3.3

Annex

SP Energy Networks 2015–2023 Business Plan

Forecasting real price effects and the scope for ongoing productivity improvements in RIIO-ED1

SP Energy Networks

June 2013

SP ENERGY NETWORKS

Forecasting Real Price Effects and the Scope for Ongoing Productivity Improvements for RIIO-ED1

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1 Introduction

1.1 Overview

Ofgem requires DNOs to submit forecasts of input price inflation and ongoing efficiency assumptions over the RIIO-ED1 period as part of their business plan submissions.[1] This report has been prepared by SP Energy Networks (SP) to examine the likely real price effects (RPEs) and expected ongoing efficiency over the price control period, to be used as the basis for our business plan submission to Ofgem.

The remainder of the report is structured as follows:

- Chapter 2 sets out our forecast RPEs for the ED1 period;
- Chapter 3 estimates the likely long run productivity improvements for DNOs; and
- Chapter 4 concludes.

1.2 Interaction between RPEs and ongoing efficiency

DNOs are subject to a revenue-cap regime where allowed revenues are indexed to changes in the Retail Prices Index (RPI). However, the regulatory framework recognises that an "efficient" DNO's costs do not change precisely in line with RPI. RPI changes due to various factors, including changes in input prices (e.g. raw materials etc) and changes in productivity in the economy as a whole. However, the input prices faced, and the productivity improvements achieved by an "efficient" DNO may be different from other sectors of the economy. Accordingly, the regulatory framework provides:

- Allowances to DNOs in the form of Real Price Effects (RPEs) representing the expected change in their input prices, above or below expected changes in RPI;
- A real reduction in allowed costs, representing the extent to which Ofgem expects DNOs to make ongoing productivity improvements at a faster rate than is achieved by other industries.[2]

At previous reviews of network companies' price controls, Ofgem has made allowances for the whole upcoming control period based on ex ante forecasts of both these parameters. We understand that for RIIO-ED1, Ofgem intends to continue with the same approach in adjusting base revenues as in DPCR5 and RIIO-T1/GD1.[3]

The approach followed in this report broadly follows the approach used by Ofgem at previous reviews.

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1 Ofgem (2013) *Strategy decisions for the RIIO-ED1 electricity distribution price control – Tools for cost assessment*, p. 19 (http://www.ofgem.gov.uk/Networks/ElecDist/PriceCntrls/riio-ed1/consultations/Documents1/RIIOED1DecCostAssessment.pdf)

2 Ofgem (2013) *Strategy decisions for the RIIO-ED1 electricity distribution price control – Tools for cost assessment*, para 4.40

3 Ofgem (2013) *Strategy consultation for the RIIO-ED1 electricity distribution price control – Tools for cost assessment*, para. 11.7

2 Forecasting real price effects

2.1 Identification and selection of appropriate inflation indices

This section sets out our evaluation of potential price indices to be used to forecast RPEs. It first describes the data sources we reviewed and sets out our criteria for selecting certain series.

2.1.1 Data sources reviewed

We reviewed data from publically available sources, including a number of data sources that Ofgem has used to set RPEs at previous price control reviews. The most comprehensive public source for historical price indices is the Office of National Statistics (ONS), and we have examined the data series from the ONS in detail. In the past, Ofgem has also used data from the British Electrotechnical and Allied Manufacturers Association (BEAMA) and the Building Cost Information Service (BCIS) in RIIO-T1/GD1, so we included price indices from these sources in our review. Appendix A provides further details on the range of input price indices we considered.

From a number of indices tracking labour costs (e.g. earnings indices) and non-labour costs (e.g. producer price indices, or PPI) from the ONS, BEAMA and BCIS, we identified a final list of potential data sources for calculating RPEs based on the criteria set out in Section 2.1.2. We selected relevant indices for the input cost categories identified by Ofgem in its recent Strategy Decision: labour, materials, plant and equipment, transport, and other costs.

We also searched for forecasts of relevant price indices published by reputable third parties. HM Treasury publishes forecasts of RPI and average earnings for 2013-17 by City and non City forecasters. The Office of Budget Responsibility published similar forecasts in its March 2013 Economic and Fiscal Outlook. However, we were not able to identify forecasts of the relevant PPI indices in the public domain.

2.1.2 Criteria for evaluation

We evaluated are range of candidate price indices against the following criteria:

- Relevance to electricity distribution, i.e. are the inputs covered by the price series wholly or substantially used by DNOs, or do they provide proxies for the inputs they do use?
- Data quality:
  - *Length of historical time series*: A longer time series would smooth specific input price shocks and the effects of the business cycle, and thus allow us to identify the long run trend. As a broad rule of thumb, we consider we require at least 10 years of data to identify a robust long-run trend.
  - *Sample size*: All price indices are to some extent based on sampling of prices charged for good or services. If indices are constructed based on a large sample size, it means the growth rate of the price index may better reflect the underlying growth rate in the prices of relevant goods and services. Although in theory it would be desirable to appraise indices based on the sample size criterion, in practice we have not been able to identify the sample size used to construct most series. However, in general, price indices for broad sectors of the economy (e.g. average earnings in the private sector) will be based on larger sample sizes than more narrowly defined sub-sectors (e.g. electrical engineering labour cost indices).
  - *Volatility of the time-series*: We also considered the volatility of the price indices, as analysis based on a volatile series is more likely to lead to conclusions driven by particular observations or outliers. Hence, we measured the sensitivity of historic growth rates in each series to the inclusion/ exclusion of any one year's data, i.e. a test for the impact of outliers.[4] We excluded four indices on the basis of their high

[4] We calculate the volatility of the series as follows: First, we calculate the mean growth rate using all of the observations. Next we drop the first observation, and calculate the mean growth rate of the remaining observations. We repeat this process for each observation in turn. Then we look at the range of growth rates obtained from our iterative process and examine the range of growth rates estimated. The wider the range of growth rates, the more susceptible the RPE forecasts using the index would be to data noise.

volatility.[5] Therefore, most of the time-series we have identified are not sensitive to inclusion/exclusion of a particular data point partly because we draw on relatively long data series.

- Regulatory precedent, i.e. has Ofgem used the series at DPCR5[6] and/or RIIO-GD1/T1?

Based on our analysis of each index against the above criteria, we then selected the most relevant indices for each cost category.

2.1.3 Selected indices

2.1.3.1 Labour

Table 2.1 shows our evaluation of the potential labour cost price indices based on the criteria described in Section 2.1.2. The rows shaded green indicate price indices that we consider highly relevant to labour costs and suitable based on the other criteria, the yellow rows indicate potentially relevant price indices which were not selected, whilst the red rows show price indices that we do not consider are relevant at all and hence are not selected.

As described in Table 2.1, we have selected the following price indices which we considered most relevant to labour cost:

- We consider that the ONS's "Private Sector Average Wage Earnings (AWE)" index is highly relevant as a general measure of the labour costs faced by DNOs. We therefore use this index as the basis for forecasting RPEs for general labour costs; and
- As measures of specialised labour costs, we consider that the BCIS's "Electrical Installations – Cost of Labour" and "Electrical Labour" PAFI indices are the most relevant measures of labour cost inflation.

2.1.3.2 Materials

Our analysis of potential price indices for material costs is described in Table 2.2. Similar to labour costs, the green rows indicate price indices that we selected, whilst potentially relevant price indices which were not selected are shaded yellow and price indices that were neither relevant nor selected are shaded red. Using the criteria in Section 2.1.2, we selected the following indices:

- BIS's "Resource Cost Index: Infrastructure Materials (FOCOS)" RCI
- BCIS's "Series 3, Pipes and Accessories: Copper" PAFI
- BEAMA's "CPA Large Power Transformer Materials" PAFI
- BEAMA's "CPA Basic Electrical Equipment Index" PAFI
- ONS's "Manufacture of Electricity Distribution and Control Apparatus" PPI
- ONS's "Manufacture of Electric Motors, Generators and Transformers" PPI
- ONS's "Manufacture of Other Electronics and Electric Wires" PPI; and
- ONS's "Manufacture of Cold Drawn Wire" PPI.

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[5] We excluded Manufacture of Copper; Manufacture of Basic Metals; Manufacture of Basic Iron, Steel and Ferro-Alloys; and Manufacture of other Non-Ferrous Metals (see Table 2.2). For all other indices, we found that the long-run growth rate did not change by more than an average of around 0.2% per annum by including/excluding a single data point, whereas these indices' long-run average growth rates changed by between 0.7% and 1.0%.

[6] Ofgem has not published a list of the indices used for DPCR5. However, since Ofgem commissioned *Cambridge Economic Policy Associates (CEPA)* to produce input price forecasts for DPRC5, we assume that the indices included in the CEPA report, *Update of Input Price Inflation Forecasts for DPCR5 (2009),* are the ones that Ofgem actually used.

2.1.3.3 Plant and equipment

Table 2.3 shows a similar assessment of those price indices that are potentially relevant for plant and equipment costs. Based on our analysis, we decided to base our forecast RPEs for plant and equipment on the following indices:

- BCIS's "Plant and Road Vehicles" PAFI;
- ONS's "Machinery and Equipment" input PPI; and
- ONS's "Machinery and Equipment" output PPI.

2.1.3.4 Transport and other costs

Transport and other costs capture the remainder of costs not classified as labour, materials and plant and equipment. The only potentially relevant index we found covering this category was the PPI index for motor vehicles. However, the index includes motor vehicles, which may only be a small subset of this cost category, and the index covers a relatively short time period between 1996 and 2012 compared to the selected indices for labour, materials and plant and equipment. Hence, we were not able to identify any relevant indices for the transport and other cost category.

Table 2.1
Analysis of labour cost indices

Index	Relevance	Data Quality	Regulatory Precedent		Selected?	Additional Comments
		Time Period	RIIO-T1/GD1	DPCR5		
Private Sector Average Weekly Earnings incl. Bonus *(Combined with older AEI series)*	Covers all industries within the Private Sector, including electricity distribution networks. May provide proxy for change in wages for general grades but not specialist (engineering) grades	1990-2012	✓	✓	✓	Provides proxy for change in wage growth for general grades.
Electrical Installations - Cost of Labour (2/E1)	Highly relevant as it is based solely on labour costs within the electricity sector.	1977-2012	×	×	✓	
Electrical Labour (CPA/4)	Highly relevant as it is based solely on labour costs within the electricity sector.	1970-2012	✓	✓	✓	
Construction (EARN03)	Includes "construction of utility projects for electricity and telecommunication" and "electrical installation", which has some relevance to electricity distribution.	2000-2012	✓	×	?	Used by Ofgem but more relevant to GDNs than DNOs? Short time period means index is sensitive to inclusion/exclusion of particular years. Eg: average for 2000-10 is '1.3% p.a. but falls to 0.2% p.a. for 2000-12
Transport & Storage (EARN03)	The transport industry is not directly related to electricity distribution. Therefore this index is likely to have limited relevance, compared to the other industry-specific indices we have considered.	2000-2012	✓	×	?	Although the transport industry is not directly related to electricity distribution, Ofgem views it as a "comparator" industry, which may merit including it in the analysis.
Manufacturing - Engineering & Allied Industries (EARN03)	Manufacturing is not directly related to electricity distribution. Therefore this index is likely to have limited relevance, compared to the other industry-specific indices we have considered.	2000-2012	×	×	×	
Electricity, Gas and Water Supply (EARN03)	Includes "operation of distribution systems (i.e., consisting of lines, poles, meters, and wiring) that convey electric power received from the generation facility or the transmission system to the final consumer"	2000-2012	×	✓	×	Index potentially reflects effects of historical structural/ownerhip changes in regulated utility sectors, and poor indicator of future change in unit costs. Low RPE relative to other comparators supports hypothesis that index reflects transitory changes in sector.

Table 2.2
Analysis of materials cost indices

Index	Relevance	Data Quality	Regulatory Precedent		Selected?	Additional Comments
		Time Period	RIIO-T1/GD1	DPCR5		
Resource Cost Index: Infrastructure Materials (FOCOS)	Provides a measure of input prices paid by contractors in infrastructure. This should capture the broad range of materials costs faced by a DNO.	1990-2012	✓	✓	✓	Recommend inclusion as it offers a comprehensive measure of the general level of input prices paid by a DNO.
PAFI (Building) Series 3, Pipes and Accessories: Copper	We would expect the price of metal pipes to vary in a similar way to the price of metal products used by DNOs. Should act as a good proxy for a DNO's materials input costs.	1991-2012	✓	×	✓	
BEAMA CPA Large Power Transformer Materials	Constructed using weighted averages of PPIs and targeted specifically at materials costs in the electricity industry. Thus, particularly relevant to DNOs.	2000-2012	×	×	✓	
BEAMA CPA Basic Electrical Equipment		1970-2012	×	×	✓	
Manufacture of Electricity Distribution and Control Apparatus (2712000000) (*Including older series*)	Highly relevant. Covers a number of DNO input costs such as circuit breakers, surge suppressors and switchgear.	1987-2012	×	×	✓	
Manufacture of Electric Motors, Generators and Transformers (2711000000) *(Including older series)*	Highly relevant. Covers distibution transformers and transmission and distribution voltage regulators.	1987-2012	×	×	✓	Ofgem has not used these indices in recent price controls. However, indices appear relevant to DNO costs.
Manufacture of Other Electronics and Electric Wires (2732000000) *(Including older series)*	These PPIs cover the cost of wires and power cables.	1987-2012	×	×	✓	
Manufacture of Cold Drawn Wire (2434000000) *(Including older series)*		1987-2012	×	×	✓	

COPI Construction Output Price Index (Infrastructure)	Of all available COPIs, this is likely to be the most relevant to a DNO's materials costs.	1955-2012	×	×	?	Depends on a number of factors, besides materials costs, such as labour and transport. The FOCOS index , which is targeted specifically at materials, should provide a more reliable measure of the materials costs faced by a DNO
PAFI (Building) Series 3, Pipes and Accessories: Aluminium	We would expect the price of metal pipes to vary in a similar way to the price of metal products used by DNOs. Therefore these indices should act as good proxies for a DNO's materials input costs.	1991-2012	×	×	?	Relevant to DNOs' material costs. However, we would need more information on SP's cost drivers to identify materials which form a significant proportion of material costs.
PAFI (Building) Series 3, Pipes and Accessories: Steel		1991-2012	×	×	?	
Manufacture of other Builders' Carpentry and Joinery	We would expect the price of wooden utility poles to follow trends in the price level of wooden goods used in the construction industry, such as beams and rafters. Therefore this PPI should act as a good proxy for the cost of utility poles	1996-2012	×	×	?	
COPI Construction Output Price Index (Private Industrial)	The Private Industrial COPI targets construction costs which have some relevance to DNOs.	1955-2012	×	×	×	
COPI Construction Output Price Index (All Construction)		1955-2012	×	×	×	
All ConstructionTender Price Index (ALLCON)	Measure of price level in tenders across all construction sectors. Should therefore reflect a DNO's materials costs to a certain extent. However, tender prices also depend on a number of other costs such as labour and transport.	1985-2012	×	×	×	
Manufacture of Copper (2444000000)	As Ofgem notes, DNOs buy manufactured products, not raw materials. Therefore commodity price indices are only indirectly related to a DNOs input costs as there are other important factors, such as the cost of labour, which affect the price paid by DNOs for metal-based products.	1996-2012	×	×	×	Not directly related to the material costs associated with DNOs, and exhibit high volatility (the average range of mean nominal growth from inclusion/exclusion of any one year's data for these indices is 0.85%). Thererfore, we share Ofgem's view that they should not be included in the RPE analysis.
Manufacture of Basic Metals (6112240000)		1996-2012	×	×	×	
Manufacture of Basic Iron, Steel and Ferro-Alloys (2410000000)		1996-2012	×	×	×	
Manufacture of Other Non-Ferrous Metals (2445000000)		1996-2012	×	×	×	

Table 2.3
Analysis of plant and equipment Indices

Index	Relevance	Data Quality	Regulatory Precedent		Selected?	Additional Comments
		Time Period	RIIO-T1/GD1	DPCR5		
Plant and Road Vehicles (70/2)	This index provides a a comprehensive measure of the general level of plant and equipment costs faced by a DNO.	1977-2012	✓	×	✓	
Machinery and Equipment Output *(Including the older series)*	These PPIs Incorporate a broad range of both general and special purpose machinery, and should cover all major equipment costs faced by a DNO.	1987-2012	✓	×	✓	
Machinery and Equipment Input *(Including the older series)*		1987-2012	✓	✓	✓	
Electrical and Optical Equipment Output *(Including older series)*	Provides a more targeted measure of the cost of the specialist equipment used by a DNO and specifically includes "transformers and distribution apparatus".	1987-2012	✓	×	?	There is considerable overlap between the factors covered by the specialist equipment PPIs and those covered by the PPIs listed in the materials table above. If this index is used, it is important to ensure that there is no double counting.
Electrical and Optical Equipment Input *(Including older series)*	Provides a more targeted measure of the cost of the specialist equipment used by a DNO and specifically includes "transformers and distribution apparatus".	1987-2012	×	×	×	There is considerable overlap between the factors covered by these PPIs and the PPIs listed in the materials table above. Therefore, it may not be appropriate to include this index in the final analysis.
Wiring and Wiring Devices	Provides a more targeted measure of the cost of the specialist equipment used by a DNO.	1996-2012	×	×	×	

2.2 Method for forecasting RPEs

2.2.1 Overview

Based on the most relevant indices selected, we then forecast RPEs as follows:

1. We look for published forecasts of the selected input price series from reputable third party agencies. If available, we base our near-term forecast RPEs on these published sources' projected difference between the expected growth rates in relevant indices, and their expected growth rates in RPI;
2. If third party forecasts are not available, or in the period after third parties' forecasts end, we base our forecasts on an extrapolation of long-run historic trends in real input price inflation based on our own statistical analysis.

We consider that this approach is broadly consistent with the methods used by Ofgem and its advisors at recent price control reviews, as our analysis is based on long-term trends in the inflation of relevant cost indices relative to the rate of RPI inflation.[7]

2.2.2 Selected approach to extrapolating historic price trends

For the majority of price series we examined, as discussed further below, reputable third party forecasts were not available, so we relied mainly on our statistical analysis of historic data to extrapolate historic input price trends.

Each of the indices we selected as potentially relevant (see above) track nominal inflation in the costs they represent. The first step of our analysis is to deflate these indices using the RPI, in effect turning them into indices that track inflation in the costs they represent *in addition to inflation in RPI.* We then take the natural logarithm of the deflated series, and estimate a statistical model, with the following form:

(1) $Ln\ (Deflated\ Index)_t = \alpha + \beta\ x\ Time\ Trend + e_t$

In this basic form, the deflated index is assumed to grow at a given percentage per annum, represented by the β parameter, which is estimated by our model. However, in any given year the model can deviate from the trend line due to statistical "noise", as represented by the residual in the equation, the e_t term. These residual terms may represent a range of factors, including cyclical macroeconomic factors causing the deflated index to depart from its long-term trend growth rate and statistical factors such as inaccuracies in measuring real price trends data.

In any given year, therefore, it is likely that the price indices we model will be above or below a trend line. In some cases, deviations from the trend may be permanent, and in other cases indices may return to their trend growth rate after a period of time. To allow for such features of the data, we model explicitly potential correlation in the error terms over time. We do this by modelling the e_t term as an Autoregressive Moving Average (ARMA) process.

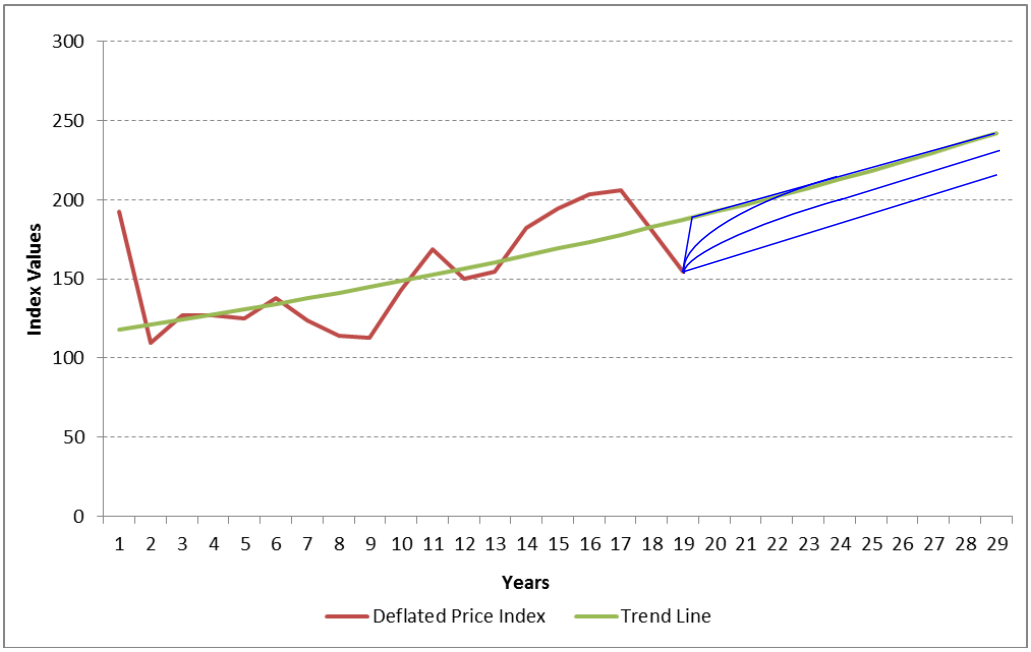
In general, an ARMA process depends on "m" past observations of itself (the autoregressive component), as well or an "n" lagged "white noise" error terms (the moving average component, represented here as the u_t terms). In general, an ARMA process therefore has the following form:

(2) $e_t = \rho_1\ x\ e_{t-1} + ..., + \rho_m\ x\ e_{t-1} + \varphi_0\ x\ u_t + \varphi_1\ x\ u_{t-1} + ..., + \varphi_Q\ x\ u_{t-n}$

This type of statistical process allows us to model explicitly whether, and how quickly, our deflated price indices return to trend, i.e. rather than just assuming the long-term growth rate applies throughout the forecast period. This is illustrated in the figure below. Essentially, we use this technique to select the likely future trajectory for the selected indices; the illustration in Figure 2.1 shows a range of potential future trajectories as a range of possible blue forecast lines.

[7] See for example Ofgem (2012) *Strategy Consultation for RIIO-ED1: Tools for cost assessment*, paras. 11,7-11.8

Figure 2.1
Range of possible trajectories for input price series - illustration



To calibrate this statistical process fort he purposes of forecasting the deflated indices, the main choice we face is selecting the parameters m and n from formula (2) above. We make this choice by estimating several models with different values of m and n,[8] and comparing how well each of the models fits the underlying data.[9] The choices we make regarding the m and n parameters, as well as the estimated values of the α,β,ρ, and φ parameters affects the forecast of the deflated price series we obtain from this analysis.

2.2.3 Alternative approaches to extrapolating price trends

An alternative approach would have been simply to calculate the compound average growth rate for each of the historic deflated series, and apply this as a forecast of future growth rates. However, this has certain disadvantages compared to the approach we adopted:

- This does not account for the fact that the series may be currently above or below its long-run trend. If (and whether) the series closes the gap to its historic trend will affect the resulting RPE, and the ARMA modelling approach described above allows for this possibility; and
- Relying on compound average growth rates only uses the first and last data point in the historic price index. This means the calculation is very sensitive to outliers, and uses less statistical information about the properties of the series than a regression or ARMA method.

A further alternative would have been to run a regression as shown in equation (1) above, without modelling the error term as an ARMA process. Again, the disadvantage of this approach would have been that the model would have only allowed us to forecast RPEs on the assumption that either the index continues from its current growth rate (i.e. the parameter β) with no transition to the long-term trend line, or that the series reverts immediately to the trend line (i.e. using both parameters α and β). Any other assumption, such as a "glidepath" back to the trend growth rate, could only have been arbitrarily selected without reference to the statistical model.

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[8] We ran a series of 25 models that allowed for an AR process of between 0 and 4 lags, an MA process of between 0 and 4 lags.

[9] We do this using a diagnostic statistic known as the Bayesian Information Criterion.

The only disadvantage of the approach we selected is the possible subjectivity in the selection of the values of m and n in equation (2). However, as noted above, we overcome this possible downside by selecting m and n to best fit the historic data.

Therefore, the relative merits of these alternative approaches led us to adopt the approach set out above in Section 2.2.2.

2.2.4 Combining forecasts of real inflation in several price indices

As noted above, our business plan requires forecasts of RPEs at the level of labour costs (general and specialised), materials, plant and equipment, and transport and other costs. For each of these categories, as set out in Section 2.1.3, we selected a number of potentially relevant cost indices, so to define an overall RPE we need to draw the forecasts of several indices.

In combining forecasts of several price indices into a single RPE, one option would be to take a weighted average based on the share of our costs that each selected price index is intended to reflect. However, there are several practical difficulties associated with this approach. Principally, not all of the costs incurred by a DNO are covered by published price indices. For example, we have not been able to find price indices that cover all the different types of materials, plant and equipment we buy. This means that any weighting of price indices would be highly subjective.

Our approach is therefore to take an un-weighted average of the selected price indices for each category of costs to define our forecast RPEs.

2.2.5 Accounting for future changes in RPI

Because Ofgem's price control indexes DNOs' allowed costs to changes in RPI, our analysis uses historic data to evaluate trends in various price indices that we deflate using an historic RPI series. Essentially, our statistical analysis assumes a continuation of the long-term relationship between selected cost/price indices and RPI. However, if this relationship were to change in the future due to a change in the way RPI is calculated, some adjustment to our forward-looking RPIs may be necessary. One reason to suspect that such a change might have taken place in the calculation of RPI is that over the past twenty years, the rate of inflation measured by the RPI has been, on average, about 0.7 percentage points higher than CPI inflation. However, this difference has been substantially higher in recent years, suggesting that there may have been some long run structural change in the level of the RPI. This would suggest a reduction may be required to the RPEs forecast based on extrapolating past trends in price/cost indices deflated at RPI.

In a recent working paper,[10] the OBR identified the RPI 'formula effect' as the key driver behind the sudden increase in the CPI-RPI inflation gap. CPI and RPI use different formulas for low-level price aggregation. The use of different formulations reduces the level of the CPI relative to the RPI. Historically, this formula effect has been relatively stable, at around 0.5 percentage points. However since 2010 the formula effect has increased to around 0.8 to 1.0 percentage point on average[11]. According to the ONS, this increase was due to changes in their clothing price data collection methodology, introduced at the beginning of 2010. Under the new methodology, clothing price data used for both the CPI and RPI are drawn from a wider sample. Wider sampling results in greater price variance, which in turn increases the formula effect.

Assuming no further methodological changes in the calculation of RPI, the OBR suggests 0.9 percentage points as a plausible estimate of the formula effect's long-run contribution to the difference between RPI and CPI inflation, representing an increase of 0.4 relative to the historic average. In practice this means that, all else being equal, the ONS' recent methodological changes should have resulted in a downward shift in CPI inflation and an upward shift in RPI inflation, with the total difference between the two increasing by 0.4 percentage points. However, it is not possible to decompose recent changes in the absolute level of the RPI between economic factors and the new methodology.

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[10] *Office for Budge Responsibility (2011), Working Paper No. 2: The Long Run Difference Between RPI and CPI inflation*

[11] ONS (2012), *The National Statistician's Consultation on Options for Improving the Retail Prices Index*

Therefore, to account for this change in the expected growth rate in RPI compared to historic trends, there may be a case for reducing the RPEs projected by our model, which is calibrated based on the historic relationship between RPI and various cost indices, by up to 0.4 percentage points per annum.[12] In practice, some of this formula effect will be to reduce CPI and not increase RPI, hence attributing the whole effect of 0.4 percentage points to an increase in RPI may overstate this effect. Hence, if we attribute some of the effect to reductions in CPI, a reduction in our forecast RPEs of less than 0.4 percentage points would be required.

Over the ED1 period, it is possible that the spread between RPI and CPI will widen or narrow for reasons besides the formula effect. For instance, mortgage interest payments, which are included in RPI but not CPI, may rise or fall and cause divergence between the series. However, movements in mortgage interest payments do not constitute a structural change in the calculation of RPI. It is not necessary to account for such factors in our analysis because over the history of the RPI and other price/cost series we analyse, mortgage interest payments have risen and fallen periodically, the effects of which are already reflected in our statistical analysis of long-term trends.

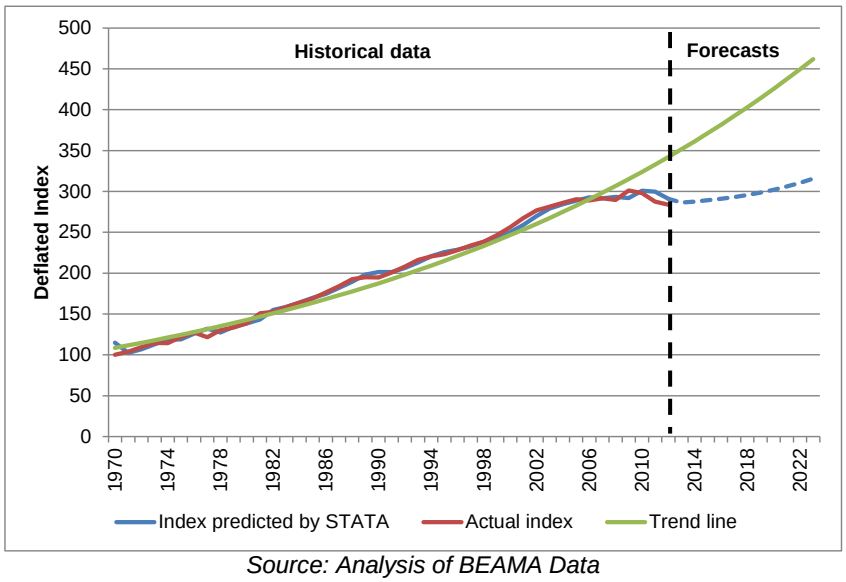
2.3 Forecast RPEs for the ED1 Period

2.3.1 Labour costs

Figure 2.2 and Figure 2.3 show historic trends in the indices we selected as most relevant to specialised labour costs, the BEAMA Electrical Labour and BCIS Electrical Installations Labour Cost series. The series shown in the figures are all deflated series, i.e. they reflect changes in the relevant index, after subtracting inflation in RPI.

As well as the historic series (the red lines), the figures show the "predicted" values produced by our statistical models, both for the historic period and the forecast period out to the end of RIIO-ED1 (the blue lines). The figures show that both these indices have fallen below the long-run trend since 2006, before and during the financial crisis and economic downturn. Our model predicts modest real growth in wages going forward when compared to both historic trends, with some acceleration of real wage inflation towards the end of the modelling period.

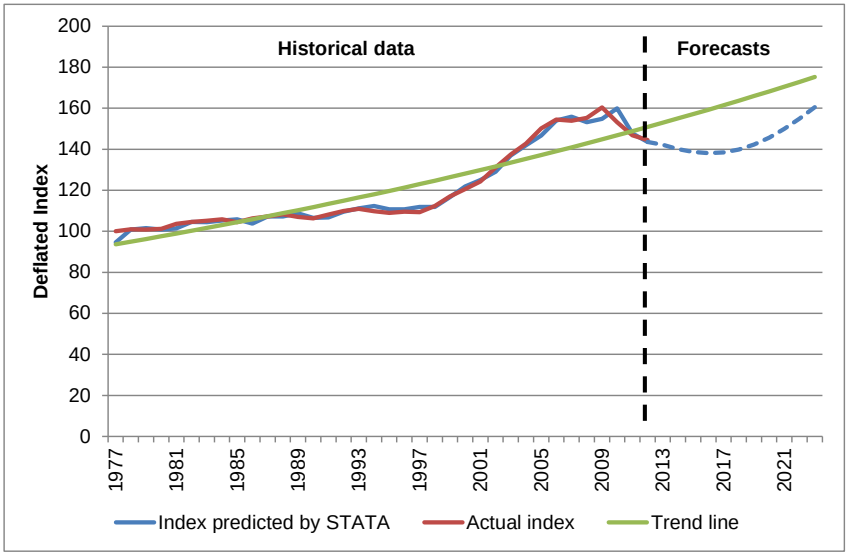
Figure 2.2
Electrical labour (BEAMA)



Source: Analysis of BEAMA Data

[12] This approach is justified if we assume that, in general, the government successfully meets its CPI inflation target of two percent and that an increase in the formula effect will therefore manifest primarily as a positive shift in the RPI.

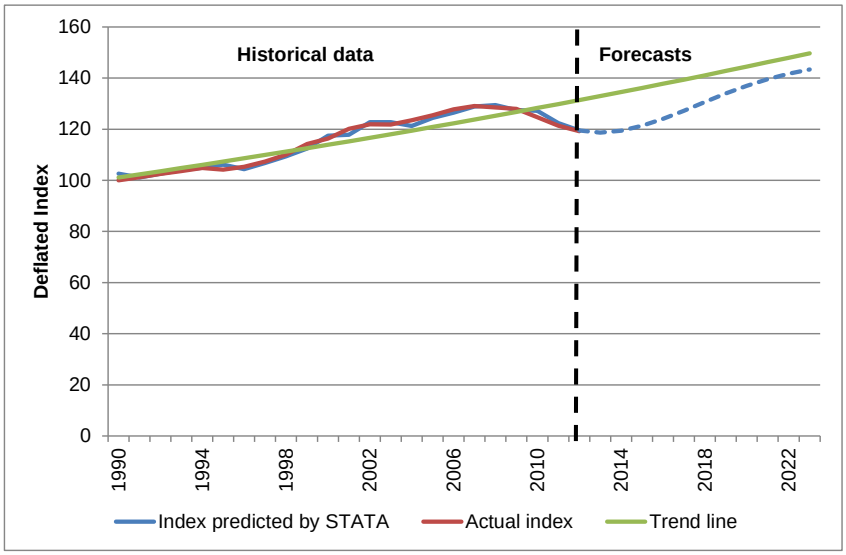
Figure 2.3
Electrical installations - cost of labour (BCIS)



Source: Analysis of BCIS Data

Growth in private sector average earnings, see Figure 2.4, which we have selected as the most relevant index for our general labour costs has followed a similar trend to the specialised electrical labour indices in Figure 2.2 and Figure 2.3 with low or negative real growth in the last few years. As for the BCIS labour index, our statistical model predicts that some recovery in real wage growth will take place over the coming period, but that this index will remain somewhat below trend throughout the ED1 period.

Figure 2.4
Private sector average weekly earnings (ONS)



Source: Analysis of ONS Data

Although we have not been able to find reputable third party forecasts of the electrical labour indices we use to measure trends in specialised labour costs, we do have third party forecasts of average private sector earnings in the

economy as a whole that we used for general labour costs. Table 2.4 shows forecasts of real growth (i.e. above RPI) in private sector average weekly earnings from the Office for Budget Responsibility (OBR), which it published in March 2013. Like the forecasts emerging from our statistical model, the OBR predicts low (or negative) real earnings growth in the coming years. However, the OBR forecasts only go out to 2017.

Table 2.4
OBR forecasts of the average weekly earnings, less RPI (March 2013)

	2013	2014	2015	2016	2017
OBR Forecasts of Private Sector Average Weekly Earnings	-1.8	-0.1	0.4	0.4	0.1

Source: OBR, March 2013.

Table 2.5 shows the RPEs we forecast using the methods described above for labour costs, based on the OBR's forecasts and from our statistical models. For the period for which the OBR figures are available, we use those forecasts directly to determine our general labour RPE, before reverting to the outputs from our statistical model that extrapolates historic trends. For the years in which we use outputs from our statistical model to forecast RPEs, as described above in Section 2.2.5, we reduce our forecasts by 0.4 percentage points per annum to account for the RPI formula effect. In the period for which the OBR forecasts are available, their forecasts are below the forecasts predicted by our model. In other words, the OBR thinks growth in real private sector earnings are going to remain well below their historic trend throughout the period to 2017. Given the difference between the OBR's forecasts and our extrapolation of long-term trends, by taking the OBR figures in the short-term and reverting to the modelled trend growth rate for the later part of the ED1 period when forecasts are no longer available, our forecast RPE for general labour is probably on the low side of the plausible range over the period as a whole.

For our specialised labour RPE, we use the outputs from our models, taking a straight average of the forecast growth rates for the BCIS and BEAMA electrical labour indices shown above, and reducing these forecasts by 0.4 percentage points to account for the RPI formula effect.

Overall, Table 2.5 shows that for specialised labour we forecast an RPE of 0.41% on average over the period from 2012/13 to the end of the ED1 period, and an average RPE of 0.86% for general labour.

Table 2.5
Labour RPE summary table

	RPE (%)										
	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	Average
Selected Price Indices											
Private Sector Average Weekly Earnings incl. Bonus											
- Modelled Extrapolation of Historic Trend	-0.78	0.48	1.34	1.91	2.20	2.24	2.08	1.78	1.41	1.04	1.37
- OBR Forecast	-1.38	0.03	0.40	0.33	0.08						-0.11
Electrical Installations - Cost of Labour	-1.50	-1.77	-1.26	-0.63	0.07	0.79	1.48	2.11	2.63	3.00	0.49
Electrical Labour	-1.53	0.08	0.16	0.26	0.37	0.50	0.64	0.79	0.95	1.11	0.33
Labour input cost categories											
General Labour (capex)	-1.38	0.03	0.40	0.33	0.64	2.24	2.08	1.78	1.41	1.04	0.86
General Labour (opex)	-1.38	0.03	0.40	0.33	0.64	2.24	2.08	1.78	1.41	1.04	0.86
Specialist Labour (capex)	-1.52	-0.84	-0.55	-0.19	0.22	0.64	1.06	1.45	1.79	2.06	0.41
Specialist Labour (opex)	-1.52	-0.84	-0.55	-0.19	0.22	0.64	1.06	1.45	1.79	2.06	0.41

Note:
1. The forecasts based on OBR projections are shaded in grey. We do not adjust these forecasts for the RPI formula effect.[13]
2. We adjusted the forecast RPEs to account for the financial year. The RPE for 2013/14 is calculated as follows: (0.75 x RPE in 2013) + (0.25 x RPE in 2014).

[13] Where we use outputs from our model, we subtract 40 basis points from the forecast RPE to account for the RPI formula effect, as set out in Section 2.2.5. Because the OBR forecasts both average earnings and RPI, we simply take the difference between the two series, and do not make an adjustment for the RPI formula effect.

However, as we discuss above in Section 2.2.5, the downward adjustment of 0.4 percentage points to account for the RPI formula effect is probably at the high end of the plausible range. Hence, Table 2.6 shows a sensitivity in which we do not apply any reduction to the forecasts from our statistical models to account for this effect.

Table 2.6
Labour RPE summary table – excluding RPI formula effect

	RPE (%)										
	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	Average
Selected Price Indices											
Private Sector Average Weekly Earnings incl. Bonus											
- Modelled Extrapolation of Historic Trend	-0.38	0.88	1.74	2.31	2.60	2.64	2.48	2.18	1.81	1.44	1.77
- OBR Forecast	-1.38	0.03	0.40	0.33	0.08						-0.11
Electrical Installations - Cost of Labour	-1.10	-1.37	-0.86	-0.23	0.47	1.19	1.88	2.51	3.03	3.40	0.89
Electrical Labour	-1.13	0.48	0.56	0.66	0.77	0.90	1.04	1.19	1.35	1.51	0.73
Labour input cost categories											
General Labour (capex)	-1.38	0.03	0.40	0.33	0.74	2.64	2.48	2.18	1.81	1.44	1.07
General Labour (opex)	-1.38	0.03	0.40	0.33	0.74	2.64	2.48	2.18	1.81	1.44	1.07
Specialist Labour (capex)	-1.12	-0.44	-0.15	0.21	0.62	1.04	1.46	1.85	2.19	2.46	0.81
Specialist Labour (opex)	-1.12	-0.44	-0.15	0.21	0.62	1.04	1.46	1.85	2.19	2.46	0.81

Note:
1. The forecasts based on OBR projections are shaded in grey.
2. We adjusted the forecast RPEs to account for the financial year. The RPE for 2013/14 is calculated as follows: (0.75 x RPE in 2013) + (0.25 x RPE in 2014).

2.3.2 Materials costs

The figures below show a similar set of charts as for the labour indices we analysed above. In contrast to the labour indices that all trend upwards in real terms, the materials cost indices follow a range of different historic trends. Accordingly, as set out below, our statistical method of extrapolating historic trends produces a range of different projections for the ED1 period:

Figure 2.5 and Figure 2.6 show trends in the ONS PPI series “Manufacture of Electricity Distribution and Control Apparatus” and “Manufacture of Electric Motors, Generators and Transformers”. Both these indices have followed relatively stable downward trends over time, and accordingly, our statistical model predicts a continuation of these trends. Figure 2.7 shows the BEAMA “Large Power Transformer Materials” index, which has also followed a relatively stable trend, but has risen gradually in real terms over time so our model a continuing upward trend in this series.

Figure 2.5
Manufacture of electricity distribution and control apparatus (ONS)

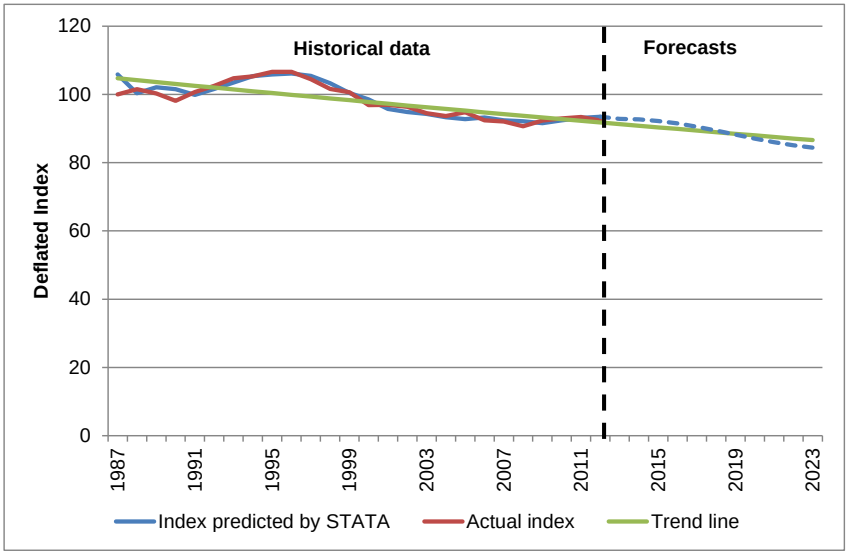


Figure 2.6
Manufacture of electric motors, generators and transformers (ONS)

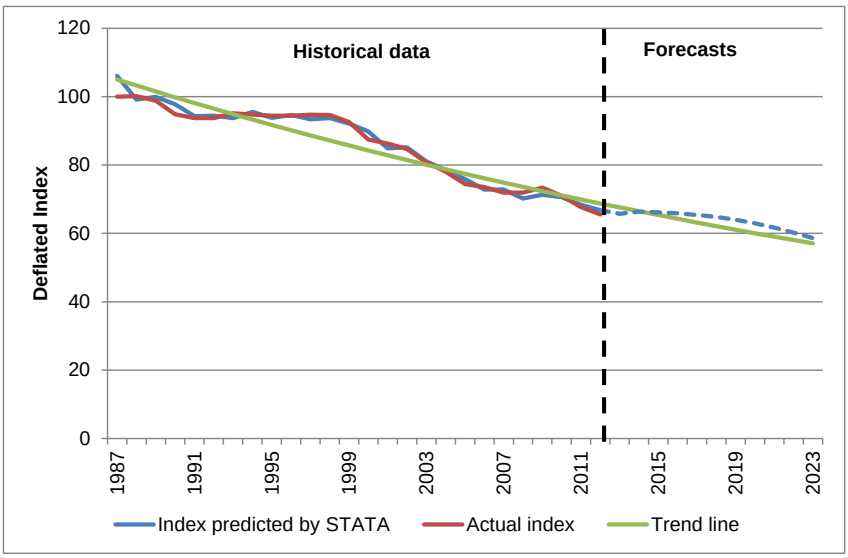
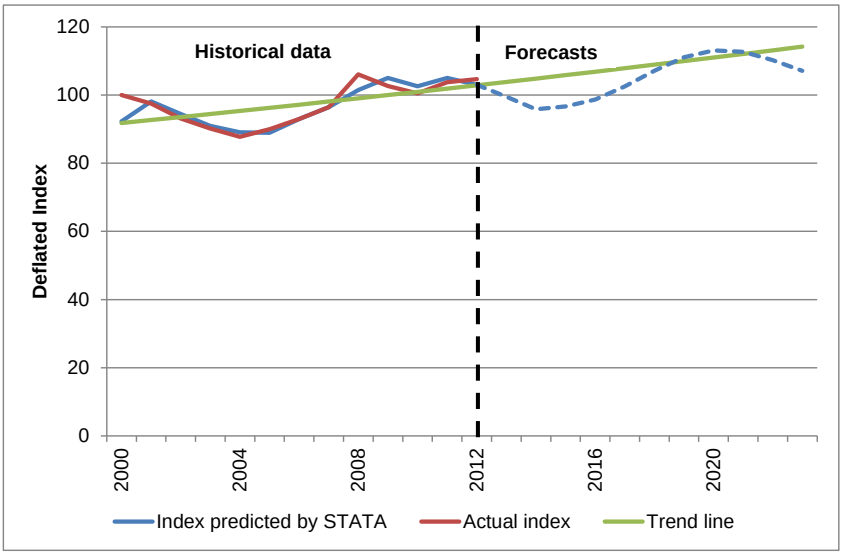


Figure 2.7
Large power transformer materials index (BEAMA)



Other materials indices do not follow such stable trends over time. A number of the other materials indices we identified as relevant to DNO costs, as shown in Figure 2.8, Figure 2.9, Figure 2.10, Figure 2.11 and Figure 2.12, have exhibited large swings in their growth rates over time. The instability of the long-term trend might suggest the presence of one or more "structural breaks" in the deflated cost indices due, for example, to structural changes in the macro-economy. If this is the case, then the projections of our statistical models may be less reliable than for the indices above that exhibit more stable trends over time. For example, the indices below all exhibit large upswings over the last decade or so, coinciding with a period of sustained growth in commodity prices, caused in part by strong growth in demand from China and other parts of the developing world. If these upward trends continue over the ED1 period, a forecast RPEs based on longer-term trends may understate likely real input price inflation over the coming control period.

Figure 2.8
Basic electrical equipment index (BEAMA)

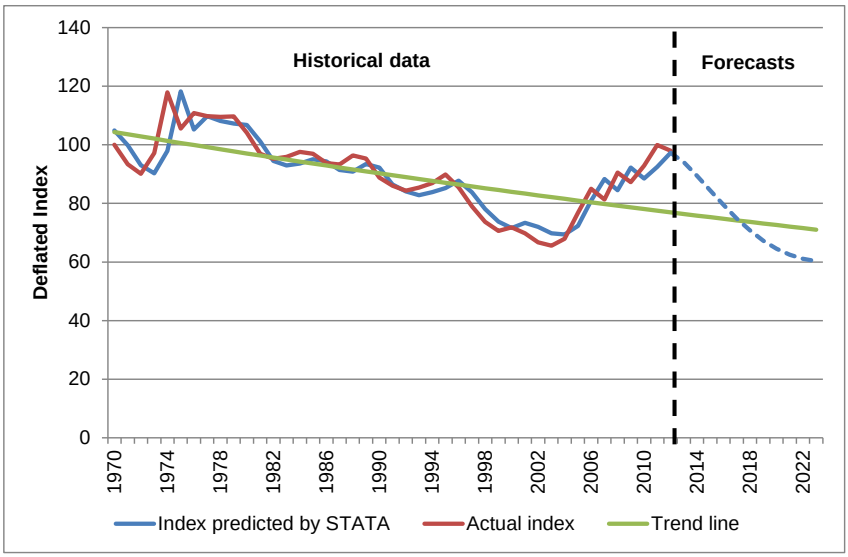


Figure 2.9
Manufacture of other electronics and electric wires (ONS)

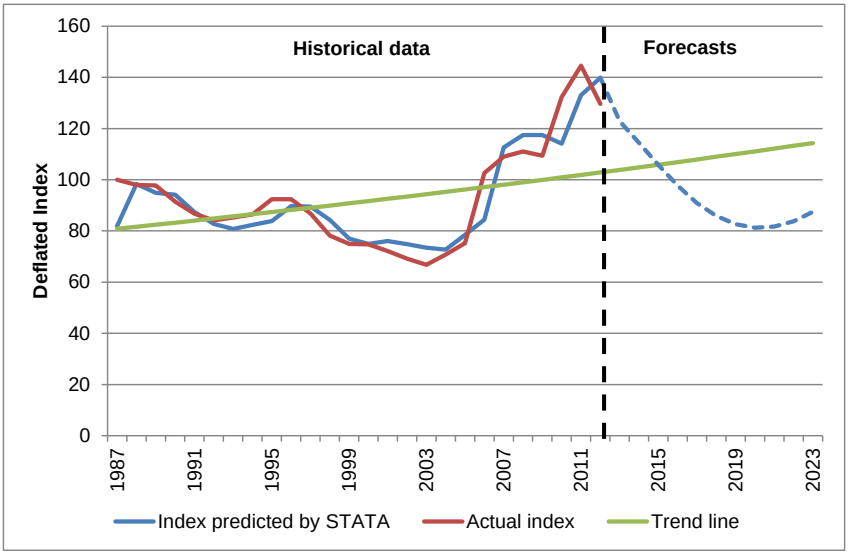


Figure 2.10
Manufacture of cold drawn wire (ONS)

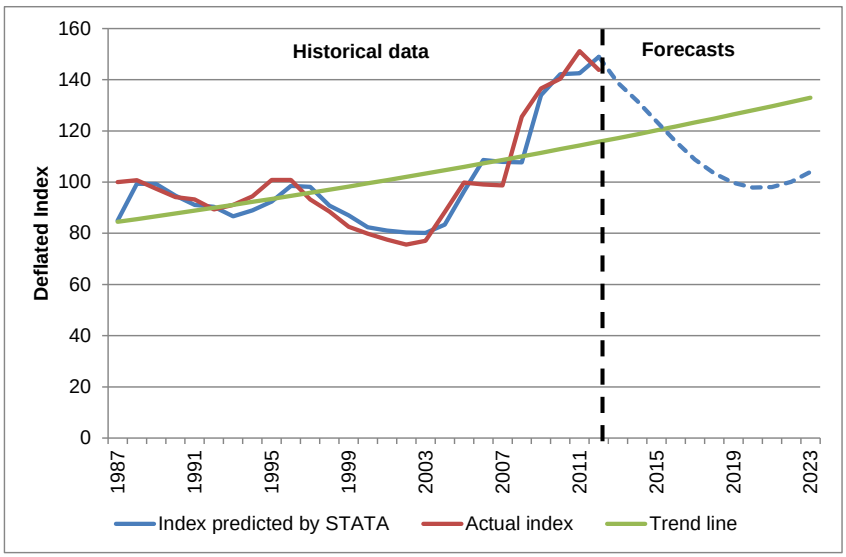


Figure 2.11
PAFI - Pipes and accessories: copper (BCIS)

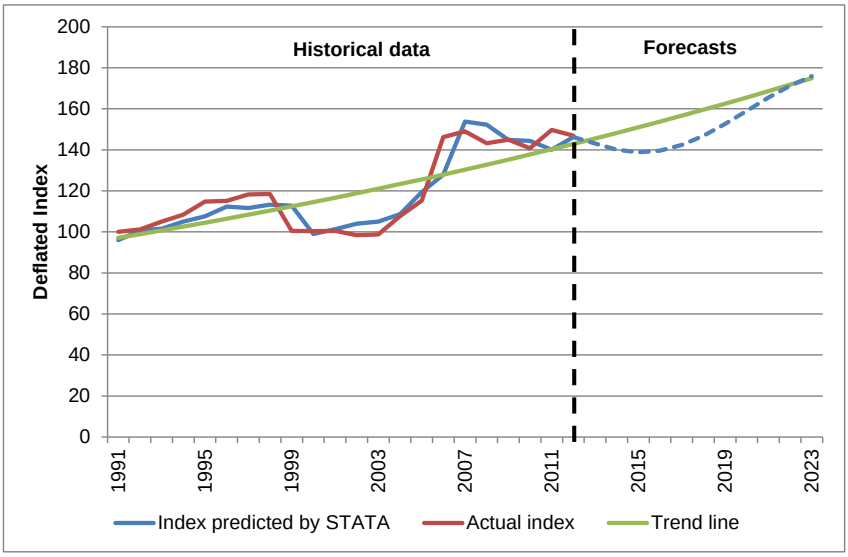
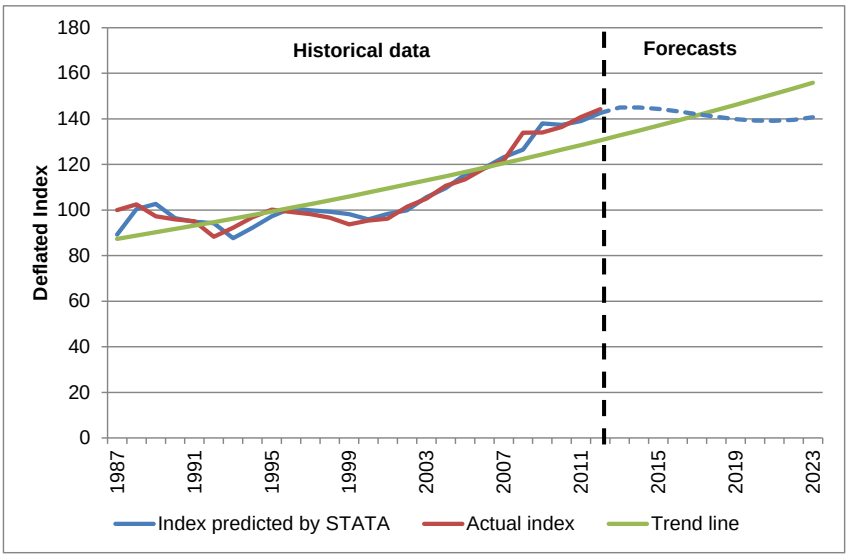


Figure 2.12
Resource Cost Index: infrastructure materials (BIS)



Given the possibility that recent trends in materials costs will continue, and hence not revert to the levels of growth seen on average since the 1970s/80s, we consider an alternative set of statistical models for the materials indices shown above in Figure 2.8, Figure 2.9, Figure 2.10, Figure 2.11 and Figure 2.12 in which we produce forecasts using data from 2000 onwards. As Figure 2.13, Figure 2.14, Figure 2.15, Figure 2.16 and Figure 2.17 show, this approach materially increases the forecast growth rates for the ED1 period.

Figure 2.13
Basic electrical equipment index (BEAMA) – Data from 2000-2012

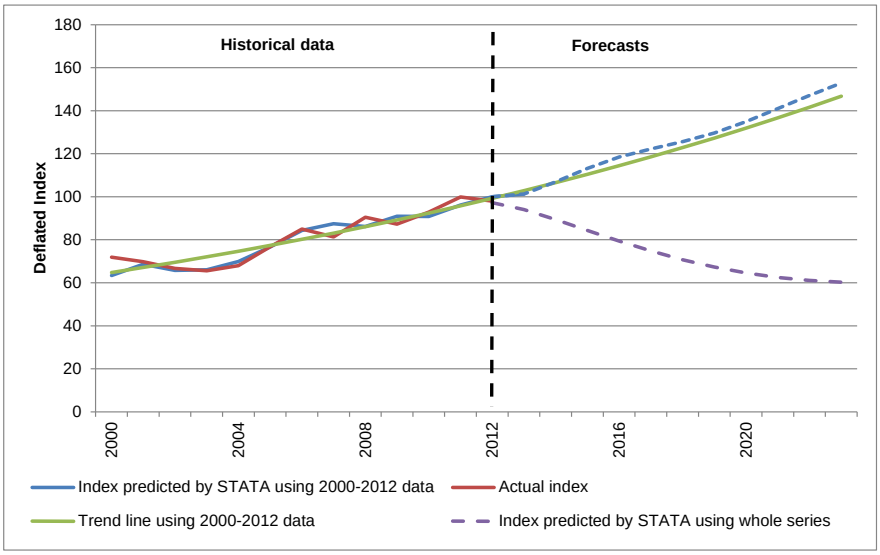


Figure 2.14
Resource Cost Index: infrastructure materials (BIS) – Data from 2000-2012

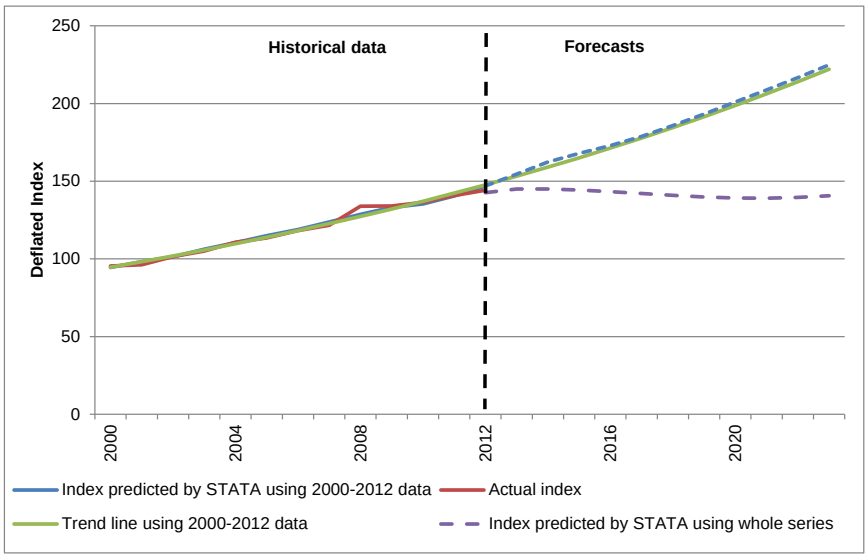


Figure 2.15
Manufacture of other electronics and electric wires index (ONS) – Data from 2000-2012

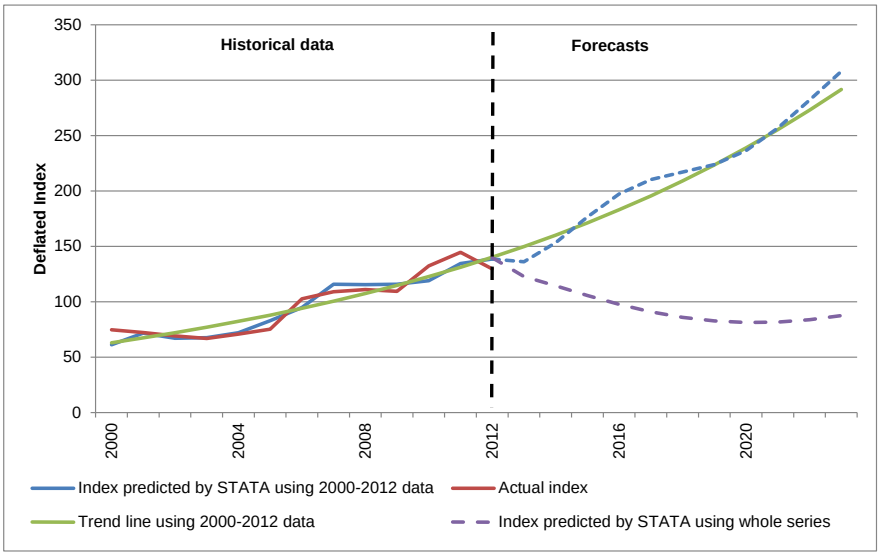


Figure 2.16
Manufacture of cold drawn wire (ONS) – Data from 2000-2012

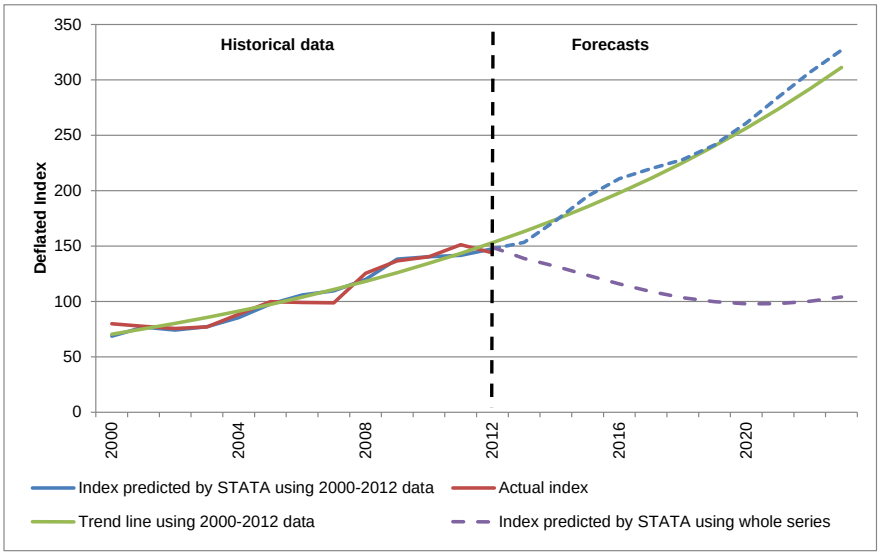
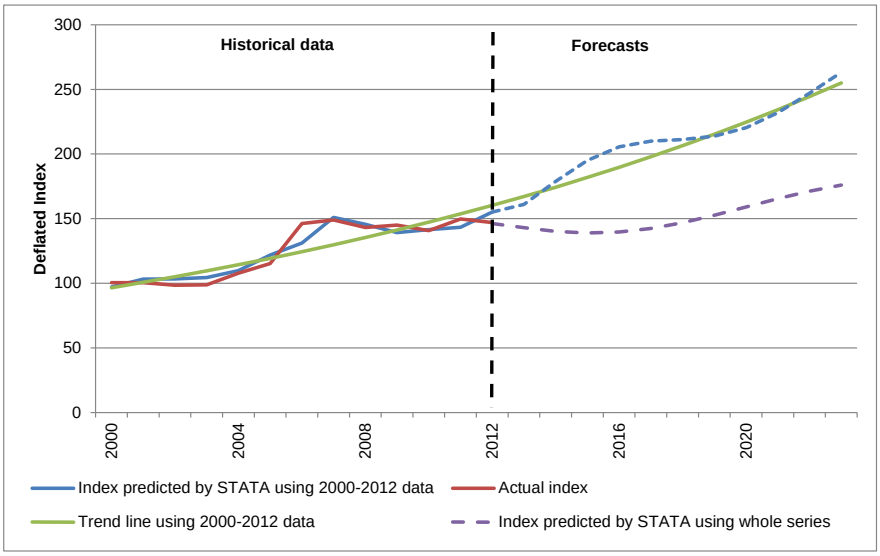


Figure 2.17
PAFI - Pipes and accessories: copper (BCIS) – Data from 2000-2012



We have no firm objective basis on which to evaluate whether materials price inflation will continue at the rates seen recently over the coming years, or whether they will revert to longer-term trend growth rates. Therefore, for those indices shown above that do not exhibit a stable trend, our approach is therefore to take an average of the growth rates forecast using the model we estimated using the whole data series, and the growth rates forecast using the model we estimated using data since 2000. The indices for which we adopt this approach are:

- PAFI - Pipes and Accessories: Copper (BCIS);
- Manufacture of Cold Drawn Wire (ONS);
- Manufacture of Other Electronics and Electric Wires Index (ONS);
- Resource Cost Index: Infrastructure Materials (BIS); and
- Basic Electrical Equipment Index (BEAMA).

The relative weights we place on the forecasts that use the more recent data as compared to the longer data should ideally be based on the probabilities we assign to the two possible growth rates. As we have little objective evidence on which to base assumptions on such probabilities, we have considered a range of forecasts that place weights of 25% and 75% on each forecast. In a "high" case, we place a 75% weight on the projections using more recent data, and in the "low" forecast, we place a 75% weight on the forecast using the longer data series. To reflect the uncertainty regarding the RPI formula effect, in the "low" case we subtract 0.4 percentage points from the forecasts emerging from our model, and in the high case we make no subtraction (see Section 2.2.5).

As Table 2.7 and Table 2.8 show, this results in a range of average annual RPE forecasts between 1.5% and 0% over the period from 2013/14 to 2022/23.

Table 2.7
Materials RPE summary table – high case

	RPE (%)										
	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	Average
Selected Price Indices											
Resource Cost Index: Infrastructure Materials (FOCOS)	4.16	3.45	2.35	2.15	2.43	2.72	2.85	2.87	2.89	2.97	2.88
PAFI (Building) Series 3, Pipes and Accessories: Coppe	3.66	7.50	6.00	3.65	1.87	1.41	2.25	3.77	5.14	5.72	4.10
BEAMA CPA Large Power Transformer Materials	-3.47	-2.57	1.16	2.56	4.03	4.28	3.22	1.27	-0.83	-2.32	0.73
BEAMA CPA Basic Electrical Equipment	0.83	2.96	2.77	1.74	0.89	0.81	1.42	2.17	2.61	2.68	1.89
Manufacture of Electricity Distribution and Control	-0.51	-0.27	-0.57	-0.85	-1.09	-1.26	-1.33	-1.30	-1.18	-0.98	-0.94
Manufacture of Electric Motors, Generators and Transfo	-0.91	0.66	-0.40	-0.50	-0.71	-1.00	-1.36	-1.73	-2.10	-2.43	-1.05
Manufacture of Other Electronics and Electric Wires	-2.53	3.11	3.33	1.56	-0.41	-0.97	0.26	2.61	4.96	6.39	1.83
Manufacture of Cold Drawn Wire	1.88	3.72	2.69	0.47	-0.79	-0.21	1.63	3.52	4.65	5.07	2.26
Materials input cost categories											
Materials (capex)	0.39	2.32	2.17	1.35	0.78	0.72	1.12	1.65	2.02	2.14	1.46
Materials (opex)	0.39	2.32	2.17	1.35	0.78	0.72	1.12	1.65	2.02	2.14	1.46

Table 2.8
Materials RPE summary table – low case

	RPE (%)										
	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	Average
Selected Price Indices											
Resource Cost Index: Infrastructure Materials (FOCOS)	1.85	0.67	0.05	-0.19	-0.17	-0.04	0.11	0.31	0.57	0.89	0.41
PAFI (Building) Series 3, Pipes and Accessories: Coppe	-0.60	0.93	1.24	1.41	1.74	2.31	3.02	3.63	3.90	3.70	2.13
BEAMA CPA Large Power Transformer Materials	-3.87	-2.97	0.76	2.16	3.63	3.88	2.82	0.87	-1.23	-2.72	0.33
BEAMA CPA Basic Electrical Equipment	-2.60	-2.83	-3.25	-3.71	-3.91	-3.67	-3.04	-2.26	-1.51	-0.85	-2.76
Manufacture of Electricity Distribution and Control	-0.91	-0.67	-0.97	-1.25	-1.49	-1.66	-1.73	-1.70	-1.58	-1.38	-1.34
Manufacture of Electric Motors, Generators and Transfo	-1.31	0.26	-0.80	-0.90	-1.11	-1.40	-1.76	-2.13	-2.50	-2.83	-1.45
Manufacture of Other Electronics and Electric Wires	-6.84	2.71	2.93	1.16	-0.81	-1.37	-0.14	2.21	4.56	5.99	1.04
Manufacture of Cold Drawn Wire	-2.55	3.32	2.29	0.07	-1.19	-0.61	1.23	3.12	4.25	4.67	1.46
Materials input cost categories											
Materials (capex)	-2.11	0.18	0.28	-0.16	-0.41	-0.32	0.06	0.51	0.81	0.93	-0.02
Materials (opex)	-2.11	0.18	0.28	-0.16	-0.41	-0.32	0.06	0.51	0.81	0.93	-0.02

2.3.3 Plant and equipment costs

Figure 2.18 shows trends in the BCIS Plant and Road Vehicles index, which we selected in Section 2.1.3 as relevant to DNOs' plant and equipment costs. The figure shows that the index exhibits a downward trend over time, but that this downward trend is driven primarily by the large reduction in this index that occurred during the late 1970s, possibly because of the reduction in commodity prices that took place after the second oil crisis. To illustrate this point, Figure 2.19 shows the same analysis using only data since 1983. Over this later period, the index has exhibited an upward trend, suggesting the long-run average growth rate for this index is being heavily influenced by a short-lived trend in prices that took place over 30 years ago. We therefore (conservatively) apply a 0% forecast for the ED1 period for this index.

Figure 2.18
Plant and road vehicles (BCIS)

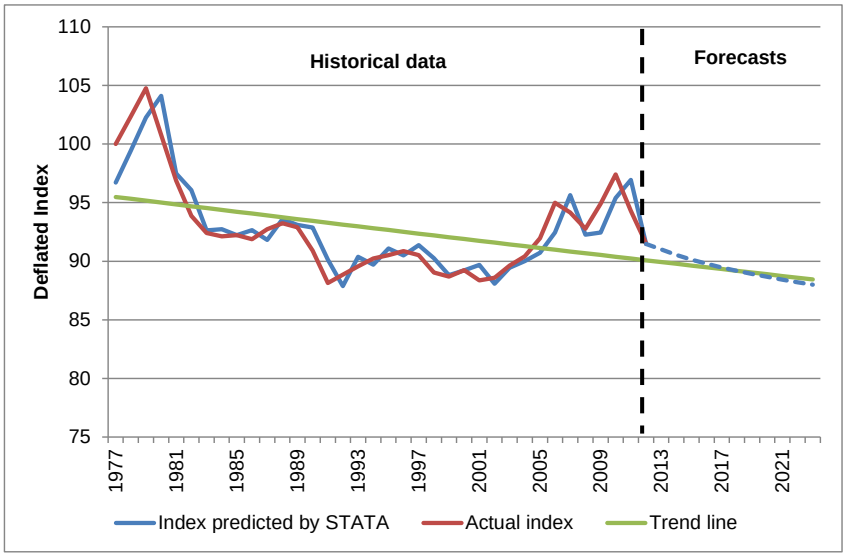
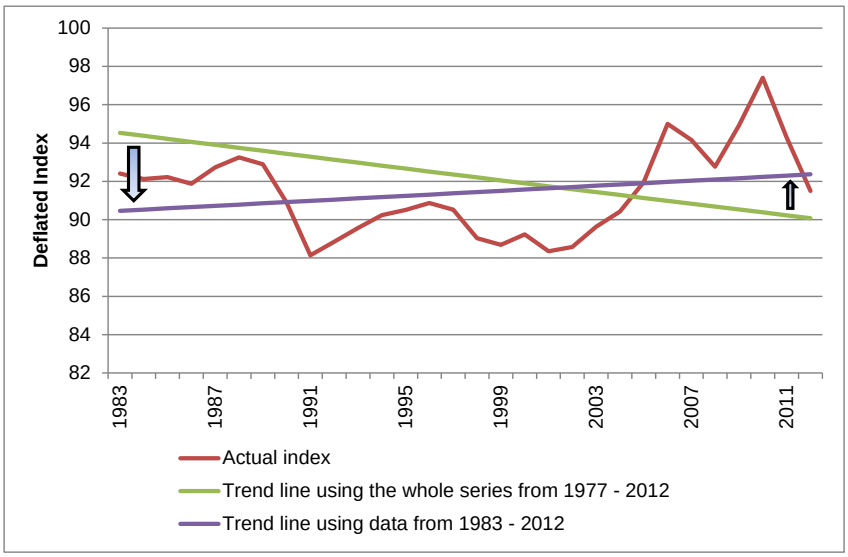


Figure 2.19
Plant and road vehicles (BCIS) – Data from 1983 onwards



For the other plant and equipment indices, as shown in Figure 2.20 and Figure 2.21, the relevant indices follow relatively stable trends, which we use the statistical methods described above to extrapolate.

Figure 2.20
Machinery and equipment input (ONS)

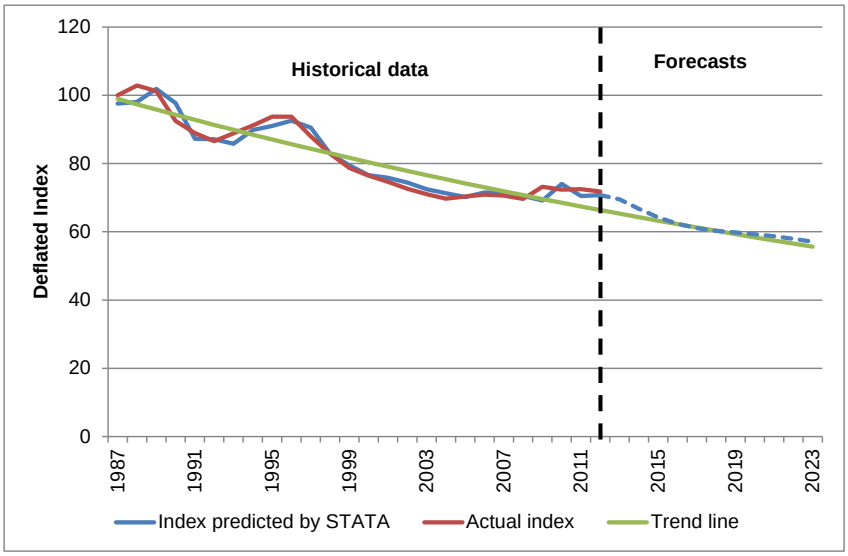
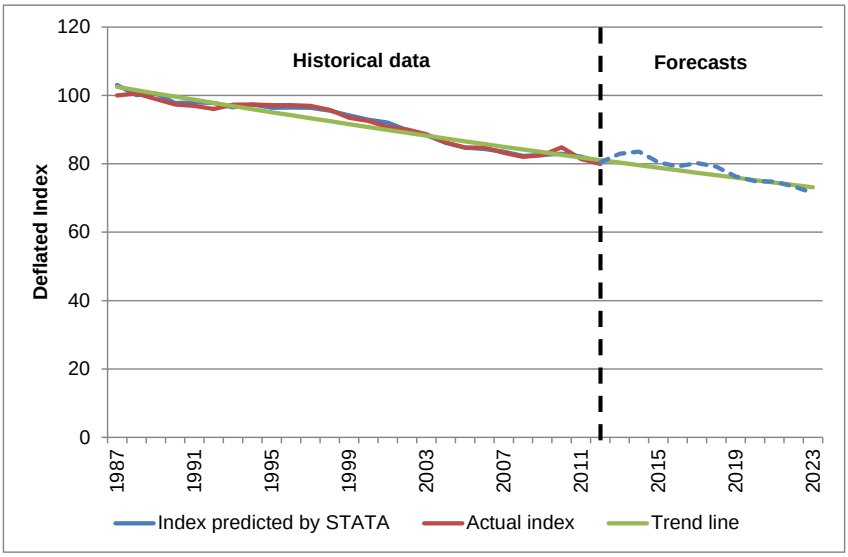


Figure 2.21
Machinery and equipment output (ONS)



Overall, Table 2.9 shows our RPE forecast for plant and equipment, which equates to -1.40% on average over the period from 2012/13 to the end of the ED1 period.

Table 2.9
Plant and equipment RPE summary table

	RPE (%)										
	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	Average
Selected Price Indices											
Plant and Road Vehicles	-0.40	-0.40	-0.40	-0.40	-0.40	-0.40	-0.40	-0.40	-0.40	-0.40	-0.40
Machinery and Equipment Output	2.75	2.75	2.75	2.75	2.75	2.75	2.75	2.75	2.75	2.75	2.75
Machinery and Equipment Input	-2.15	-2.15	-2.15	-2.15	-2.15	-2.15	-2.15	-2.15	-2.15	-2.15	-2.15
Plant and Equipment input cost category											
Equipment/Plant	-0.32	-1.84	-2.64	-1.57	-0.79	-1.42	-1.76	-1.16	-0.96	-1.51	-1.40

2.3.4 Transport and other costs

As described above, we were not able to identify a sufficient number of relevant price indices to reach an informed view on likely RPEs for the "transport and other" category of costs. We therefore conservatively assume an RPE of zero for the ED1 period.

2.4 Conclusion

Table 2.10 and Table 2.11 show our overall RPE forecasts for each cost category in the high and low cases set out above. In the high case, we apply no adjustment for the RPI formula effect, and in the low case we reduce the RPEs projected by our statistical models by 0.4 percentage points. In the high case, we place more weight on recent data when deriving our materials RPEs forecasts, and less weight on the more recent forecasts in the low case. Table 2.12 and Table 2.13 show the same information, but in the format required for Ofgem's RIIO-ED1 Business Plan template.

Table 2.10
Overall summary of RPE forecasts (%) – high case

	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	Average
General Labour (capex)	-1.38	0.03	0.40	0.32	0.74	2.64	2.48	2.18	1.81	1.44	1.07
General Labour (opex)	-1.38	0.03	0.40	0.32	0.74	2.64	2.48	2.18	1.81	1.44	1.07
Specialist Labour (capex)	-1.12	-0.44	-0.15	0.21	0.62	1.04	1.46	1.85	2.19	2.46	0.81
Specialist Labour (opex)	-1.12	-0.44	-0.15	0.21	0.62	1.04	1.46	1.85	2.19	2.46	0.81
Materials (capex)	0.39	2.32	2.17	1.35	0.78	0.72	1.12	1.65	2.02	2.14	1.46
Materials (opex)	0.39	2.32	2.17	1.35	0.78	0.72	1.12	1.65	2.02	2.14	1.46
Equipment/Plant	0.08	-1.44	-2.24	-1.17	-0.39	-1.02	-1.36	-0.76	-0.56	-1.11	-1.00
Transport	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 2.11
Overall summary of RPE forecasts (%) – low case

	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	Average
General Labour (capex)	-1.38	0.03	0.40	0.32	0.64	2.24	2.08	1.78	1.41	1.04	0.86
General Labour (opex)	-1.38	0.03	0.40	0.32	0.64	2.24	2.08	1.78	1.41	1.04	0.86
Specialist Labour (capex)	-1.52	-0.84	-0.55	-0.19	0.22	0.64	1.06	1.45	1.79	2.06	0.41
Specialist Labour (opex)	-1.52	-0.84	-0.55	-0.19	0.22	0.64	1.06	1.45	1.79	2.06	0.41
Materials (capex)	-2.11	0.18	0.28	-0.16	-0.41	-0.32	0.06	0.51	0.81	0.93	-0.02
Materials (opex)	-2.11	0.18	0.28	-0.16	-0.41	-0.32	0.06	0.51	0.81	0.93	-0.02
Equipment/Plant	-0.19	-1.71	-2.51	-1.43	-0.66	-1.29	-1.62	-1.02	-0.83	-1.38	-1.26
Transport	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 2.12
Overall summary of RPE forecasts (index) – high case

	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23
General Labour (capex)	1.000	0.986	0.986	0.990	0.994	1.001	1.027	1.053	1.076	1.095	1.111
General Labour (opex)	1.000	0.986	0.986	0.990	0.994	1.001	1.027	1.053	1.076	1.095	1.111
Specialist Labour (capex)	1.000	0.989	0.984	0.983	0.985	0.991	1.002	1.016	1.035	1.058	1.084
Specialist Labour (opex)	1.000	0.989	0.984	0.983	0.985	0.991	1.002	1.016	1.035	1.058	1.084
Materials (capex)	1.000	1.004	1.027	1.049	1.064	1.072	1.080	1.092	1.110	1.132	1.156
Materials (opex)	1.000	1.004	1.027	1.049	1.064	1.072	1.080	1.092	1.110	1.132	1.156
Equipment/Plant	1.000	1.001	0.986	0.964	0.953	0.949	0.940	0.927	0.920	0.915	0.904
Transport	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Other	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table 2.13
Overall summary of RPE forecasts (index) – low case

	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23
General Labour (capex)	1.000	0.986	0.986	0.990	0.994	1.000	1.022	1.044	1.062	1.077	1.088
General Labour (opex)	1.000	0.986	0.986	0.990	0.994	1.000	1.022	1.044	1.062	1.077	1.088
Specialist Labour (capex)	1.000	0.985	0.977	0.971	0.969	0.971	0.978	0.988	1.002	1.020	1.041
Specialist Labour (opex)	1.000	0.985	0.977	0.971	0.969	0.971	0.978	0.988	1.002	1.020	1.041
Materials (capex)	1.000	0.979	0.981	0.983	0.982	0.978	0.975	0.975	0.980	0.988	0.997
Materials (opex)	1.000	0.979	0.981	0.983	0.982	0.978	0.975	0.975	0.980	0.988	0.997
Equipment/Plant	1.000	0.998	0.981	0.956	0.943	0.937	0.924	0.909	0.900	0.893	0.880
Transport	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Other	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

To provide an indication of the overall effects of these RPE forecasts, we have weighted them together using the weightings Ofgem published for a representative GDN in its RIIO-GD1 Initial Proposals document, shown below in Table 2.14 and Table 2.15.[14] To derive an overall RPE, we also weighted the RPEs for opex, capex and repex together by their respective shares in total expenditure (see the bottom row of Table 2.14) using data from the GD1 final proposals financial model. We also assumed that all contract labour (see Ofgem's weightings in Table 2.14) corresponds to the "specialist labour" category, while direct labour corresponds to the "general labour" category. As Table 2.14 shows, this procedure results in an overall average RPE of between 0.33% and 0.71% per annum for the RIIO-ED1 period.

Table 2.14
Weighted average RPE based on Ofgem RIIO-GD1 weightings – high case

				ED1
	Opex	Capex	Repex	**RPE (%)**
Direct Labour	34%	11%	10%	**1.07%**
Contract Labour	18%	45%	67%	**0.81%**
Materials	6%	19%	13%	**1.46%**
Plant & Equipment	1%	4%	0%	**-1.00%**
Transport	2%	0%	0%	**0.00%**
Other	39%	21%	11%	**0.00%**
Weighted Avg ED1 RPE	**0.59%**	**0.72%**	**0.84%**	**0.71%**

Source: Ofgem, SP Calcs

Table 2.15
Weighted average RPE based on Ofgem RIIO-GD1 weightings – low Case

				ED1
	Opex	Capex	Repex	**RPE (%)**
Direct Labour	34%	11%	10%	**0.86%**
Contract Labour	18%	45%	67%	**0.41%**
Materials	6%	19%	13%	**-0.02%**
Plant & Equipment	1%	4%	0%	**-1.26%**
Transport	2%	0%	0%	**0.00%**
Other	39%	21%	11%	**0.00%**
Weighted Avg ED1 RPE	**0.35%**	**0.23%**	**0.36%**	**0.33%**

Source: Ofgem, SP Calcs

[14] RIIO-T1/GD1: Initial Proposals – Real price effects and ongoing efficiency appendix, 27 July 2012, Table 2.2

3 Forecasting Ongoing Efficiency Improvements

Ofgem uses the term "ongoing efficiency" to mean "the productivity improvement that even the most efficient DNO should be able to achieve".[15] For RIIO-ED1, Ofgem intends to include an account for the ongoing productivity improvements that can be achieved a company operating on the "efficient frontier" over the price control period.[16] Ofgem has proposed separate adjustments for ongoing productivity to two categories of cost over the ED1 period: "operational activities", and "network investment".

Our approach to estimating the scope for ongoing efficiency improvements follows the method set out by Ofgem in the recent strategy decision document.[17] We draw on historical trends in productivity for comparator sectors set out in the EU KLEMS dataset.[18] Ofgem used this dataset to estimate ongoing productivity at RIIO-T1/GD1 and proposes to use the same database for RIIO-ED1.

This section is structured as follows:

- Section 3.1 describes the EU KLEMS dataset and other potential sources of productivity data.
- Section 3.2 explains the productivity measures that are most relevant given the intended use by us and Ofgem.
- Section 3.3 presents our estimates of expected productivity improvements, and compares our estimates to Ofgem's RIIO-T1/GD1 decision.

3.1 Potential Data Sources

The EU KLEMS database comprises two separate data sets:

- NACE[19] 1.1 dataset – which contains productivity data where output is measured on the basis of both gross output (GO) and value added (VA).[20] The data series covers the period from 1970 to 2007.
- NACE 2 – which contains productivity measures based on VA output measures only, and follows a different sector classification from NACE 1.1. The data series runs from 1997 to 2007 but productivity estimates prior to 1997 are estimates compiled by "back-casting".[21]

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15 See for example: Ofgem (2013), Strategy decisions for the RIIO-ED1 electricity distribution price control: Tools for cost assessment, para. 4.40

16 See: Ofgem (2012) Strategy consultation for the RIIO-ED1 electricity distribution price control: Tools for cost assessment, p. 86.

17 Ofgem (2013) Strategy decisions for the RIIO-ED1 electricity distribution price control: Tools for cost assessment, chapter 4.

18 http://www.euklems.net/euk09i.shtml. The database contains industry-level measures of outputs, inputs, and productivity for the US, Japan and 25 European countries for the period from 1970 onwards. See also: O' Mahony, M. and Timmer, M.P. (2009) Output, Input and Productivity Measures at the Industry Level: The EU KLEMS database. The Economic Journal, Volume 199, Issue 538 pp. F374-F403, Abstract. See: http://onlinelibrary.wiley.com/doi/10.1111/j.1468-0297.2009.02280.x/pdf

19 NACE stands for the *Nomenclature générale des activités économiques dans les Communautés Européennes*, and is the obligatory statistical classification introduced by the EU in 1990. Source: ONS (1997) Annual Abstract of Statistics, p.1.

20 We explain GO and VA terms in Section 3.2.1.

21 NACE 2 is based on a revised industry classification. The EU KLEMS website notes that: "*The National Accounts (NA) data in the new classification is typically provided for shorter time series than were previously available in the NACE 1 classification. We back-cast time series of output and labour data using growth rates from the earlier data in the NACE 1 classification. These imputations are denoted in grey in the new release.*" Link: http://www.euklems.net/eukNACE2.shtml

To estimate ongoing productivity for RIIO-ED1, we propose to draw on the NACE 1.1. data as used by Ofgem for RIIO-T1/GD1. We take this approach because we are primarily interested in gross output (GO) rather than value-added (VA) measures of TFP as we discuss in section 3.2.1 below. From these datasets, we draw productivity data on the comparator sectors identified by Ofgem at RIIO-T1/GD1, which were based on the comparators used at DPCR5.[22] We have not identified any additional relevant comparator sectors from our review of the EU KLEMS database.

We considered other sources of data but concluded that they did not provide additional information as compared to the indices used by Ofgem at RIIO-T1/GD1. Specifically, we decided not to use productivity data published by the Office for National Statistics (ONS), because it focuses only on labour productivity. The productivity estimates it publishes for other factors of production relevant to DNOs' costs are only issued on an "experimental basis".[23]

3.2 Interpreting Productivity Measures

Table 3.1 shows several productivity measures for the comparator sectors for the period 1970-2007, as presented by Ofgem at RIIO-T1/GD1.[24] The Table presents the following productivity measures:

- *Total factor productivity (TFP) measures:* TFP growth is measured as the growth rate in physical outputs *minus* the growth rate in physical inputs. TFP (as set out in the KLEMS dataset) is a measure of disembodied technological change or technical change that is "costless" in the form of an expansion of general knowledge, adoption of better management techniques, more efficient organisation, etc.[25]
- *Partial factor productivity (PFP) measures for labour, and labour, energy, materials and services (or LEMS).* In measuring input quantities, the KLEMS database distinguishes between capital (K), labour (L), energy (E), materials (M), and service (S) inputs. PFP measures are calculated as the growth in physical outputs minus the growth in any one (e.g. labour) or more (e.g. LEMS) factor inputs. PFP measures reflect the extent of capital substitution. For example, an increase in capital employed per labour input will increase output per worker and improve labour or LEMS productivity.

  At RIIO-T1/GD1, Ofgem calculated LEMS productivity measures adjusting for the impact of capital substitution on LEMS productivity, i.e. correcting for that element of LEMS or labour PFP explained by a reduction in LEMS or the labour expenditure share in total output. Using Ofgem's terminology, Table 3.1 refers to such PFPs as "constant capital" measures.

- *Productivity measures based on a gross output (GO) and value-added (VA) basis*. GO productivity measures use an index of all outputs produced by an industry, and TFP based on GO is calculated as the growth in the outputs index minus the growth in the index for all factors of production (i.e. KLEMS). By contrast, VA output measures are calculated by subtracting (an index) of intermediate (EMS) outputs from an index of gross output, and VA TFP is calculated as the net output index minus the growth in the index of capital and labour inputs (or primary inputs). Value added productivity therefore measures the maximum amount of value added that can be produced given the inputs of the firm (or industry), i.e. labour and capital, for given prices of intermediate inputs and outputs. As shown in Table 3.1, value-added TFP is systematically higher than gross output TFP.

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22 In terms of comparator sectors, Ofgem notes that it will focus on those industry sectors with similarities to DNOs, for example, the sectors with significant asset management roles. See: Ofgem (2012) op. cit., p. 86.

23 Source: ONS (2007) The ONS Productivity Handbook, Chapter 2, Section 2.4. Link: http://www.ons.gov.uk/ons/guide-method/method-quality/specific/economy/productivity-measures/productivity-handbook/index.html

24 See: Ofgem (27 July 2012) RIIO-T1/GD1: Initial Proposals – Real price effects and ongoing efficiency appendix, Table 3.2, p.19.

25 For an explanation of such terms, see: OECD (2001) Measuring Productivity, Measurement of aggregate and industry level productivity growth, OECD manual.; p. 116 Available on-line: http://www.oecd.org/std/productivity-stats/2352458.pdf

Table 3.1
Average annual growth rates for productivity measures from EU KLEMS (1970-2007)

	Value Added (VA) measures:		Gross output (GO) measures:		
Sector (EU KLEMS sector code)	**TFP (VA)**	**Labour Productivity (VA) at constant capital**	**TFP (GO)**	**Labour & Intermediate Input Productivity (GO) at constant capital**	**Labour, energy, materials and services (LEMS) Productivity (GO)**
Manufacture Of Chemicals & Chemical Products (24)	3.9%	5.8%	1.3%	1.4%	1.4%
Manufacture Of Electrical & Optical Equipment (30-33)	4.1%	5.8%	1.6%	1.8%	1.9%
Manufacture Of Transport Equipment (34-35)	3.3%	3.3%	1.1%	1.1%	0.9%
Construction (F)	0.7%	0.7%	0.3%	0.3%	0.4%
Sale, Maintenance & Repair Of Motor Vehicles/Motorcycles; Retail Sale of Fuel (50)	2.0%	2.4%	1.0%	1.1%	1.4%
Transport & Storage (60-63)	2.4%	2.6%	1.2%	1.3%	1.2%
Financial Intermediation (J)	-0.6%	-0.9%	-0.3%	-0.4%	0.3%
Unweighted average selected industries	**2.3%**	**2.8%**	**0.9%**	**0.9%**	**1.1%**
Unweighted average selected industries (exc. manufacturing)	**1.1%**	**1.2%**	**0.5%**	**0.6%**	**0.8%**
Unweighted average all industries[1]	**1.3%**	**1.5%**	**0.5%**	**0.5%**	**0.8%**
Weighted average all industries[1]	**1.1%**	**1.1%**	**0.5%**	**0.5%**	**0.8%**

Source: Ofgem (27 July 2012) RIIO-T1/GD1: Initial Proposals – Real price effects and ongoing efficiency appendix, Table 3.2.
(1) The unweighted averages exclude the following industries: real estate (K); public administration (L); education (M); health (N); and, social services (O).

3.2.1 Interpreting the data for RIIO-ED1

As we explain further below, in selecting productivity measures for both operational activities and network investment expenditure categories, a number of choices are required. As per Ofgem's approach at RIIO-T1/GD1, we propose to draw on LEMS productivity measures as our proxy for ongoing productivity for the operational activities expenditure category, as our operational activities draw on labour, energy, materials and services (or LEMS) inputs. For the network investment expenditure category we draw on TFP estimates as our measure of on-going productivity as our network investment activities will draw on capital as well as other inputs. However, a number of further choices include:

- the time period used to calculate the productivity measures;
- the comparator sectors;
- whether we use GO or VA measures of productivity; and
- whether we adjust LEMS for the effect of capital substitution in determining productivity for operational activities.

- **Data quality issues mean that we must rely on long-term averages**

The productivity figures set out in Table 3.1 are calculated based on the maximum time period available from the EU KLEMS database, from 1970 to 2007. Alternatively, we could draw on shorter more recent time periods, e.g. 1997-2007.

The guidance notes on the methodology and the construction of the KLEMS database highlight a number of "health warnings" associated with the data.[26] The guidance states that the growth accounting framework (which is the theoretical basis for the EU KLEMS productivity measures) rests on a number of assumptions about the real economy. It assumes that factor markets are competitive; constant returns to scale; full utilisation of inputs, and, that all companies are technically efficient. For example, if the assumption of constant returns to scale does not hold, then the TFP measure will reflect the effect of scale economies as well as productivity growth. The guidance note also highlights potential difficulties with output and input measurement, e.g. in relation to measuring quality adjusted output volumes for industries with rapid quality changes, such as IT, and indeed utilities.[27]

These theoretical and data measurement issues suggest that we should draw on longer time-series evidence (i.e. from 1970-2007). For example, a longer time period may help smooth for changes in scale effects, changes in capacity utilisation, and changes in efficiency, which are picked-up in the residual TFP measure. (As Ofgem shows, the productivity estimates are not particularly sensitive to the time period chosen.[28]) The theoretical and data measurement issues also suggest that we should not place weight on the productivity estimates associated with any particular sector but potentially place greater weight on aggregate industry measures, again, in order to smooth for measurement issues. Ofgem also concluded that is was better to rely on composite industry averages and longer term time-series at RIIO-GD1/T1. [29]

- **The absence of directly relevant comparators also supports the use of broadly defined industry averages**

The comparator sectors used by Ofgem at previous reviews do not closely match the activities we undertake. For example, the retail sale of fuel and financial intermediation categories do not closely represent the functions we undertake. We also agree with Ofgem that the manufacturing comparators do not undertake processes or activities that closely match our own. However, it is not clear which other sectors in the KLEMS dataset, if any, would be better comparators for the DNOs. The lack of directly relevant comparators supports the use of composite industry averages, and indeed, "all industry" productivity estimates.

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[26] O' Mahony, M. and Timmer, M.P. (2009) Output , Input and Productivity Measures at the Industry Level: the EU KLEMS database. Link: http://www.euklems.net/eukNACE2.shtml . We also draw on: OECD (2001) Measuring Productivity, Measurement of aggregate and industry level productivity growth, OECD manual, pp. 21-24. Available on-line: http://www.oecd.org/std/productivity-stats/2352458.pdf

[27] OECD (2001) Measuring Productivity, Measurement of aggregate and industry level productivity growth, OECD manual, pp. 21-24. Available on-line: http://www.oecd.org/std/productivity-stats/2352458.pdf

[28] See for example: Ofgem (27 July 2012) RIIO-T1/GD1: Initial Proposals – Real price effects and ongoing efficiency appendix, Table 3.3, p.21.

[29] See: Ofgem (27 July 2012) RIIO-T1/GD1: Initial Proposals – Real price effects and ongoing efficiency appendix, p.21.

- **The use of GO productivity measures is consistent with Ofgem's intended use**

We have considered whether to use gross output (GO) or value added (VA) productivity measures. The correct productivity measure (i.e. GO or VA) depends on its intended use. As at RIIO-T1/GD1, we understand that Ofgem will apply a productivity measure to all factor inputs in order to set the final price for DNOs' gross output rather than specifically to the labour and capital inputs employed by DNOs. This implies that we require a productivity measure which reflects the growth rate of total output minus the growth in all inputs, i.e. a GO measure. By contrast, it is not clear to us how VA productivity measures could be used for the intended purpose.

Ofgem also acknowledges the difficult with applying VA measures in its Initial Proposals document for RIIO-T1 and GD1. Ofgem states:

> "T*he VA measure of productivity only allows us to evaluate the impact of the use of labour and capital on outputs, and thus limiting the costs that this can be applied to. Therefore, to fully evaluate the productivity improvements that a network company can make would require making additional assumptions about the use of intermediate inputs.*" [30,31]

- **The use of a LEMS measure based on capital substitution or constant capital depends on Ofgem's overall approach to setting cost allowances**

As set out above, we draw on LEMS productivity measures as our estimate for productivity associated with operational activities. There are two LEMS measures: one which reflects changes in factor shares (or "capital substitution") and a measure that corrects for this effect ("constant capital").

The use of a LEMS measure based on constant capital depends on Ofgem's overall approach to setting cost allowances For example, if Ofgem makes a separate adjustment to allowed operating expenditure for changes in capital inputs (e.g. through its approach to comparative efficiency modelling), then a LEMS measure based on constant capital should be employed. Otherwise using a LEMS measure which reflects the effects of capital substitution will result in a double-adjustment.

Alternatively, if Ofgem does not make an adjustment to allowed operating expenditure for changes in capital share, a LEMS measure which captures the scope for capital substitution should be employed.

Ofgem's approach to taking into account capital substitution in setting cost allowances is not clear to us. In practice, the difference between the two measures is around 0.2-0.3% p.a., and we draw on both measures in calculating the scope for ongoing productivity improvement for operating expenditure.

3.3 Conclusions on Productivity Measures

As set out above, we use long-term GO TFP for our network investment expenditure category, and LEMS productivity for operational activities. These data are set out in Table 3.2 (a subset of the data included in Table 3.1).

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30 Ofgem (27 July 2012) RIIO-T1/GD1: Initial Proposals – Real price effects and ongoing efficiency appendix, para 3.15, p.19.

31 We also understand that there are advantages and disadvantages to the use of GO and VA productivity indices but these issues are secondary to the intended use. For example, GO based TFP measures are less sensitive to changes to the vertical integration of the sector, e.g. to outsourcing. Value-added based TFP measures vary with the level of purchased services. On the other hand, for labour productivity, value-added measures are less sensitive to changes in the vertical integration of the sector. OECD (2001) Measuring Productivity, Measurement of aggregate and industry level productivity growth, OECD manual, p.31. Available on-line: http://www.oecd.org/std/productivity-stats/2352458.pdf

Table 3.2
Productivity measures relevant to the intended use
(EU KLEMS data, 1970-2007, % p.a.)

	For network investment expenditure category:	For operational activities expenditure category:	
Sector (EU KLEMS sector code)	**TFP (GO)**	**LEMS (GO) at constant capital**	**LEMS Productivity (GO) allowing for capital substitution**
Unweighted average selected industries (inc manufacturing)	0.9%	0.9%	1.1%
Unweighted average selected industries (exc. manufacturing)	0.5%	0.6%	0.8%
Unweighted average all industries[1]	0.5%	0.5%	0.8%
Weighted average all industries[1]	0.5%	0.5%	0.8%

Source: Sub-set of data set out in Ofgem (27 July 2012) RIIO-T1/GD1: Initial Proposals – Real price effects and ongoing efficiency appendix, Table 3.2

From these results, we draw the following conclusions:

- For network activities, GO TFP sector averages and for (all industries) provides a range of 0.5% to 0.9% p.a. .
- For operational activities, LEMS productivity data provides an expected improvement in productivity in the ranges:
  - 0.5% to 0.9% based on GO LEMS at constant capital, if Ofgem makes a separate adjustment to operating expenditure for capital substitution; or
  - 0.8% to 1.1% p.a. based on GO LEMS and allowing for capital substitution, which is the relevant measure if Ofgem assumes that the rate of capital substitution for DNOs is identical to the comparator set.

Table 3.3 summarises our recommended range and mid-point for on-going productivity applying to network investment and operational activities, and compares these results to Ofgem's conclusions at RIIO-T1. As shown, we estimate a mid-point improvement in productivity over the RIIO-ED1 period of 0.7% p.a. and 0.8% p.a. for network investment and operational activities expenditure categories respectively.

Our mid-point estimate of the scope for productivity improvement in operational activities for RIIO-ED1 is 0.2% p.a. lower than Ofgem's equivalent estimate for RIIO-T1/GD1. The reason for the difference is that Ofgem included VA TFP as well as GO TFP within the range used to provide conclusions for RIIO-T1. Ofgem also cited productivity estimates set out in network companies' business plans, which were (for at least two groups) based on VA productivity estimates. [32,33] Estimates of VA TFP are systematically higher than estimates of GO TFP, due to

[32] In relation to evidence from companies' plans, NGN and SGN commissioned a report from First Economics which set out estimate for ongoing efficiency of 1.05% for opex, and 0.6% for capex. See: FE (August 2011) The Scope for Future Productivity Growth, A report prepared for Northern Gas Networks. Link: http://www.northerngasnetworks.co.uk/documents/a7.pdf p.4.

[33] National Grid (NG) based its assumption on the Competition Commission's (CC) assessment of Bristol Water's price decision of 1% p.a., with some adjustments. See: Ofgem (27 July 2012) RIIO-T1/GD1: Initial Proposals – Real price effects and ongoing efficiency appendix, p.20.

differences in their definition. However, Ofgem noted that VA measures may not be well-suited to its intended purpose.

In addition, we consider that there is a rationale for more moderate productivity improvements for DNOs relative to GDNs. As noted by Ofgem, the potential scope for GDNs to continue to realise efficiencies following DN sales in 2005 supported the use of relatively high productivity assumptions for RIIO-GD1.[34]

Table 3.3
Our productivity estimates and Ofgem RIIO-T1/GD1 decision

	Range	Mid-point	Ofgem RIIO-T1/GD1
Network investment	0.5%-0.9%	0.7%	0.7%
Operational activities	0.5%-1.1%	0.8%	1%

Source: SP analysis, and Ofgem (27 July 2012) RIIO-T1/GD1: Initial Proposals – Real price effects and ongoing efficiency appendix, p.22

[34] See: Ofgem (December 2012) Final Proposals Supporting Document – Cost efficiency, para. 3.18, p. 20. http://www.ofgem.gov.uk/Networks/GasDistr/RIIO-GD1/ConRes/Documents1/4_%20RIIOGD1_FP_Cost_Efficiency.pdf

4 Conclusions

The analysis shown in this report suggests an overall RPE of between 0.3% and 0.7% on average over the upcoming price control period. Offset against this, long-run historic data indicates trend productivity growth of between 0.5% and 1.1%. This suggests a net effect on overall unit costs of between -0.6% per annum and +0.2% per annum.

Given this relatively wide range of possible outcomes that could be supported through analysis of historic data and trends, we have crosschecked our RPE and productivity analysis against observed trends in unit costs in comparator sectors of the UK economy using data from the EU KLEMS database.

We have analysed data using the two measures of unit cost growth used by Ofgem in a similar analysis conducted as part of RIIO-T1/GD1.[35] The first measure is growth in unit labour cost (VA) at constant capital (gL**)**. The second is growth in unit labour and intermediate input costs (GO) at constant capital (gLEMS**)**. Both these measures are calculated relative to RPI and reflect the yearly growth in expenditure on labour and intermediate inputs (EMS) required to produce a certain level of output, keeping capital constant. Therefore they form a benchmark for our estimate of RPEs, net of productivity growth.[36] The results of this unit cost analysis are displayed in the table below.

Table 1
Growth in Unit Costs (KLEMS Data)

Sector	gL Unit Cost Measure (Relative to RPI)	gLEMS Unit Cost Measure (Relative to RPI)
Manufacture Of Chemicals & Chemical Products	-2.63%	-1.03%
Manufacture Of Electrical & Optical Equipment	-3.30%	-2.27%
Manufacture Of Transport Equipment	-1.21%	-0.73%
Construction	1.82%	1.33%
Sale, Maintenance & Repair Of Motor Vehicles/ Motorcycles; Retail Sale of Fuel	0.39%	0.13%
Transport & Storage	-0.38%	-0.54%
Financial Intermediation	2.26%	1.13%
Unweighted average	**-0.44%**	**-0.29%**
Unweighted average selected industries (exc. manufacturing)	**1.02%**	**0.51%**
Unweighted average all industries	**1.00%**	**0.23%**
Weighted average all industries	**1.39%**	**0.607%**

These figures suggest that the overall historic trend in unit costs, relative to RPI, lies between -0.4% and +1.4%, depending on the comparator industries selected and the method used. However, by most measures, long-term trends in unit costs are slightly positive, i.e. real input price inflation exceeds improvements in productivity. In contrast, our forecast RPEs and productivity growth are equivalent to a net change in unit costs of between -0.6% per annum

[35] *Ofgem (27 July 2012) RIIO-T1/GD1: Initial Proposals – Real price effects and ongoing efficiency appendix, p.24*

[36] The unit cost measures presented in this section are based on LEMS productivity and therefore, for reasons cited in section 3.2.1, are likely to provide a better proxy for operating expenditure than capital expenditure. However, it is reasonable to assume that long term trends in expenditure on operations, which covers a wide range of activities, reflect trends in the general level of costs faced by a DNO.

and +0.2% per annum. Comparing our range of RPEs and ongoing productivity to historic unit cost trends therefore suggests a value towards the top end of the range would be most appropriate.[37]

[37] Ofgem has argued that this apparent difference between the current outlook and the longer-term trends can be explained by the fact that the EU KLEMS database only covers data up to 2007 and does therefore not reflect the recent downward trend in real wages. It is important to note, however, that the drop in wages has been accompanied by falling productivity. According to figures published by the ONS, labour productivity rose steadily between 1990 and 2008 Q2 but has fallen since the onset of the recession and remains lower than pre-recession levels. Since wage growth is less cyclical than productivity, the ONS reports that decreasing productivity tends to be accompanied by increasing unit costs. Hence, our conclusion based on the historic data that a value towards the top end of the range for RPEs net of productivity improvement does not change in light of recent macroeconomic trends.

See: (1) ONS data on Labour productivity: *http://www.ons.gov.uk/ons/taxonomy/index.html?nscl=Labour+productivity*
and (2) *ONS (29 March 2012), Labour Productivity Q4 2011*: *http://www.ons.gov.uk/ons/dcp171778_260753.pdf*

Appendix A. List of Potentially Relevant Price Indices

Appendix A presents our list of potentially relevant price indices, comprising the data series that Ofgem used at RIIO-T1/GD1 and other data associated with cost items that an electricity distribution network uses (e.g. wires and cables):

- Table A.1 shows the indices we identified as being potentially relevant to general and specialised labour costs;
- Table A.2 shows the indices we identified as being potentially relevant to material costs;
- Table A.3 shows the indices we identified as being potentially relevant to plant and equipment costs; and
- Table A.4 shows the indices we identified as being potentially relevant to transport and other costs.

Table A.1
Potential Labour Cost Indices

Index	Type	Source	Available	Description	Reference
Private Sector incl. Bonus	AEI	ONS	Jan 1990 - Jul 2010	This is an average earnings index, which was discontinued by ONS and replaced by the AWE (see below).	
Private Sector incl. Bonus (EARN01)	AWE	ONS	Jan 2000 - Dec 2012	This Average Weekly Earnings (AWE) measures short-term changes in earnings and is designed to produce robust estimates at whole economy level. It is based on the Monthly Wages and Salaries Survey (MWSS), which "provides comprehensive information on earnings by industry." ONS publishes monthly series for eight higher-level sectors and 24 lower-level industries.	ONS (2011) *Average Weekly Earnings Information Paper* pp. 1-2 (http://www.ons.gov.uk/ons/guide-method/method-quality/quality/quality-information/business-statistics/quality-and-methodology-information-for-average-weekly-earnings.pdf)
Construction (EARN03)	AWE	ONS	Jan 2000 - Dec 2012	EARN03 is the ONS measure of average weekly earnings by *industry*. It includes the construction industry. The SIC 2007 classification states that the construction industry includes "construction of utility projects for electricity and telecommunication", and "electrical installation".	ONS (2009) *UK Standard Industrial Classification of Economic Activities 2007 (SIC 2007): Structure and Explanatory Notes,* p. 39
Transport and Storage (EARN03)	AWE	ONS	Jan 2000 - Dec 2012	EARN03 includes the transport industry. The SIC 2007 classification states that the transport industry includes "warehousing and storage" and "support activities for transportation".	ONS (2009) *UK Standard Industrial Classification of Economic Activities 2007 (SIC 2007): Structure and Explanatory Notes,* p. 43
Manufacturing - Engineering & Allied Industries (EARN03)	AWE	ONS	Jan 2000 - Dec 2012	EARN03 includes the manufacturing industry. The SIC 2007 classification states that the manufacturing industry includes "substantial alteration, renovation or reconstruction of goods".	ONS (2009) *UK Standard Industrial Classification of Economic Activities 2007 (SIC 2007): Structure and Explanatory Notes,* p. 71
Electricity, Gas and Water Supply (EARN03)	AWE	ONS	Jan 2000 - Dec 2012	EARN03 includes the electricity supply industry. The SIC 2007 classification states that this industry Includes "operation of distribution systems (i.e., consisting of lines, poles, meters, and wiring) that convey electric power received from the generation facility or the transmission system to the final consumer".	ONS (2009) *UK Standard Industrial Classification of Economic Activities 2007 (SIC 2007): Structure and Explanatory Notes,* p. 143
Electrical Installations - Cost of Labour (2/E1)	PAFI	BCIS	Jan 1977 - Jan 2013	This is used by industry to update costs of electrical installation contracts. The index is drawn from ONS data and national labour agreements.	BCIS (1997) *BCIS Building Cost Index Models*
Electrical Labour (CPA/4)	PAFI	BEAMA	Jan 1970 - Jan 2013	This is used by the industry to update costs of electrical labour contracts. It measures average earnings in the electrical labour sector.	Email from Emmanuel Amoakohne, Head of Statistics, BEAMA, 5 March 2013

Table A.2
Potential Materials Cost Indices

Index	Type	Source	Available	Description	Reference
Resource Cost Index: Infrastructure Materials (FOCOS)	RCI	BIS	Q1 1990 - Q2 2012	FOCOS provides a measure of input prices paid by contractors in infrastructure. They are weighted averages of the PAFI, weighted according to a given category. "The indices are national averages. Material prices are generally representative of UK prices."	BIS *Construction Resource Cost Indices Notes and Definitions*, p. 4 (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/36850/resource-cost-indices-methodology-and-revision-policy.pdf)
Construction Output Price Index: All New Construction	COPI	BIS	March 1955- Dec 2012	Construction OPIs provide a measure of the price level for construction work carried out in a given period . They are primarily used as a price deflators for construction output. They are derived from TPIs by "applying weights to the sector TPIs, based on the typical duration of development for each sector".	BIS *Construction Output Price Indices Notes and Definitions,* p. 1 (http://www.bis.gov.uk/assets/BISCore/statistics/docs/C/output-price-indices-methodology-and-revision-policy.pdf)
Construction Output Price Index: Private Industrial	COPI	BIS	March 1955 - Dec 2012	The Private Industrial COPI is constructed in the same way as the All New Construction COPI, but focuses specifically on private industrial construction.	BIS *Construction Output Price Indices Notes and Definitions,* p. 1
Construction Output Price Index: Infrastructure	COPI	BIS	March 1980 - Dec 2012	The Infrastructure COPI is constructed in the same way as the All New Construction COPI, but focuses specifically on infrastructure construction.	BIS *Construction Output Price Indices Notes and Definitions,* p. 1
PAFI (Building) Series 3, Pipes and Accessories: Copper	PAFI	BCIS	Jan 1991 - Jan 2013	PAFI (Price Adjustment Formulae Indices) provide a measure of input costs faced by contractors.	BCIS *Price Adjustment Formulae Indices* (http://www.bcis.co.uk/pafi)
PAFI (Building) Series 3, Pipes and Accessories: Aluminium	PAFI	BCIS	Jan 1991 - Jan 2013		BCIS *Price Adjustment Formulae Indices* (http://www.bcis.co.uk/pafi)
PAFI (Building) Series 3, Pipes and Accessories: Steel	PAFI	BCIS	Jan 1991 - Jan 2013		BCIS *Price Adjustment Formulae Indices* (http://www.bcis.co.uk/pafi)
All Construction Tender Price Index (ALLCON)	TPI	BCIS	Jan 1985 - Dec 2012	The ALLCON TPI provides a broad measure of the price level of accepted tenders across all construction sectors. "ALLCON indices are compiled by weighting together relevant quarterly sector TPIs using weights derived from the value of construction new orders and the volume of construction output for the corresponding quarter."	BIS *Construction Tender Price Indices Notes and Definitions*, p. 1 (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/36851/tender-price-indices-methodology-and-revision-policy.pdf)
BEAMA CPA Large Power Transformer Materials Index	PAFI	BEAMA	Jan 2000 - Dec 2012	Weighted average of 6 PPIs: 22.56% Paper and Paperboard, 12.36% Pumps and Compressors, 1.97% Valves, 22.02% cooling and Ventilation Equipment, 10.48% Electric Motors, Generators and Transformers, 30.6% for a variety of instruments and appliances e.g instruments for Measuring and Testing equipment	BEAMA, *Appendix C (Document unknown) - Material Weightings*, pp. 78-81
BEAMA CPA Basic Electrical Equipment Index	PAFI	BEAMA	Jan 1970 - Dec 2012	Weighted average of 72 PPIs including: 4.6% Imported Organic Materials, 11.4% Parts- Plant and Machinery, 2.67% Iron and Steel, 15.02 Motor Spirit etc.	BEAMA, *Appendix C (Document unknown) - Material Weightings*, pp. 78-81

Manufacture of Copper (2444000000)	PPI*	ONS	Jan 1996 - Jan 2013	Includes "the manufacture of fuse wire or strip" and "manufacture of wire of these metals by drawing".	ONS (2009) *UK Standard Industrial Classification of Economic Activities 2007 (SIC 2007): Structure and Explanatory Notes*, p. 106
Manufacture of Basic Metals (6112240000)	PPI	ONS	Jan 1996 - Jan 2013	Includes cold drawing of wire and casting of metals.	ONS (2009) *UK Standard Industrial Classification of Economic Activities 2007 (SIC 2007): Structure and Explanatory Notes*, p. 33
Manufacture of Basic Iron, Steel and Ferro-Alloys (2410000000)	PPI	ONS	Jan 1996 - Jan 2013	Sub-set of Basic Metals, includes manufacture of tubes, pipes, hollow profiles and related fittings, of steel	ONS (2009) *UK Standard Industrial Classification of Economic Activities 2007 (SIC 2007): Structure and Explanatory Notes*, p. 34
Manufacture of Other Non-Ferrous Metals (2445000000)	PPI	ONS	Jan 1996 - Jan 2013	Sub-set of Basic Metals, includes production of non-ferrous metals.	ONS (2009) *UK Standard Industrial Classification of Economic Activities 2007 (SIC 2007): Structure and Explanatory Notes*, p. 34
Manufacture of Electricity Distribution and Control Apparatus (2712000000)	PPI	ONS	Jan 1996 - Jan 2013	Includes the manufacture of power circuit breakers and manufacture of power switching equipment i.e. switchgear.	ONS (2009) *UK Standard Industrial Classification of Economic Activities 2007 (SIC 2007): Structure and Explanatory Notes*, p. 118
Manufacture of Electricity Distribution and Control Apparatus (2712000000)	PPI	ONS	1987-1996	Older series based on SIC 1992 classification (available in print editions of Annual Abstract of Statistics).	
Manufacture of Electric Motors, Generators and Transformers (2711000000)	PPI	ONS	Jan 1996 - Jan 2013	Includes "manufacture of all electric motors and transformers: AC, DC and AC/DC."	ONS (2009) *UK Standard Industrial Classification of Economic Activities 2007 (SIC 2007): Structure and Explanatory Notes*, p. 118
Manufacture of Electric Motors, Generators and Transformers (2711000000)	PPI	ONS	1987-1996	Older series based on SIC 1992 classification (available in print editions of Annual Abstract of Statistics).	
Manufacture of Other Electronics and Electric Wires (2732000000)	PPI	ONS	Jan 1996 - Jan 2013	Inlcudes the manufacture of insulated wires.	ONS (2009) *UK Standard Industrial Classification of Economic Activities 2007 (SIC 2007): Structure and Explanatory Notes*, p. 117
Manufacture of Insulated Wires and Cables	PPI	ONS	1987-1996	Older series based on SIC 1992 classification (available in print editions of Annual Abstract of Statistics).	
Manufacture of Cold Drawn Wire (2434000000)	PPI	ONS	Jan 1996 - Jan 2013	Sub-set of Manufacture of Basic Metals.	ONS (2009) *UK Standard Industrial Classification of Economic Activities 2007 (SIC 2007): Structure and Explanatory Notes*, p. 34
Manufacture of other Builders' Carpentry and Joinery	PPI	ONS	Jan 1996 - Jan 2013	Includes the manufacture of wooden goods intended to be used primarily in the construction industry	ONS (2009) *UK Standard Industrial Classification of Economic Activities 2007 (SIC 2007): Structure and Explanatory Notes*, p. 34
Manufacture of Cold Drawn Products (2434000000)	PPI	ONS	1987-1996	Older series based on SIC 1992 classification (available in print editions of Annual Abstract of Statistics).	ONS (2009) *UK Standard Industrial Classification of Economic Activities 2007 (SIC 2007): Structure and Explanatory Notes*, p. 34

Table A.3
Potential Plant and Equipment Cost Indices

Index	Type	Source	Available	Description	Reference
Plant and Road Vehicles (70/2)	PAFI	BCIS	Jan 1977 - Jan 2013	This is a weighted average of relevant sub-series.	BIS *Construction Resource Cost Indices Notes and Definitions*, p. 4 (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/36850/resource-cost-indices-methodology-and-revision-policy.pdf)
Machinery and Equipment Input	PPI	ONS	Jan 1996 - Jan 2013	The machinery and equipment input index is reported as part of the MM22 PPI. The machinery and equipment industry includes the manufacture of general purpose machinery, excluding electrical equipment. Input PPIs are based on prices paid by manufacturers for materials used in the manufacturing process.	ONS (2009) *UK Standard Industrial Classification of Economic Activities 2007 (SIC 2007): Structure and Explanatory Notes*, p. 36
Machinery and Equipment Output	PPI	ONS	Jan 1996 - Jan 2013	The machinery and equipment output index is also reported as part of the MM22 PPI. This index includes the manufacture of general purpose machinery, excluding electrical equipment. The Ouput PPI is based on prices charged by manufactures for goods destined for the UK market.	ONS (2009) *UK Standard Industrial Classification of Economic Activities 2007 (SIC 2007): Structure and Explanatory Notes*, p. 36
Electrical and Optical Equipment Input	PPI	ONS	Jan 1996 - Jan 2013	The electrical and optical equipment input index is reported as part of the MM22 PPI. This index includes the manufacture of specialist machinery, such as transfomers and distribution apparatus. Input PPIs are based on prices paid by manufacturers for materials used in the manufacturing process.	ONS (2009) *UK Standard Industrial Classification of Economic Activities 2007 (SIC 2007): Structure and Explanatory Notes*, p. 35
Electrical and Optical Equipment Output	PPI	ONS	Jan 1996 - Jan 2013	The electrical and optical equipment output index is reported as part of the MM22 PPI. This index includes the manufacture of specialist machinery, such as transfomers and distribution apparatus. The Ouput PPI is based on prices charged by manufactures for goods destined for the UK market.	ONS (2009) *UK Standard Industrial Classification of Economic Activities 2007 (SIC 2007): Structure and Explanatory Notes*, p. 35
Wiring and Wiring Devices	PPI	ONS	Jan 1996 - Jan 2013	The wiring and wiring devices index is reported as part of the MM22 PPI. It includes the manufacture of current-carrying and non current-carrying wiring devices for wiring electrical circuits regardless of material.	ONS (2009) *UK Standard Industrial Classification of Economic Activities 2007 (SIC 2007): Structure and Explanatory Notes*, p. 118
Machinery and Equipment Input	PPI	ONS	1987-1996	Older series based on SIC 1992 classification (available in print editions of Annual Abstract of Statistics).	
Machinery and Equipment Output	PPI	ONS	1987-1996	Older series based on SIC 1992 classification (available in print editions of Annual Abstract of Statistics).	
Electrical and Optical Equipment Input	PPI	ONS	1987-1996	Older series based on SIC 1992 classification (available in print editions of Annual Abstract of Statistics).	
Electrical and Optical Equipment Output	PPI	ONS	1987-1996	Older series based on SIC 1992 classification (available in print editions of Annual Abstract of Statistics).	

Table A.4
Potential Transport Cost Index

Index	Type	Source	Available	Description	Reference
Manufacture of Motor Vehicles	PPI	ONS	Jan 1996 - Jan 2013	The Manufacture of Motor Vehicles Index is reported as part of the MM22 PPI. It includes the manufacture of passenger cars and commercial vehicles such as vans, lorries, etc.	ONS (2009) *UK Standard Industrial Classification of Economic Activities 2007 (SIC 2007): Structure and Explanatory Notes,* p. 118

Appendix B. Regression Outputs

Table B.1, Table B.2 and Table B.3 present the regression outputs for the statistical models we estimated using the indices we selected as relevant to labour, materials and plant and equipment input costs respectively.

Table B.1
Regression Output of Selected Labour Price Indices

Indices	α		β		ρ_1		ρ_2		ϕ_1		ϕ_2	
	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.
Private Sector Average Weekly Earnings incl. Bonus	4.289	0.248	0.009	0.005	1.659	0.193	-0.771	0.196				
Electrical Installations - Cost of Labour	4.271	0.069	0.012	0.002	1.890	0.095	-0.956	0.097	-0.633	.	-0.367	0.377
Electrical Labour	4.393	0.196	0.022	0.007	1.978	0.049	-0.988	0.038	-1.197	.	0.197	0.167

Table B.2
Regression Output of Selected Materials Price Indices

Indices	α		β		ρ_1		ρ_2		ϕ_1		ϕ_2		ϕ_3		ϕ_4	
	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.
Resource Cost Index: Infrastructure Materials (FOCOS) - Whole Series	4.006	0.187	0.015	0.004	1.876	0.084	-0.935	0.058	-1.000	.						
Resource Cost Index: Infrastructure Materials (FOCOS) - 2000-2012	2.814	0.093	0.038	0.002	0.748	0.706	-0.407	0.810	-1.000	.						
PAFI (Building) Series 3, Pipes and Accessories: Copper - Whole Series	3.906	0.187	0.018	0.004	1.666	0.125	-0.838	0.144	-1.000	.						
PAFI (Building) Series 3, Pipes and Accessories: Copper - 2000-2012	2.605	0.332	0.043	0.006	1.320	0.304	-0.784	0.339	-1.000	.						
BEAMA CPA Large Power Transformer Materials	4.197	0.273	0.007	0.005	1.631	0.128	-0.994	0.036	-1.504	.	-0.934	.	2.767	4.900	-1.330	1.894
BEAMA CPA Basic Electrical Equipment - Whole Series	4.778	0.087	-0.008	0.002	1.837	0.071	-0.897	0.065	-1.000	.						
BEAMA CPA Basic Electrical Equipment - 2000-2012	2.398	0.251	0.038	0.005	0.960	0.602	-0.695	0.254	-1.000	.						
Manufacture of Electricity Distribution and Control Apparatus	4.851	0.044	-0.006	0.001	1.838	0.039	-0.967	0.040	-1.441	.	0.441	0.198				
Manufacture of Electric Motors, Generators and Transformers	5.227	0.044	-0.017	0.001	1.895	0.055	-0.986	0.065	-1.159	.	-0.634	0.282	0.824	0.596		
Manufacture of Other Electronics and Electric Wires - Whole Series	4.187	0.411	0.007	0.009	1.838	0.111	-0.928	0.145	-1.000	.						
Manufacture of Other Electronics and Electric Wires - 2000-2012	0.920	0.504	0.069	0.010	1.121	0.284	-0.750	0.268	-1.000	.						
Manufacture of Cold Drawn Wire - Whole Series	4.097	0.342	0.010	0.008	1.852	0.104	-0.941	0.121	-1.000	.						
Manufacture of Cold Drawn Wire - 2000-2012	1.126	0.404	0.067	0.008	0.920	0.380	-0.685	0.589	-1.000	.						

Table B.3
Regression Output of Selected Plant and Equipment Price Indices

Indices	α		β		ρ_1		ρ_2		ρ_3		ρ_4		ϕ_1		ϕ_2	
	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.
Plant and Road Vehicles	4.619	0.057	-0.002	0.001	0.781	0.106							0.669	0.239		
Machinery and Equipment Output	4.944	0.011	-0.009	0.000	1.781	0.330	-1.615	0.518	1.383	0.428	-0.786	0.270	-1.975	0.258	1.000	.
Machinery and Equipment Input	5.075	0.121	-0.015	0.003	1.306	0.211	-0.608	0.247								