Section 5.2.1), we identified sectors of the UK economy which we consider (having discussed choices with ORR and HE) are the most similar to the components of HE’s opex, and used these to develop a composite index specific to HE that is matched to HE’s activities as follows:

- We divided HE’s opex into cost areas, and calculated the percentage within each area.
- For each cost area, we selected the most appropriate comparator sector (or multiple comparator sectors, if appropriate) for which productivity data was provided. (As sensitivities, we selected various alternative weightings of the comparator sectors.)

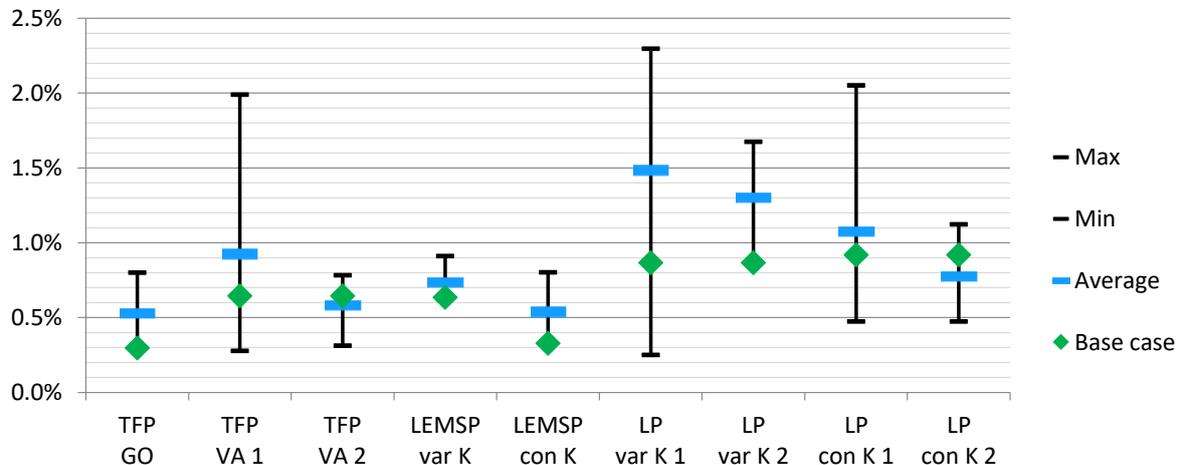
- For each of these relevant sectors, we calculated initial (unweighted) productivity metrics based on the EU KLEMS database.
- We used the percentages in the first step to weight the selected sector productivity metrics and calculate a weighted composite index (specific to HE) to act as a suitable comparator for HE.
- We calculated each of the variants to the metrics described in the previous section.
- We carried out sensitivity analysis as follows. For each metric we calculated a number of sensitivities based on comparator sector weights. For some of the variant “2” metrics, we calculated sensitivities based on the number of business cycles covered. This produced a range of results. Within that range, we report the **Maximum**, **Minimum**, **Average**, and our **Base Case** (described above).

These methodological issues are discussed in more detail in Annex A.2.

5.2.4. Results and analysis

The results for our TFP, LEMS productivity and labour productivity analysis are provided below, detailed explanations of these tests, as well as further detailed analysis, can be found in the Annexes.

Figure 5.1: Productivity gain per annum



Source: EU KLEMS dataset, CEPA analysis

Abbreviations: GO = Gross Output, VA = Value-added; TFP = Total Factor Productivity; LEMSP = LEMS Productivity, LP = Labour Productivity; var K = variable capital, con K = constant capital. “1” and “2” refer to coverage period variants.

All of our base case results are in the range 0.3% to 0.9% per annum. We have considered which measure is most appropriate in relation to HE’s resource expenditure:

- TFP, by nature, measures productivity for all factors of production, including capital. However, we are considering resource expenditure (which excludes capex), so TFP is less appropriate than the LEMS or LP metrics.

- The difference between LEMS productivity and labour productivity is the efficiency gain made due to intermediate inputs (energy, materials and services). Whilst some intermediate inputs are included within HE's operating cost base (i.e. energy for providing signage and materials used for light maintenance), the remainder are likely to sit within HE's capex base (i.e. materials and capex-related services such as construction). Therefore, we consider that both LEMS productivity and labour productivity should be taken into account when reaching a final estimate for the scope of efficiency.
- Finally, there is a choice between LEMS (or labour) productivity at either constant capital, or with variable capital. Given that DfT/ORR are likely to take into account changes in capex when setting opex efficiency targets, this favours using a variable capital approach. However, the relationship between capex and opex efficiencies is difficult to determine, so it is also prudent to take into account the constant capital productivity metric.

5.2.5. Summary

The 'base case' LEMS and labour productivity gains with variable capital are in the range 0.6% to 0.9% per annum, i.e. outputs grow by 0.6-0.9% per annum more than inputs. These are our preferred results. However, if we were to take into account the 'base case' LEMS and labour productivity gains under the assumption of *constant capital*, this would widen the range of productivity gains to 0.3% (low end) to 0.9% (high end) per annum.

Applying this to HE, the implication is that a reasonably competitive company with similar activities to HE will have made productivity gains at around 0.6% to 0.9% per year. Therefore this is a reasonable proxy benchmark to apply to HE's future performance.

5.3. Benchmarking of partial factor cost measures

5.3.1. Introduction

Partial factor cost measures calculate the percentage annual changes in operating costs. They are based on the top-down productivity metrics and adjusted for variations in input prices to provide a measure of *cost efficiency*. Partial factor cost measures can be compared to the change in RUOE, because they take into account changes in both physical productivity and input prices. Given that we are considering HE's opex efficiency, we focus on partial factor cost measures that include changes in labour and intermediate inputs, but exclude capital inputs.

There are some further reasons why whole economy or whole sector partial factor cost measures do not compare exactly with the RUOE we calculated for comparator regulated industries:

- Many of the comparator industries for which we calculated the average change in RUOE are regulated industries, operating within a monopoly environment, or at least having significant market power. Therefore, they are likely to have greater potential for catch-up efficiency over the course of the period we considered. In contrast, these partial factor cost measures are derived by considering productivity across a much wider range of sectors in the UK economy, many of which are more competitive than the selected comparators we chose when calculating the average change in RUOE. So on average whole industry/sector partial factor productivities are likely predominantly to represent frontier shift when applied to regulated/public sector companies. Therefore, on average we might expect these cost measures to exhibit lower productivity gains than we saw looking at changes in RUOE for selected comparator industries.
- The simple change in RUOE we calculated did not involve any adjustment for capital substitution. So to the extent that the comparator companies engaged in capital substitution, that would appear to represent a unit productivity gain. This again is likely to mean that the change in RUOE for our selected comparators is larger than the partial factor productivity measures under the constant capital assumption, i.e. where the impact of capital inputs on outputs is controlled for.

5.3.2. Methodology

Our methodology for calculating these cost measures is the same as the methodology used for the top-down productivity metrics, i.e. we have used the same data sources, comparator weightings, time periods, permutations (gross output and value-added, variable and constant capital). As such:

- The LEMS cost measure is based on gross output productivity data. Therefore our base case (main estimate) is based on the 2009 data release, and the most recent business cycle (1997-2006) within this dataset.
- The Labour cost measure is based on value-added productivity data. Therefore our base case (main estimate) uses the 2016 data release, and is based on data for the period 1998-2014, i.e. the two most recent business cycles.

5.3.3. Results and analysis

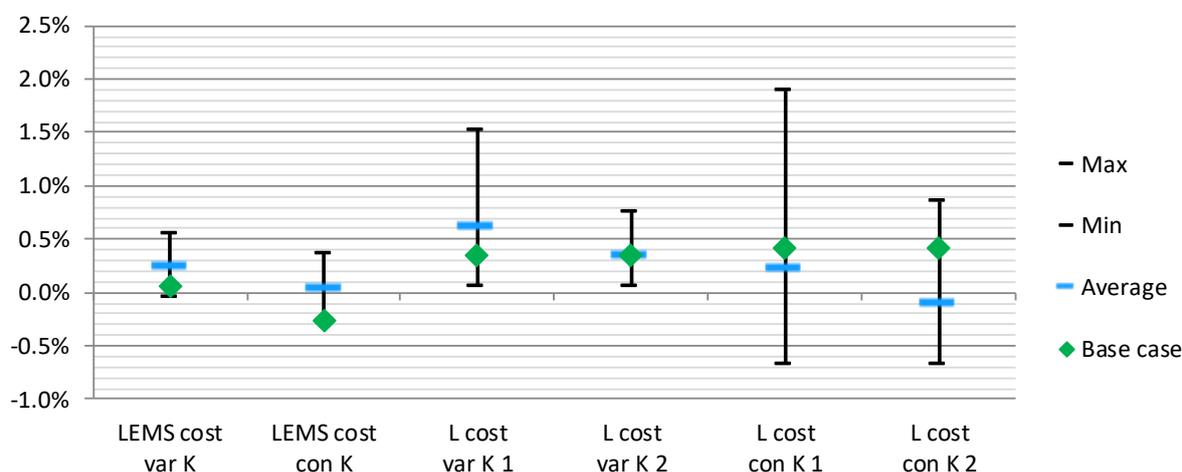
The results are presented below. This shows the average annual unit cost efficiency gains for industries similar to HE, based on a weighted average of relevant industries. Acronyms are provided below the chart. For the labour cost metric we have included two ranges:

- Based on all data: The number “1” is used in the acronym.
- Based on the most relevant data, having removed (in our judgement) the least relevant data points (i.e. the results from the 2009 data release, given it is the oldest

data; and the 2006-2014 result, given was a highly unusual period). Here, the number “2” is used in the acronym. This does not affect our base case assumption.

Taking all results together, in the following chart we present our base case, the range, and the average (based on the different time periods and sensitivities discussed above).

Figure 5.2: Average annual change in factor productivity



Source: EU KLEMS dataset, CEPA analysis

Acronyms: LEMS cost = LEMS cost measure; L cost = Labour cost measure; var K = variable capital; con K = constant capital

Based on our base case choices, the chart shows that LEMS cost efficiencies were -0.3% to 0.1% per annum on average, whilst labour cost efficiencies were circa 0.9% per annum on average.

5.3.4. Summary

Consistent with our analysis for the top-down productivity metrics, our preferred results for cost efficiency are based on measures which allow for variable capital. When taking into account both LEMS and labour productivity measures, the annual productivity gains (under the base case) are in the range of 0.1% to 0.9%. If we were to include constant capital, the bottom of the range would move to -0.3%. Given that the LEMS cost measure with constant capital is the only point that implies negative efficiency, we propose a range of 0% (low end) to 0.9% (high end) per annum.

5.4. Further consideration of Real Unit Operating Expenditure

5.4.1. Methodology²¹

In Section 4.3 we calculated changes in RUOE to show the level of operating efficiencies achieved by relevant comparator industries in their first control period. In this section we

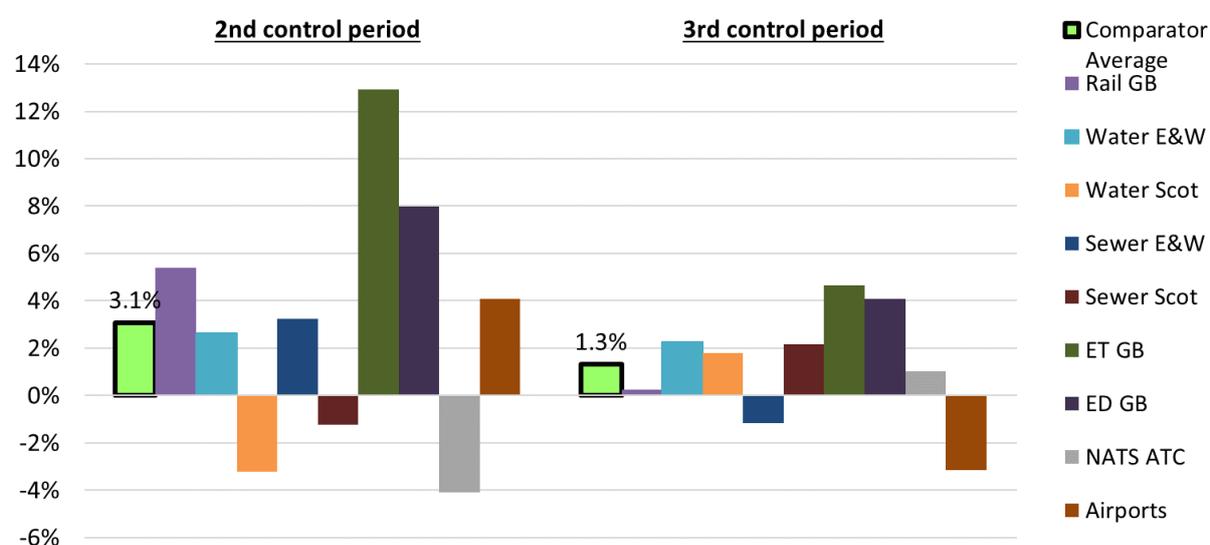
²¹ Our general methodology for calculating the RUOE efficiency benchmark is discussed earlier in Section 3.3.

calculate efficiency gains for the comparators companies/sectors in their *second* price control period after privatisation because (as noted in Section 3.2), we are using the second price control period as a proxy benchmark for RIS1. We also present the efficiency gains made by companies in their *third* price control period after privatisation, as this would correspond to RIS2, and we refer to this result in the following chapter.

5.4.2. Results and analysis

The chart below shows the productivity gains for different regulated networks in their second and third price control periods after privatisation.

Figure 5.3: Average annual unit cost efficiencies for chosen comparators



Source: CEPA Database (full details of all data sources available in A.3.1).

Note: Gas distribution is not included in this graph as the available data does not include control periods 2 and 3.

The average efficiency gain across the observed comparators is 3.1% for the second control period post-privatisation, and is 1.3% for the third period.

5.4.3. Summary

Based on changes in RUOE for our comparator sectors, our benchmark for HE's efficiency gains in RIS1 is 3.1% per annum. This is applicable when considering HE's potential performance in RIS1. The average efficiency gain for the third control period, 1.3%, would be applicable to any future cost efficiency targets that HE might set for RIS2 and onwards.

5.5. Highways England's forecast performance

5.5.1. Introduction

Based on different forecast scenarios for HE's resource expenditure over RIS1, we can calculate what these would imply in terms of annual efficiency savings per unit of output. This allows us to develop metrics that are comparable with the unit cost benchmarks.

5.5.2. Methodology

As noted above in Section 5.1, our two forecast cost scenarios are:

- Keeping resource expenditure stable in real terms throughout the remainder of RIS1. This is a more conservative assumption than HE’s RIS1 Delivery Plan.
- Reducing costs in line with the RIS1 budget as per HE’s Delivery Plan, i.e. a reduction in real costs of circa 10% over RIS1.

For forecasts we are able to focus solely on our measure of ‘core costs’, because the renewals component of resource expenditure is budgeted consistently over time during RIS1.

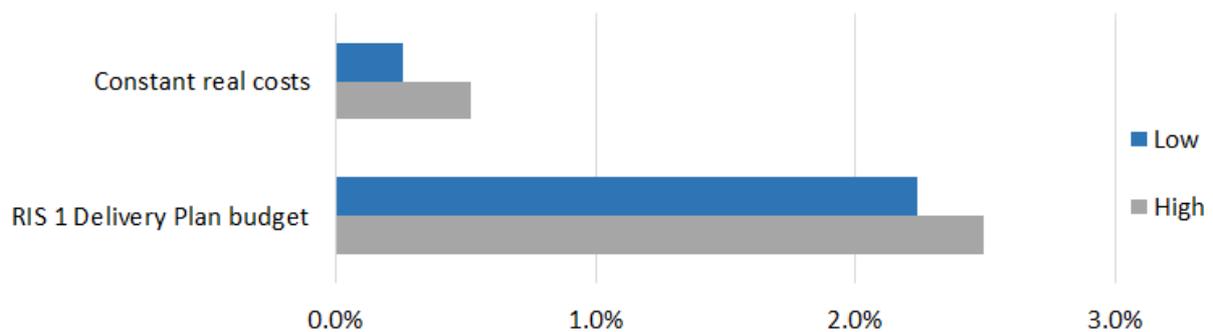
We have used two different output measures in our modelling. The first is lane km, and the second is vehicle km. As shown in Section 2.4, both measures are expected to rise over RIS1, although vehicle km are forecast to rise by more than lane km. Therefore, using vehicle km will imply higher efficiency savings on a ‘cost per unit of output’ basis, so the efficiency results using vehicle km are higher.

For consistency with our RUOE analysis, we have also adjusted for economics of scale. As noted in Section 3.3, we have used costs elasticities of 0.3 for vehicle km and 0.84 for lane length.

5.5.3. Results and analysis

The annual efficiency gains are shown below. The ‘low’ results correspond to using lane km as the output measure. The ‘high’ results correspond to using vehicle km as the output measure.

Figure 5.4: Average annual efficiency gains for HE under different cost forecast scenarios



Source: Highways England data received directly from company. CEPA analysis.

If HE is able to meet its RIS1 budget as per the Delivery Plan, it will have made cost efficiencies of almost 2.5% per annum (with the precise level of efficiency gain dependent on whether lane km or vehicle km is the chosen output measure). Under a more conservative assumption of constant real costs over the remainder of RIS1, the cost efficiencies are smaller, at almost 0.5% per annum.

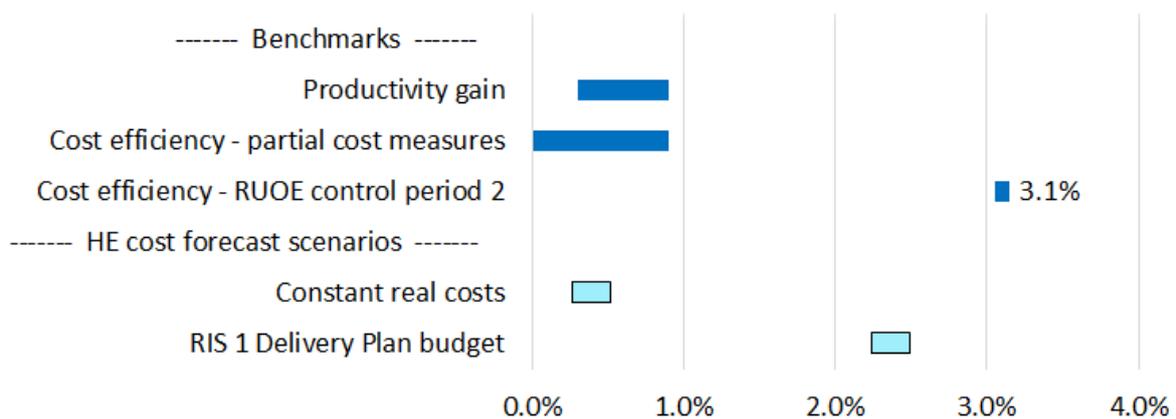
5.5.4. Summary

The Delivery Plan is the basis for HE's planning and therefore should be considered the 'base case' in terms of the forecast we use. HE's recent historic performance shows a combination of significant cost reduction before 2012/13, but no evidence of any efficiency savings since then, so it is uncertain to what extent these savings are achievable. Therefore, we also consider that a more conservative 'constant real costs' scenario.

5.6. Comparison

In this section we compare the different forecast scenarios against the different benchmarks that we have calculated for HE. The chart below makes this comparison. Positive numbers equate to significant productivity gains. Benchmarks are shown in blue and forecasts are shown in grey. Bars are used to show ranges, although for the RUOE productivity benchmark we have a point estimate of 3.1%.

Figure 5.5: Comparison of HE's forecast average annual efficiency gains (under different scenarios) versus efficiency benchmarks



Source: CEPA Database (full details of all data sources available in A.3.1). CEPA analysis.

The RUOE productivity benchmark includes both catch-up efficiencies and frontier shift efficiencies. The partial cost measures and productivity gains are based on economy-wide data, which tends to comprise primarily of frontier shift, and therefore does not include the catch-up that we would expect for newly-privatised companies. Given HE is a recently reorganised monopoly network operator, we consider that there is likely to be scope for catch-up, and therefore consider the RUOE productivity benchmark (3.1% efficiency gain per annum) is the most relevant benchmark.

5.7. Summary

The forecasts suggest that HE will largely (i.e. almost) meet the RUOE productivity benchmark, implied by our analysis, if it manages to reduce its core costs in line with its Delivery Plan (although the precise result is somewhat sensitive to the output measure chosen to assess HE's expenditure).

6. CONSIDERING EFFICIENCY SAVINGS IN RIS2

6.1. Introduction

In this section we discuss:

- Firstly, HE's performance both prior to and during RIS1
- Secondly, we consider how regulated companies have performed (on average) during the third control period 'after privatisation', as this will be a relevant benchmark for RIS2. We assess efficiency gains made by such companies by calculating the change in RUOE over time to develop an efficiency benchmark.
- Thirdly, we review recent regulatory precedent from other sectors to provide a sense check on the magnitude of efficiency targets being applied by other regulators.
- Finally, we consider the efficiency benchmark that might be set for RIS2.

6.2. Highways England's performance

HE's future efficiency target for RIS2 should be informed by its performance both prior to and during RIS1. If HE performs poorly in these periods, a greater level of catch-up should be required during RIS2.

Our analysis in Section 4 shows that it is difficult to compare HE's historic efficiency performance against other regulated sectors/companies with similar characteristics. Whilst HE's performance has lagged behind other regulated sectors/companies since 2012/13, HE made productivity gains prior to that (in response to a significant cost challenge from the Government), driven by lower maintenance costs. However, there is uncertainty around whether efficiency gains, scope reduction or changing standards were the main cause of these lower maintenance costs.

Our analysis in Section 5 suggests that HE will have achieved a reasonable level of efficiency gains during RIS1 if it manages to reduce its resource expenditure in line with the Delivery Plan. Based on historic performance it is unclear whether HE is likely to achieve this.

6.3. Performance of regulated companies in the third control period

As presented earlier in Section 5.4, we have also assessed the average efficiency gain achieved across relevant regulated networks and focusing on the third price control period after privatisation, which we consider is a potential benchmark for RIS2. The average efficiency gain across the relevant comparators in this period is 1.3% per annum. Setting this target for HE in RIS2 would however be contingent on it having realised a sufficient level of catch-up efficiency prior to and during RIS1.

6.4. Sense check - regulatory precedent

In the table below we present recent regulatory precedent for the Frontier Shift (FS) and Catch-up (CU) opex efficiency targets set by regulators in recent price controls.

Table 6.1: Recent regulatory precedent for opex efficiency targets (to 1 decimal place)

Regulator	Country	Sector	Price control	Costs	FS	CU
ORR	GB	Rail	2015 – 2019	Opex	0.3%	4.4%
Ofwat	Eng & Wal	Water and Sewerage	2010 – 2015 ¹	Opex	0.2-0.4%	2.2-2.9%
WICS	Scotland	Water and Sewerage	2015/16 - 20/21	Opex	1.9% ²	
Ofgem	GB	Transmission	2013 – 2021	Opex	1.0%	n/a
Ofgem	GB	Electricity Distribution	2016 – 2023	Totex	0.8-1.1%	Various
Ofgem	GB	Gas distribution ³	2013 – 2021	Opex	1.0%	n/a
				Totex	0.8%	1.6%
CAA	GB	Heathrow Airport	2014 – 2018	Opex	1.0%	1.0% ⁴
CAA	GB	Gatwick Airport	2014/15 - 18/19	Opex	0.9-1.0%	0.7% ⁴
Range					0.2-1.2%	Up to 4.4%

Notes: ¹ Ofwat: Not possible to obtain FS and CU figures for the latest price control (2015-2020).

² Breakdown not available between FS and CU.

³ Gas distribution: Totex is included as it shows the CU target (not available for opex).

⁴ HAL/LGW: CU is the residual cost reduction after netting off FU, so not the same as CU.

Source: Various regulatory determination documents

Regulatory precedent suggests that scope for FS is assessed to be relatively consistent across the regulated sectors, i.e. it tends to be in the range 0.8% to 1.2%. However, it is occasionally lower at circa 0.3% (e.g. ORR’s Network Rail determination and Ofwat’s determination for England and Wales water and sewerage companies).

In contrast, CU efficiency targets vary considerably, as would be expected given that this depends on the specific circumstances of a company or industry at a given point in time. For example, Network Rail’s large catch-up efficiency target (4.4%) was influenced by the view that Network Rail was inefficient at the point in time of the determination.²²

6.5. Summary

If HE is able to meet its Delivery Plan in RIS1, we consider that a relevant benchmark for unit cost efficiency in RIS2 could be in the region of the following:

²² The 2011 McNulty Report stated that passengers and taxpayers in Great Britain were “paying at least 30% more than their counterparts in other European countries”.

- 1.3% per annum, as implied by the RUOE analysis for the average efficiency gain across relevant regulated networks for the third price control period post privatisation (which is broadly consistent with our analysis of top down productivity measures and partial cost factors); *plus*
- An additional annual 'catch-up' efficiency component if it is determined that the reduction in maintenance costs prior to 2012/13 was primarily driven by scope reductions and/or changing standards, as opposed to genuine efficiencies.
- However, if HE fails to meet its Delivery Plan for RIS1, this would present a further argument for increasing the efficiency target for RIS2.

Overall our analysis suggests an efficiency target of 'at least 1.3% per annum' but with scope for adjustment based on the outcome of RIS1. This figure is broadly consistent with regulatory precedent, although we note that there is considerable variation between industries.

7. CONCLUSIONS AND SCOPE FOR FURTHER ANALYSIS

7.1. Conclusions

Overall, the key messages from our work are as follows:

- Data has been difficult to acquire on a consistent basis over time. Whilst HE has endeavored to provide data to the best of its capabilities, the process of data collection was time-consuming and involved various iterations. After a considerable number of discussions with HE, we still do not have a series for HE's resource expenditure (i.e. including the renewals component) for the period 2010-2013 that we are confident is consistent with data from 2013 onwards. As such, our analysis of HE's resource expenditure prior to RIS1 is only partial.
- Based on the data that we have received, and our analysis of it, there is evidence of productivity gains by HE over the period from 2009/10 onwards (excluding the renewals component of resource expenditure). These were driven by lower maintenance costs in response to the SR10 efficiency challenge. However, it is not possible to say what combination of efficiency gains, scope reduction or changing standards were the main cause of this productivity gain. However there is no evidence that HE has made efficiency savings in the period 2012/13 – 2015/16 inclusive, whether renewals are included or excluded.
- The Cook Report, HE's Delivery Plan and our benchmarking analysis (against other comparable industries) all suggest that there is scope for HE to make efficiency savings during RIS1.
- If HE manages to reduce its resource expenditure in line with the Delivery Plan prior to the end of the RIS1 period, our analysis suggests that it will broadly (i.e. almost) have achieved a reasonable level of efficiency gain during RIS1, i.e. on a par with what other regulated industries achieved over a comparable time period post-privatisation.
- We have provided initial thoughts on how ORR/HE might set an efficiency target for RIS2. Whilst this will clearly require further detailed analysis, our initial high level recommendation is a target of 'at least 1.3% per annum', with the precise amount being dependent upon how HE performs during the remainder RIS1 (and further analysis of the period prior to RIS1 if improved data is made available).
- As a caveat, efficiency performance is dependent upon the scope of outputs and the level of service quality. Our analysis seeks to capture output scope by assessing unit costs, although we recognise that there may be other factors influencing costs. In addition, the Performance Specification for HE is relatively new and is still evolving, and as such further analysis of HE's performance indicators would need to be undertaken in order to understand how the efficiency target should be adjusted to take HE's level of performance into account.

7.2. Scope for further analysis

We consider that there may be scope for further work in several areas:

- Further engagement with HE to understand its costs prior to 2013, and therefore to understand the extent to which efficiency savings were made during the period 2010 – 2013, as opposed to reductions in scope and/or changes in standards, particularly in relation to maintenance activities.
- On a related issue, ORR might wish to engage with HE to improve data comparability between HE's current data and the Highways Agency's data (i.e. before 2015) – the lack of comparability has created an issue for this piece of work. However, given ORR and HE have agreed performance monitoring statements for RIS1 and beyond, and given that the relevance of the Highways Agency's data (i.e. before 2015) is likely to decline over time, value would likely only be achieved by addressing this issue in the short term.
- Given that HE is currently undertaking a significant capex programme during RIS1 (and beyond), it would be relevant to understand how this impacts operating and maintenance costs. The link between opex and capex is complicated: Some capex may increase opex (e.g. Smart Motorways may increase monitoring and signage requirements), whereas other types may reduce opex (e.g. increased road re-surfacing reduces the short term requirement for defect repair).
- A detailed analysis in the area of performance metrics would aid consideration of the need to adjust efficiency targets to take performance into account. The time lag between expenditure and performance indicators is also an important factor: It may be possible for HE to reduce expenditure and not experience the consequences until later years, which would make it seem that HE has made opex efficiencies whereas in fact it has simply reduced work scope.

ANNEX A DETAILED EXPLANATION OF APPROACH

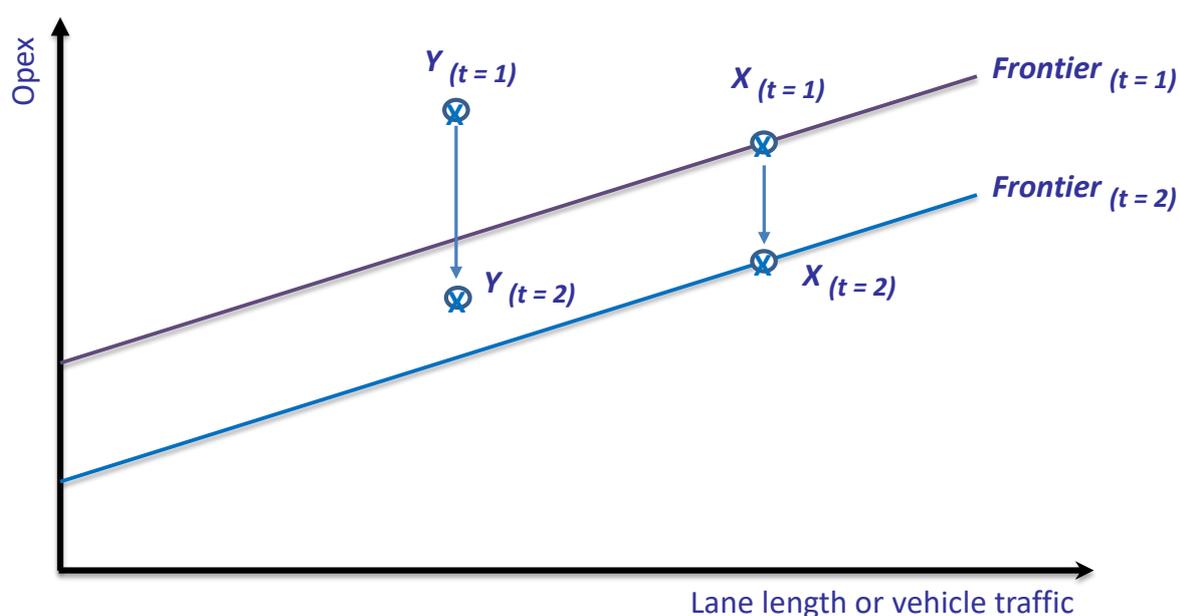
A.1. Frontier shift efficiency and catch-up efficiency

Operating cost efficiencies describe the scenario when a company is able to produce the same outputs by spending less on inputs (or producing more outputs with the same inputs). Even the most efficient companies can be expected to make efficiency improvements over time - for example, by employing new technologies or working processes. Typically, regulators assume that a company is able to achieve a degree of ongoing efficiency (or frontier shift) over time, and this is incorporated within the price control allowance.

However, at any one time, some companies will be efficient (i.e. at the frontier of efficient performance), whereas others will be lagging behind. For the latter group of companies, they will need to catch-up to the other companies if they themselves wish to be considered as efficient. This is referred to as catch-up efficiency. It is defined as efficiency improvements which are made by adopting current technology or efficient working practices, in order to catch-up to current best practice.

The chart below illustrates the difference between ongoing and catch-up efficiency improvements. In general, an efficiency is achieved by a movement downwards, i.e. generating the same level of output (e.g. passenger numbers) for lower costs. At $t=1$, Company X is at the efficient frontier, whereas Company Y is inefficient. At $t=2$, Company X is still at the efficient frontier – this change between $t=1$ and $t=2$ is *frontier shift* efficiency. At $t=2$, Company Y is closer to the efficient frontier, therefore it has achieved both (i) the ongoing efficiency improvements in line with the shift in the frontier, and (ii) a degree of *catch-up* efficiency, i.e. getting closer to the frontier level of performance.

Figure 7.1: Distinction between ongoing (frontier shift) and catch-up efficiency



However, whilst a relatively clear distinction can be made in theory, in practical terms it is often not possible directly to observe or distinguish between frontier shift and catch-up efficiency. There is debate around what assumptions – if any – are appropriate for identifying each component. However, there are academic studies from which simplifying assumptions can be obtained for the purposes of undertaking top-down benchmarking. In particular, academic studies²³ have suggested that the majority of total factor productivity growth in the wider economy is frontier shift, with the (smaller) remainder due to catch-up efficiency.

This also applies to our analysis of partial factor cost measures, which are also based on the EU KLEMS database. Therefore, any cost efficiency gains observed within these cost measures are likely to be predominantly related to frontier shift.

²³ For example, Färe et al. (1994), *Productivity Growth, Technical Progress, and Efficiency Change in Industrialized Countries*, American Economic Review.

A.2. Top-down productivity metrics

We analysed historic UK productivity metrics over different time periods to assess the level of productivity achieved by other industries over time. The aim was to calculate high level productivity metrics for sectors that have similarities with Highways England's opex.

We considered several metrics based on UK-wide data across a number of years. For each of these metrics we identified the sectors that would be most similar to the components of HE's opex. We considered a number of different permutations, including the type of measure, the choice of relevant comparator sectors, the time period of analysis, etc. These issues are discussed here.

Data source. The EU KLEMS, a database containing productivity data for EU members from 1970 onwards, provided data on variables that were used to develop the productivity metrics. For each country in the database the data is at a sector (or industry) level, e.g. transport and storage.

Data releases. There have been three data releases: In 2009 (updated in 2011, using the NACE 1.1 classification system), in 2012 and in 2016 (both using the NACE 2 classification system). The 2009 release has data for both *Gross output* and *Value-added* metrics (explained below), whilst the 2012 and 2016 releases only provide data on a *Value-added* basis.

NACE is a statistical classification system for economic activities occurring within the European Union. The sectors under NACE 1.1 are similar – although slightly different – to the sectors under NACE 2.

Gross output and value-added TFP. There are two different types of TFP statistics: gross output TFP and value-added TFP. Under the gross output measures of productivity, intermediate inputs are assumed to contribute to productivity growth, whereas their impact is removed in the value-added measure. Generally, gross output measures of TFP growth are the preferred concept for industry specific studies because the role of intermediates is acknowledged, and so the measure better reflects the business decisions taken by companies. However, the value-added measure has the advantage that it is not impacted by changes in the vertical structure of an industry. We have calculated both in our analysis, where data has been available, i.e. Gross output measures could be calculated using the 2009 data, but not using the 2012 or 2016 data.

Partial productivity measures. Given that we are assessing the efficiency of HE's operating costs, it is not necessarily appropriate to assess TFP, because TFP is a total factor productivity measure, i.e. it includes capital, as well as labour and intermediate inputs. For the purposes of this study, it is preferable to consider partial productivity measures such as labour productivity and LEMS productivity (which considers labour and intermediate inputs).

Variable or constant capital assumption. Partial productivity measures have the potential to create misleading results if substitution between inputs occurs. For example, capital substitution (automation) could result in measured gains in a labour productivity. Therefore,

we calculate these partial productivity measures under the assumptions of both variable and constant capital.

Selection of comparators. The EU KLEMS website provides documents which contain a very detailed explanation of the types of activities contained within each of the sectors. We reviewed this information in detail to determine the likely best comparator sector for each component of HE’s opex. In some cases this was relatively straightforward, e.g. under NACE 2, there is a sector entitled Professional, scientific, technical, administrative and support service activities, which is a good proxy for HE’s support costs. Choosing comparator sectors is not an exact science, and so judgement was required in some cases.

Table 7.1: Comparator selection and weightings under base case, for 2016 data release²⁴

EU KLEMS comparator used	Weight	Rationale
Construction	39%	Includes "asphalt paving of roads, road painting and other marking, and installation of crash barriers, traffic signs and the like". Likely to be a reasonable proxy for the maintenance and renewals components of resource expenditure, and possibly some aspects of traffic management.
Transportation and storage	30%	Includes the "operation of roads, bridges, tunnels", etc. Used as a proxy for general operations and traffic management.
Professional, scientific, technical, administrative and support service activities	19%	Includes "legal, accounting, head office activities, advertising, employment activities, office admin and business support". Used as a proxy for HE’s support costs.
Other manufacturing; repair and installation of machinery and equipment	11%	Includes repairs/maintenance. Therefore, along with construction, likely to be a good proxy for the maintenance and renewals components of resource expenditure.

Given that judgement was necessary when selecting comparator sectors, we ran a sensitivity on the weightings ('Sensitivity 1'). In this sensitivity, we increased the weight on the sector entitled "Other manufacturing; repair and installation of machinery and equipment", and reduced the weight on the "Construction" sector. This is because the renewals/maintenance components of resource expenditure are related to light repairs. Therefore, whilst the construction sector is likely to be relevant to some aspects of resource expenditure, it is most applicable to capex enhancements/renewals. The impact of this sensitivity on the weightings is shown below. The key changes are highlighted in bold.

²⁴ We note that the sectors used for the 2012 and 2009 data releases were virtually the same, although with some minor variations, e.g. certain sectors were not available.

Table 7.2: Impact of sensitivity on sector weightings

Sector	Weightings	
	Base case	Sensitivity 1
Construction	39%	28%
Transportation and storage	30%	30%
Professional, scientific, technical, administrative and support service activities	19%	19%
Other manufacturing; repair and installation of machinery and equipment	11%	22%

ANNEX B presents full results for our benchmarks for changes in productivity and cost efficiency. Overall, the sensitivity has a noticeable, although not hugely significant impact on the level the changes in productivity/cost efficiency.

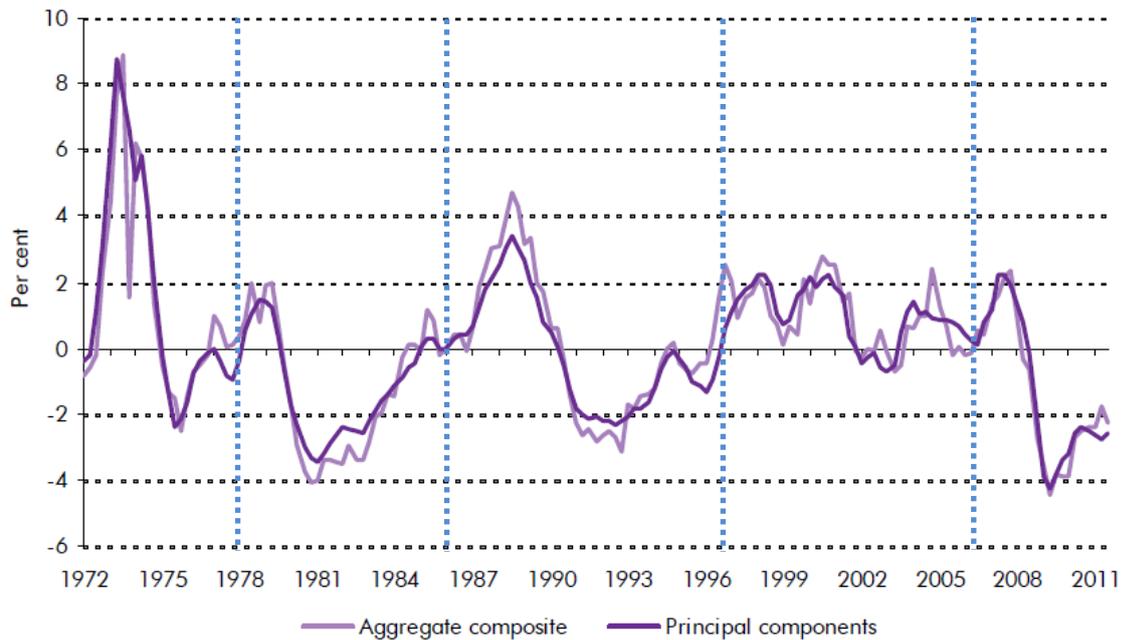
Time period of analysis. Productivity is a highly cyclical variable which shows marked variation over the business/economic cycle. In general it is pro-cyclical, as productivity growth tends to accelerate during periods of economic expansion and decelerate during periods of recession.²⁵ Hence it is standard practice to consider TFP growth over complete economic cycles. Consistent with our previous work for ORR,²⁶ we consider the following to be complete business cycles, reckoned as a point of zero output gap to another point of zero output gap, including both a peak and a trough. The business cycles since 1972 are, by this definition 1972 – 1978, 1978 – 1986, 1986 – 1997, and 1997 – 2006. This is based on the Office of Budgetary Responsibility's (OBR) data on the output gap,²⁷ shown in the chart below.

²⁵ OECD (2001), Measurement of aggregate and industry level productivity growth, p.119

²⁶ CEPA, Scope for Improvement in the Efficiency of Network Rail's Expenditure on Support and Operations, Report for ORR, March 2012

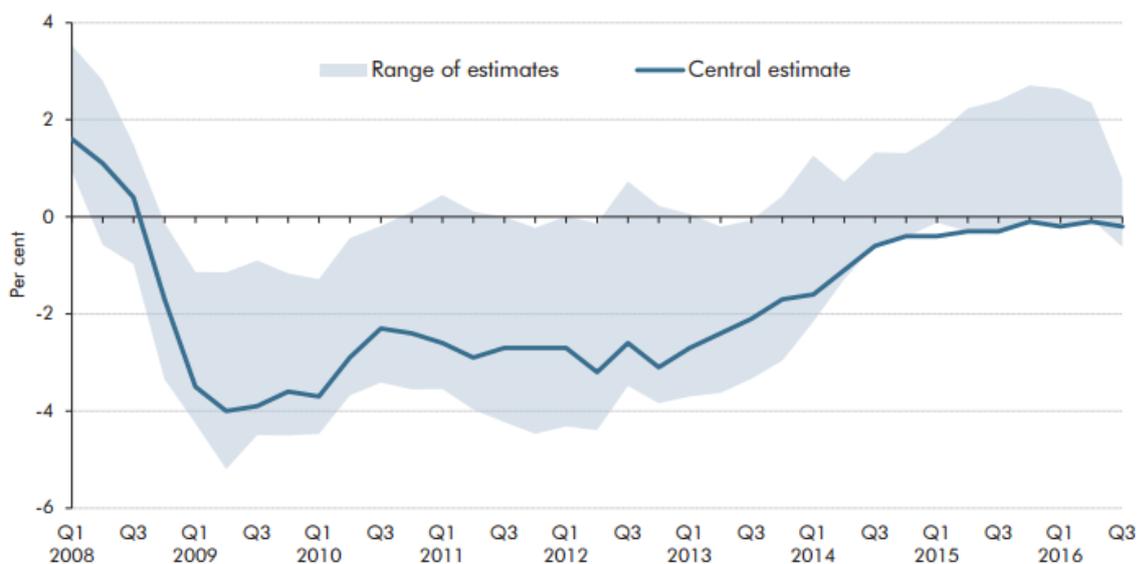
²⁷ Source: OBR, Estimating the UK's historical output gap, Working paper 1, Nov 2011.

Figure 7.2: UK Output Gap (%) and identification of complete business cycles



Given that the 2016 EU KLEMS data release includes data up to 2014, we considered whether it would be appropriate to include this latest data. We used OBR's latest data to review estimates of the output gap in recent years. As shown by the chart below, the output gap was slightly below (although close to) zero in 2014. Therefore, when using the 2016 EU KLEMS data, we also include the period 2006 – 2014 as the most recent business cycle in our analysis. However, given that it may not precisely be a full business cycle, and because this was a period of highly unusual economic conditions, the estimate for this period may not be as precise as for other periods in our analysis.

Figure 7.3: UK Output Gap (%) and identification of complete business cycles



Source: OBR, Economic and Fiscal Outlook, November 2016, p.46

We used the following time periods:

- 2016 data release: 2006-2014 (1 business cycle); and 1998-2014 (2 business cycles).
- 2012 data release: 1997-2006 (1 business cycle); and 1986-2006 (2 business cycles).
- 2009 data release: 1997-2006 (1 business cycle); 1986-2006 (2 business cycles).
- 1978-2006 (3 business cycles); and 1972-2006 (4 business cycles).

Our base case is **1998-2014** (2 business cycles) using the 2016 data, as it uses the most recent data, and does not focus solely on the period 2006-2014 which was unusual from an economic perspective, i.e. due to the global recession.

A.3. Top-Down Unit Cost Metric: RUOE

A.3.1. Data Collection

Building on our dataset that we have developed from previous reports on operating efficiency, we refined the existing data, added new comparator sectors and collected new data. Table 7.3 below sets out the new data that was collected within this project, including both new comparator industries, as well as industries from our previous work where existing data has been brought up to date.

Table 7.3: Source of collected data

Comparator	Years	Input Type	Source	Output Measure Used
Highways England	2006/07 – 2014/15	Output Measure	Department for Transport Website	Vehicle km's and lane km's
	2009/10 – 2015/16	Total Opex	Received directly from Highways England	
Airports (All)	2000/01 – 2014/15	All	Published accounts and annual reports	Passenger numbers
Network Rail	2011/12 – 2015/16	Output Measures	NRT Data Portal, ORR Website	Passenger train km
	2006/07 – 2013/14	Controllable Opex	Network Rail Regulatory Accounts	
	2014/15	Total Opex	Network Rail Regulatory Accounts	
Transport Scotland	1993/94 – 2012/13	Output Measure	Scottish Transport Statistics	Vehicle km's
	2006/07 – 2015/16	Total Opex	Transport Scotland Annual Report	
Water and Sewerage (England and Wales)	2011/12 – 2012/13	All	Ofwat Website	Water delivered and properties billed
Water and Sewerage (Scotland)	2010/11 – 2015/16	All	Regulatory Accounts, WICS Website	Water delivered and population connected
Electricity Transmission	2011/12 – 2014/15	Output Measure	DECC Energy Trends	Electricity demand
	2002/03 – 2015/16	Total Opex	NGET Regulatory Accounts	
Electricity Distribution	2010/11 – 2014/15	All	DPCR5 Performance Report, Ofgem Website	Customer numbers

Comparator	Years	Input Type	Source	Output Measure Used
Gas Distribution	2007/08 – 2015/16	Output Measure	Received directly from Frontier Economics	Customer numbers
	2013/14 – 2015/16	Total Opex	RIIO DD1 Model, Ofgem Website	
Retail Estate Management	2006/07 – 2014/15	All	Intu Annual Accounts	Number of shopping centres
NHS England	2001/02 – 2015/16	All	Individual Trusts Annual Accounts	Staff numbers
NATS	2006/07 – 2015/16	All	Annual Report and Accounts	UK flights handled

For non-GB comparators (some airports), exchange rate adjustments were made, whereby we converted foreign currency figures into pounds using annual average spot exchange rates, before secondly adjusting these new figures for inflation, using their domestic CPI rate. This allowed for consistent comparison across the sectors, regardless of the country the comparator resides in.

There were several comparators whom we had to exclude some years from our analysis due to unresolvable issues, which are explained in the table below.

Table 7.4: Data Exclusions

Comparator Sector	Region	Excluded Year/s	Reason
Airports	Germany	2002	Frankfurt: There is a substantial decrease in opex for which we cannot find an explanation, despite having undertaken further research.
Electricity Distribution	GB	2000/01	There appears to be an abnormally large reduction in costs in this year, which affects a large number of companies.
		2010/11	There appears to be an abnormally large reduction in costs in this year as a result of a reporting change.
Electricity Transmission	GB	2000/01	A change in reporting requirements means that NGC started to include the whole of Great Britain in their reported electricity volumes (in line with Oxera 2008).
		2008/09	There is a substantial jump in NGET's "other expenditure (by c. 30%) for which we cannot find an explanation, despite having undertaken further research.
Water and Sewerage	England & Wales	2005/06	"...reported operating expenditure no longer includes cost for recovering pension deficit.... at the same time, companies are dealing with volatile energy costs - which have risen overall since price limits were set...' Ofwat, 2006: 'Water and sewerage services unit costs and relative efficiency', December, p.3.

A.3.2. Selection of comparators

In this project, we set out the development of efficiency in a number of sectors of industry over time, using them as comparators to Highways England's own possible future efficiency development. The following section will detail the selection process of which comparator industries which have been used for that purpose.

Comparator Criteria

Six main criteria were applied during the process for selecting Highways England's comparators, with regards to operating costs/efficiencies, which are detailed below.

- **Similar activities:** Our analysis in this project is focused on the efficiency of operational expenditure therefore, bodies that undertake relatively similar operational activities to Highways England are likely to be better suited comparators.
- **Similar assets:** Similarly, industries with a similar asset base are likely to experience similar operational requirements. HE operates the SRN, so other industries that operate large-scale infrastructural networks are likely to be good comparators.
- **Similar rate of technological progress:** Highways England's operations exhibit some progression in technology over time however, the requirement to physically attend accidents and maintain the roads are areas with relatively slow technical progress and high labour intensity. Appropriate comparators for HE are those that have a consistent service offering, with some scope for technological progress.
- **Similar level of competition:** Highways England – and previous the Highways Agency – is a monopoly operator of the SRN, but experiences administrative pressure to reduce operating costs. Therefore, it will be most appropriate to compare it against other regulated monopoly companies.
- **Similar policy environment:** Given that Highways England is now regulated by the Highways Monitor, it would be more relevant to consider companies within other regulated industries.
- **Data availability/consistency over time:** In reality the analysis is constrained by what data is available. It is important that available data is sufficiently consistent over time.

Assessment Results

We used a three level qualitative assessment metric as follows, with our results summarised in the table below.

- Strongly meets criteria = ✓✓
- Meets criteria to some extent = ✓
- Does not meet criteria = ✗

Table 7.5: Assessment of potential comparator sectors against criteria

Sector	Activities	Assets	Technology	Competition	Policy	Data
Transport Scotland	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓
Rail Networks	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓
Energy Networks	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓
Water Networks	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓
Telecoms Networks	✓✓	✓✓	✗	✓	✓	✓✓
Airports	✓	✓	✓	✓	✓✓	✓✓
Air Traffic Control	✓	✓	✓	✓✓	✓✓	✓✓
Hospitals	✗	✓	✓	✓	✓	✓✓
Manufacturers	✗	✓	✗	✗	✗	✓
Retailers	✗	✓	✗	✗	✗	✓

Following discussions with HE and ORR, we agreed to consider the following as comparators:

- Transport Scotland
- Network Rail
- Energy Networks
- Water and Sewerage Networks
- Airports
- Air Traffic Control (although this is a more marginal comparator given it is relatively asset light)

We also considered whether it would be possible to add some other highways comparators (e.g. M6 toll, Welsh Assembly roads, TfL). However, due to a lack of available data, this was not possible.

A.3.3. Calculations

Calculation of Real Unit Operating Expenditure metric

The change in RUOE is the percentage change in real unit operating expenditure (costs) from one year to the next. The most simplistic calculation would be to calculate the change in RUOE between the year $t+1$ and the year t . However, where economies of scale are present within an industry (i.e. average costs fall as the scale of production increases), RUOE may fall simply because outputs have risen. In this case, the fall in RUOE is not a genuine efficiency saving. To correct for this effect, we use a *Corrected RUOE* in year t , which takes into account the growth in outputs.

$$\Delta RUOE_{t,t+1} = \left(\frac{ROE_{t+1}}{O_{t+1}} \div \text{Corrected } RUOE_t \right) - 1$$

$$\text{Where: } \text{Corrected } RUOE_t = ROE_t \times \left(\frac{(1 + \Delta O_{t,t+1} \times \varepsilon)}{O_{t+1}} \right)$$

Economies of Scale values

Adjusting for ‘economies of scale’ or the ‘volume effect’ was undertaken during the RUOE analysis in order to account for opex reductions that may occur as a result of operations growth, as oppose to genuine improvements in efficiency. This allows the results to take into account the marginal cost increases that arise through marginal increases in output, and thus provide a more accurate picture of the efficiency achieved by Highways England and its comparators.

The adjustment was achieved through the application of a cost elasticity value, specific to each industry, to the RUOE calculations. These cost elasticities represent the percentage change in costs that would arise from a one percent increase in output. Table 7.6 below sets out the cost elasticity value used for each sector within our analysis. For consistency, most of these are the same as the figures used in our previous opex efficiency work (e.g. for CAA in 2013), whilst we have added values for industries/sectors added since that work.

Table 7.6: Cost Elasticities

Sector	Elasticity	Source
Roads (lane km)	0.84	Krause (1981) – see below.
Roads (vehicle km)	0.3	CATRIN project report (2008) – see below.
Retail Estate Management	0.5	Keh and Chu (2003)
Air Traffic Control	0.95	Pels, et al (2002)
Healthcare	0.76	Marini and Miraldo (2009)
Airports	0.5	SDG (2012) and regulatory precedent
Electricity Transmission	0.721	Burns and Weyman-Jones (1994)
Electricity Distribution	0.721	Burns and Weyman-Jones (1994)
Gas Transmission	0.9	Oxera 2008 assumption: TFP elasticity figure
Gas Distribution	0.9	Oxera 2008 assumption: TFP elasticity figure
Rail	0.2	CEPA assumption from various sources
Water and Sewerage	0.96	CC (2000)

Our cost elasticity assumptions for HE were developed as follows:

- **Lane km.** A study by Kraus²⁸ estimated that returns to scale in urban highway network capital costs (with respect to highway length and number of intersections) to be 0.84. Whilst our work is focused on HE's resource expenditure (opex), we consider that this estimate is reasonable, on the basis that a number of components of opex will need to rise as lane length increases, e.g. maintenance, inspections related to renewals, etc.
- **Vehicle km.** A European Commission-funded report as part of the CATRIN²⁹ project contains a number of road cost elasticity estimates (with respect to vehicle km) based on different academic studies. The cost elasticities in relation to operations and maintenance costs are as follows:
 - Schreyer et al. 2002, Switzerland motorways and main roads, cost elasticity of operational maintenance costs with respect to vehicle km = 0.69.
 - Haraldsson 2006, Sweden all roads, cost elasticity of operations costs with respect to vehicle km = 0.05.
 - Haraldsson 2006, Sweden all roads, cost elasticity of maintenance costs with respect to heavy goods vehicle km = 0.58.
 - Bak 2006, Poland national roads, cost elasticity of maintenance costs with respect to vehicle km = 0.12.
 - Haraldsson 2007, Sweden all paved roads, cost elasticity of operations costs with respect to vehicle km = -0.05.
 - Haraldsson 2007, Sweden all paved roads, cost elasticity of maintenance costs with respect to heavy goods vehicle km = 0.27.

These elasticity estimates are across different countries, and relate to varying activities, e.g. operations or maintenance. As a high level assumption for this study, we have chosen 0.3 as the cost elasticity to use in our study. This is approximately the average of the point estimates stated above.

²⁸ Kraus, *Scale Economies Analysis for Urban Highway Networks*, 1984

²⁹ Cost Allocation of Transport Infrastructure cost (CATRIN), *Cost allocation Practices in the European Transport*, March 2008

A.4. Top-Down Cost Metric: LEMS and labour cost measures

A.4.1. Introduction

The LEMS and labour cost measures calculate changes in input costs (per unit of output) for the UK sectors deemed most similar to HE. The LEMS cost measure includes both labour and intermediate inputs, whilst the labour cost measure only includes labour. As per our top-down productivity measures (discussed earlier), we identified the sectors that would be most similar to the components of HE's opex. These partial factor cost measures calculate the percentage annual changes in operating costs over time (rather than the level at a point in time). They combine our top-down productivity metrics (see earlier), with variations in input prices, to provide a measure of *cost efficiency*, i.e. taking into account changes in productivity and in factor input prices.

LEMS cost measure. The LEMS cost measure calculates the average annual percentage change in input costs (per unit of output) for the UK sectors deemed most similar to HE. The LEMS cost measure includes both labour and intermediate inputs. It calculates the percentage *change* in operating costs, rather than the level at a point in time. It combines changes in LEMS productivity (from our top-down productivity metrics, presented earlier) with variations in input prices, to provide a measure of cost efficiency. We show reductions in unit costs (i.e. efficiency *gains*) as *positive* numbers. Whilst this may appear slightly counterintuitive, it has been done to achieve consistency with the top-down productivity metrics, where a positive number represents a productivity *gain*.

Labour (L) cost measure. The labour cost measure calculates the average annual percentage change in labour input costs (per unit of output) for the UK sectors deemed most similar to HE. It is effectively the same as the LEMS cost measure, except that it only takes into account labour inputs, rather than labour and intermediate inputs. As noted above, we show reductions in unit costs (i.e. efficiency *gains*) as *positive* numbers, for consistency with our top-down productivity metrics.

A.4.2. Methodology

Given that these cost measures are based on the top-down productivity metrics (see formulas), our approach was consistent with these productivity metrics, in relation to: the data source (EU KLEMS); the data releases used (2009, 2012 and 2016); the application of either variable or constant capital assumption; the selection of comparators and their weightings (including sensitivities); the time period of analysis; and our choice of base case.

These cost measures are conceptually similar to the RUOE measure (above), although there are a few differences:

- Like the top-down productivity measures, these costs measures are derived from data in the EU KLEMS database, which is comprised of industries across the whole economy, and therefore will include sectors which are relatively competitive. In

contrast, our selected RUOE comparators feature mostly regulated industries where companies have a degree of market power. Companies in both sectors will have potential for *frontier-shift efficiency*, but there is likely to be an additional *catch-up efficiency* component for regulated companies. Therefore, on average, we might expect these cost measures to exhibit lower efficiencies than RUOE.

- RUOE does not make any adjustment for capital substitution. For industries where capital growth has been significant (relative to growth of labour and intermediate inputs), the cost efficiencies implied by RUOE will therefore be higher. In these costs measures, we control for this by showing the results both with variable capital, and under a constant capital assumption.

A.4.3. Frontier shift and catch-up efficiency

Whilst we are not required in this study to provide a specific estimate for frontier shift and catch-up efficiency, this distinction is relative to the extent that we need to interpret the results of the RUOE analysis and the partial factor cost measures. Following our discussion in Annex A.1, we assume that the majority of any reductions in unit costs within the partial factor cost measures will be due to frontier shift, and only a small amount of catch-up, because the industries tend to be relatively competitive. (In contrast, our RUOE analysis contains a number of regulated industries where we would expect higher potential for catch-up, due to the lower competitive pressures.)

A.4.4. Presentation of results

We show reductions in unit costs (i.e. efficiency *gains*) as *positive* numbers. Whilst this may appear slightly counterintuitive, it has been done to achieve consistency with the top-down productivity metrics, where a positive number represents a productivity *gain*.

A.5. Formulas

A.5.1. Productivity metrics

For productivity metrics: **TFP** is total factor productivity, **LEMS** represents intermediate inputs (Labour, Energy, Materials and Services), **LEMSP** is LEMS productivity, **LP** is labour productivity, **var K** stands for variable capital, **con K** stands for constant capital, **TFP_{GO}** is gross output TFP, **TFP_{VA}** is value-added TFP, output volume is denoted **Y**, labour volume is denoted **L**, capital volume is denoted **K**, volume of intermediate inputs is denoted **M**, **GO** is the value of gross output, **LAB** is expenditure on labour, **CAP** is expenditure on capital, **II** is expenditure in intermediate inputs, and **s_L**, **s_K** and **s_M** are labour, capital and intermediate input's share of value respectively.

TFP GO

$$TFP_{GO} = Y_{GO} / (L^{s_L} \times K^{s_K} \times M^{s_M})$$

TFP VA

$$TFP_{VA} = Y_{VA} / (L^{s_L} \times K^{s_K})$$

Where: $\Delta Y_{VA} = \Delta Y_{GO} - II$. i.e. the value of output produced in a sector minus expenditure on intermediate inputs used in their production.

LEMSP var K

$$\Delta LEMSP_{varK} = \Delta Y_{GO} - s_{L2} \cdot \Delta L - s_{M2} \cdot \Delta M$$

$$\text{Where: } s_{L2} = \frac{LAB}{(LAB+II)} \text{ and } s_{M2} = \frac{II}{(LAB+II)}$$

LEMSP con K

$$\Delta LEMSP_{conK} = \Delta TFP_{GO} / (1 - \frac{K}{GO})$$

LP var K

$$\Delta LP_{varK} = \Delta Y_{VA} - \Delta L$$

LP con K

$$\Delta LP_{conK} = \Delta TFP_{VA} / (1 - \frac{K}{GO})$$

A.5.2. Cost metrics

For cost measures³⁰: **RUOE** is Real Unit Operating Expenditure; **ROE** is Real Operating Expenditure; **O** is the chosen output measure (e.g. lane length); **Corrected RUOE** is RUOE adjusted for economies of scale; **LEMS** represents intermediate inputs (Labour, Energy, Materials and Services), **LEMS cost** is the LEMS cost measure, **L cost** is the labour cost measure, **var K** stands for variable capital, **con K** stands for constant capital, **GO** is the value of gross output, **LAB** is expenditure on labour, **CAP** is expenditure on capital, **II** is expenditure in intermediate inputs.

RUOE

$$\Delta RUOE_{t,t+1} = \left(\frac{ROE_{t+1}}{O_{t+1}} \div \text{Corrected } RUOE_t \right) - 1$$

$$\text{Where: } \text{Corrected } RUOE_t = ROE_t \times \left(\frac{(1+\Delta O_{t,t+1} \times \varepsilon)}{O_{t+1}} \right)$$

LEMS cost var K and LEMS cost con K

$$\Delta LEMScost_{varK} = \Delta P_{LEMS} - \Delta LEMSP_{varK}$$

$$\Delta LEMScost_{conK} = \Delta P_{LEMS} - \Delta LEMSP_{conK}$$

$$\text{Where: } \Delta P_{LEMS} = s_{L2} \cdot (\Delta LAB - \Delta L) + s_{II2} \cdot (\Delta II - \Delta M)$$

$$\text{And where: } s_{L2} = \frac{LAB}{(LAB+II)} \text{ and } s_{II2} = \frac{INT}{(LAB+II)}$$

L cost var K and L cost con K

$$\Delta Lcost_{varK} = \Delta P_L - \Delta LP_{varK}$$

$$\Delta Lcost_{conK} = \Delta P_L - \Delta LP_{conK}$$

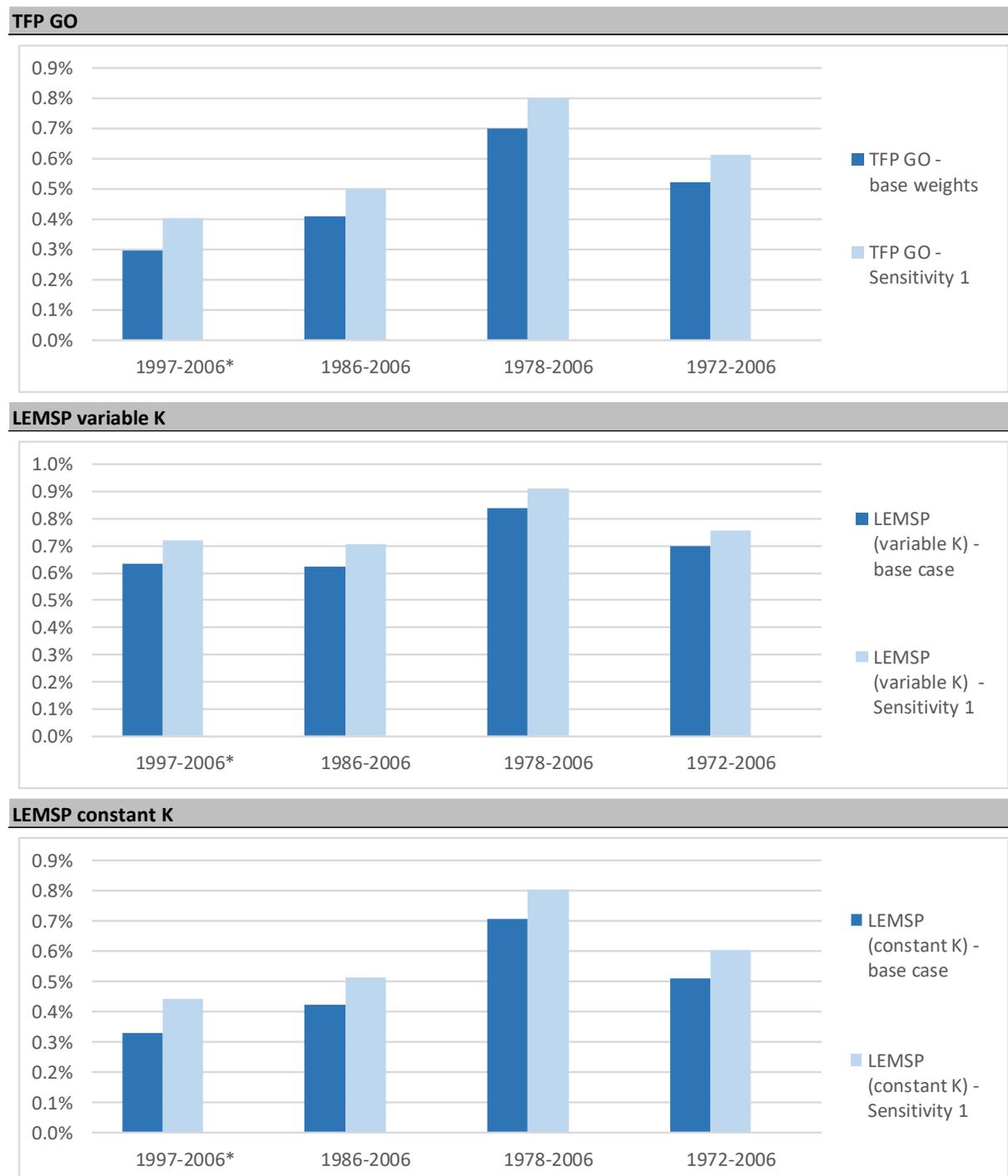
$$\text{Where: } \Delta P_L = \Delta LAB - \Delta L$$

³⁰ The basic theory of the cost measures is, like the RUOE measure, the change in real unit operating costs is equal to the changes in factor input prices minus changes in productivity growth. More detail is available at Reckon, *Report for Ofwat: PR09 Scope for efficiency studies*, October 2008, p.185.

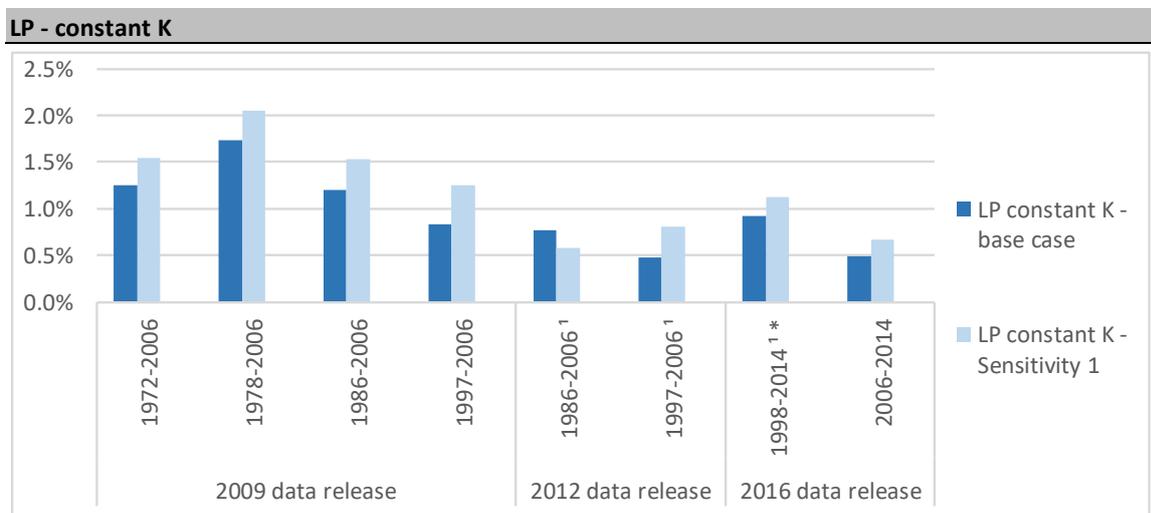
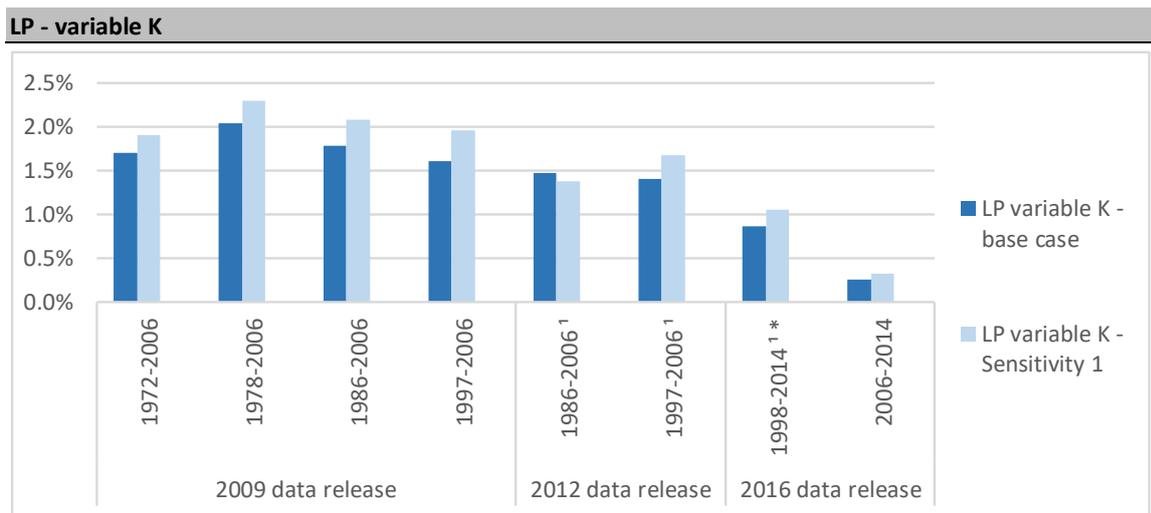
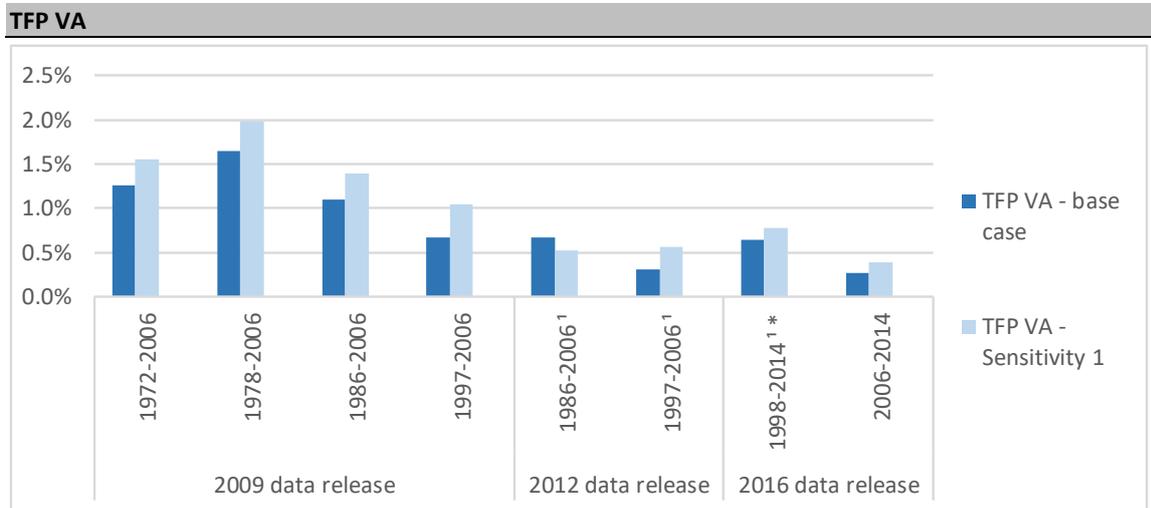
ANNEX B DETAILED ANALYSIS

B.1. Top down productivity metrics

Below, we show the annual productivity gains calculated using several different benchmarks: Total Factor Productivity using the Gross Output measure (TFP GO); LEMS productivity allowing for variable capital (LEMSP variable K); and LEMS productivity under a constant capital assumption (LEMSP constant K).

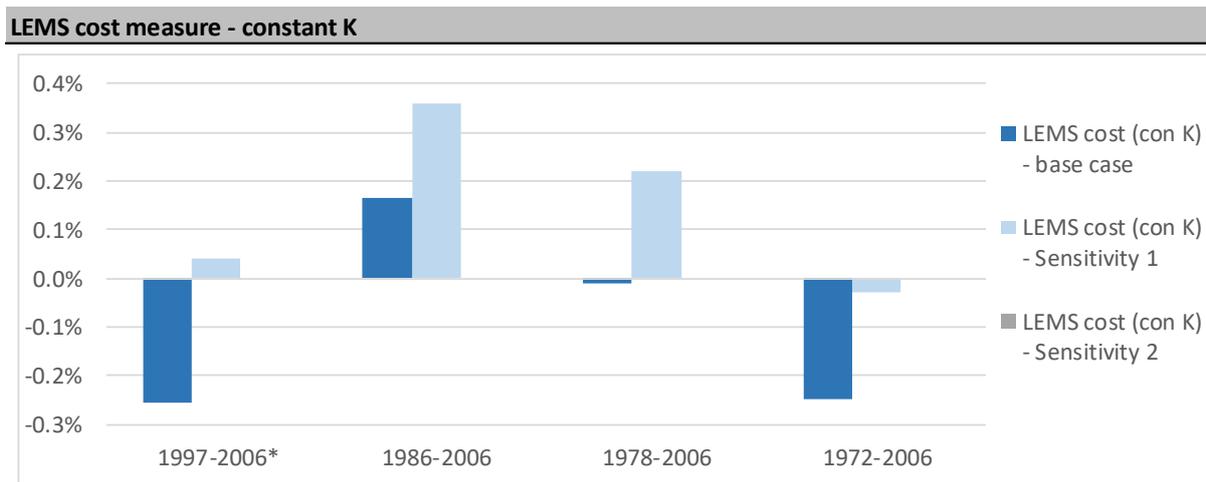
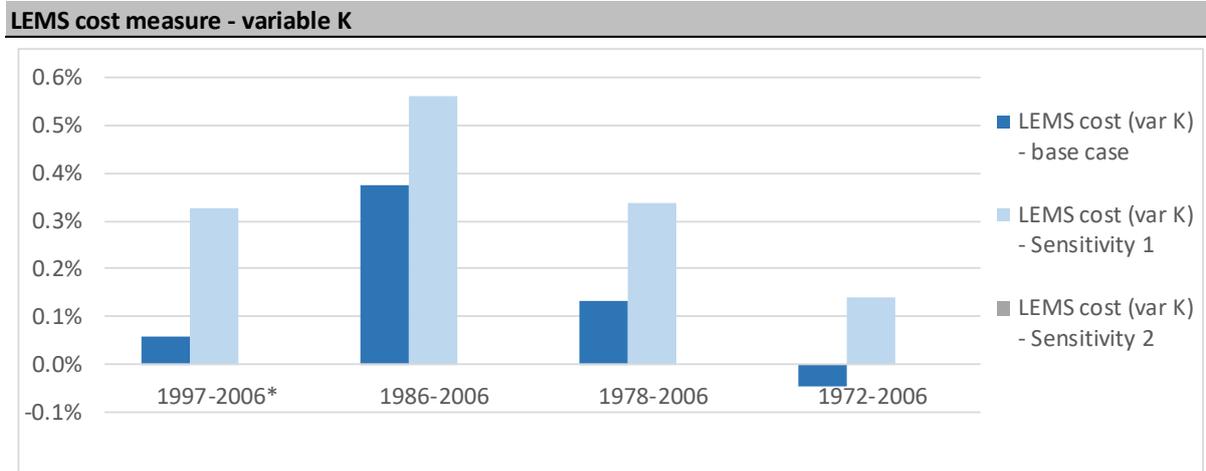


Below, we show the annual productivity gains calculated using several different benchmarks: Total Factor Productivity using the Value Added measure (TFP VA); Labour productivity allowing for variable capital (LP variable K); and labour productivity under a constant capital assumption (LP constant K).



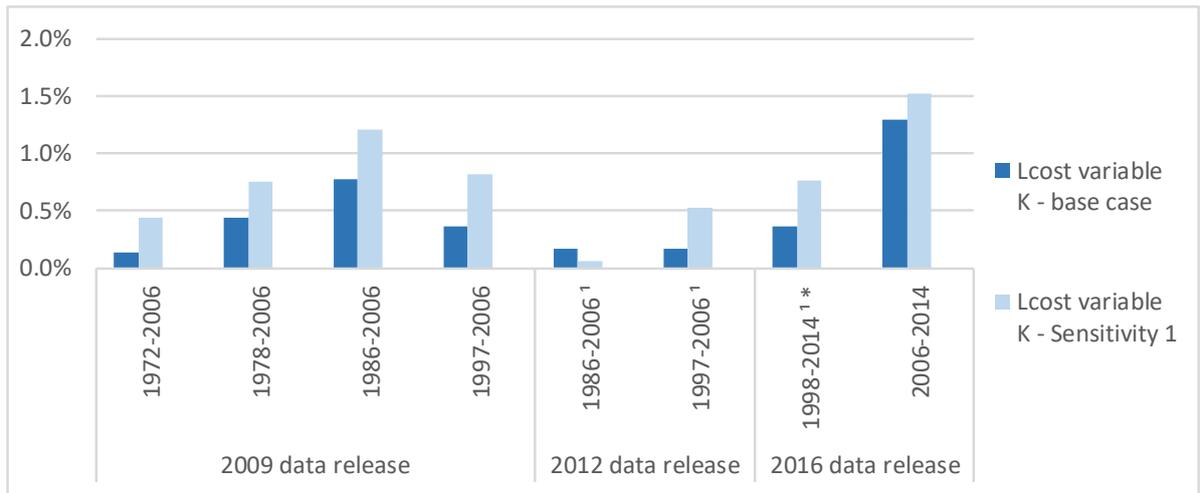
B.2. Partial factor cost measures

Below, we show the annual cost efficiency gains calculated using the LEMS cost measure allowing for variable capital (*LEMS cost measure – variable K*); and the LEMS cost measure under an assumption of constant capital (*LEMS cost measure – constant K*).



Below, we show the annual cost efficiency gains calculated using the labour cost measure allowing for variable capital (*L cost measure – variable K*); and the labour cost measure under an assumption of constant capital (*L cost measure – constant K*).

L cost - variable K



L cost - constant K

