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Consultation

RIIO-2 tools for cost assessment

Publication date:	28 June 2019	**Contact:**	RIIO Team
		Team:	Network Price Controls
Response deadline:	23 August 2019	**Tel:**	020 7901 7000
		Email:	RIIO2@ofgem.gov.uk

This document outlines the scope, purpose and questions of the consultation and how you can get involved. Once the consultation is closed, we will consider all responses. We want to be transparent in our consultations. We will publish the non-confidential responses we receive on our website at **Ofgem.gov.uk/consultations**. If you want your response – in whole or in part – to be considered confidential, please tell us in your response and explain why. Please clearly mark the parts of your response that you consider to be confidential, and if possible, put the confidential material in separate appendices to your response.

Contents

1. Introduction

What are we consulting on?

1.1. This consultation provides further details on the cost assessment tools and techniques we intend to apply in setting the RIIO-2 price controls. It primarily discusses issues relevant to our gas distribution (RIIO-GD2) cost assessment, but also aspects of cost assessment relevant to other sectors.[1] These price controls will run from 1 April 2021 to 31 March 2026. The network companies will submit draft Business Plans to the RIIO-2 Challenge Group in July and October 2019, and we expect to receive final Business Plans from network companies on 9 December 2019.

1.2. The next price control for electricity distribution network operators (DNOs), RIIO-ED2, will begin in 2023. We are not consulting on the cost assessment tools we will apply to this price control at this time. The RIIO-ED2 consultation process will start later this year with the publication of an open letter. Subject to that consultation process, and any developments in the interim period that we will take into account, the cost assessment tools we discuss in this consultation may be capable, in principle, of application to RIIO-ED2.

1.3. This consultation primarily discusses and seeks views on technical aspects of econometric benchmarking, our primary cost assessment tool for gas distribution networks (GDNs). It also discusses and seeks views on the assessment of business support costs, ongoing efficiency and real price effects (RPEs) across all sectors. Further detail on other cost assessment tools that we more typically apply in the transmission sector are also provided (but for which we do not seek explicit views).

1.4. In December 2018 we issued a consultation on our methodology for applying the RIIO-2 framework in the context of each sector[2] (SSMC), and in May 2019 we issued our decision on this methodology (SSMD). We are now in the process of developing the tools and techniques we will apply as part of our assessment of costs proposed by the companies in their Business Plans.

1.5. We have also held Gas Distribution Cost Assessment Working Groups (CAWGs) focusing on the development of our cost assessment tools.[3] We will not be publishing a final decision on our cost assessment tools; instead, we will continue to engage with companies through the CAWGs up until the submission of final Business Plans in December and will confirm our approach to cost assessment in our Draft Determinations.

Overall approach to cost assessment

1.6. One of the core elements of RIIO-2 is the assessment of the efficient level of costs that will enable network companies to maintain safe and reliable networks and deliver an appropriate level of service.

1.7. In RIIO-1, we used a toolkit of methodologies to assess the network companies' cost efficiency and to set baseline cost allowances. In the SSMC, we noted that we intend to

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[1] Gas and electricity transmission (RIIO-GT2/ET2) and the electricity system operator (ESO).
[2] Gas distribution, gas and electricity transmission and the electricity system operator.
[3] CAWG presentations and minutes are available here.

evolve this approach rather than establish a whole new methodology.[4] Stakeholders broadly agreed with maintaining the toolkit of methodologies and evolving this approach.[5]

1.8. For the key issues we discuss in this paper, we take into account:

- **learnings from RIIO-1**: we look at the cost assessment approaches we followed for RIIO-GD1/T1 and more recently those we adopted for RIIO-ED1. We consider the strengths and weaknesses of these approaches and whether they remain applicable
- **industry feedback:** we take into account the key issues raised by stakeholders in response to our SSMC, along with issues discussed at our CAWGs and other meetings
- **expert advice:** we engaged Cambridge Economic Policy Associates Ltd (CEPA) and Economic Consulting Associates (ECA) to assist in scoping, developing, and interrogating cost assessment methodologies for RIIO-2 and to provide advice on a number of issues.[6] We also engaged Professor Andrew Smith from the University of Leeds to provide advice on issues specific to econometric benchmarking.[7]

1.9. We decided in our SSMD that we will introduce a Business Plan Incentive (BPI) to encourage high quality and ambitious Business Plans. The assessment of Business Plans for the purposes of the BPI will be undertaken after we have carried out our cost assessment modelling. We intend to continue our engagement with stakeholders on our application of the BPI up until the submission of final Business Plans in December.

1.10. Our toolkit contains a range of analytical techniques. In this consultation we broadly distinguish these as econometric and non-econometric tools. We seek views on a number of questions in this document, responses to which will be taken into consideration in our selection of the most appropriate cost assessment tools and techniques to use.

Structure of this document

1.11. **Chapter 2** introduces our econometric analysis and discusses our approaches in RIIO-GD1 and the key issues for us to consider in evolving our approaches. We also discuss trade-offs between different cost models and set out our proposed criteria for developing and selecting models.

1.12. **Chapter 3** discusses how we can use econometric analysis at an aggregated (or relatively aggregated) level. We discuss our previously-used top-down totex model, as well as the middle-up assessment we considered in RIIO-GD1.

1.13. **Chapter 4** discusses ways we can apply our econometric analysis as part of our bottom-up or disaggregated assessment of activities within direct opex, capex and repex.

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[4] See RIIO-2 Sector Specific Methodology Consultation – Gas Distribution Annex available here.
[5] Stakeholders' responses to SSMC are available here.
[6] Annexes 1-3.
[7] Annexes 4-5.

1.14. **Chapter 5** summarises the bottom-up, non-econometric, assessment techniques we will use for RIIO-2 and discusses potential approaches to assessing business support costs across all sectors.

1.15. **Chapter 6** discusses regional factor cost adjustments that we have historically applied to GDNs' costs prior to undertaking econometric analysis, as well as potential approaches to the assessment of these in RIIO-GD2.

1.16. **Chapter 7** discusses potential approaches to assessing RPEs and ongoing efficiency across all sectors.

1.17. **Chapter 8** discusses how we set the efficiency benchmark and the potential ways we can combine the aggregated and disaggregated aspects of our analysis.

Related publications

RIIO-2 Sector Specific Methodology Consultation

RIIO-2 Sector Specific Methodology Decision

RIIO-GD2 Working groups

Consultation stages

Figure 1: Consultation stages

How to respond

1.18. Please send your response to the person or team named on this document's front page.

1.19. We've asked for your feedback in each of the questions throughout. Please respond to each one as specific and fully as possible. Your responses should, where appropriate, include practical ideas and recommendations to improve our cost assessment tools (eg the cost drivers we include in our econometric models or the price indices we use to determine RPEs).

1.20. We will publish non-confidential responses on our website at www.ofgem.gov.uk/consultations.

Your response, data and confidentiality

1.21. You can ask us to keep your response, or parts of your response, confidential. We'll respect this, subject to obligations to disclose information, for example, under the Freedom of Information Act 2000, the Environmental Information Regulations 2004, statutory directions, court orders, government regulations or where you give us explicit permission to disclose. If you do want us to keep your response confidential, please clearly mark this on your response and explain why.

1.22. If you wish us to keep part of your response confidential, please clearly mark those parts of your response that you *do* wish to be kept confidential and those that you *do not* wish to be kept confidential. Please put the confidential material in a separate appendix to your response. If necessary, we'll get in touch with you to discuss which parts of the information in your response should be kept confidential and which can be published. We might ask for reasons why.

1.23. If the information you give in your response contains personal data under the General Data Protection Regulation 2016/379 (GDPR) and domestic legislation on data protection, the Gas and Electricity Markets Authority will be the data controller for the purposes of GDPR. Ofgem uses the information in responses in performing its statutory functions and in accordance with section 105 of the Utilities Act 2000. Please refer to our Privacy Notice on consultations, see Appendix 1.

1.24. If you wish to respond confidentially, we'll keep your response itself confidential, but we will publish the number (but not the names) of confidential responses we receive. We won't link responses to respondents if we publish a summary of responses and we will evaluate each response on its own merits without undermining your right to confidentiality.

General feedback

1.25. We believe that consultation is at the heart of good policy development. We welcome any comments about how we've run this consultation. We'd also like to get your answers to these questions:

1. Do you have any comments about the overall process of this consultation?
2. Do you have any comments about its tone and content?
3. Was it easy to read and understand? Or could it have been better written?
4. Were its conclusions balanced?
5. Did it make reasoned recommendations for improvement?
6. Any further comments?

Please send any general feedback comments to stakeholders@ofgem.gov.uk

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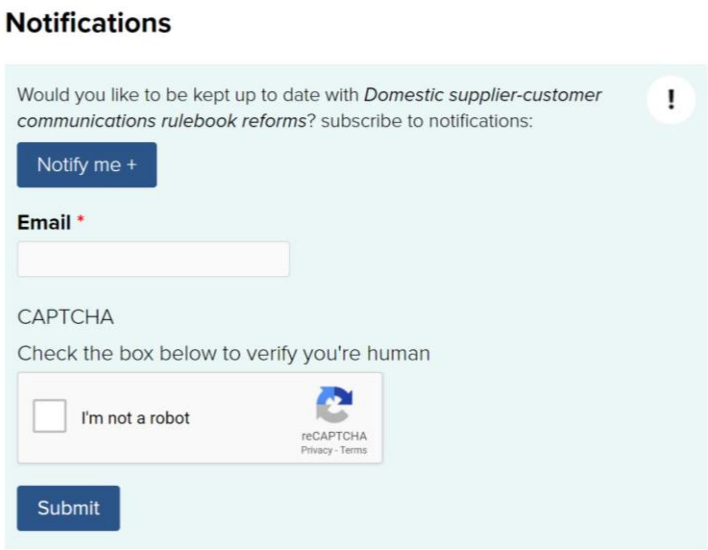
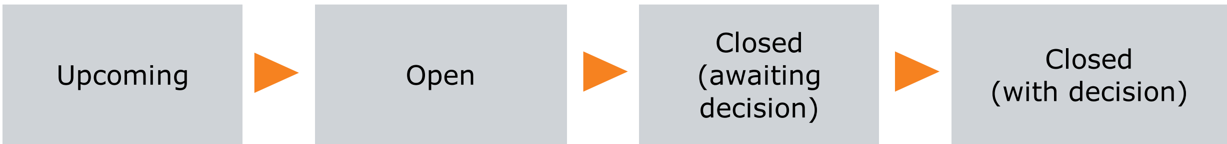
You can track the progress of a consultation from upcoming to decision status using the 'notify me' function on a consultation page when published on our website. Ofgem.gov.uk/consultations.



Once subscribed to the notifications for a particular consultation, you will receive an email to notify you when it has changed status. Our consultation stages are:



2. Approach to econometric analysis

Chapter summary
This chapter discusses and seeks views on the key issues we consider we should address when using econometrics to assess GDNs' costs. We consider estimation techniques, model selection criteria, model specification and the data available to us.

Questions

Question 1: What model estimation options should be considered for our cost assessment and why?

Question 2: Do you agree with our proposed criteria for developing potential cost pools? If not, what additional criteria do you propose and why?

Question 3: Should we continue to use the Cobb-Douglas functional form? If not, why?

Question 4: Do you agree with the proposed model selection criteria and model development phases?

Overview

2.1. In RIIO-GD1, we applied econometric analysis at a top-down 'totex' level and a bottom-up 'activity' level, which covered around 90% and 60% of the GDNs' controllable expenditure, respectively. The sample included eight GDNs, and the regression analysis was carried out on four years of historical data (2008-09 to 2011-12) as well as on two years of forecast data (2013-14 to 2014-15).

2.2. The different levels of analysis provided useful information in assessing GDNs' costs. For example, totex models ensured that we considered GDNs' opex-capex trade-offs in our comparative efficiency assessment, whereas activity level analysis allowed us to accurately identify the drivers of particular cost categories. By taking a simple arithmetic average of the top-down and bottom-up results in RIIO-GD1, we considered that we had captured both of these aspects.

2.3. The econometric analysis establishes a relationship between GDNs' costs and our chosen driver of those costs. We use this analysis in understanding the relative efficiency of GDNs as part of setting efficient cost allowances. In all RIIO-GD1 cost models, we included either a single cost driver or a Composite Scale Variable (CSV, a combination of different drivers).[8] Moreover, we assumed a Cobb-Douglas functional form with time fixed-effects and used Ordinary Least Squares (OLS) for estimation.

[8] In RIIO-GD1, we used CSVs in some of our regressions (eg totex and emergency) to encompass a wider range of factors influencing costs than are captured in a single cost driver. The weight of each factor in the CSV was computed based on industry spend.

2.4. This chapter discusses the key issues to be considered in defining our approach to econometric analysis for RIIO-GD2. These include:

- estimation techniques
- model specification
- model selection criteria.

2.5. In later chapters we present empirical applications of selected models based on historical data. **Note that these are purely for illustrative purposes and do not necessarily imply they will be used to assess GDNs' costs in RIIO-GD2**.

Estimation techniques

2.6. For RIIO-GD2 we intend to use econometrics analysis where appropriate, building on our experience from in RIIO-GD1, expert advice and any relevant feedback. The academic literature proposes several options to perform cost benchmarking with econometric tools.[9] These are referred to as parametric techniques, as they result in the estimation of one or more parameters reflecting the relationship between costs and corresponding selected drivers. Specifically, the estimated model will provide insights on the expected efficient costs of work delivery, given the corresponding driver.

2.7. It is worth noting that cost benchmarking can also be undertaken via non-parametric approaches, which include simple unit costs analysis and mathematical optimisation techniques that do not allow for statistical testing. One example is Data Envelopment Analysis (DEA), which will be briefly discussed at the end of this section and, in more detail, in Annex 4.[10]

Options for model estimation

2.8. Within the econometric realm, the most commonly used or tested techniques for benchmarking of regulated infrastructure are:

- **OLS models**. These are often conducted on 'pooled' data (ie using every data point without accounting for the year that data point has been observed)[11] and is referred to as a pooled OLS (POLS). OLS identifies the average expenditure levels for the comparators based on their cost drivers/explanatory variables, which can be adjusted to a chosen efficiency benchmark if deemed appropriate. This is referred to as corrected OLS or corrected POLS (jointly referred to as COLS)
- **Random effects (RE) models**. POLS does not specifically identify comparators' inefficiency, rather the error term comprises both company effects and statistical noise. With RE it is possible to exploit the panel nature of the data (ie explicitly accounting for the fact that comparators are observed over time) and thus to identify the company effect within the error term, and this effect can be interpreted as inefficiency

[9] For an overview, see C.J. O'Donnell, 2018 – *Productivity and Efficiency Analysis*, Springer Singapore.
[10] Annex 4 - Prof. Andrew Smith, *Note for Ofgem on Alternative Methodologies*, June 2019.
[11] As mentioned in the previous section, this is also the approach we followed in RIIO-GD1. Nonetheless, we accounted for potential time effects by introducing year dummies in all the estimated models.

- **Stochastic frontier analysis (SFA) models**. Like RE, SFA allows for the separate identification of inefficiency, however it requires a significant amount of data for the estimation process to run successfully. We discuss the application of SFA further below.

2.9. Each method is characterised by different assumptions about the composition of the error term and different data requirements. For example, a pure COLS approach assumes the error term to be completely imputable to (in)efficiency, while SFA models statistical noise and inefficiency separately. Moreover, compared to panel data models such as RE and SFA, COLS does not directly control for systematic differences across GDNs that are not captured by the cost driver. However, compared to SFA and RE, COLS is less demanding in terms of sample size.

2.10. Although we now have a longer time series of data, the number of comparators available to us is unchanged.[12] CEPA noted that this is the most crucial element in getting robust estimates of the GDNs' relative efficiencies. This is particularly pertinent when most of the available cost drivers, such as customer numbers and modern equivalent asset value (MEAV), do not exhibit material variations year-on-year.

2.11. CEPA noted that overall, the availability of a few additional years of data does not greatly increase the feasibility or robustness of RE or SFA approaches. Our academic advisor made similar remarks based on the same grounds and the risk of transparency/interpretation issues. Nonetheless, some of these more advanced models could still be tried and compared against the COLS model. The following subsection addresses this issue by comparing SFA and COLS, followed by a brief discussion of the DEA methodology.

Stochastic frontier analysis

2.12. A reason to consider comparing SFA against OLS is to explicitly allow for inefficiency in the model (which OLS does not). Specifically, SFA permits a decomposition of the residual between inefficiency and random noise, whereas corrected OLS (COLS) assumes all deviations from the shifted regression line to be attributed to inefficiency.

2.13. Whilst the academic literature would tend to support the use of SFA techniques over the COLS approach, there are a number of caveats in relation to economic regulation:[13]

- despite the possibility to distinguish between noise and efficiency, the resulting firm efficiency rankings are the same as those that would result from simply ranking firms based on the overall error term (as occurs in the COLS approach)
- SFA implementation requires discretionary assumptions on the distribution of noise and the efficiency term
- in the absence of correlation between the components of the error term and the explanatory variables, OLS still yields unbiased and consistent parameter estimates.

[12] Specifically, in RIIO-GD1 we mainly used four years of historical data from the previous regulatory period (GDPCR) and two years of forecast data. For RIIO-GD2, we could potentially exploit from ten to twelve years of data (GDPCR and RIIO-GD1 actual data). However, the number of comparators (eight) will be the same as in RIIO-GD1. This implies that, for RIIO-GD2, the dataset is bigger only with respect to the time dimension.
[13] Annex 4.

2.14. Therefore, from an implementation perspective it is as yet unclear whether the decomposition achieved by the SFA model is superior to the use of COLS to inform setting an efficiency frontier, for example through an upper quartile adjustment.

2.15. As an illustration, we applied two techniques (COLS and SFA) to estimate the top-down (totex) model using RIIO-GD1 actual data (2013-14 to 2017-18).[14] In line with RIIO-GD1 assumptions, we considered a Cobb-Douglas functional form with only one driver (a CSV) and time fixed effects.[15] Table 2.1 compares the efficient costs obtained from the two estimations.

Table 2.1: COLS and SFA totex models

COLS (Upper Quartile)						
GDN	**2013/14**	**2014/15**	**2015/16**	**2016/17**	**2017/18**	**Ranking**
EoE	293.63	294.60	287.76	276.95	266.74	7
Lon	183.14	185.15	177.49	185.41	176.44	8
NW	230.25	213.61	224.72	209.87	200.87	6
WM	180.24	157.83	183.65	177.44	160.16	5
NGN	253.35	255.11	228.52	226.31	224.15	1
Sc	176.77	163.57	160.90	159.26	147.08	2
So	346.08	333.12	306.32	303.97	301.79	3
WWU	235.02	238.01	228.34	226.32	209.37	4
SFA						
GDN	**2013/14**	**2014/15**	**2015/16**	**2016/17**	**2017/18**	**Ranking**
EoE	268.30	275.53	274.00	267.54	261.05	6
Lon	164.78	170.55	166.36	176.78	170.35	8
NW	208.72	197.69	212.26	200.91	194.76	7
WM	162.08	144.63	172.32	168.93	154.14	5
NGN	230.38	237.48	215.96	217.18	218.11	1
Sc	158.86	150.06	150.32	151.09	141.16	2
So	317.93	312.81	292.27	294.54	296.54	3
WWU	213.19	221.06	215.78	217.19	203.28	4

Note. £m, 2017-18 prices.

2.16. The efficient costs estimated via COLS reflect the upper quartile view[16] and are on average 6% higher than those estimated via SFA. The variation is higher in the first years of the price control (10% in 2013/14 compared to 3% in 2017/18). This seems to suggest that, although in terms of relative efficiency the results are very similar (ie almost the same cumulative ranking), SFA provides a tougher target than COLS. Nonetheless, with the SFA approach implemented here, firm rankings do not change over time, whereas the COLS approach permits not only efficiency change over time, but also the relative rankings of firms to change in a flexible way. That said, the strength of the SFA model is that it puts a structure on efficiency variation over time which could be seen as more realistic.

2.17. We note that the SFA example presented here is the result of preliminary investigation. Further analysis will be required before making any decisions on estimation techniques.

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[14] The SFA model estimated assumed time-varying efficiency (G.E. Battese and T.J. Coelli, 1992 – Frontier production functions, technical efficiency and panel data: with application to paddy farmers in India, *Journal of Productivity Analysis* 3(1-2), pp. 153-169).
[15] A discussion of the Cobb-Douglas functional form can be found in the section on model specification.
[16] In RIIO-GD1, we set the efficiency benchmark at the upper quartile level instead of the frontier (ie the GDN with lowest cost) recognising model measurement errors, but also that the frontier could have been an unfeasible target for GDNs.

A non-parametric option: Data Envelopment Analysis

2.18. DEA is a non-parametric approach that employs mathematical optimisation techniques (linear programming) for efficiency measurement. As such, the basic/standard implementation of this method does not account for statistical noise. Like the COLS method, DEA assumes that all deviations from the frontier are due to inefficiency, implying that random factors that may have an impact in particular years for particular firms are disregarded.

2.19. As opposed to SFA, DEA only requires the definition of inputs and outputs without assumptions on the shape of the production function (ie the exact mathematical relationship that links inputs to outputs). However, the flexibility of the functional form also implies that the effect of the cost drivers on costs is not as clear as in the case of parametric approaches, thus threatening model transparency and interpretation. More details on the workings of DEA can be found in Annex 4.

Question 1: What model estimation options should be considered for our cost assessment and why?

Model specification

2.20. It is also important to select an appropriate model specification when arriving at the final modelling methodology. This includes the preliminary choice of the level of cost aggregation at which the analysis is performed, the choice of the corresponding cost drivers and the choice of the mathematical relationship (eg linear vs. non-linear) that links costs and cost drivers (ie the functional form).

2.21. In this section we set out our proposed principles for model specification with a particular focus on cost aggregation, cost drivers and functional form. Issues specific to our aggregated and disaggregated econometric analysis are discussed in Chapters 3 and 4.

Cost aggregation

2.22. The level of analysis (eg totex vs. activity level) is an important prerequisite to defining a model specification. In this section we discuss cost aggregation issues and scenarios where it may be appropriate to pool costs together.

2.23. CEPA proposed the following criteria for developing a long list of potential cost pools for our RIIO-GD2 cost assessment:

- **complementarity:** Is there a strong technical/economic reason to believe that activities or groups of expenditure are complementary and should be benchmarked together and a consistent set of cost drivers can be identified?
- **cost trade-offs:** Can GDNs make trade-offs in expenditure between the different activities/areas included in the cost pool, and so benchmarking those activities/costs together will help avoid biased relative efficiency results or unintended managerial incentives for the GDNs?
- **cost boundary complexity:** How complex is the boundary of cost reporting data that needs to be defined to benchmark the identified cost pool/activity (eg how well defined is the group of costs within Ofgem's regulatory reporting templates)?

- **risk of inaccurate/biased models:** Is there too much 'noise' in the data to be confident that including certain types of expenditure within aggregated regressions could lead to inaccurate model results, or coefficient estimates that are difficult to interpret using engineering/economic logic?

2.24. The final point above is particularly relevant to us. The choice of the cost pool has clear consequences on the selection of appropriate cost drivers. In general, there are advantages and disadvantages of more or less disaggregated benchmarking for selecting explanatory variables:[17]

- As cost models become more granular it may be possible to better identify explanatory variables that reflect the specific costs and drivers under consideration. More disaggregated benchmarking may help to explain the causes of differences in GDN cost performance/efficiency which more aggregated models fail to achieve.
- However, it may be argued that at more disaggregated levels it is more challenging to establish explanatory variables that meaningfully reflect all of the cost drivers of the costs of particular activities. More aggregative cost pools are more likely to reflect the more aggregative narrative of drivers of gas distribution costs.

2.25. In Chapter 4 we discuss this issue in greater detail and provide examples demonstrating the consequences of cost aggregation decisions on cost drivers' selection.

Question 2: Do you agree with our proposed criteria for developing potential cost pools? If not, what additional criteria do you propose and why?

Cost drivers

2.26. The choice of an appropriate cost driver is another key element of our econometric analysis. Economic theory and engineering logic suggest that there are a number of different drivers of the costs of gas distribution networks. These drivers could be exogenous, such as the number of customers served, or endogenous, such as workload. Our interpretation of model results is affected by the type of cost driver that we select.

2.27. In this section we summarise the principles for selecting cost drivers we set out in our SSMC. Responses from stakeholders were generally supportive of the proposed approach.[18] We also discuss issues to be mindful of when using particular cost drivers. Cost driver issues specific to our aggregated and disaggregated econometric analysis are discussed in Chapters 3 and 4, respectively.

2.28. The following principles should be considered in developing appropriate cost drivers. They should:

- **make economic and/or engineering sense** – so they can be interpreted and understood as reasonable and relevant

[17] Annex 1 - CEPA, *RIIO-GD2 cost assessment – econometric modelling & regional factors*, June 2019.
[18] See stakeholders' responses to SSMC available here.

- **be accurately and consistently measurable**
- **have a relatively stable relationship with the costs over time** and incorporate as much relevant information as possible – in order to be able to distinguish between costs which are explained by differences in exogenous conditions and costs which are explained by differences in efficiency
- **be beyond the control of the network company**, as far as is reasonably practicable, to avoid distorting company incentives in ways which might be ultimately inefficient.

2.29. CEPA set out a plausible causal narrative of what might be expected to be the exogenous and endogenous drivers of total expenditure within the GB gas distribution sector.[19] Indeed, there are trade-offs to consider when selecting cost drivers. Some scale drivers, such as customer numbers, will likely have a strong external influence on expenditure. However, it is difficult to determine the extent to which these types of variables can explain expenditure requirements for particular activities. Workload (or activity) cost drivers, such as the number of Public Reports of Gas Escapes (PREs), can more accurately forecast required expenditure (provided workloads are actually delivered), but can potentially reward companies where the network is in relatively poor condition.

2.30. Another important issue relates to the number of variables included in a model. In RIIO-GD1, all model specifications accounted for a single cost driver or CSV, and this was mainly due to data limitations. It is worth noting that, more generally, the CMA was critical of Ofwat's PR14 approach where a large number of explanatory variables were included in the model specification, in part because this made the models challenging to understand but also because it may lead to less precise coefficient estimates, particularly where there may be a high degree of correlation between variables. Using a CSV helps to address some of these issues[20], although this would require discretionary extra-model assumptions (eg on the weight assigned to each component of the CSV).

2.31. In RIIO-GD1, all model specifications also included yearly dummy variables in addition to the selected cost driver or CSV to account for potential unobserved effects. This is particularly important where it is considered that the GDNs' real expenditure (expenditure adjusted for inflation) changes over time relative to the cost drivers and explanatory variables. Real expenditure is expected to change over time due to ongoing efficiency and RPEs, as well as other exogenous factors.

2.32. An alternative to time dummies is a time trend. The economic rationale supports the use of a time trend variable over annual dummy variables as more appropriate if we aim to capture the average change in frontier shift.[21] CEPA modelled illustrative regressions comparing these two options to account for time effects. As shown in Table 2.2, in this example there seem to be no substantial differences in terms of model fit between the two options, as the estimated coefficient of the cost driver (totex CSV) as well as the R squared are similar once either of the time effects are introduced. Nonetheless, with a time trend we would only estimate one additional parameter as opposed to ten (one for each time dummy), resulting in a more parsimonious model. This would be a relative advantage given the limited size of our sample.

[19] Annex 1.
[20] Annex 1.
[21] Annex 1.

Table 2.2: Illustrative totex regressions with time trends and time dummies

	No time controls	Linear time trend	Time dummies
GD1 Totex CSV	0.799***	0.758***	0.758***
Time Trend		-0.019***	
Dummy_2010			0.002
Dummy_2011			-0.007
Dummy_2012			-0.014
Dummy_2013			0.03
Dummy_2014			-0.051
Dummy_2015			-0.058
Dummy_2016			-0.112***
Dummy_2017			-0.119***
Dummy_2018			-0.166***
Constant	-0.233	37.549***	0.099
Observations	80	80	80
R-squared	0.883	0.924	0.930

*Source: CEPA analysis. *** p<0.01, ** p<0.05, * p<0.1*

Functional form

2.33. The specification of the functional form is an important aspect of the econometric methodology. Different functional forms reflect different assumptions on the relationship between the dependent and explanatory variables.

2.34. The models we used in RIIO-GD1 employed a Cobb-Douglas form. This is a standard approach used in cost assessment literature as it allows for economies of scale to be captured. Another advantage of this functional form is that, given the logarithmic transformation of the data, the variables more closely follow a normal distribution better than when the data are not applied the transformation.

2.35. In the case of a single explanatory variable, the model takes the following general form:

$$\log(cost) = \beta_0 + \beta_1 \log(cost\ driver) + \epsilon$$

2.36. Where β_0 is a constant term, β_1 is the coefficient associated with the cost driver and ε is the error term representing the component of costs not explained by the cost driver. When both cost and cost driver are expressed in logarithmic terms, β_1 can be interpreted as the elasticity of costs with respect to the driver – if the cost driver increases by 1%, costs can be expected to increase by β_1%. Therefore, if β_1 is less than one, an activity can be said to have increasing returns to scale (with respect to the given driver).

2.37. Cobb-Douglas models are relatively easy to replicate and interpret but suffer from the imposition of single degree economies of scale being assumed across the industry (ie all companies are assumed to have the same level of economies of scale). Therefore, the use of this form could require the introduction of other variables that can reflect variations in economies of scale across companies.[22] Moreover, the Cobb-Douglas functional form reflects given convexity assumptions for the production function, which might not be suitable in presence of lumpy investments.

2.38. In terms of functional form, an alternative specification to the Cobb-Douglas is the more flexible translog function, which introduces quadratic terms and interactions between variables. It has the advantage of accounting for non-linearities as well as allowing for returns to scale to vary with companies' size. However, it requires the estimation of a higher number of parameters, which might be a problem with small samples. Moreover, the interpretation of coefficients is less intuitive. Nonetheless, it could still be useful to add a quadratic term to the standard Cobb-Douglas functional form to test for the presence of potential non-linearities, followed by a model specification test.

Question 3: Should we continue to use the Cobb-Douglas functional form? If not, why?

Model selection criteria

2.39. Broadly there are three main criteria to consider when selecting models:

- **economic/technical rationale** – Do the model specifications and results have a clear economic/technical rationale?
- **transparency** – Including the data used, the results and ease of interpretation for stakeholders
- **robustness** – Does the model pass statistical tests? Is the model sensitive to the underlying assumptions?

Economic/technical rationale

2.40. As a first step to building an appropriate econometric model, it is important to justify the variables (ie the cost drivers) that are assumed to explain given costs from a theoretical or engineering or business perspective. This guards against the possibility of 'data mining', whereby we are merely picking up spurious relationships between variables.

2.41. Moreover, the choice of the functional form (ie the type of relationship between costs and drivers) should also be based, in part, on an underlying economic and engineering understanding of a gas distribution business. For example, if there is a strong rationale for believing an explanatory variable has a U-shaped relationship with costs, this may justify the use of squared terms in the functional form. This might be the case for the effect of network density on the cost to run the emergency service, as both low and high levels of density might be associated with higher costs for a GDN. Visual inspection of the data could help investigate the presence of such non-linear relationships.

[22] Annex 5 - Prof. Andrew Smith, *Note for Ofgem on Diagnostic Tests in Efficiency Benchmarking Studies*, June 2019.

2.42. Other aspects to consider while selecting a model are consistency with policy objectives and check for the potential for models to generate perverse incentives.[23]

Transparency

2.43. For a model to be used in economic regulation it is important that it is clearly explained and can be interpreted by the companies and other stakeholders. These criteria could suggest that it is beneficial to avoid complex estimation approaches and also to choose a parsimonious model. However, in some cases more complex techniques and specifications may be necessary to ensure the selected model captures all the relevant aspects of the relationship between costs and drivers.[24]

2.44. The rationale for selecting the final model or models (as compared to the alternatives) should also be clear. The models should be replicable, and methods used should be capable of being implemented using standard econometric packages.

2.45. In PR14, Ofwat implemented a version of the 'translog' functional form mentioned above, which introduces squared and cross-product terms in order to capture potential non-linear effects. However, the use of these models makes it more difficult to identify the specific effect of each variable on costs. They also require the introduction of a larger number of explanatory variables in each one of the models to account for these variations. Following Bristol Water's PR14 appeal, the CMA noted that Ofwat's models were difficult to interpret and, given the small sample size and the data requirements of translog, its use seemed overly ambitious.[25]

Robustness

2.46. The statistical robustness of a model could be defined as covering three broad areas:[26]

- the robustness of the model to appropriate statistical tests
- the stability of the model to changes in, for example, the data sample or precise model specification
- the ability of the model to explain the existing data and to forecast future costs.

2.47. Table 2.3 lists some of the diagnostic tests typically carried out to determine the statistical robustness of a model. The 'failure' of some tests is more serious than others. We comment on the usefulness of each test in the context of assessing our models. The list is not exhaustive[27], but includes the statistical tests that were relevant to our RIIO-GD1 analysis (ie models with a single cost driver or CSV).

[23] Annex 1 and 5.
[24] Annex 5.
[25] CMA (2015), *'Bristol Water plc. A reference under section 12(3)(a) of the Water Industry Act 1991'*, available here.
[26] Annex 5.
[27] A more complete list of statistical tests is provided in Annex 5.

Table 2.3: Statistical tests used to determine model robustness

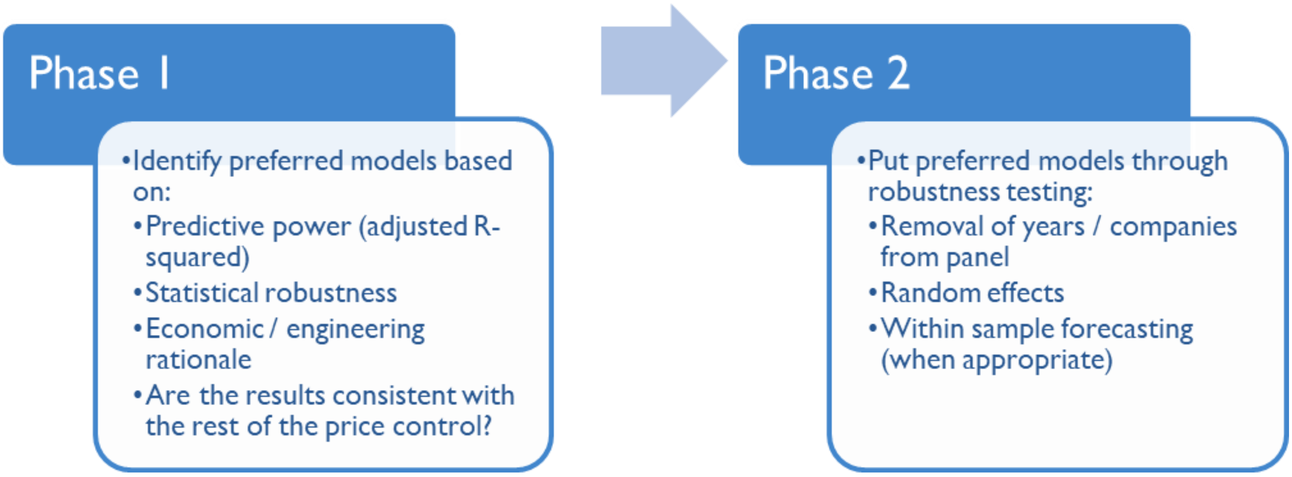
Test	Description
Statistical significance of the coefficients (elasticities)	This test is asking whether we can be confident that there is a relationship between the explanatory variable and cost – or more formally can we (statistically) reject the proposition that there is no relationship (ie that the coefficient is zero). Establishing that the coefficient is different to zero may be a low hurdle to overcome for a composite scale measure, which will surely have a positive coefficient. What may be more important is whether the coefficient is plausible in terms of its size, which is also related to whether we think we have constant, increasing or decreasing returns to scale.
The RESET test	This test considers whether there is some non-linear relationship in the model that has not been captured. In the cost modelling literature this is normally dealt with by considering a translog specification which captures these non-linearities directly. A translog model explicitly seeks to incorporate squared and interaction terms for the purpose of approximating complex technologies where, for example, the degree of returns to scale may vary with firm size.
Normality of errors	Violations of this assumption does not affect the properties of OLS estimators themselves. They remain the best linear unbiased estimators. The impact of non-normality only has implications for the ability to use finite sample inference – that is, making judgements about the statistical significance of the parameters in small samples.
Correlation/ heteroscedasticity	Violations of the assumptions in OLS impact only on the standard errors and do not cause the estimates themselves to be biased. The standard response to this potential issue is therefore to use robust standard errors when making an assessment of statistical significance.
Testing for panel effects	Given that our dataset comprises observations on multiple GDNs over several years, it is a valid question to consider whether models that explicitly recognise the panel structure of the data might be valid alternatives to OLS (which pools the data and treats all observations as independent).
Endogeneity	In regression analysis the explanatory variables are assumed to be exogenously given and not under the control of the firm. However, this assumption may not hold for some variables, such as measures of quality. This introduces a possible source of bias since, for example, factors that are omitted from the model (and which are therefore part of the error term) may be correlated with both costs and quality. This issue is complex and should be considered on a case by case basis.

2.48. In assessing the robustness of a model it is pertinent to ask how the results change with small changes to the sample (dropping firms and years) and to the model assumptions (estimation method). It is also important to consider whether the parameter estimates are stable over time. Before omitting data points, we should consider the small data sample available to us and whether there are very strong reasons for believing that the omitted firm or year are highly unrepresentative.[28]

2.49. In terms of model fit (ie how well we are explaining the dependent variable), for OLS models the R-squared statistic is the standard measure. In assessing whether the R-squared measure is 'good' it is important to compare against similar cost models.[29]

2.50. More generally, CEPA recommended a two-phase process to model development, which it applied to models tested for Ofwat as part of PR19. Under this process the stringency of assessment increases as models pass through various criteria. These phases are set out in Figure 2.1.

Figure 2.1: Model development phases



Question 4: Do you agree with the proposed model selection criteria and model development phases?

Summary

2.51. We intend to continue using parametric approaches as these allow for a more comprehensive view of industry dynamics such as economies of scale and density. This is particularly important in regulated network industries where these factors may vary greatly. COLS appears to be the most suitable estimation technique for us to use as a starting point in testing models for our RIIO-GD2 cost assessment. Nonetheless, in line with our academic advisor and CEPA's advice, we will consider testing RE and SFA as alternative methods.

2.52. We consider it appropriate that we use a set of criteria, such as those suggested by CEPA, for selecting cost pools. We also intend to develop a set of aggregated and

[28] Annex 5.
[29] There can be a danger of overly focusing on this measure by adding more and more variables to the model and thus it is important to have a clear rationale for the inclusion of additional variables. An adjusted R-squared measure is available that includes a penalty for adding extra variables, partly to address this problem.

disaggregated models and test for their robustness. We discuss these potential models in greater detail in Chapters 3 and 4.

2.53. We intend to consider a mixture of explanatory variables, including both scale and workload variables, when developing and testing our RIIO-GD2 econometric models. We note it is possible to test the validity of new explanatory variables in our models, however some data limitations exist. We intend to consult further with GDNs via the CAWGs as we refine our modelling approaches.

2.54. We intend to select models based on the three main model selection criteria proposed in this chapter. We also intend to broadly follow the two-phase model development process set out above, and if we continue to develop COLS models, we will test these to determine model robustness against the statistical tests we have outlined.

3. Aggregated econometric analysis

Chapter summary
This chapter discusses and seeks views on aggregated approaches to econometric benchmarking, including 'top-down' totex modelling approaches, 'middle-up' models and the benefits of such approaches. We also discuss more generally the rationale for aggregating certain costs as part of our econometric benchmarking process and seek views on alternative ways of aggregating costs.

Questions

Question 5: Should the cost driver of the totex regression model be determined by the cost drivers of the 'bottom-up' models, or should the totex regression model account for different explanatory variables? Why?

Question 6: What could be appropriate cost drivers in middle-up models for opex, capex and repex? Why?

Question 7: For which opex activities are there trade-offs that support the rationale for testing 'totex and opex plus' modelling?

Question 8: Are there other particular costs that we should aggregate and test in our analysis?

Overview

3.1. As explained in Chapter 2, our RIIO-GD1 econometric benchmarking combined top-down and bottom-up modelling to set final totex allowances. Our benchmarking analysis included models that grouped costs according to:

- **Expenditure areas**: either at the totex level or individual expenditure[30] area (opex, capex and repex); and
- **Activity levels**: such as repairs, maintenance, connections, mains and services replacement.

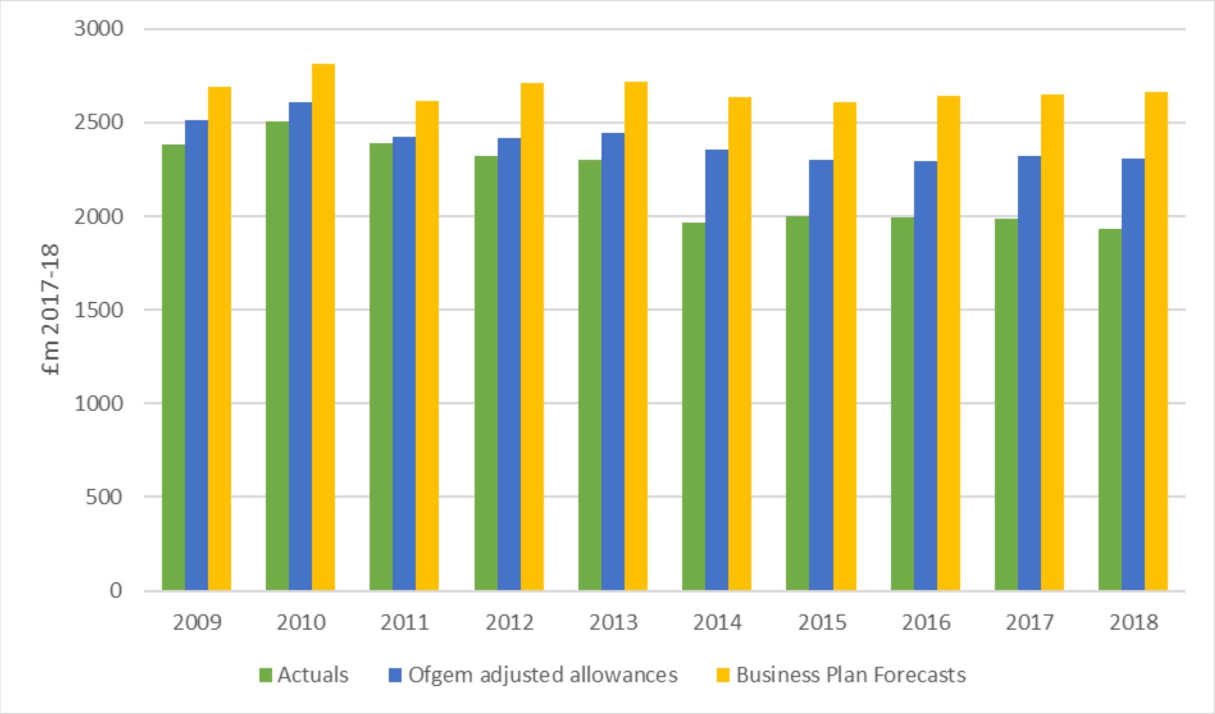
3.2. In our RIIO-GD1 Final Proposals we used the totex model as our top-down assessment, which we considered adequately accounted for opex-capex trade-offs. This type of model provides the most aggregative view of efficiency, however other approaches to aggregating costs are possible and will be considered.

3.3. In the following sections we examine historical totex, discuss the potential benefits of different approaches to aggregating costs and the reasoning for aggregating some costs but not others. Our bottom-up modelling (or disaggregated analysis) is discussed further in Chapter 4 and the ways we can combine our analyses are discussed in Chapter 8.

[30] Models on individual expenditure areas (ie middle-up) were initially considered in RIIO-GD1. However, they were not included in our Final Proposals as they were replicating the results at the totex level. For more details, see RIIO-GD1: Final Proposals – Supporting document – Cost efficiency available here.

3.4. Figure 3.1 presents actual and Business Plan (BP) forecast totex for all GDNs relative to our price control baselines from 2008-09 to 2017-18. In the first five years of RIIO-GD1, GDNs have outperformed totex allowances by £1.7 billion (15%). This compares with a 5.2% totex underspend over GDPCR1.[31]

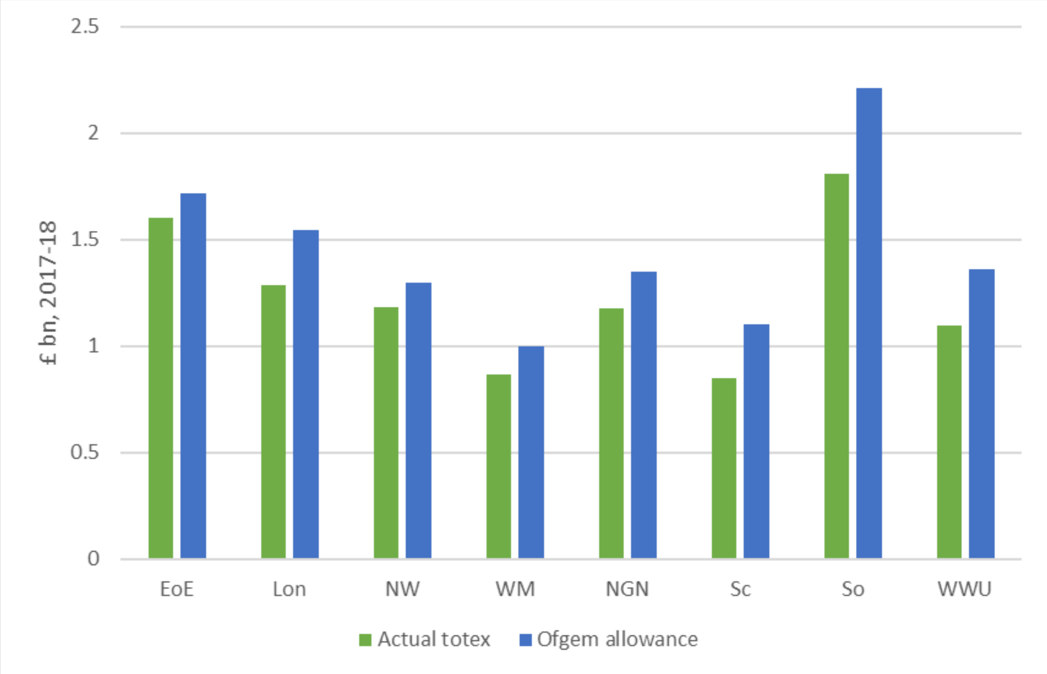
Figure 3.1: GD industry actual totex, 2008-09 to 2017-18



3.5. Figure 3.2 presents actual totex for each of the GDNs relative to our totex allowances from 2013-14 to 2017-18. In the first five years of RIIO-GD1, all GDNs have underspent totex allowances, with the largest in the SGN Scotland (23%), WWU (19%), SGN Southern (18%) and Cadent London (17%) networks. As highlighted in our last RIIO-GD1 Annual Report, this outperformance is due to enhanced operational efficiency (thanks, for example, to innovations improving productivity and reductions in emergency and repairs costs linked to the repex programme deployment), but also to exogenous factors such as mild winters and variations in the assumptions set at the beginning of the price control.[32]

[31] See End of Period Review of GDPCR1 available here.
[32] See RIIO Gas Distribution annual report 2017-18 available here.

Figure 3.2: GDN actual totex relative to allowances, 2013-14 to 2017-18



Totex modelling

3.6. In RIIO-GD1, baseline allowances were set at the totex level. As part of our analysis, our totex modelling approach (top-down) used a single regression model to determine the efficient level of controllable totex.[33] The main advantage of this approach is that it balances trade-offs between different cost areas while mitigating potential cost reporting inconsistencies between companies.

3.7. Specifically, for our totex benchmarking approach in RIIO-GD1, we defined totex as controllable opex plus shrinkage plus capex plus repex, and used a seven-year moving average to smooth capex.[34] We applied regional cost adjustments and normalisation adjustments to ensure that we benchmarked GDNs on a comparable basis (discussed further in Chapter 6). In RIIO-GD1, our bottom-up regression models had a significant influence on the top-down model as our totex model specification aggregated the explanatory variables used in the disaggregated (activity level) regressions.

3.8. Specifically, within the framework outlined in Chapter 2, the totex model's cost driver was a CSV, which combined network scale (proxied by MEAV) with workload drivers based on our bottom-up regressions (discussed further in Chapter 4). We applied a 38% weighting on MEAV, 43% on repex workload, 2% each on mains reinforcement and connections workload, 6% on the number of external condition reports, 5% on maintenance MEAV and 4% on the emergency service CSV.[35] We defined efficient costs equal to the upper quartile costs, then rolled forward efficient base year costs for changes in outputs and workload volumes, applied

[33] Excluding certain costs that were assessed outside the regression.
[34] This is the measure of total costs chosen in RIIO-GD1 based on the fact that it relates more closely to the current state of technology, government regulation and environmental concerns, and the operators' levels of efficiency. As for the smoothing of capex, it was done to avoid bias from sporadic expenditure (eg LTS and other capex).
[35] CSV weights were based on industry spend proportions for the disaggregated cost activities to which the drivers applied. The residual was then applied to the scale variable, MEAV. We considered that this approach took into account the relative importance of each cost driver based on the knowledge of the GDNs' costs.

our view of growth in input prices and ongoing efficiency, and added back costs that we assessed separately.[36]

3.9. In response to our SSMC, SGN noted that top-down regressions provide an essential sense check. It also suggested that such regressions mitigate the risks that aggregating bottom-up regressions 'cherry picks' the best performer across numerous categories and that disaggregated cost drivers may not always fully explain trade-offs made across activities. WWU agreed with aggregating the cost categories to reduce the risk of allocation errors which will result in an improved correlation between drivers and costs.[37]

Question 5: Should the cost driver of the totex regression model be determined by the cost drivers of the 'bottom-up' models, or should the totex regression model account for different explanatory variables? Why?

Middle-up modelling

3.10. We tested a 'middle-up' approach for RIIO-GD1 that drew together three separate regressions for total controllable opex, capex and repex. For this approach we used weighted average repex workload as the repex regression cost driver; a CSV of MEAV, connections workload and mains reinforcement workload as the capex cost driver; and a CSV of MEAV, external condition reports, maintenance MEAV, and the emergency CSV as a cost driver for opex.

3.11. In our Final Proposals for RIIO-GD1 we did not use these middle-up models because they produced broadly the same comparative efficiency scores as the top-down model and including them would have effectively added more weight to the totex analysis.

3.12. In response to our SSMC, Cadent noted that the middle-up approach should be investigated again for RIIO-GD2, to assess its statistical robustness. It noted that if it is found to be robust, then it would provide a third view of cost efficiency.[38]

3.13. There are other potential variations to the middle-up model that could be tested for robustness. These could include changes to existing cost drivers, the addition of new cost drivers or the aggregation of certain cost activities.

Question 6: What could be appropriate cost drivers in middle-up models for opex, capex and repex? Why?

[36] For more details, see the RIIO-GD1 step-by-step guide for the cost efficiency assessment methodology available here.
[37] SGN and WWU responses to SSMC available here.
[38] See Cadent response to SSMC available here.

Other approaches to aggregating costs

3.14. Aside from the top-down and middle-up approaches, there are a variety of other approaches to aggregating costs that we could consider for our cost assessment. In Chapter 2 we discussed the high-level factors CEPA recommended we consider when aggregating costs.

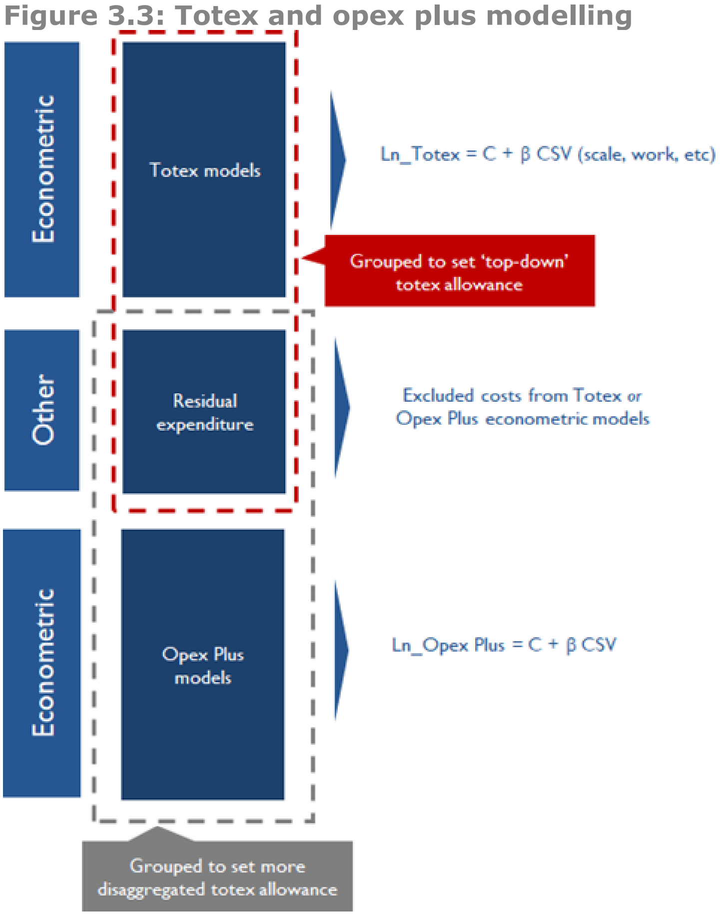
3.15. CEPA also suggested we consider using statistical tests to identify how complementary the different types of expenditure and their expected explanatory variables are for benchmarking purposes. This may include:

- testing for year-on-year volatility in expenditure in particular areas/activities that appears to be unrelated and/or correlated with changes in business scale drivers
- testing the expected consistency of workload and other cost drivers between different types of expenditure before costs are grouped together for benchmarking.

Totex and opex plus modelling

3.16. CEPA developed a series of options that we could, in principle, consider for aggregating costs. One of these options was totex and opex plus modelling, the latter element being less aggregative than totex modelling but more aggregative than bottom-up modelling approaches. This option would include totex modelling but more disaggregated regression-based modelling would only be undertaken for pooled opex and other costs where clear complementarities and trade-offs for pooling exist.

Figure 3.3: Totex and opex plus modelling



3.17. This approach has similar advantages to our RIIO-GD1 methodology of combining top-down and bottom-up approaches, but would also consider trade-offs between different opex activities. For example, in this setting emergency and repairs costs would be assessed jointly, which in principle might be reasonable given their strong correlation.[39]

3.18. Under this approach, the treatment of repex and capex would potentially be more understandable within the overall cost assessment, as relative to previous approaches it is less bundled into the econometric modelling. However, this approach maintains the use of the totex model and therefore criticisms of this model are also relevant under this approach. CEPA outlined other potential approaches to aggregating costs and modelling at a different levels of aggregation.[40]

Question 7: For which opex activities are there trade-offs that support the rationale for testing 'totex and opex plus' modelling?

Question 8: Are there other particular costs that we should aggregate and test in our analysis?

Summary

3.19. We recognise the positive incentive properties and benefits for regulatory consistency in retaining a top-down based benchmarking framework as part of our cost assessment toolkit. We are also mindful of the limitations of the totex model and consider it will also be necessary to undertake more detailed analysis at a disaggregated level.

3.20. We intend to continue testing models and will develop a set of potential aggregated (or relatively aggregated) models that could be applied (including totex, middle-up and totex and opex plus models) and discuss these in CAWGs up until the submission of final Business Plans in December. We expect that our final approach will depend on how well these models perform against the proposed model selection criteria outlined in Chapter 2.

[39] The potential for pooling emergency and repair costs was also discussed at CAWG 7. However, preliminary analysis was not conclusive about the appropriateness of doing this. Presentations and minutes available here.
[40] Annex 1.

4. Disaggregated econometric analysis

Chapter summary
This chapter discusses and seeks views on disaggregated approaches to our econometric analysis, including 'bottom-up' benchmarking of direct operational expenditure (opex), capital expenditure (capex) and replacement expenditure (repex).

Questions

Question 9: Are there trade-offs between opex and capex activities that support the rationale for considering 'opex plus' modelling?

Question 10: Which cost areas should be assessed using workload drivers as opposed to other cost drivers? Why?

Question 11: Should repex (or some categories of repex) be excluded from our regression analysis and assessed using other techniques?

Question 12: Are there other approaches to disaggregated benchmarking that we should consider?

Overview

4.1. Disaggregated analysis refers to our 'bottom-up' assessment of the costs of undertaking activities specific to opex, capex and repex.

4.2. In this chapter we discuss trends in these activities as well as the cost drivers we used in RIIO-GD1 to explain these costs. We also discuss the suitability for using these and alternative cost drivers in RIIO-GD2 and consider the rationale for aggregating some of these costs in our analysis.

Direct opex

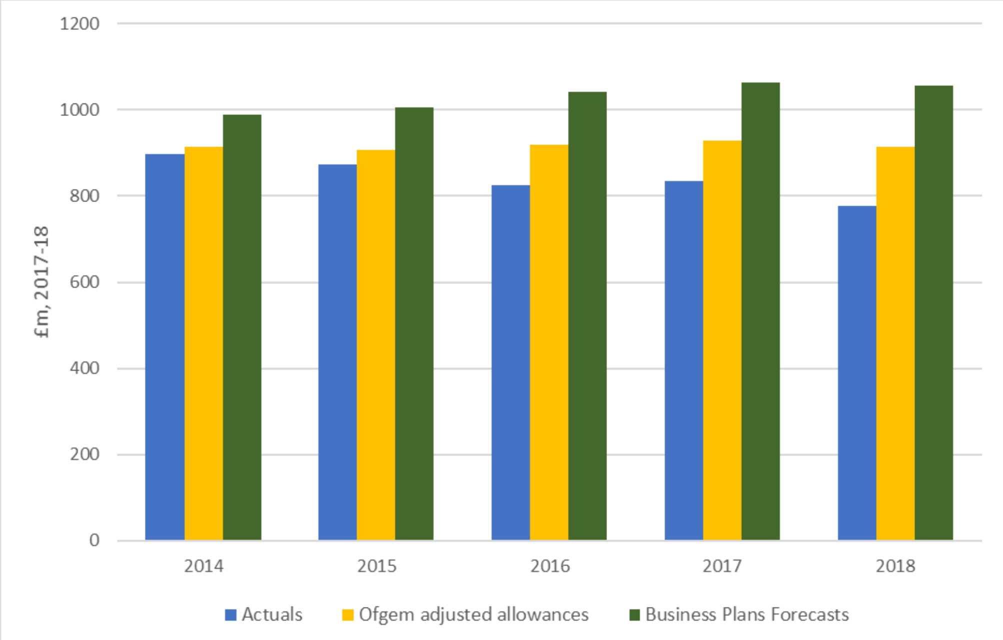
4.3. Direct opex is the costs associated with direct operating activities carried out by the GDNs. These activities account for 31% of the totex to date for RIIO-GD1.

4.4. Direct opex is split between controllable and non-controllable operating costs.

- Controllable operating costs are specific costs that are deemed to be within the control of the GDN. This consultation focuses solely on controllable costs.
- Non-controllable costs are costs that are beyond management control in the short term and are therefore subject to a pass-through mechanism which removes the risk of variations in costs from the businesses by allowing actual costs to be recovered through revenues within the price control period. Examples of costs included in this area are network rates, Ofgem licence fees and contributions to the national transmission system (NTS) pension deficit scheme.

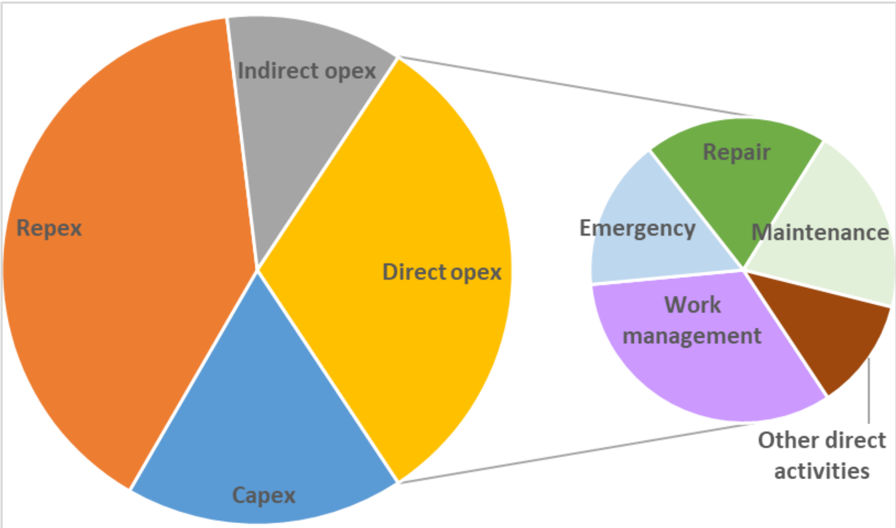
4.5. Figure 4.1 shows the industry's actual and BP forecast opex performance against the baselines in the first five years of RIIO-GD1. In this period, GDNs have underspent on inferred[41] opex allowances by £373 million (8%), with annual underspends increasing from 2% in 2013-14 to 15% in 2017-18.

Figure 4.1: RIIO-GD1 actual v allowed controllable opex, 2013-14 to 2017-18



4.6. Direct opex comprises four main activities: work management, emergency, repairs and maintenance. In RIIO-GD1 we modelled these activities separately using regression analysis. Figure 4.2 shows direct opex activities relative to totex in RIIO-GD1.

Figure 4.2: RIIO-GD1 opex activities relative to total expenditure, 2013-14 to 2017-18



4.7. Work management is the biggest component of direct opex, making up approximately 33% of the costs. Work management is a labour-intensive activity which includes asset

[41] Companies are provided a totex allowance, which is the sum of 'inferred' activity level allowances.

management, operations management, customer management and system control centre costs.

4.8. Emergency costs are the direct costs of providing an emergency service to respond to all reported gas escapes and make any escapes safe. Following calls to the national gas emergency number, an engineer of First Call Operative is dispatched to follow up reports of gas escapes or no gas supply at individual premises.[42]

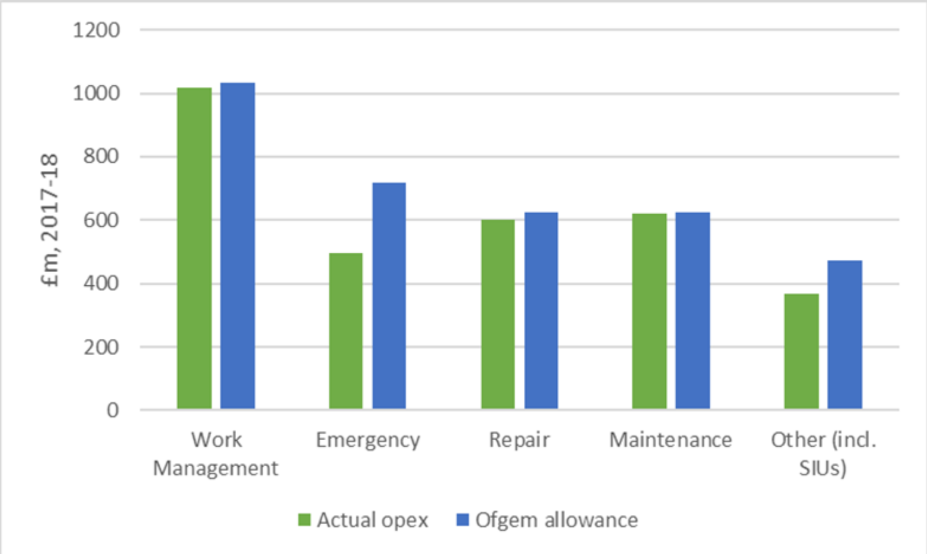
4.9. The repair activity is the process set up to repair gas escapes from gas distribution assets. Repair costs are the costs of the team attending sites, locating, excavating and repairing a leaking main and reinstating all excavations.

4.10. The maintenance activity is the preventative and corrective actions of the GDNs on their assets required to ensure ongoing reliable operation of their assets. These activities are split into three main activities: routine, non-routine and exceptional items maintenance.

4.11. Other direct activities cover a number of activities and include tools and equipment, interruption payments and Statutory Independent Undertakings.[43] These costs were excluded from our bottom-up regression analysis in RIIO-GD1 and we accepted the GDNs' forecasts (except for the RPEs) as the costs were in line with historical amounts and were not material.

4.12. Figure 4.3 shows actual GDN direct opex by activity against our baselines for the period 2013-14 to 2017-18. In the first five years of RIIO-GD1, the GDNs have underspent on the emergency activity by 31%. GDNs have spent less on this activity due to milder winters (and subsequently fewer reported gas escapes) than previous years, as well as other practices to minimise gas leakages.

Figure 4.3: RIIO-GD1 actual v allowed direct opex by activity, 2013-14 to 2017-18



[42] The emergency service is the process set up to discharge the Network obligations, under the Gas Safety (Management) Regulations (GS(M)R) 1996, to respond to Public Reports of Gas Escapes (PREs).
[43] Scotland has five Statutory Independent Undertakings for gas supplies that are operating gas networks not connected by pipeline to the rest of the network.

4.13. The cost drivers we used in the regressions for direct opex activities in RIIO-GD1 included both scale and workload variables, as outlined in Table 4.1.

Table 4.1: RIIO-GD1 direct opex activity cost drivers

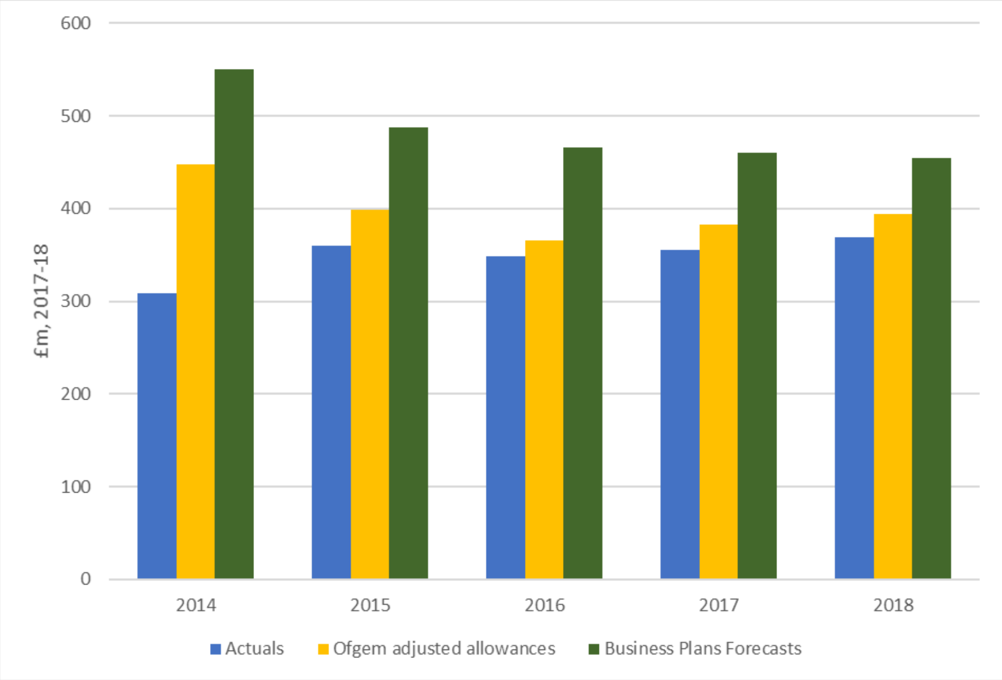
Activity	Cost driver
Work management	MEAV
Emergency	CSV: 80% on customer numbers and 20% on number of external condition reports
Repair	Number of external condition reports
Maintenance	Maintenance MEAV

Capex

4.14. Our capex assessment in gas distribution covers five cost areas: Local Transmission System (LTS) and storage, network reinforcement, new connections, governors and other. The principal drivers of capex are the safety, reliability and integrity of the network, and the addition of capacity due to network load growth.

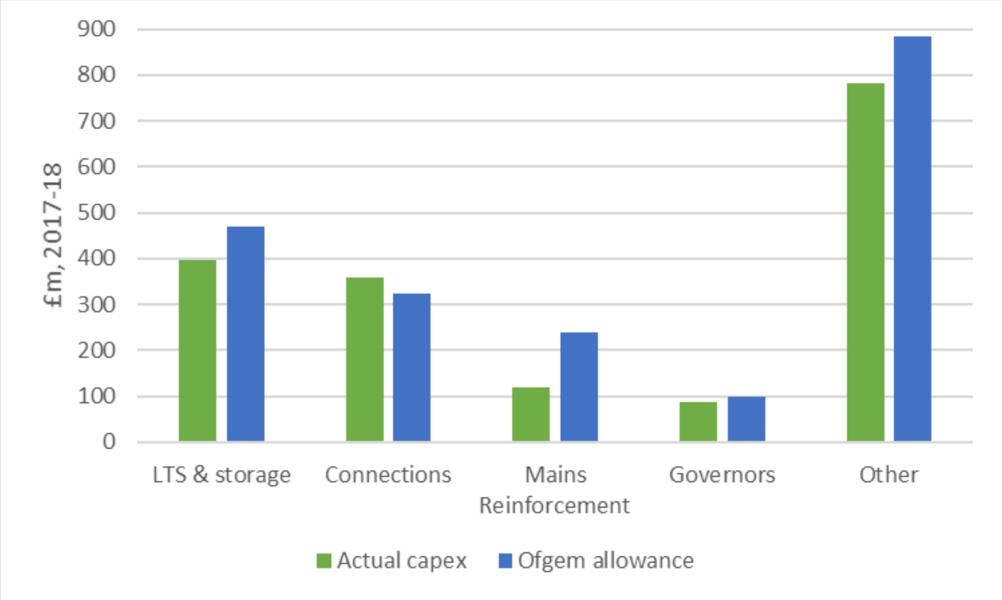
4.15. Figure 4.4 shows the industry's actual and BP forecast net capex performance against the baselines for the first five years of RIIO-GD1. In this period, GDNs have underspent on inferred capex allowances by £247 million (12%), driven largely by a 31% underspend in 2013-14.

Figure 4.4: RIIO-GD1 actual v allowed net capex, 2013-14 to 2017-18



4.16. Figure 4.5 shows the actual GDN expenditure by capex activity against our baselines for the period 2013-14 to 2017-18. In the first five years of RIIO-GD1, GDNs have overspent on new connections and underspent on all other capex activities. Notably, GDNs have underspent on reinforcement by 50%.

Figure 4.5: RIIO-GD1 actual v allowed net capex by activity, 2013-14 to 2017-18

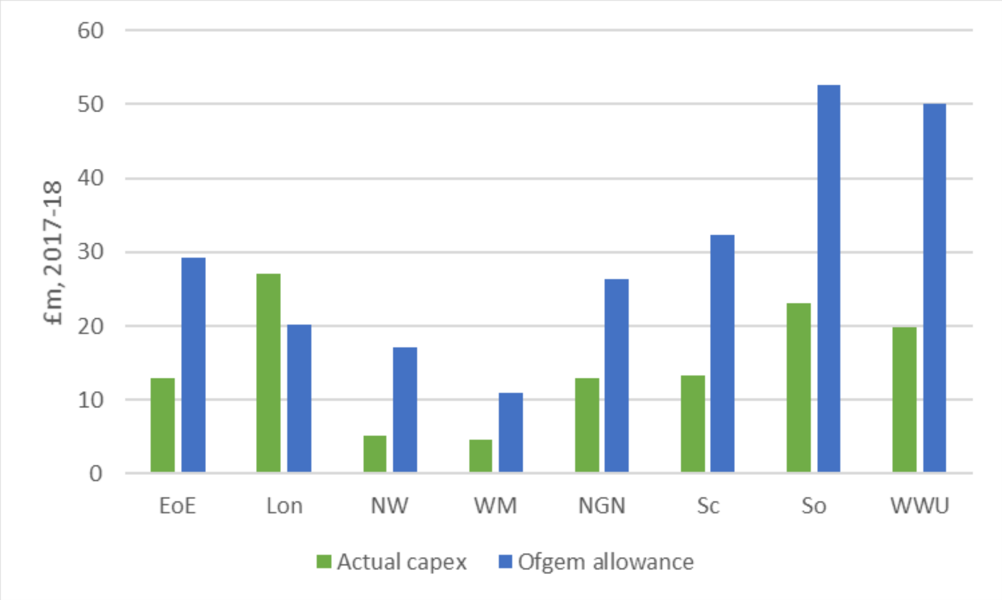


4.17. Historically, we have used regression analysis for the high-volume, low unit-cost activities of connections and mains reinforcement and have carried out technical and qualitative assessment for the other areas of costs. Below we focus on the regression analysis we use in our assessment of capex, and so do not discuss the LTS, governors and other capex activities.

4.18. The GDNs are required to design and manage their network to meet the 1 in 20 peak demand requirement, which is the level of demand that would be exceeded in 1 out of 20 winters. GDNs carry out localised reinforcement on the network, which typically involves new gas mains being laid to provide increased network flows and pressures in specific areas along with the replacement and upgrading of pressure regulating equipment to control network pressures.

4.19. Figure 4.6 shows actual GDN expenditure on mains reinforcement and governors against our baselines for the period 2013-14 to 2017-18. With the exception of the Cadent London network, all GDNs have significantly underspent against allowances for reinforcement.

Figure 4.6: RIIO-GD1 actual v allowed mains reinforcement expenditure by GDN, 2013-14 to 2017-18



4.20. In terms of reinforcing the networks, the GDNs normally have the option of physically laying new pipes to reinforce the network or increasing system pressures, where appropriate, by adjusting the governors controlling the inlet pressures to the networks. Mains reinforcement expenditure is highly sensitive to localised network growth and the GDNs have highlighted a number of areas where specific load growth has triggered investment despite an overall downturn in annual demand.

4.21. In RIIO-GD1, we determined the efficiency of the GDN-proposed capex using regression analysis of mains reinforcement costs with weighted average workloads as the cost driver. The weighted average workload was calculated by multiplying the work volume for each pipe diameter by an average industry unit cost for each pipe diameter.

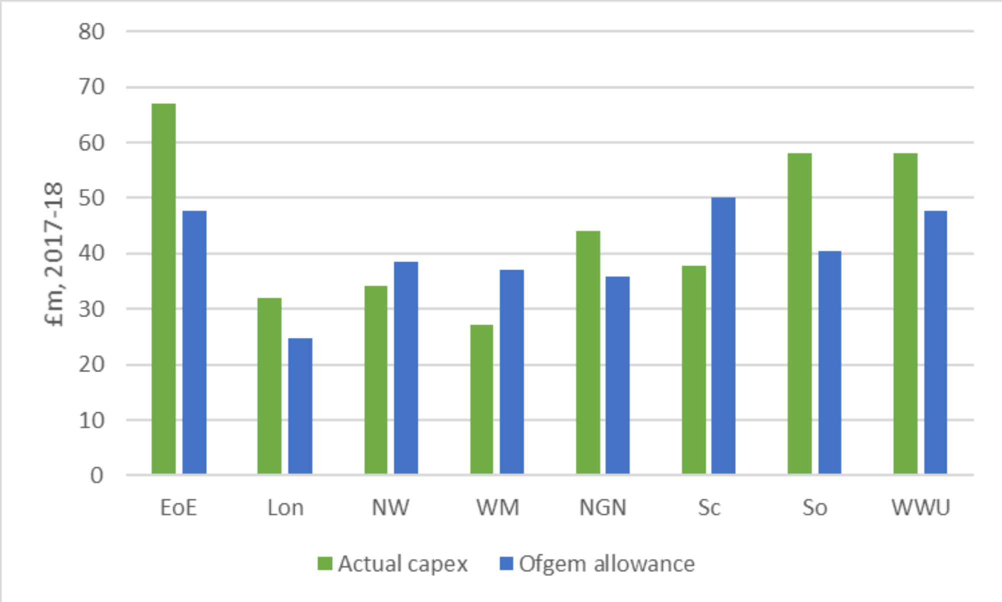
4.22. We encountered a number of issues that reduced the model's overall robustness, including sporadic mains reinforcement spend from one reporting period to the next and workload and expenditure for the same projects reported in different reporting periods. We mitigated these issues by using a regression model based on an average of workload and expenditure over a four-year period.

4.23. The connections activity involves the quotation, design and physical construction of mains and services to connect new housing, developed premises and non-domestic or industrial premises to the gas network.

4.24. Connections fall into three categories which are new housing, existing housing and non-domestic properties. The expenditure categories cover the total costs of connecting a premises, including all elements of the back-office costs associated with providing quotations to customers and the design and planning of connection works, whether the customer ultimately accepts a quotation and continues with the physical connection, or not.

4.25. Figure 4.7 shows actual GDN expenditure on connections against our baselines for the period 2013-14 to 2017-18. Five of the eight GDNs have overspent against allowances for connections.

Figure 4.7: RIIO-GD1 actual v allowed connections expenditure by GDN, 2013-14 to 2017-18



4.26. In RIIO-GD1, we used regression analysis to consider the relative efficiency of the GDNs in this area. Gross connections expenditure was assessed against a CSV including total connections costs and weighted average workloads, which included a combination of the length of mains installed and number of services connected (excluding fuel poor services).

4.27. We assessed efficiency of connections activity using gross rather than net expenditure. Using net costs would identify the efficiency of GDNs in recovering connections contributions, but would not reflect the efficiency in executing the operational activity. We also considered that possible regional differences in the connections work mix could affect a GDNs eligibility to make contribution charges, and gross expenditure would eliminate such issues.[44]

Repex

4.28. Repex is expenditure related to activities undertaken to replace pipes constructed of cast iron, ductile iron, steel and polyethylene. Compliance with health and safety legislation is the primary driver of repex.

4.29. In June 2011, the Health and Safety Executive (HSE) announced a change in the approach to managing risk on the iron mains distribution network. The HSE enforcement policy for the Iron Mains Risk Reduction Programme (IMRRP) targets 'at risk' iron gas mains (ie those pipes within 30 metres of buildings) and is designed to reduce the risk of injuries, fatalities and damage to buildings resulting from the failure of iron mains. The three-tier approach allows a greater focus on risk, with smaller diameter Tier 1 pipes being mandatory to abandon and larger diameter 'at risk' iron pipes only subject to decommissioning if either condition or risk assessment indicates that this is justified.

[44] We applied individual GDN figures for net capex as a percentage of gross capex to convert the result into net allowances. We also excluded streetworks and fuel connections from the regression analysis and added this back post-regression.

4.30. In RIIO-GD1, we split repex workloads into non-discretionary and discretionary categories. Non-discretionary repex included Tier 1, Tier 2A (above risk threshold[45]), Services and other non-standard mains. Discretionary repex included mains and associated services (Tier 2B (below risk threshold), Tier 3, iron mains >30 metres from a property, other mains), associated services and multi occupancy buildings (MOBs). Table 4.2 summarises the different iron mains categories.

Table 4.2: Overview of iron mains categories

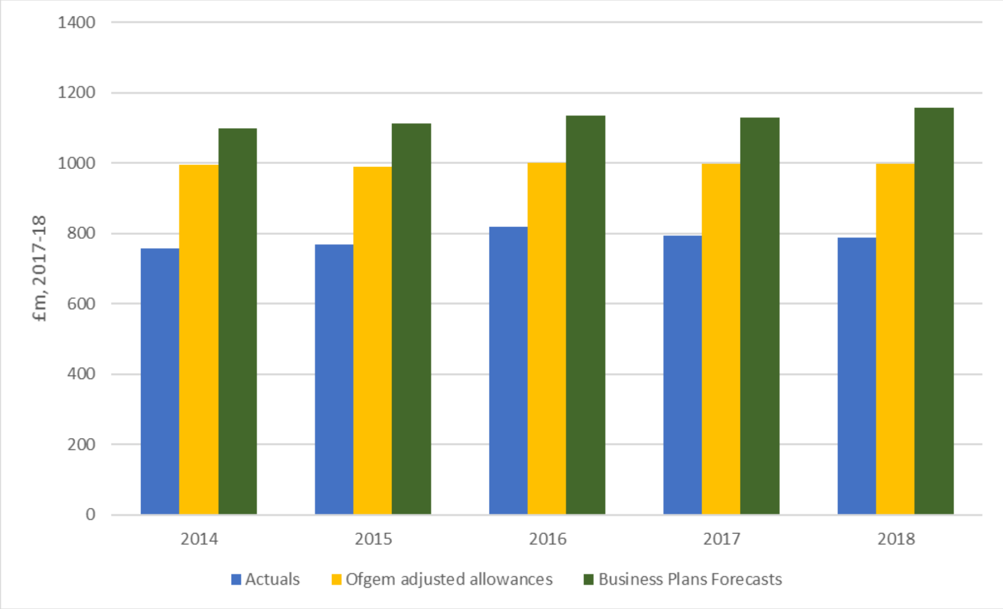
Tier	Description
Tier 1	Less than or equal to 8 inches in diameter and within 30 metres of a building. Must be decommissioned under a 30-year programme concluding in 2032.
Tier 2A	Greater than 8 inches to less than 18 inches in diameter, within 30 metres of a building which breach a threshold.[46] Must be decommissioned or remediated.
Tier 2B	Greater than 8 inches to less than 18 inches in diameter, within 30 metres of a building and which are below a risk threshold. Mains can remain operational, but decommissioning funded if supported by CBA.
Tier 3	Greater than 18 inches in diameter and within 30 metres of a building. Mains can remain operational, but decommissioning funded if supported by CBA.

4.31. Figure 4.8 shows the industry's actual and BP forecast net repex performance against the baselines for the RIIO-GD1 period.

[45] The risk on individual mains assets is assessed using the Mains Risk Prioritisation System (MRPS) methodology. Tier 2 pipes scoring above a GDN-specific threshold on the MRPS system are designated as Tier 2A and must be abandoned under the IMRRP. Tier 2 mains which scored below the threshold are designated as Tier 2B and are abandoned on a discretionary basis, justified through CBA.

[46] The risk action threshold is agreed between the HSE and each GDN individually. It is a risk score for an individual main, above which the GDNs are expected to take appropriate action to make the pipe safe, either through remediation or decommissioning and/or replacement. The score is measured by the MRPS methodology and estimates the probability of the mains pipe causing an explosion incident, per kilometre, per annum. The MRPS takes into account factors such as the fracture history of the pipe, the fracture history of other mains within the same area, the likelihood that gas will enter a building, the operating pressure of the pipe and the diameter of the main.

Figure 4.8: RIIO-GD1 actual v allowed net repex, 2013-14 to 2017-18

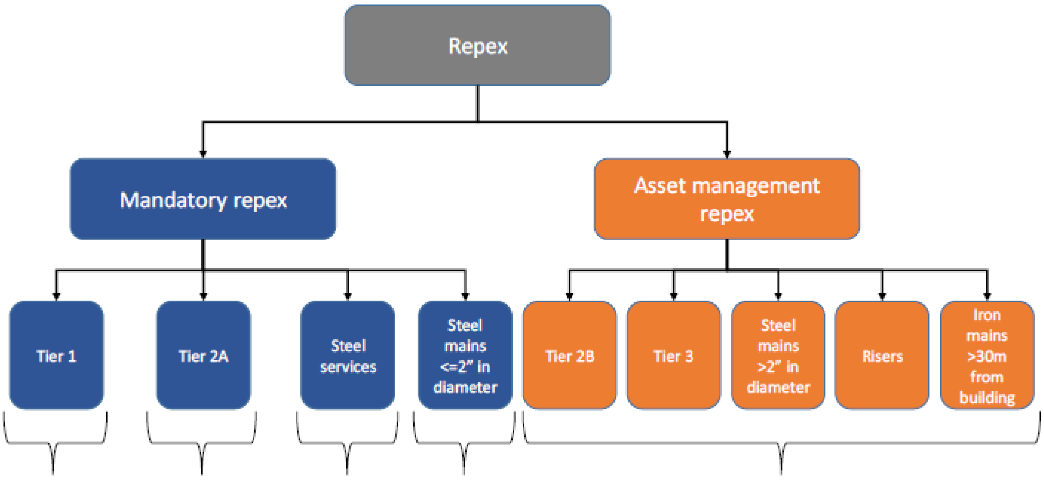


4.32. In the first five years of RIIO-GD1, GDNs have underspent on inferred repex allowances by over £1 billion (21%). The rate of underspend is consistent throughout the period, however GDNs are forecasting greater repex costs in the remaining years of RIIO-GD1 (but still less than the inferred allowances). This underspend has been driven by a combination of factors, including efficiency gains, differences between forecasts and outturn values for certain costs (eg RPEs) which have generally benefitted the GDNs and the design of some elements of the price control.

4.33. In our SSMD, we noted that we need to ensure consumers are protected from under-delivery, or delivery to a different specification[47] than funded.[48] Our aim is to design a structure that encourages the GDNs to deliver genuine innovations and effectively manage workload risk, but limits the scope for benefitting from simply re-profiling workloads. Figure 4.9 summarises the outputs package for repex in RIIO-GD2.

[47] In this context, specification refers to the mix of workloads being delivered, rather than detailed aspects of specific projects.
[48] For more details, see SSMD available here.

Figure 4.9: Summary of repex outputs



Outputs	PCD	No output target, volume driver	*To be decided*	*No output (ring-fenced from NARM)*	NARM

4.34. In our SSMD, we decided to introduce a price control deliverable (PCD) for Tier 1 iron mains abandoned. Under the PCD we will set a target for each GDN for the total kilometres of Tier 1 iron mains abandoned over RIIO-GD2, and cost allowances will be adjusted for any undelivered workloads relative to the target. We also confirmed our decision to implement the following uncertainty mechanisms for RIIO-GD2 related to repex:[49]

- Tier 2A iron mains volume driver: for RIIO-GD2, we will ensure GDNs' allowances are better aligned with the workloads delivered. We have decided to retain the current volume driver that is in place for RIIO-GD1 to support this

- HSE policy changes re-opener: in the event that the HSE makes changes to its policy during RIIO-GD2, there could be changes to output targets and substantive cost implications. Given the importance of the repex programme to overall costs in RIIO-GD2, we have decided to introduce a re-opener.

4.35. In RIIO-GD1, we used regression analysis to consider the relative efficiency of the GDNs in this area. Repex was assessed against a workload driver defined as a weighted average of the workloads for each asset type, with weights applied to average industry unit costs (so called 'synthetic unit costs') derived from expert review.

[49] For more details, see SSMD – Gas Distribution Annex available here.

Key issues for our disaggregated econometric analysis

Cost aggregation options

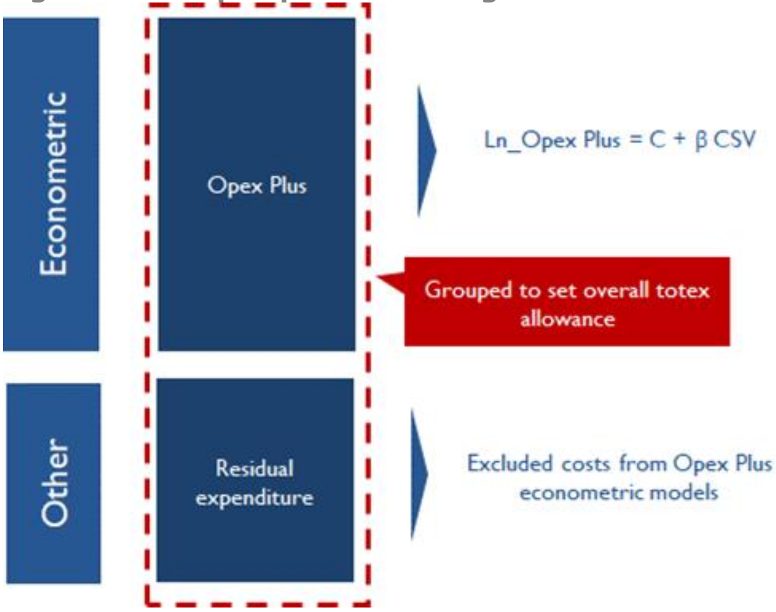
4.36. In RIIO-GD1, we took a bottom-up approach to assessing seven cost categories[50] using regression analysis. We have discussed with stakeholders the possibility of aggregating some categories to address reporting inconsistencies and trade-offs between costs.[51]

4.37. In response to our SSMC, Cadent was generally doubtful over the value of combining disaggregated activities, because the advantage of the disaggregated approach is its granularity which provides a clear view of cost drivers and regional factors. Cadent noted that clarity could be lost if activities are combined.[52]

4.38. CEPA suggested a number of options for aggregating some of the costs that were disaggregated in our RIIO-GD1 bottom-up models, including 'opex plus modelling'. Under this approach, costs would only be benchmarked at an aggregative level to the extent that the pooled costs are considered to be complementary, have trade-offs and can be robustly explained by a consistent set of cost drivers/explanatory variables (eg scale variables). Residual expenditure would be evaluated using activity level assessments.

4.39. CEPA considered that this approach is arguably the most consistent with the CMA recommendations from the Bristol Water PR14 appeal. This approach puts greater emphasis on justifying why expenditure should be included in an aggregative model, as opposed to previous approaches where our emphasis has been on why expenditure should be excluded from totex regressions. This option will produce less aggregative modelling.

Figure 4.10: Opex plus modelling



[50] Work management, emergency, repair, maintenance, mains reinforcement, connections and repex.
[51] See SSMC – Gas Distribution Annex available here.
[52] See Cadent response to SSMC available here.

4.40. While this approach may lead to greater weight on bottom-up/engineering analysis to set the final totex allowances than was the case in RIIO-GD1, the potential benefits are:[53]

- aggregative regression models that are developed with a clearer statistical, economic and engineering logic and fit
- less concern that the variations in capex and repex expenditure patterns, particularly repex, lead to potentially less reliable benchmarking results.

4.41. On this latter point, capex and repex may indeed be 'lumpy' over time and so may not be consistent over a price control period. This can cause issues when using regression techniques, since atypical expenditures, or companies being at different stages in their investment cycles, may distort modelling results. In RIIO-GD1, our solution to this problem was to smooth capex using a seven-year moving average. This issue may be somewhat mitigated by the availability of a longer time series. If this longer time series is used, it will likely better capture different investment cycles. Although smoothing is a common approach, it raises the question of whether these activities should be included within the econometric model, given that they are treated differently from opex.

Question 9: Are there trade-offs between opex and capex activities that support the rationale for considering 'opex plus' modelling?

Workload cost drivers in econometric modelling

4.42. As noted above, we have previously used workload cost drivers in our disaggregated econometric analysis. These drivers can control for the effects of different workloads by the GDNs that may be due to factors outside their control. For example, asset condition and corresponding repex and maintenance workloads is at least partly due to the inherited state of the distribution network. Workload drivers can accurately forecast costs where there may be specific year-on-year variations that are unexplained by changes in scale variables (such as MEAV or number of customers).

4.43. There are disadvantages to using workload drivers. Using explanatory variables that are within company control creates incentive problems. They incentivise the GDNs to put forward high workload forecasts in business plans, even if in practice these are not delivered. GDNs could also be rewarded for running relatively poorer condition networks provided they can still meet their price control deliverables.

4.44. However, benchmarking models that exclude workload variables may suffer from omitted variable bias (as discussed in Chapter 2). Models that place greater weight on scale variables (as opposed to workload) may require greater use of a special cost factor process, in which GDNs may argue that some of their costs are not explained by our models.

4.45. For example, in RIIO-GD1, all mains and services repex was assessed using regression modelling. We took synthetic unit costs (£/m for mains, £/service for services) for different categories of mains and services, multiplied the synthetic unit costs by the GDN-submitted

[53] Annex 1.

workload (km of mains, number of services) and derived a synthetic cost of workload. We regressed this workload explanatory variable against actual repex.

4.46. This approach to repex assessment may be described as a weighted unit cost assessment. While this approach is likely to, in part, reveal underlying differences in inefficiency between the GDNs, the costs of delivering a safe and reliable network will also depend on the mix of work undertaken which could be done more or less efficiently depending on how each of the GDNs chooses to structure its maintenance and asset replacement programmes.[54]

4.47. In RIIO-GD1, we also made adjustments to GDNs' forecast workloads. For example, we revised GDNs' forecasts of the number of external condition reports, which was the cost driver for the repair activity model, where we considered that they overstated the expected increase. We made such adjustments to ensure that we did not overstate GDNs' efficient costs because of an overstatement of the expected deterioration of the networks. In considering GDNs' workload forecasts, we undertook a comparison of GDNs' forecast workloads and relied on a technical/engineering assessment.

4.48. More generally, there are a number of practical issues to consider with the use of workload drivers as explanatory variables within the context of the GB gas distribution sector:[55]

- The model coefficients in the disaggregated models are relatively easy to interpret from a technical/economic logic point of view, as they indicate a benchmark of unit costs for different work activities within the industry (although arguably the approach is less transparent for the repex programme where a synthetic workload driver is used). However, this is not the case for the more aggregated totex models when combined in a CSV.[56]

- Interactions with other areas of the price control – it may not be appropriate to reflect some aspects of activity within the cost allowance modelling if they have already been accounted for elsewhere in the price control.

- Looking at the specific repex example, in previous price reviews GDNs may have had less control over the workloads in their repex programmes, however the change in HSE policy[57] at the start of RIIO-GD1 has meant that the GDNs may have had more freedom to select which mains to replace. Arguably this may extenuate the endogeneity/incentive problems from using workload drivers than was the case when the approach was originally applied in GB gas distribution sector benchmarking.

4.49. Our ability to confidently assess costs for repex was an important factor in determining the repex outputs outlined in Figure 4.9. Larger diameter mains replacement is smaller in volume but higher in cost (and these costs are more variable due to the more bespoke nature

[54] Annex 1.
[55] Annex 1.
[56] Annex 1.
[57] Under the 20:80 rule which was introduced at the beginning of RIIO-GD1, the first 20% of the pipes GDNs are required to abandon must come from the highest risk 20% of mains within the qualifying population. The remaining 80% of pipes can then be selected from the remaining mains population, regardless of risk profile. This is designed to ensure that the highest risk pipes are abandoned, while allowing the GDNs flexibility to design cost efficient projects.

of each project), and so there could be objective reasons to remove these activities from our regression analysis and assess them separately.

Question 10: Which cost areas should be assessed using workload drivers as opposed to other cost drivers? Why?

Question 11: Should repex (or some categories of repex) be excluded from our regression analysis and assessed using other techniques?

Issues with existing cost drivers

4.50. It is possible we will maintain the modelling framework that we adopted in RIIO-GD1. If this is the case, it is still important to re-evaluate the existing cost drivers against the principles we set out in Chapter 2.

4.51. For example, if a GDN has control over a cost driver this can result in perverse incentives. In general, such cost drivers should be avoided to the extent that there are better options. For example, in RIIO-GD1 we used MEAV as a cost driver for some of our regressions. MEAV reflects GDNs' investment decisions and is, therefore, partially under companies' control, particularly over the longer term. This element of control provides a potential incentive for GDNs to invest more in capital solutions than might otherwise have been the case. Other things being equal, this higher MEAV will both make them appear more efficient in the regression analysis and could result in higher cost allowances.[58]

4.52. However, we consider that GDNs are not able to materially impact on MEAV in the short run. For GDNs to influence MEAV they would need to spend a significant amount to influence regression results, relative to the fixed historical value of the network asset base.[59] We also note that gas distribution networks comprise very long-lived assets, and therefore asset condition is largely the result of investment decisions under previous ownership.

4.53. Activity level (or workload) drivers present similar endogeneity issues. For example, the level of repex activity that has historically been undertaken is a reflection of external policy as well as decisions by the GDNs of how they choose to maintain and replace their ageing network assets. Since some investment decisions (such as asset replacement) are not fully exogenous, they could present incentive problems, whereby GDNs are rewarded for previous underinvestment or inefficient decisions.

4.54. In a scenario where we maintain our RIIO-GD1 modelling framework, another important consideration would be to update cost drivers where it is appropriate to do so. These include MEAV and all workload drivers calculated by using the synthetic unit costs.

4.55. MEAV includes LTS, capacity and storage, mains, governors, NTS, pressure reduction stations, services and non-operational holders. Some stakeholders suggested including MOBs and embedded entry points, while another one proposed to place less emphasis on LTS when assessing maintenance costs.[60]

[58] See SSMC – Gas Distribution Annex available here.
[59] For more details, see Cadent response to SSMC available here.
[60] Some of these issues were discussed at previous CAWGs. Minutes and presentations are available here.

4.56. Moreover, the mains diameter band mix that was used to define MEAV is different from that which GDNs are currently reporting in the Regulatory Reporting Packs (RRPs). The updated MEAV will therefore need to reflect the existing diameter split, as well as updated new build unit costs.

4.57. The workload drivers based on synthetic unit costs relate to the repex, connections and mains reinforcement regressions. In RIIO-GD1, the synthetic unit costs consisted of average industry costs that experts computed for the previous price control. As a first step, it is important to understand whether these unit costs are still a good reflection of current costs. We have discussed this issue at the CAWGs with GDNs, and undertook collaborative work to develop a sensible approach to updating synthetic unit costs.[61]

Alternative cost drivers

4.58. Existing cost drivers have been discussed at length in the CAWGs, and stakeholders proposed some alternatives in response to our SSMC. For example, SGN suggested that the existing cost drivers do not properly explain repex, as efficiency scores are volatile over time. It suggested we consider alternative cost drivers, noting that length of mains laid does not recognise GDNs that optimise design and avoid greater workloads. SGN also suggested we account for abandonment ratios using a set industry standard, consider the impact of greater insertion rates and broader risk management options such as remediation.[62]

4.59. Other potential cost drivers for repex noted in the CAWGs include abandonment to lay ratios, proportion of mains in the footpath, carriageway or verge, the technique used to replace mains and the number of connections.[63]

4.60. Another proposal regarded the inclusion of quality in the regression analysis. We have previously noted that quality is within the GDNs' control, undermining its potential use as a cost driver. Further, incorporating quality in regression analysis does not necessarily inform the value that consumers place on the level of quality delivered. Another reason not to include quality in the analysis is that it may be challenging to do so in more disaggregated benchmarking models, where the link between quality of service and the costs of specific activities is more difficult to establish through a set of relevant explanatory variables.[64]

4.61. In our SSMD we summarised alternative cost drivers that were suggested by stakeholders.[65] CEPA also identified possible explanatory variables for cost benchmarking and noted the plausibility of each.[66]

Question 12: Are there other approaches to disaggregated benchmarking that we should consider?

[61] See CAWG 8 presentations available here.
[62] For more details, see SGN presentation at CAWG 9 available here.
[63] See CAWG 9 minutes available here.
[64] Annex 1.
[65] See SSMD – Gas Distribution Annex available here.
[66] Annex 1.

Summary

4.62. We recognise that disaggregated models can more accurately capture relevant cost drivers than aggregated models and therefore can more accurately predict future costs. However, we note potential issues with these models, including the challenges presented if cost drivers are not fully exogenous, such as workload variables. Disaggregated models can be used in combination with more aggregated models to inform our view of efficiency.

4.63. We intend to develop a set of potential disaggregated (or relatively disaggregated) models that could be applied (including 'opex plus' models and updates to existing bottom-up models) and discuss these in the CAWGs up until the submission of final Business Plans in December. We expect that our final approach will depend on how well these models perform against the proposed model selection criteria outlined in Chapter 2.

5. Non-econometric analysis

Chapter summary
This chapter summarises the bottom-up, non-econometric, assessment techniques we will use for RIIO-2. It also discusses and seeks views on potential approaches to assessing business support costs across the transmission and gas distribution sectors.

Questions

Question 13: Should we assess business support costs at a group level in order to address cost allocations across companies within groups?

Question 14: Which types of business support costs should be benchmarked, and how should they be benchmarked?

Question 15: Which types of business support costs should be excluded from benchmarking?

Overview

5.1. Not all network costs can be estimated using econometric analysis. Large 'lumpy' expenditure, often involving bespoke projects and non-repeated workloads, are examples which more often occur on transmission networks. In such cases the task of estimating totex allowances is a more tailored process than that for distribution networks. Transmission networks (particularly electricity) also tend to have a higher proportion of capex relative to distribution networks. In this chapter we provide further detail on the cost assessment techniques we will use to assess transmission network expenditure and certain types of distribution network expenditure.

5.2. There are also elements of opex that we have typically assessed using non-econometric techniques. Business support costs, a subset of indirect opex, is one example. As in RIIO-1, we intend to assess business support costs using a consistent approach across gas distribution and gas and electricity transmission sectors in RIIO-2. In this chapter we look at the approaches we used to assess business support costs in RIIO-1 and potential approaches for RIIO-2.

Cost assessment techniques

5.3. In the preceding chapters we have discussed econometric analysis techniques, which are our primary cost assessment tools in assessing distribution network expenditure. In the transmission sectors, we rely on other cost assessment techniques, which are equally applicable to some types of distribution network expenditure. For RIIO-T1, our cost assessment techniques included disaggregated benchmarking, historical trend analysis, unit quantity and unit cost analysis, expert review and project by project review.

5.4. In our SSMC we noted (for both gas and electricity) that due to the bespoke nature of many transmission projects, a bottom-up assessment approach supported by engineering judgement would be key for many capex assessments.[67]

5.5. In our SSMD, we confirmed our intention to use RIIO-GT1 as a starting point to develop our RIIO-GT2 cost assessment, as it has proved to be successful in driving NGGT's performance.[68] For ET, we confirmed that we will adopt a range of techniques, underpinned by use of historical cost data, in determining our view of efficient costs.[69]

5.6. Further to the information provided in our SSMD, our business plan assessment process for transmission capex is broadly characterised as follows:

- business plans will be assessed for completeness and additional information will be sought if required
- once all information and documentation is received, our three primary workstreams will be (i) needs case assessment, (ii) Network Asset Risk Metric (NARM) and (iii) cost assessment.

5.7. Needs case assessment will focus on considering the rationale for the proposed scheme/project (both technical and financial cost-benefit), the options considered for meeting the functional requirements of the project and the timing of the work. The information will draw on the supplied engineering justification and cost benefit analysis (CBA) documentation.

5.8. The NARM assessment will review how transmission companies have planned for offsetting the natural degradation of their network assets over time, both in the short term (over RIIO-T2) and the longer term (commensurate with the lifespan of the planned interventions). The company submission should inform both the reduction of network monetised risk through the planned interventions and also address the optimal timing for the interventions. We will combine this with the needs case assessment to inform our view on the appropriateness of the work programme in respect of content, timing and robustness of outputs.

5.9. Cost assessment will review the appropriateness of the costs for the work that passes both of the above stages. The primary tools for assessing costs will be:

- comparison with relevant historical costs[70] for similar work: for instance, taking into account any cost information from historical projects of a similar scale and scope, to understand what is achievable and what can be improved
- comparison of costs for individual project elements on a unit cost basis: disaggregating project costs into their individual elements to facilitate cost comparisons between projects on a cost per unit basis, as appropriate
- evidence from market testing of costs: we will expect that for projects deemed to be at an advanced stage of development, submitted costs will have undergone some market scrutiny through an EU-compliant competitive tendering process

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[67] See SSMC – Core Document available here.
[68] See SSMC – Gas Transmission Annex (paragraph 5.14) available here.
[69] See SSMC – Electricity Transmission Annex (paragraph 5.11) available here.
[70] These could be from work previously conducted by the company, from GB peer companies or international comparators as appropriate.

- maturity and firmness of cost estimates: we expect that as a project progresses through its development stages, the cost envelope range should become smaller and be backed by greater market evidence. Projects that are at early stages of maturity or are not backed by a commercial procurement process are more likely to be dealt with through uncertainty mechanisms, rather than forming part of the baseline allowances
- benchmarking of costs where appropriate: certain elements of costs will be benchmarked against comparators, where similar types and levels of activity are evident. These comparators may well come from outside the transmission sector, and might even come from outside the energy sector if deemed appropriate and relevant
- expert review: some elements/activities within companies' business plans may require experts to assist our analysis and inform our position.

5.10. As mentioned above, we may equally apply these tools in our assessment of certain elements of gas distribution expenditure, or use these tools to supplement our econometric analysis.

5.11. As part of the overall business plan assessment process, we will form a view on the certainty of submitted project timings. We are likely to include those where we have significant confidence in the timing of delivery as part of the baseline funding (subject to those projects meeting the other relevant criteria outlined above). However, they may be assigned as Price Control Deliverables with ring-fenced deliverables and funding. For those where we believe there is a justifiable needs case, but either the timing is less certain or there is uncertainty about the preferred solution, we may either defer consideration of the costs until the uncertainties are resolved, or assess the costs but make the triggering of allowances subject to an uncertainty mechanism.

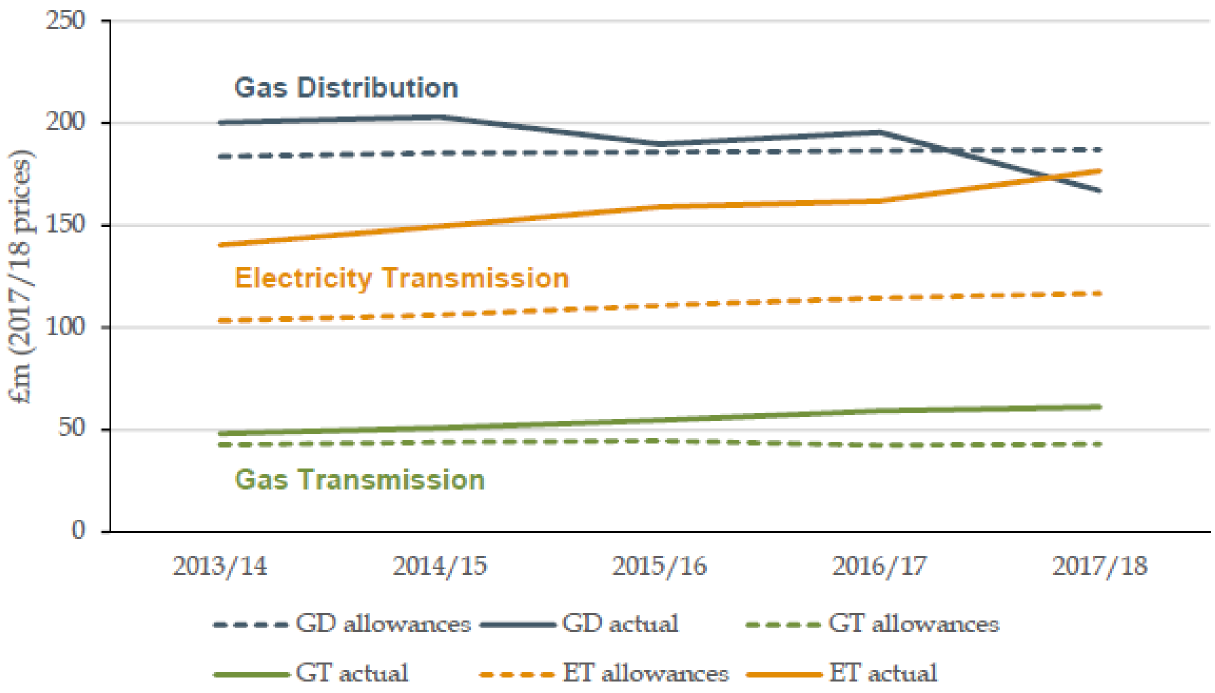
Business support costs

5.12. Business support costs cover the following activities: non-operational IT and telecoms; property management; finance, audit and regulation; HR and non-operational training; insurance; procurement; stores and logistics (gas distribution only); and CEO and group management.

5.13. In the five years of RIIO-1 to date, business support costs have accounted for an average of 8.4% of totex across GD, GT and ET. The proportion of business support costs in totex varies across the sectors: in ET it is 7.5%; in GD it is 8.3%; and in GT it is 14.9%.

5.14. Figure 5.1 shows the trend in actual business support costs and allowances by sector in RIIO-1. Across the first five years of RIIO-1, cumulative business support costs have exceeded allowances in all sectors. Trends vary across sectors; in GD there has been a general downward trend, however both ET and GT have seen upward trends.

Figure 5.1: Business support costs – actuals vs allowances, 2013-14 to 2017-18



RIIO-GD1/T1 approach

5.15. In our RIIO-GD1/T1 Initial Proposals we used a disaggregated benchmarking approach and expert review to assess the business support activities listed above, with the exception of insurance, which was assessed separately due to differences in risk appetites and appropriate coverage levels between companies and sectors. The benchmarks were derived multiplying an 'activity cost driver' with the appropriate 'benchmark comparator'. We benchmarked at a group level and selected the lower of the networks' upper quartile benchmark and an external upper quartile benchmark (derived from a database developed by Hackett Group). The activity cost drivers were:

- revenue (£m) – finance, audit and regulation, property management and CEO and group management
- end-users (number) – IT and telecoms
- employees (number) – HR and telecoms
- total spend (£m) – procurement.

5.16. Respondents to the Initial Proposals argued that the external benchmark was not transparent and the disaggregated approach gave rise to 'cherry picking'. In response to these concerns, we switched to an aggregated (top-down) benchmarking approach in our RIIO-GD1/T1 Final Proposals, with the intention of focusing on total business support costs rather than individual activity costs.

5.17. Under this aggregated benchmarking approach, we derived a 'composite cost driver' based on an average weighted by the activity cost of each of the previous bottom-up activity drivers. For benchmarking, the upper quartile for each activity in the Hackett comparator group was used (except CEO and group management where the Ofgem/Hackett composite was used) to represent the aggregate business support costs of an efficient proxy company.

RIIO-ED1 approach

5.18. In our RIIO-ED1 fast-track assessments, we benchmarked group-level, aggregated business support costs against the median, using a composite driver. We then allocated benchmarked costs to individual DNOs within a group in proportion to their submitted forecasts.

5.19. For the composite driver, we identified an appropriate activity size metric for each business support activity and weighted each by the contribution of the activity to overall costs, as shown in Table 5.1. We applied alternative size metrics as a sensitivity check and found these to be immaterially different.

Table 5.1: RIIO-ED1 business support drivers (fast-track)

Business support activity	Size metric	Alternative size metric
Finance	Revenue	MEAV
Procurement	Total spend	MEAV
Insurance	Excluded from benchmarking	
HR & non-operational training	Employees	n/a
IT & telecoms	IT end-users	n/a
Property management	Revenue	Network length
CEO & group management	Revenue	MEAV

5.20. We derived business support cost efficiency using a Monte Carlo simulation.[71] This involved applying the benchmarking methodology described above a number of times with varying input parameters in order to produce a range of results for each DNO group. Our final view of efficiency that we used in our totex models was the average of all results in the range and was based on one thousand simulations with varying composite size.

5.21. In our RIIO-ED1 slow-track assessments, we conducted ratio benchmarking on the aggregate of four business support cost categories (finance and regulation including insurance, HR and non-operational training, property management and CEO and group management) at the ownership group level. IT & telecoms business support costs were subject to a separate assessment combining ratio analysis and expert review (weighted 50% each). We used MEAV as the cost driver for the ratio analysis. Other drivers were rejected either due to their lack of economic rationale, their endogenous nature, or differences between fast-track and slow-track DNO submissions which lowered our confidence in the submitted data. The DNOs generally strongly supported this approach.[72]

Potential assessment approaches for RIIO-2

5.22. As with RIIO-1, RIIO-GD2/T2 will run simultaneously and we consider that, as far as practicable, the same approach should be applied to the assessment of business support

[71] A Monte Carlo simulation builds models of possible results by substituting a range of values – a probability distribution – for any factor that has inherent uncertainty. It then calculates results over and over, each time using a different set of random values from the probability functions.
[72] See RIIO-ED1 Final Determinations for the slow-track electricity distribution companies available here.

costs across each sector. It may also be possible to compare costs with DNOs in some cases. We will also look to identify appropriate external comparators.

5.23. Some costs within the areas of business support are small in relation to other areas. We will therefore ensure that the assessment is proportionate to the magnitude of costs involved and the potential for savings. The overall assessment of business support costs should also be proportionate to the assessment of capex and direct opex.

5.24. As with other types of costs we assess, business support costs may need to be adjusted or normalised before we undertake our assessment, to ensure we can compare companies over time. ECA noted a number of cost normalisation issues[73], including:

- opex-capex trade-offs: Although business support costs are indirect opex, there can be trade-offs between opex and capex, and only looking at business support costs in isolation runs the risk of such trade-offs not being accounted for. It was for this reason we included non-operational capex for IT & telecoms and property management in our RIIO-ED1 assessment of business support costs

- group companies: Where a network is part of a larger group of companies, much of its business support costs may be incurred at the group level and allocated to it. Therefore, business support costs may differ at the network level as a result of different allocation methods. To enable a consistent comparison, we assessed business support costs in RIIO-1 at the group level.

Question 13: Should we assess business support costs at a group level in order to address cost allocations across companies within groups?

5.25. There are a number of ways we could assess business support costs in RIIO-T2/GD2, which, as evidenced by our approaches at RIIO-1, are not mutually exclusive. Broadly, these approaches may include:

- trend analysis
- benchmarking
- expert review.

5.26. Trend analysis is a relatively unsophisticated tool, but can be undertaken at aggregated and disaggregated levels of business support costs in order to determine where further analysis may be required. In particular, trend analysis can help identify step changes in costs, which may mean we rely less on historical benchmarks. It can also inform our level of confidence in certain costs. For example, if trends are unstable year-on-year, we would be less confident in simply using historical costs as our benchmark.

5.27. Benchmarking approaches relevant to the assessment of business support costs include ratio benchmarking and econometric benchmarking. Regardless of the benchmarking approach, the selection of cost drivers is critical to the analysis.[74] The use of external

[73] Annex 2 - ECA, *RIIO-2 Cost Assessment: Business Support Costs*, June 2019.
[74] Principles to be considered in the development of cost drivers are discussed in Chapter 2.

benchmarks will limit the use of drivers that are specific to network sectors, such as network length and MEAV.

5.28. As with our econometric analysis, another key decision when benchmarking business support costs is the level of cost aggregation at which we benchmark. Disaggregated benchmarking (at each cost category) would likely result in cost allowances set at an 'above benchmark' level that may not be achievable by any GDN, and therefore aggregated benchmarking may be preferable. However, an aggregated approach is only beneficial if differences in business support costs are due to different cost allocations between business support categories.[75]

5.29. A clear understanding of cost trade-offs is required if any cost adjustments are to be applied to facilitate benchmarking. This understanding could be developed through a disaggregated assessment, even if a disaggregated approach is not used to benchmark business support costs.[76]

5.30. In determining a benchmark, we could potentially use comparators from:

- outside the network sectors (ie external benchmark)
- across different network sectors
- within a network sector.

Question 14: Which types of business support costs should be benchmarked, and how should they be benchmarked?

5.31. Expert review is typically used to assess specific activities. As noted above, our RIIO-ED1 cost assessment relied on expert review (a 50% weighting) to assess IT & telecoms costs. An expert review is most likely to be beneficial for the more material cost categories where it is challenging to reasonably benchmark activities, either due to the difficulty of comparing costs across networks or other comparator groups or if there is reason to believe that the cost environment for these activities may significantly change in the future.[77]

Question 15: Which types of business support costs should be excluded from benchmarking?

Summary

5.32. As noted in this chapter, we are not consulting further on the cost assessment techniques we will use to assess transmission network expenditure. Our three primary workstreams will be (i) needs case assessment, (ii) Network Asset Risk Metric (NARM) and (iii) cost assessment, maintaining our toolkit approach.

[75] Annex 2.
[76] Annex 2.
[77] Annex 2.

5.33. There are a number of issues for us to consider as part of our assessment of business support costs, including data consistency, cost adjustments, benchmarking techniques and how we define efficiency.

5.34. Our final approach to the assessment of business support costs in RIIO-GD2/T2 will depend on the companies' forecasts, since these forecasts will inform us on the best assessment tool (or combination of tools).

6. Regional factors and company-specific effects

Chapter summary
This chapter presents and seeks views on options for the treatment of regional factors and company-specific effects as part of our assessment of GDNs' proposed costs.

Questions

Question 16: How should we estimate and model the impact of regional factors?

Question 17: Do you agree with the proposed criteria for justifying regional cost factors that we have outlined?

Overview

6.1. As discussed in Chapter 2, our econometric benchmarking compares the GDNs against each other and helps determine the efficient level of expenditure required to achieve a given output. Where there are differences between GDNs, due to regional factors and/or company-specific effects, we must carefully consider the impact these have on our assessment of efficiency.

6.2. In RIIO-GD1, we applied ex ante adjustments to GDNs' costs in order to benchmark them on a comparable basis. We applied adjustments for regional labour cost differences (direct and contract labour), for sparsity and urbanity (labour productivity and reinstatement) effects and for salt cavity costs.[78] A comprehensive summary of historical approaches to regional factors, by Ofgem and other regulators, is provided in Annex 6.[79]

6.3. For several of the regional and company-specific factors, we made upward cost adjustments for some GDNs and downward adjustments for others. These opposing adjustments, when applied, did not necessarily fully offset each other. For some factors, we made adjustments in one direction only, as shown in Table 6.1.[80]

[78] We also made adjustments to costs to ensure consistency of data reported by GDNs and to remove costs we considered unsuitable for our benchmarking.
[79] Annex 6 – Office of Research & Economics - Research Hub, *Review of Regional and Special Cost Factors*, June 2019.
[80] Adjustments were made prior to cost benchmarking. Negative adjustments were added back to cost allowances after benchmarking, and vice versa.

Table 6.1: Annual average RIIO-GD1 regional labour and company-specific factors adjustments, £m 2009-10

Adjustment factor	EoE	Lon	NW	WM	NGN	Sc	So	WWU	Industry
Labour	4.31	-25.1	4.42	3.47	4.89	3.61	-17.5	4.89	-17.0
Sparsity	-0.8	0.72	0.50	0.07	-0.5	-1.3	0.44	-2.6	-3.5
Urbanity	-0.5	-14.0	0.13	0.09	0.19	0.10	-5.5	0.09	-19.4
Salt cavity			-0.6						-0.6
Total	3.01	-38.4	4.47	3.63	4.58	2.38	-22.5	2.34	-40.5

6.4. In our SSMC, we noted that we propose to retain the use of opposing adjustments for individual factors, where appropriate. We also noted there may be merit in making adjustments for individual factors symmetrical, whilst recognising this may not be appropriate for every case.[81] We noted that the onus will be on GDNs to justify their case for any proposed adjustments, providing robust and transparent evidence, and we expect to set a high evidential bar for accepting any cost adjustment claims.

6.5. In response, Cadent commented that Ofgem's adjustments for regional factors, whether opposing (positive or negative across all networks) or single direction, do not add to costs paid by customers because the adjustment is made before regression. Cadent referred to Ofwat's 'symmetrical' approach, whereby the adjustments are made after regression. It noted that in such circumstances, if Ofwat did not reduce the rest of the industry's allowance for the amount one company received as a regional factor, customers would be paying more than the efficient industry cost.

6.6. Cadent agreed that there should be a high evidential bar for accepting any cost adjustment claims, but noted that a number of smaller claims together could become material, especially in respect of working in London, and that in these circumstances it would not be reasonable to apply a materiality threshold to each item individually.[82]

6.7. NGN noted that the case for regional and company-specific factors needs to be considered in detail following the submission of Business Plans to effectively deal with any issues presented.[83]

6.8. SGN noted that imposing symmetrical adjustments might lead to arbitrary increases/decreases in cost allowances across the sector and could undermine the cost assessment models. SGN suggested that adjustments be set for specific companies reflecting the evidence of issues that are unique to a particular GDN or area, and which are material enough to merit benchmarking normalisation.[84]

6.9. WWU noted that symmetrical adjustments are appropriate when the base cost and regional factors are understood and company specific, and using the average of GDNs will not reflect the balance and U-shape curve of these factors (positive and negative).[85]

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[81] See SSMC – Gas Distribution Annex available here.
[82] See Cadent response to SSMC available here.
[83] See NGN response to SSMC available here.
[84] See SGN response to SSMC available here.
[85] See WWU response to SSMC available here.

Question 16: How should we estimate and model the impact of regional factors?

Key issues

6.10. The cost adjustments we made in RIIO-GD1 were generally one-sided, with large upward adjustments[86] to the London and Southern networks significantly outweighing downward adjustments to the other networks. If the process is one-sided, customers may not be adequately protected in cases where the models overestimate the GDNs' expenditure requirements.

6.11. Before a regional/company-specific factor adjustment approach is chosen it is necessary to determine what costs should be appropriately adjusted. Companies should be able to sufficiently justify that:

- the regional or company-specific factor in question is clearly defined
- this factor, and the subsequent costs it drives, are beyond the control of an efficient company (having taken all the feasible measures to mitigate the costs)
- the company (or a small number of companies) are impacted by a significant amount, and in a materially different way to others.[87]

6.12. There are three main approaches to take account of regional factors within the cost assessment framework:

- **pre-modelling adjustment:** the data is adjusted ahead of our modelling, as we have done previously in RIIO-1
- **within-model adjustment:** the regional factor is controlled for through the explanatory variables included in our models
- **post-modelling adjustment:** our models are based on unadjusted data; however special cost factor adjustments would be applied prior to us determining an expenditure allowance.

6.13. Although post-modelling adjustments could be used for well-defined costs, they would not be appropriate for general models applicable to all GDNs. Such adjustments can lead to an increasingly complex regime, and could lead to companies considering it a 'one-way bet'.[88] For these reasons we do not consider post-modelling adjustments to be appropriate for use in RIIO-GD2.

6.14. In the rest of this chapter we discuss the rationale for making either pre-modelling adjustments or within-model adjustments in order to account for regional labour and urbanity/sparsity factors.

[86] After cost benchmarking.
[87] Annex 1.
[88] Annex 1.

Question 17: Do you agree with the proposed criteria for justifying regional cost factors that we have outlined?

Pre-modelling adjustments

6.15. It may be sensible to adjust data ahead of modelling, particularly if regional or company-specific costs affect the accuracy of the modelling (as evidenced by changes in coefficients and efficiency scores). Pre-modelling adjustments can then be reversed out after the efficiency analysis, and an estimated efficiency adjustment can be applied to the adjustment factor if it is appropriate. In this section we discuss the pre-modelling adjustments we previously made for regional labour differences and urbanity/sparsity, as well as the pros and cons of this approach.

Regional labour

6.16. The relative cost of labour in different regions can influence the underlying cost base of companies operating in different regions. The degree to which these labour pressures influence costs will depend on a number of factors such as the magnitude of structural differences in labour costs across regions, the type of labour being procured and the ability of GDNs to source labour from other markets. Table 6.1 above shows that regional labour represented the largest regional cost factor adjustment for each GDN in RIIO-GD1.

6.17. In RIIO-GD1, we recognised labour cost differentials between London, the South-East and elsewhere in Great Britain. We calculated labour indices using the Office of National Statistics' (ONS) Annual Survey of Hourly Earnings (ASHE) data. We took into account the additional costs associated with working in London and the South-East and considered the proportion of work that is done in these areas and elsewhere.[89] We also applied an additional adjustment for East of England to recognise areas such as Tottenham which are located inside the M25.

6.18. We used broadly the same methodology to account for regional labour costs in RIIO-ED1, however used only 2-digit Standard Occupational Classification (SOC) level of ASHE data for RIIO-ED1 (as opposed to 2- and 3-digit SOC level data for RIIO-GD1).

6.19. Pre-modelling adjustments can provide a clear monetary effect that can be related back to specific company activities. However, removing these costs from modelling could remove the incentives on companies to mitigate them where possible.[90]

[89] For example, we applied a 15% reduction to London's direct labour costs and 18% reduction to their contract labour costs before carrying out the regressions.
[90] Annex 1.

Urbanity and sparsity

6.20. Sparsity factors seek to account for cost differentials attributable to sparsely populated areas, primarily due to the difficulty in providing emergency and repair services over large geographical areas that may have more limited infrastructure. Urbanity factors attempt to correct for cost differentials which are driven by lower labour productivity levels in densely populated urban areas, largely due to above ground congestion and having to work around other utilities. In this section we also refer to urbanity factors as 'density' factors.

6.21. In RIIO-GD1, we used district-level area and population estimates to provide sparsity adjustments to GDNs' costs (for emergency and repair activities only). For urbanity, we provided a 15% adjustment to GDN's labour costs for activities within the M25 (for repex, connections and reinforcement activities only). In RIIO-ED1, we accepted similar cost adjustment claims for labour costs in the London area, primarily for additional transport and travel costs.

6.22. Since labour is a cost, regional labour cost adjustments are relatively straightforward to make. However, for urbanity and sparsity, we need to estimate their functional relationships with cost, which can be ambiguous. Regional labour cost differentials are also generally accepted and evidenced by ONS ASHE data, whereas urbanity and sparsity adjustments have been made based on information submitted by GDNs. This approach is more complex and less transparent, and raises potential information asymmetry problems.

Within-model adjustments

6.23. In this section we discuss potential methods of making within-model adjustments to account for regional labour differences and urbanity/sparsity, as well as the pros and cons of this approach. An explanatory variable(s) that we may choose to include in our models to account for regional factors would be subject to such a model specification satisfying the various model robustness tests outlined in Chapter 2.

Regional labour

6.24. As part of our initial model development for RIIO-ED1, we engaged Frontier Economics to investigate and recommend suitable benchmarking approaches. Frontier Economics recommended we consider a range of explanatory variables to capture the impact of input prices on costs.[91] All specifications identified included a capital price index (BEAMA index for Basic Electrical Equipment). We decided against applying this approach and instead made pre-modelling adjustments.

6.25. Ofwat has previously included a regional wage variable in its models to control for cost differentials between regions, by constructing a regional wage variable using a weighted average of ASHE data on regional wages. However, during the Bristol Water appeal, the CMA identified a number of concerns with this approach, and noted that a lack of sufficiently granular ASHE data meant it was not possible to investigate company-specific issues as it does not provide data for the specific geographic areas that water companies serve.[92]

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[91] Frontier Economics, *Total cost benchmarking at RIIO-ED1 – Volume 1*, May 2013. Available here.
[92] CMA (2015), 'Bristol Water plc. A reference under section 12(3)(a) of the Water Industry Act 1991', available here.

6.26. In its initial assessment of business plans for PR19, Ofwat tested models using an explanatory variable but found that it was not significant in most models and the sign and size were different to the prior expectation for this variable. Ofwat also considered making ex ante adjustments to cost data before running its models (in line with our previous approaches), but found that compared with models without these adjustments, the introduction of the adjustment did not seem to improve the capacity of the model to explain the data. Further, Ofwat considered that the inclusion of a density variable in its models (discussed further below), and a square of density, captured the effect of regional wages as the two are correlated.[93]

6.27. CEPA considered that regional wages could be explored further using within model adjustments. However, it can be difficult to develop simple regional wage indices that produce consistently significant and intuitive results.[94]

Urbanity and sparsity

6.28. Company costs can increase with both density and sparsity. That is, GDNs in highly dense or highly sparse environments are likely to face greater costs for certain activities. The ambiguity of the relationship between density and costs is often referred to as being a 'U-shaped' relationship.

6.29. The use of a density variable in econometric modelling may deal with the need for a separate urbanity adjustment. The introduction of density into econometric modelling has been considered or employed in a number of price controls and there is a range of possible explanatory variables that could be used to capture its effect on efficient costs.

6.30. Ofwat (PR19) has accounted for urbanity and sparsity by way of an explicit density cost variable within its models. It tested a range of different density measures and concluded that the weighted average density was the most advantageous (from a modelling perspective). It found that unlike other density measures such as the average number of households per length of main (as it previously applied in PR14), the weighted average density is beyond company control and better reflects relative densities within regions.[95]

6.31. To capture density, Ofwat calculated the population density per each local authority district (LAD) in terms of population per square km. The weight it assigned to the density of each LAD was the population in the LAD (which resides within the company's service areas) divided by the total population in the company's service area.

6.32. In Ofwat's Cobb-Douglas functional form, the coefficients of explanatory variables can be interpreted as elasticities. Ofwat was able to study how the elasticity of costs for different levels of aggregation varies with respect to density across companies, and relate this to the economic and technical rationale behind their a priori expectations.[96]

6.33. CEPA listed a number of proxies for density that have been considered in the context of cost assessment, including:

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[93] Ofwat, *PR19 – Supplementary technical appendix: Econometric approach*, January 2019. Available here.
[94] Annex 1.
[95] Ofwat, *PR19 – Supplementary technical appendix: Econometric approach*, January 2019. Available here.
[96] Annex 1.

- total connections divided by total length of mains, or number of customers divided by service area: these variables reflect network activity or use per unit of network size, and are a 'simple' way to capture the density of the network
- Ofwat-style weighted average density variable: this variable reflects the percentage of the population living in densely populated areas
- percentage of urban assets: assets in urban areas may cost more to operate due to, for example, harder access, traffic permissions and restricted land footprints.

6.34. CEPA then ran illustration regressions on RIIO-GD1 totex under four separate model specifications: (i) no urbanity/sparsity adjustments, (ii) a pre-modelling urbanity/sparsity adjustment, (iii) a linear density term included in the model and (iv) linear and quadratic density terms included to capture the U-shape relationship between density and costs.[97] The results of this analysis are presented in Table 6.2.

Table 6.2: Density illustration regressions

	(i) No sparsity/ urbanity adjustment	(ii) Pre-modelling adjustment	Within model density controls	
			(iii) Linear	(iv) Linear and Quadratic
Totex CSV	0.739***	0.758***	0.739***	0.743***
Density			-0.049**	0.211
Density Squared				0.016
Time trend	-0.017***	-0.019***	-0.019***	-0.019***
Constant	34.952***	37.549***	38.161***	38.398***
Observations	80	80	80	80
R-squared	0.891	0.924	0.898	0.897

*Source: CEPA analysis. *** p<0.01, ** p<0.05, * p<0.1.*

6.35. Comparing the outputs presented in Table 6.2, it is evident that the predictive power is greater when the urbanity/sparsity pre-modelling adjustment is applied, which implies that the density explanatory variable may not be capturing the full effect of urbanity/sparsity on costs. However, overall there were not significant differences between the efficiency scores of the pre- and within-modelling adjustment model specifications.

6.36. Note that in this example the impact of density when included within the econometric model is on all totex, whereas it may be more effective to test these adjustments on the emergency and repair costs, which were subject to sparsity/urbanity adjustments in RIIO-GD1. It may also be worthwhile testing other proxies for density, such as the weighted average density variable.

Summary

6.37. We consider that the onus is on GDNs to justify their case for any proposed adjustments, in line with the criteria we have outlined. We will set a high evidential bar for accepting any cost adjustment claims, and we do not expect to consider claims that are not materially significant enough to account for the complexity they create.

[97] In this illustrative example density is defined as the number of connections divided by network length.

6.38. We consider that both regional wages and density (urbanity/sparsity) could be explored further as within-model adjustments. However, due to regulatory precedent and the issues with including these factors within-model, the feasibility of this approach will need to be demonstrated through a robust model development process.[98]

6.39. Noting the problems and complexities with using input prices (such as labour indices) as explanatory variables within our models, we consider it unlikely that we will make within-model adjustments to account for regional labour differences. Nonetheless, we intend to undertake further analysis and compare model performance before we make a final decision on the best approach.

6.40. Our initial analysis suggests there is greater merit in exploring within-model adjustments for density. We will similarly undertake further analysis and test whether within-model approaches to density result in improved model performance before we make a final decision.

[98] Annex 1.

7. Real price effects and ongoing efficiency

Chapter summary
This chapter sets out and seeks views on potential approaches to real price effects (RPEs) and ongoing efficiency in setting cost allowances for the network companies.

Questions

Question 18: What RPEs should we account for, how should we gauge materiality, and what criteria should we use for index selection?

Question 19: What common input and expenditure categories are appropriate for structuring RPEs?

Question 20: How should we identify an appropriate ongoing efficiency assumption?

Question 21: How should we determine frontier shift?

Overview

7.1. In this chapter we discuss our approach to assessing both Real Price Effects and ongoing efficiency in RIIO-1, and highlight a number of considerations that we consider to be important for assessing both topics in RIIO-2. We also explore some of the interactions that RPEs and ongoing efficiency have with other elements of the price control, including general consumer price inflation. This chapter should be read in conjunction with CEPA's report on Frontier Shift (refer to Annex 3).

7.2. We set price control allowances which can include a general inflation measure (eg CPI or CPIH) and certain price indices that reflect the external pressures on companies' costs. We refer to the difference between these two as Real Price Effects (RPEs).

7.3. We refer to ongoing efficiency assumptions as the reduction in the volume of inputs required to produce a given volume of output - ie the productivity improvements that we consider even the most efficient company is capable of achieving.

Real price effects

7.4. In RIIO-1, we set fixed assumptions to adjust allowances over the eight-year price controls to account for the forecast difference between the Retail Prices Index (RPI), which is the measure of general consumer price inflation Ofgem applies in RIIO-1, and input price inflation. In general, we forecast input price inflation to be greater than RPI, resulting in us providing upfront allowances for RPEs.

7.5. Our approach to developing these allowances for the slow-track companies in RIIO-1 involved, in broad terms:

- constructing trends from price indices relevant to the inputs purchased by the networks (eg labour and materials), relative to RPI

- weighting together these input price trends based on the assumed proportions of each expenditure category (eg direct opex and load-related capex)
- multiplying the resulting index by upfront allowances, resulting in upfront RPE allowances.

7.6. This approach took account of the different inputs purchased in each sector, allowing our RPE assumptions to vary across the network sectors. This variation related to both the input price indices chosen and the weightings applied, as we describe below.

Table 7.1: Indices used for RPE assumptions in RIIO-1 price controls

Index	Source	Sector(s) applied in
RPI	ONS	ED, ET, GD, GT
Labour		
Average earnings index for private sector incl. bonus	ONS	ED, ET, GD, GT
Average weekly earnings (AWE) private sector incl. bonus	ONS	ED, ET, GD, GT
AWE construction incl. bonus	ONS	ET, GD, GT
AWE transport and storage	ONS	ET, GD, GT
PAFI Labour and Supervision in Civil Engineering	BCIS	ED, ET, GD, GT
BEAMA labour cost index: electrical engineering	BEAMA	ED, ET
Materials – opex		
FOCOS Resource Cost Index of Infrastructure: Materials	BCIS[99]	ED, ET, GD, GT
Materials – capex/repex		
PAFI Plastic Pipes and Fittings	BCIS	GD
PAFI Pipes and Accessories: Copper	BCIS	ED, ET, GD
PAFI Pipes and Accessories: Aluminium	BCIS	ED
PAFI Structural Steelwork – Materials: Civil Engineering Work	BCIS	ED, GD, GT
Equipment and plant		
PAFI Plant and road vehicles	BCIS	ET, GD, GT
Machinery and equipment (Output PPI)	ONS	ED, ET, GD, GT
Manufacture of machinery and equipment (Input PPI)	ONS	ET, GD, GT
Plant and road vehicles: providing and maintaining	BCIS	ED

7.7. In our RIIO-2 Framework Decision[100] in July 2018, we confirmed that we would index uncertain costs, where possible, including for labour and construction cost inflation (to the extent evidence suggests that input prices are different from general consumer price inflation). In our SSMC and SSMD, we addressed a number of topics related to the implementation of RPE indexation.

[99] BCIS: Building Cost Information Service.
[100] RIIO-2 Framework Decision available here.

7.8. For RIIO-2, we intend to place strong emphasis on the materiality of RPE claims, and to impose a high evidential bar to ensure their appropriateness. We consider these principles as being important for the following reasons:

- it will challenge network companies to focus on key risk areas, and to produce robust evidence of why general consumer price inflation is not an adequate proxy for certain input prices
- it will optimise our assessment process by allowing us to focus only on significant and robust claims
- it will ensure only genuine input price risks are treated, thereby simplifying any RPE indexation mechanism and its overarching governance framework

7.9. We presented the following guidance on the types of evidence companies are expected to submit in support of their RPE proposals in our RIIO-2 Business Plan Guidance document[101]:

- we expect companies to show that each RPE is material relative to both totex and general consumer price inflation
- we expect companies to provide clear evidence of a sustained deviation between input costs and general consumer price inflation
- we expect companies to propose indices for any proposed RPEs, along with evidence to support their use in indexation and justification for their selection over alternatives.

Question 18: What RPEs should we account for, how should we gauge materiality, and what criteria should we use for index selection?

7.10. In our SSMC and SSMD, we set out how we intend to treat network companies' cost structures when assessing RPEs. We set out our intention to base the assumed proportions of each expenditure category (eg opex and capex) on the average (notional) cost structures, where appropriate, as reported by companies in their business plans. There are two elements to consider:

- input categories, eg general labour and capex materials
- expenditure categories, eg direct opex and load-related capex.

7.11. Input categories distinguish between the various types of inputs required by network companies to deliver their services to consumers. To enable a common assessment of RPEs across network companies, we must establish a common format for input categories. In RIIO-GD1, as an example, we used the following input categories in our assessment, common across each of the GDNs:

- direct Labour
- contract Labour
- materials

[101] RIIO-2 Business Plan Guidance available here.

- plant and equipment
- transport
- other.

7.12. Expenditure categories distinguish between the various types of activities that network companies undertake in delivering their services to consumers. To enable a common assessment of RPEs across network companies, we must also establish a common format for expenditure categories within each sector. In RIIO-GD1, for example, we used the following expenditure categories in our assessment, common across each of the GDNs:

- direct opex
- indirect opex
- capex
- repex mains
- repex services.

Question 19: What common input and expenditure categories are appropriate for structuring RPEs?

Ongoing efficiency

7.13. For RIIO-GD1 and T1, we developed ongoing efficiency assumptions informed by historical productivity data from the EU KLEMS[102] database. In doing so, we selected those sectors for comparison that we considered to be comparable to electricity and gas transmission and distribution activities, such as the construction sector.

7.14. In deriving our ongoing efficiency assumptions for opex and capex/repex in RIIO-GD1 and T1, we drew on both partial factor (ie labour, and labour and intermediate inputs) and total factor (ie labour, capital and intermediate inputs) productivity measures. Our productivity determinations for opex and capex/repex were informed by PFP (Partial Factor Productivity) and TFP (Total Factor Productivity) measures, respectively, reflecting the different composition of inputs typically used in each category.

[102] EU KLEMS growth and productivity data can be found here.

Table 7.2: Average annual growth rates for productivity measures from EU KLEMS (1970 to 2007): RIIO-T1/GD1 selected industry sectors[103]

Sector (EU KLEMS sector code)	TFP (VA[104])	Labour productivity (VA) at constant capital	TFP (GO[105])	Labour & intermediate input productivity (GO) at constant capital	Labour & intermediate input productivity (GO)
Construction	0.7%	0.7%	0.3%	0.3%	0.4%
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%	0.5%	0.5%	0.8%

7.15. We consider that ongoing efficiency improvements are largely within a sector's control, and can be generated in a variety of ways, eg through effective management of capital, collaboration between companies or sectors, employing new technologies and effective investment in innovation.

7.16. Setting an ambitious ongoing efficiency challenge is vital to ensuring networks continually strive to identify and exploit opportunities to optimise their processes and operations. By doing so, networks are able to remain resilient in the face of change and ensure value for money for consumers.

7.17. In order to establish an ambitious ongoing efficiency challenge for each sector in RIIO-2, we aim to explore the many interactions that ongoing efficiency has with the rest of the price control. In doing so, we will seek to identify the various drivers of ongoing efficiency, including any residual efficiency benefits from legacy actions.

7.18. We expect network companies to provide challenging forecasts of their ongoing efficiency assumptions in RIIO-2 as part of their business plans, and to clearly demonstrate how these forecasts compare to what they have delivered previously.

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[103] See RIIO-T1/GD1 Final Proposals: Real price effects and ongoing efficiency appendix. Available here.
[104] Value Added (VA) is a measure of the value of gross output minus the value of intermediate inputs (energy, materials and services) required to produce the final output. The inputs for VA are therefore labour and capital.
[105] Gross Output (GO) is a measure of the value of the output of an industry, ie the combined turnover of the companies within that industry. The inputs for gross output are therefore capital, labour, energy, materials and services.

Question 20: How should we identify an appropriate ongoing efficiency assumption?

Frontier shift

7.19. CEPA describes frontier shift as the rate at which the unit costs of an efficient company change over time. It captures both changes in the volume of inputs needed to produce a given level of output and changes in the price of inputs used. In other words, frontier shift is ongoing efficiency net of RPEs.[106]

7.20. We are interested in exploring ways in which we can utilise network companies' historical performance data from previous price controls to understand how outturn frontier shift compares to RIIO-2 forecasts, and how we could use this information as part of cost assessment.

Question 21: How should we determine frontier shift?

Summary

7.21. We consider that the onus is on network companies to justify their case for any proposed RPEs, including clearly demonstrating why a general consumer price inflation index (eg CPI or CPIH) is not an adequate proxy for input prices. We intend to place strong emphasis on the materiality of RPE claims, and to impose a high evidential bar to ensure their appropriateness.

7.22. We are interested in exploring the many interactions that ongoing efficiency has with the rest of the price control in order to establish an appropriate and challenging ongoing efficiency assumption. We expect network companies to provide challenging forecasts of their ongoing efficiency assumptions in RIIO-2 as part of their business plans, and to clearly demonstrate how these forecasts compare to what they have delivered previously.

7.23. We are interested in exploring ways in which we can utilise network companies' historical performance data from previous price controls to understand how outturn frontier shift compares to RIIO-2 forecasts, and how we could use this information as part of cost assessment.

[106] Annex 3 - CEPA, *RIIO-2 Cost Assessment: Frontier shift*. p.4, June 2019.

8. Combining the elements of our cost assessment

Chapter summary
This chapter discusses and seeks views on approaches to combining the various elements of our cost assessment. This includes how we set the efficiency benchmarks and combine our aggregated and disaggregated analyses to determine totex allowances.

Questions

Question 22: Should we set the efficiency benchmark at the upper quartile level?

Question 23: Are there types of expenditure that we should model using only historical or forecast data?

Question 24: If we use a combination of aggregated and disaggregated modelling approaches, how should we determine the weight we apply to each?

Overview

8.1. There are two main issues for us to consider in combining all of the elements of our cost assessment. These are how we set the efficiency benchmark and how we combine the different levels of analysis to determine totex allowances. In this chapter we discuss each of these issues and consider whether our previous approaches should be applied to our RIIO-GD2 cost assessment.

Setting the efficiency benchmark

8.2. In setting efficiency benchmarks in RIIO-1, we were mindful the level of the company with the lowest costs may be unachievable and unrealistic. This was because our models did not account for all company differences or perfectly map costs with cost drivers.

8.3. In RIIO-GD1, we identified upper quartile (UQ) costs for 2011-12 for our econometric models estimated using historical costs, and for 2013-14 for models estimated using two-year forecast data (separately for our top-down model and combined bottom-up models). We identified UQ costs over the RIIO-GD1 period by rolling forward these benchmark costs from the base year for RPEs and ongoing efficiency. Our final cost allowances were based upon 75% of our view of efficiency and 25% of each GDN's view. This was an additional recognition that the models, results and the target remained affected by measurement error.

8.4. In other sectors, a more gradual shift to the 'frontier' was adopted.[107] Glide-paths have typically been used when the regulator considers that it is not feasible for the network companies to achieve the full scale of the efficiency savings over one price control period.

8.5. More recently, in RIIO-ED1 we combined the results of our different modelling approaches before calculating the UQ, not after as we did in RIIO-GD1. We then added back

[107] Including Ofgem's DPCR3, Ofwat's PR09 and ORR's 2008 Network Rail decision.

our efficient view of normalisations/adjustments and applied the UQ to the total costs provided by the models.

8.6. We received some responses to our SSMC in relation to how we set the efficiency benchmark. Cadent suggested that we apply the RIIO-ED1, rather than the RIIO-GD1, approach to calculating the UQ, as the RIIO-GD1 approach caused an extra element of cherry-picking, by calculating a number of UQs at different levels of analysis.

8.7. Cadent suggested that the results of the alternative, top-down and middle-up approaches could be spread pro-rata to the results of the bottom-up approach for individual activities, as was carried out at RIIO-GD1 for the top-down approaches. Cadent also noted that there could be a case for using average costs rather than UQ costs, and/or applying a glide path.[108]

8.8. Our choice of benchmark will be driven by our level of confidence in the data and the variability in the modelling results. If the data is accurate, and is likely to provide accurate results, then we may be more inclined to set a tougher target. Alternatively, if there is a relatively large distribution in the GDNs' expenditure around the line of best fit, this can indicate that there may be a greater degree of measurement error and we may need to be cautious about setting a high benchmark.[109]

8.9. As the GDNs have now had two price controls (GDPCR and GD1) to catch up to the 'frontier', CEPA recommended that we explore the case for not applying a glide-path towards the efficiency target. It considered that, in line with RIIO-ED1, the use of the UQ is likely to be sufficient in dealing with measurement error in the models.[110]

Question 22: Should we set the efficiency benchmark at the upper quartile level?

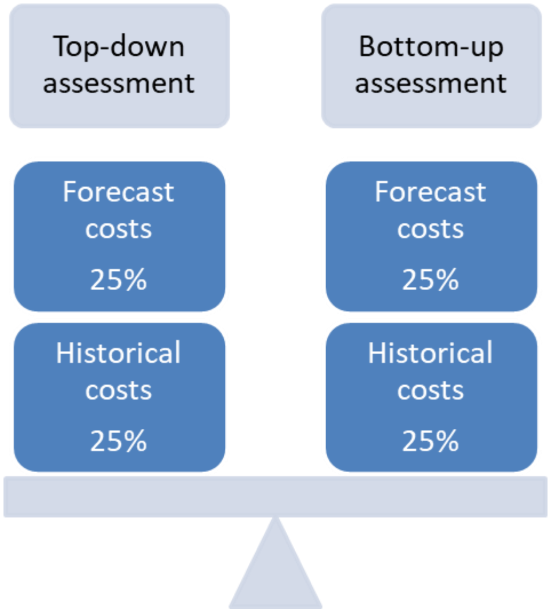
Combining aggregated and disaggregated analysis

8.10. In RIIO-GD1, we calculated our view of efficiency based on our top-down and bottom-up analysis using both historical (4 years) and forecast (2 years) costs. We took a straight line average of these four approaches to arrive at our view of baseline costs (pre-Information Quality Incentive (IQI) adjustment). Given the respective merits of the totex and the disaggregated approach, we did not find strong justification to favour one approach over the other. This approach acknowledged that there was no single correct specification for modelling efficient costs.

8.11. This approach might be described as a 'disaggregated to aggregated' approach to benchmarking, in that our totex model specification aggregated many of the explanatory variables used in the activity level regressions.

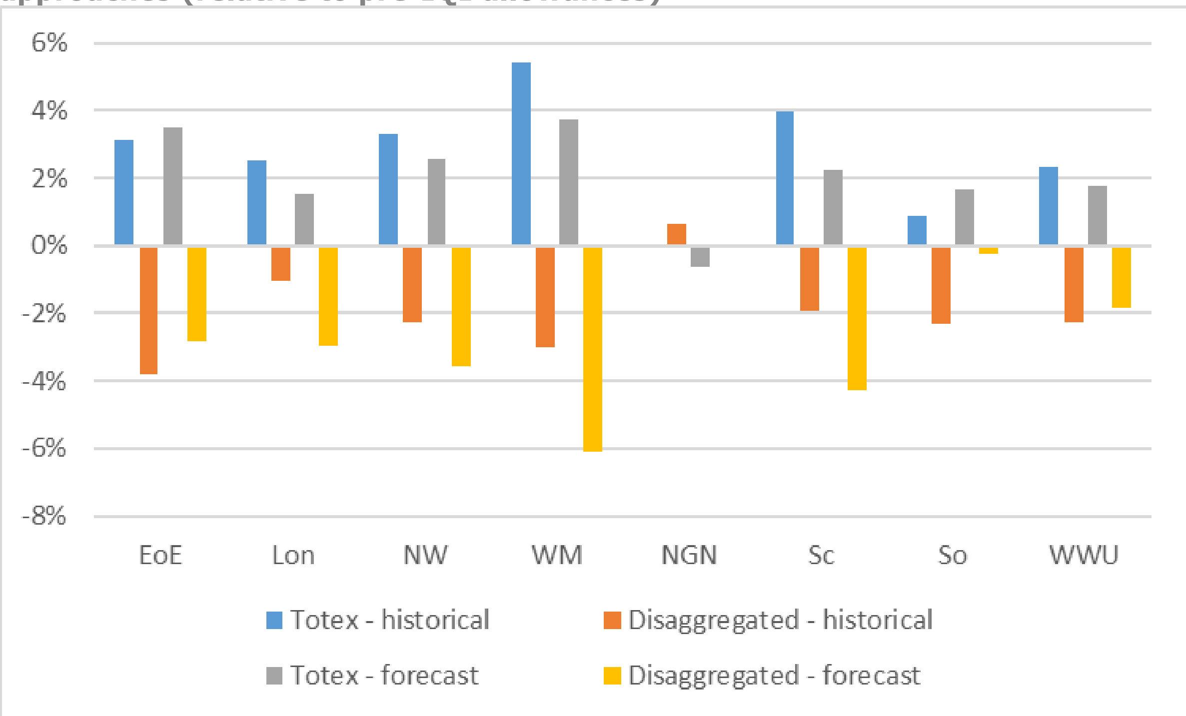
[108] See Cadent response to SSMC available here.
[109] Annex 1.
[110] Annex 1.

Figure 8.1: RIIO-GD1 approach to setting totex allowances



8.12. In RIIO-GD1, the allowances obtained from the totex models were generally higher than the disaggregated models, as shown in Figure 8.2. One reason for this is the disaggregated models make greater use of technical or qualitative assessment which relied on benchmark data wider than the set of GDNs, eg in relation to business support costs. By contrast, the totex modelling approach included a number of such cost areas subject to qualitative assessment under the disaggregated approach within the econometric modelling, with the benchmark defined as the UQ GDN.

Figure 8.2: RIIO-GD1 controllable cost allowances for the four modelling approaches (relative to pre-IQI allowances)



8.13. Similarly, in RIIO-ED1 we combined our top-down and bottom-up analysis based on 50% weightings. However, our top-down assessment included two different totex models (weighted at 25% each). We used data from a 13-year period (four historical years and nine forecast years) to estimate the cost parameters instead of only using historical data as we had for the fast-track assessment. We considered that this accounted for changes in technology and was more consistent with our approach for the disaggregated models where we took account of a mixture of historical and forecast data.

8.14. Models that use forecast data may provide useful information, particularly if the cost structures of GDNs are expected to change during the RIIO-GD2 period. However, there are risks with estimating econometric models using forecast data, as it reduces the level of independence in the benchmarks.

8.15. A further question for us to consider is whether the time period chosen for different levels of aggregation of modelling needs to be consistent. There is a risk that using different time periods for different models could lead to unbalanced efficiency scores and cost allowances. However, it may be justifiable to use different time periods where there are structural breaks in the data for particular cost activities, and therefore it may be reasonable to model aggregated or disaggregated activities using only historical or forecast data. CEPA suggested that, in general, we should seek to maintain as consistent sample periods as possible across our benchmarking.[111]

Question 23: Are there types of expenditure that we should model using only historical or forecast data?

8.16. In response to our SSMC, SGN noted that when combining overall results, a mixture of top-down and bottom-up should be retained. Top-down regressions provide an essential sense check and mitigates the risk that aggregating bottom-up regressions 'cherry picks' the best performer across numerous categories and also mitigates the challenges that disaggregated cost drivers may not always fully explain trade-offs made across activities. Any move away from a 50% weighting of top-down needs firm justification. SGN also made a general point that there needs to be a mixture of both regressions and non-regression analysis, as there are activities which are not suitable to put into regressions. SGN noted that in these areas, provided there is an independent review of efficiency, this should not weaken the overall methodology.[112]

8.17. Cadent considered that the abolition of totex interpolation (IQI), and the potential emphasis on bottom-up analysis, could act to give insufficient weight to the uncertainty present in any approach to cost assessment. Therefore, depending on how the analysis proceeds, it may be necessary to consider how else that uncertainty could be reflected in cost allowances.[113]

8.18. As we noted in earlier chapters, there are advantages and disadvantages to both aggregated and disaggregated-type benchmarking. As benchmarking becomes more granular there is an increasing risk that different company approaches in cost allocation methodologies are the cause of differences in GDN costs, rather than (in)efficiency. We therefore recognise

[111] Annex 1.
[112] See SGN response to SSMC available here.
[113] See Cadent response to SSMC available here.

the importance of data quality and consistency where we undertake more disaggregated benchmarking.

8.19. Where more disaggregated cost pools are adopted for benchmarking, the interactions between the benchmarking of each cost pool requires careful consideration. This is to avoid 'cherry picking' when we combine the results of each level of analysis, and also to avoid creating unintended incentives for companies when making expenditure choices.[114]

Question 24: If we use a combination of aggregated and disaggregated modelling approaches, how should we determine the weight we apply to each?

Summary

8.20. We consider the UQ to be the best starting point in setting the benchmark, although we are open to other approaches. Our choice of benchmark will be driven by the robustness of the models and the variability in the modelling results.

8.21. Under the BPI, we will assess companies' Business Plans and may apply a reward or penalty. Further information on the four-stage assessment process we set out is available from the SSMD core document and the RIIO-2 Business Plan Guidance.[115]

8.22. We generally agree with stakeholders that the RIIO-ED1 approach, where the models are summed together before the benchmark is set, is appropriate. This provides simplicity and avoids the possibility of setting an unrealistic benchmark.

8.23. We have discussed a number of potential modelling approaches that we intend to test for robustness against our model selection criteria. If we combine different modelling approaches, we intend to do so based on the robustness of the different models. If, as in RIIO-GD1, we have two different modelling approaches of similar strength, we consider a simple average of these to be the most common sense approach to combining the models.

[114] Annex 1.
[115] For more details, see SSMD available here and Business Plan Guidance available here.

Appendices

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Appendix 1 – Privacy notice on consultations

Personal data
The following explains your rights and gives you the information you are entitled to under the General Data Protection Regulation (GDPR).

Note that this section only refers to your personal data (your name address and anything that could be used to identify you personally) not the content of your response to the consultation.

1. The identity of the controller and contact details of our Data Protection Officer
The Gas and Electricity Markets Authority is the controller, (for ease of reference, "Ofgem"). The Data Protection Officer can be contacted at dpo@ofgem.gov.uk

2. Why we are collecting your personal data
Your personal data is being collected as an essential part of the consultation process, so that we can contact you regarding your response and for statistical purposes. We may also use it to contact you about related matters.

3. Our legal basis for processing your personal data
As a public authority, the GDPR makes provision for Ofgem to process personal data as necessary for the effective performance of a task carried out in the public interest, ie a consultation.

3. With whom we will be sharing your personal data
(Include here all organisations outside Ofgem who will be given all or some of the data. There is no need to include organisations that will only receive anonymised data. If different organisations see different sets of data then make this clear. Be as specific as possible.)

4. For how long we will keep your personal data, or criteria used to determine the retention period.
Your personal data will be held for ***(be as clear as possible but allow room for changes to programmes or policy. It is acceptable to give a relative time, eg 'six months after the project is closed')***

5. Your rights
The data we are collecting is your personal data, and you have considerable say over what happens to it. You have the right to:

- know how we use your personal data
- access your personal data
- have personal data corrected if it is inaccurate or incomplete
- ask us to delete personal data when we no longer need it
- ask us to restrict how we process your data
- get your data from us and re-use it across other services
- object to certain ways we use your data
- be safeguarded against risks where decisions based on your data are taken entirely automatically
- tell us if we can share your information with 3rd parties
- tell us your preferred frequency, content and format of our communications with you
- to lodge a complaint with the independent Information Commissioner (ICO) if you think we are not handling your data fairly or in accordance with the law. You can contact the ICO at https://ico.org.uk/, or telephone 0303 123 1113.

6. Your personal data will not be sent overseas (Note that this cannot be claimed if using Survey Monkey for the consultation as their servers are in the US. In that case use "the Data you provide directly will be stored by Survey Monkey on their servers in the United

States. We have taken all necessary precautions to ensure that your rights in term of data protection will not be compromised by this".

7. Your personal data will not be used for any automated decision making.

8. Your personal data will be stored in a secure government IT system. (If using a third party system such as Survey Monkey to gather the data, you will need to state clearly at which point the data will be moved from there to our internal systems.)

9. More information For more information on how Ofgem processes your data, click on the link to our "Ofgem privacy promise".

Appendix 2 – List of annexes

Annex	Name of annex
1	CEPA, RIIO-GD2 cost assessment – econometric modelling & regional factors, June 2019.
2	ECA, RIIO-2 Cost Assessment: Business Support Costs, June 2019.
3	CEPA, RIIO-2 Cost Assessment: Frontier shift, June 2019.
4	Prof. Andrew Smith, Note for Ofgem on Alternative Methodologies, June 2019.
5	Prof. Andrew Smith, Note for Ofgem on Diagnostic Tests in Efficiency Benchmarking Studies, June 2019.
6	Office of Research & Economics - Research Hub, Review of Regional and Special Cost Factors, June 2019.