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CAWG 13

Presentation

Ofgem
09/03/2020

Agenda

- Introduction - Ofgem (10:00 – 10:15)
- Trend analysis - Ofgem (10:15 – 10:45)
- Data adjustments - Ofgem (10:45 – 11:30)
- Data adjustments - SGN (11:30 – 12:15)
- Lunch (12:15 – 1:00)
- Regional factors - Ofgem (1:00 – 1:30)
- Repex regression approach - Ofgem (1:30 – 3:00)
- Econometric modelling – Ofgem (3:00 – 4:00)
- AOB (4:00 – 4:30)

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Trend analysis

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Trend analysis

- Trend analysis is undertaken on submitted gross costs pre-normalisation
- Aim is to identify atypical costs and/or trends that may impact econometric benchmarking
- Cost drivers and business plan narratives also reviewed

Summary of trend analysis

- Totex relatively stable on a year-by-year basis between GD1 and GD2
- Movements in specific regression pools
  - Repex – step increase in 2020 and 2021 then falls slightly and stabilises in GD2
  - Repair and Work Management – declining trend from GD1 into GD2
- Both trends expected given maturity of repex programme
- In contrast, emergency and maintenance opex is increasing in GD2 while capex activities are volatile year-by-year

Summary of trend analysis

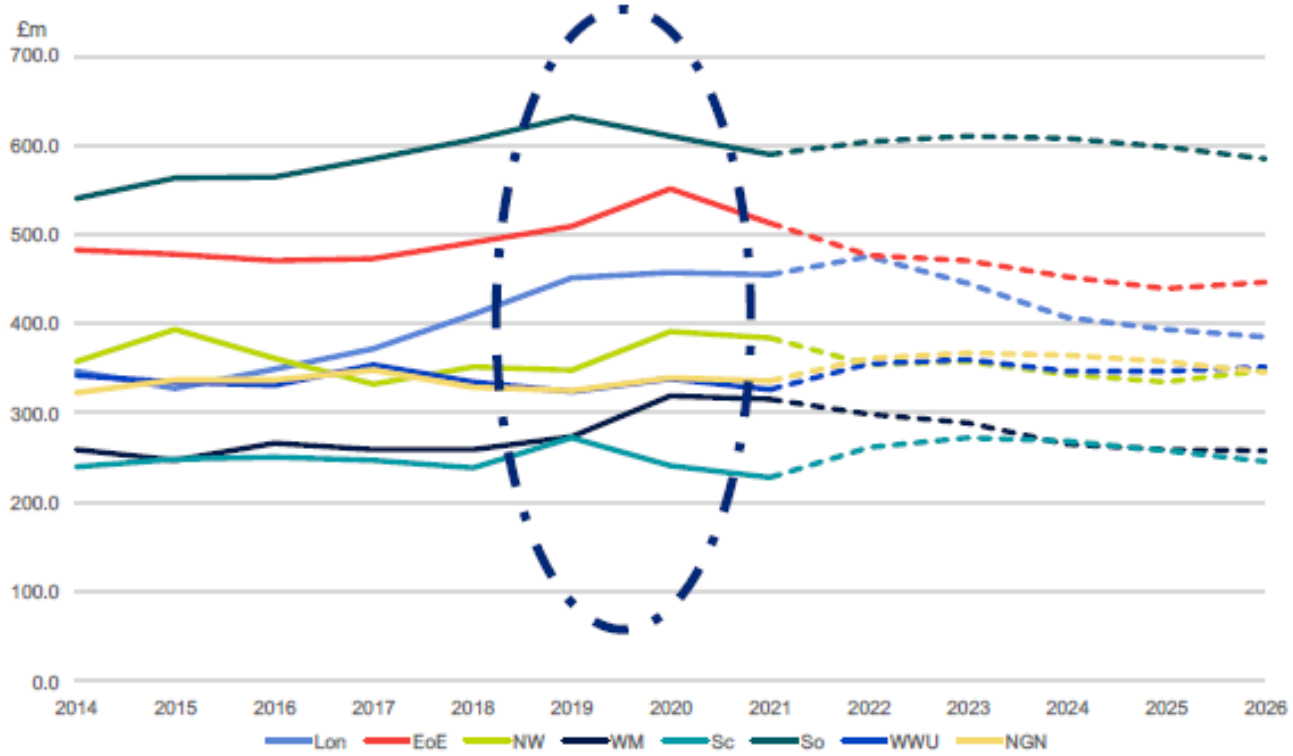
Cost pool	Regression driver (GD1)	Cost Trend – GD1	Cost Trend GD2	Notes
Totex	CSV [1]	Flat then increasing	Downward then flat	Masks different trends in individual cost pools (see below)
Work management	MEAV	Volatile initially then downwards trend	Generally flat expen. over GD2	External cost driver also expected to be flat (MEAV typically stable)
Emergency	CSV [2]	Downward trend for most GDNs	Increasing trend in GD2	GDNs say workload decreasing in GD2 but unit cost increasing
Repair	External Condition Reports (ECRs)	Downward trend for most GDNs	Continued downward trend	Expected given repex programme – same trend for forecast ECRs?
Maintenance	Maintenance MEAV	General upward trend	General upward trend	Maintenance MEAV will generally remain flat
Connections	Synthetic unit costs	General upward trend	Generally flat over GD2	Two Cadent networks have a large step down in first year of GD2
Mains reinforcement	Synthetic unit costs	Volatile year-on-year	Volatile year-on-year	Justification for smoothing given the volatile costs
Repex	Synthetic unit costs	General upward trend	Flat following step down in year 1	Forecast repex generally above GD1 levels of expenditure

Note 1 - Emergency CSV, maintenance MEAV, ECR, synthetic connections capex, synthetic mains capex, synthetic repex, total MEAV

Note 2 – Customers, External Condition Reports

Trend analysis: Totex

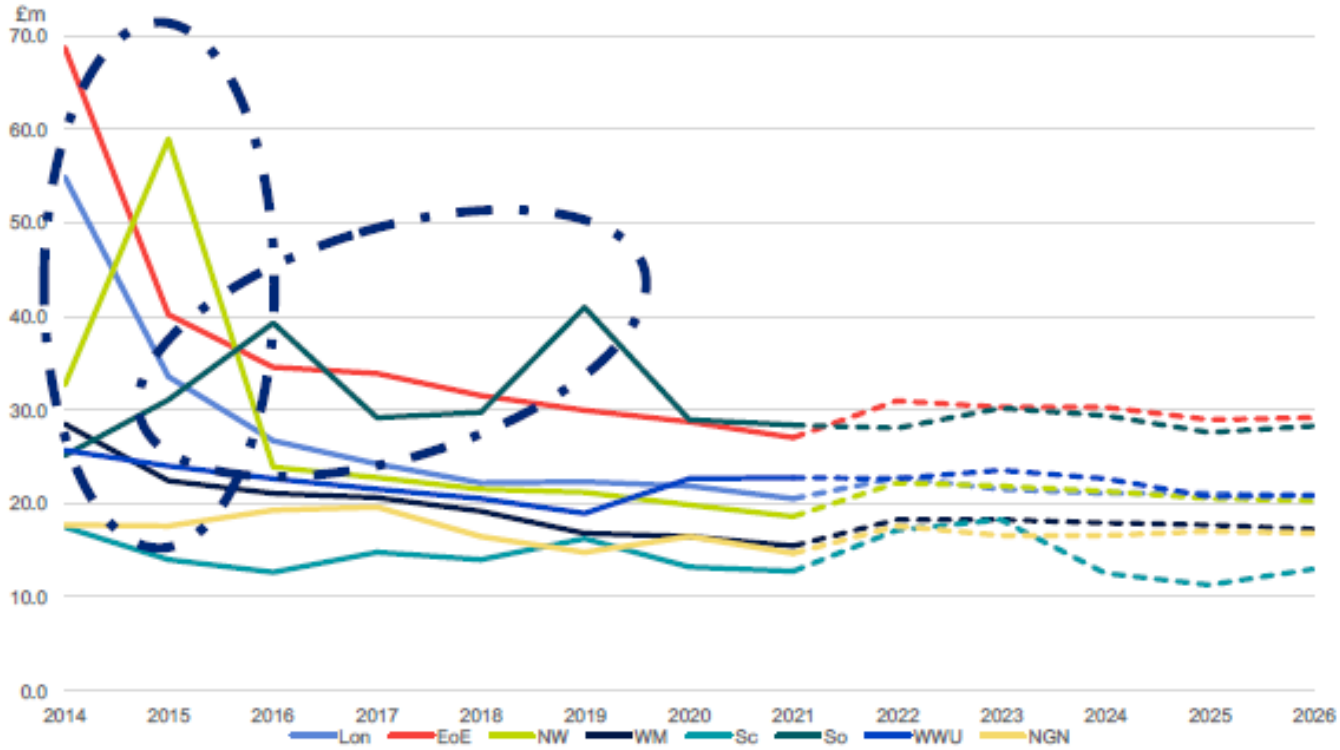
Submitted total expenditure



- Gradual upward trend for most GDNs in GD1
- Some spikes in 2018/19 and 2019/20
- Trend in GD2 is relatively flat

Trend analysis: Work Management

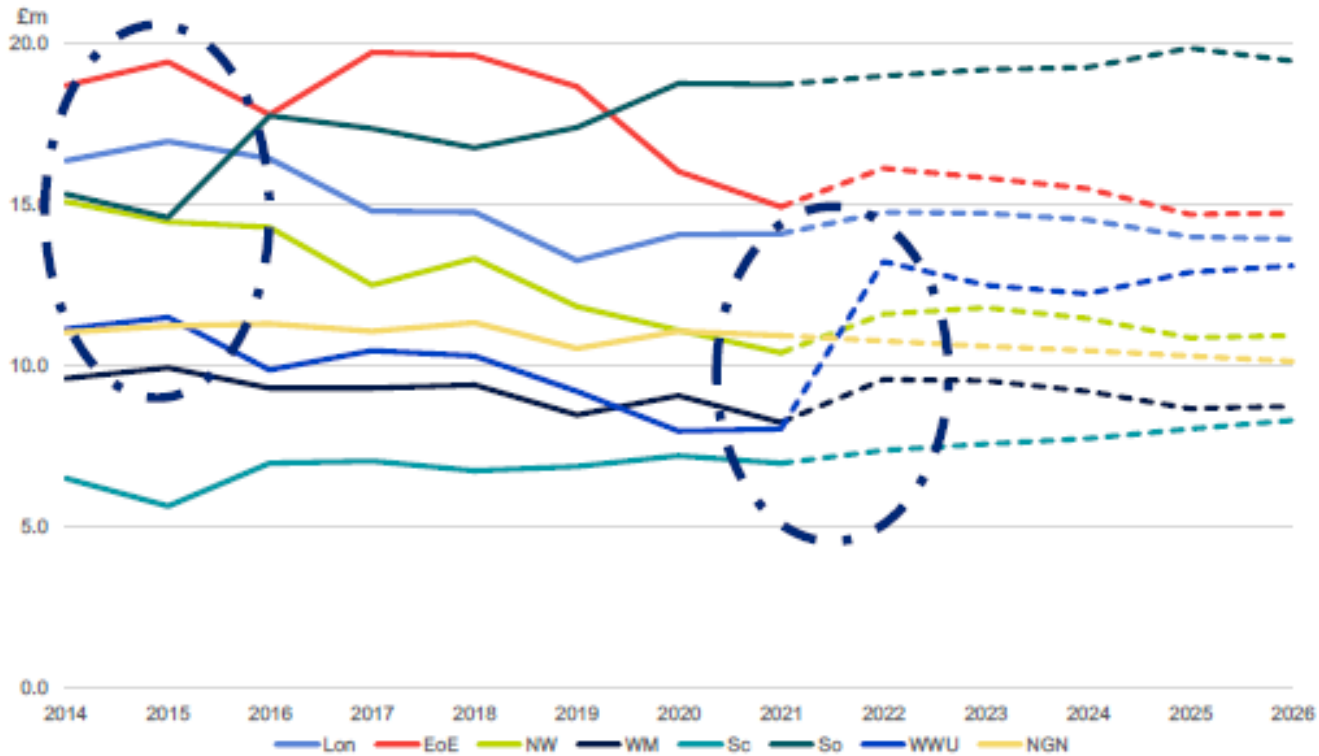
Submitted Work Management costs



- Relatively flat trend in GD2
- Some large spikes due to gasholder demolition and land remediation costs

Trend analysis: Emergency

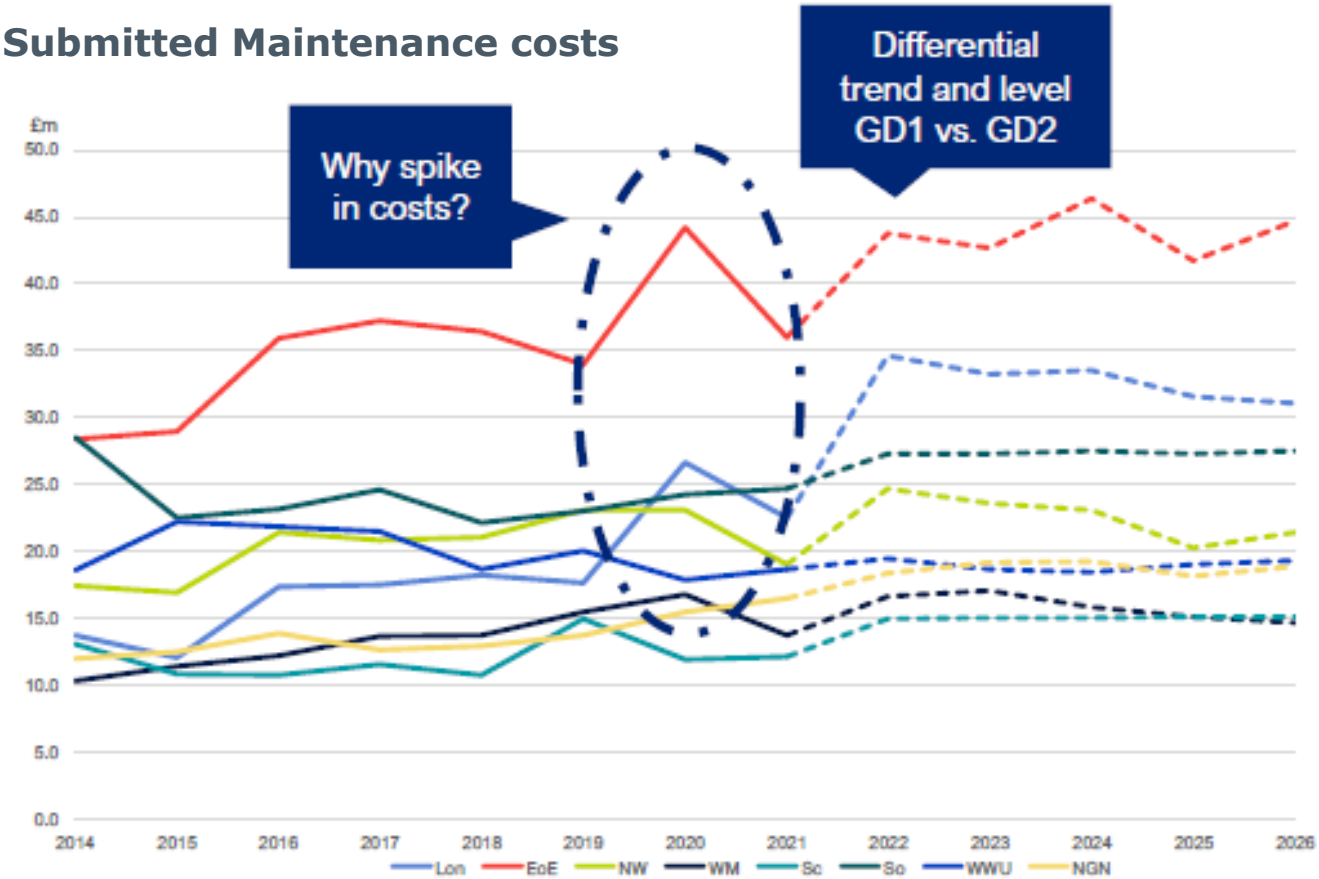
Submitted Emergency costs



- WWU's increase in emergency costs at the start of GD2 is driven by a more than doubling of staff costs in 2022 from the year before.
- Cost driver (CSV) remains flat
- Smart metering adjustments may reduce volatility

Trend analysis: Maintenance

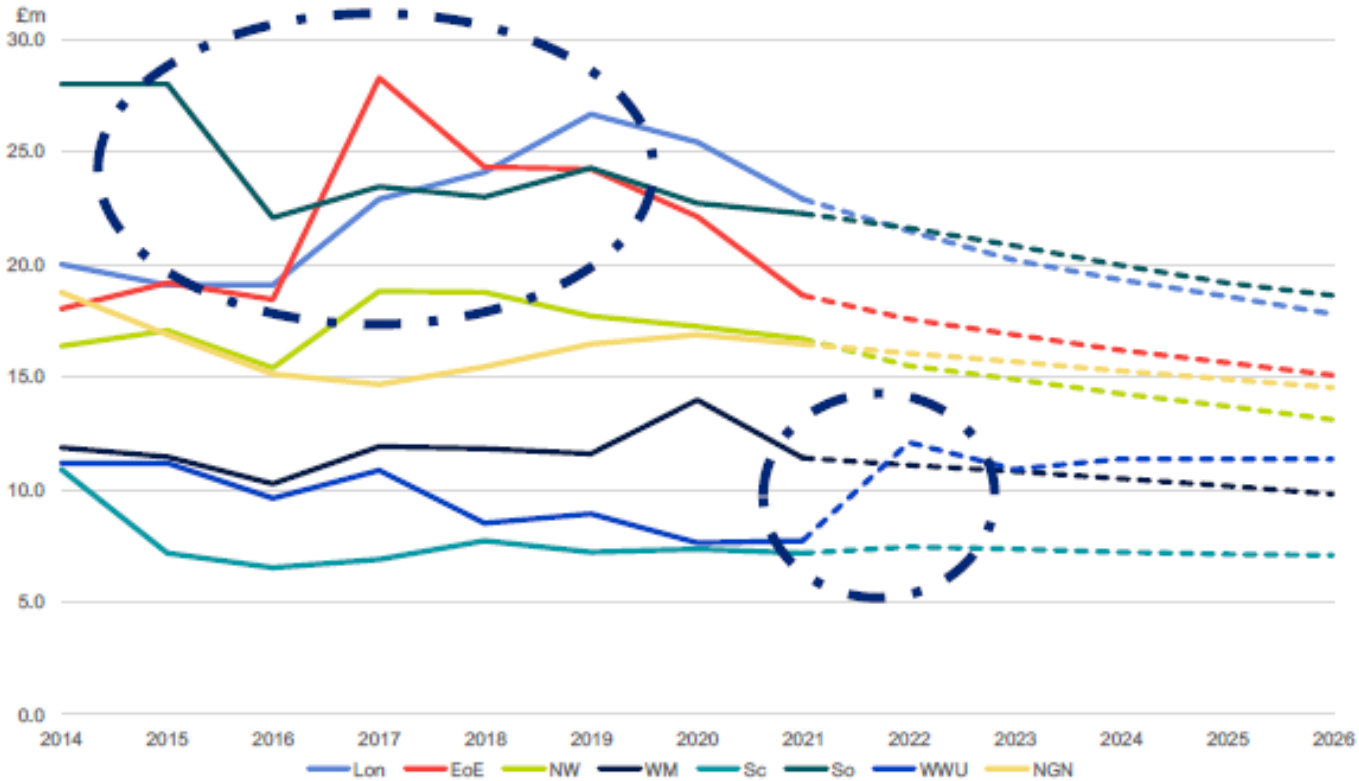
Submitted Maintenance costs



- General upward trend in costs between GD1 and GD2
- Removal of MOBs will address London spike
- EoE spike caused by 'other' non-routine maintenance – should some non-routine maintenance costs be assessed separately?

Trend analysis: Repair

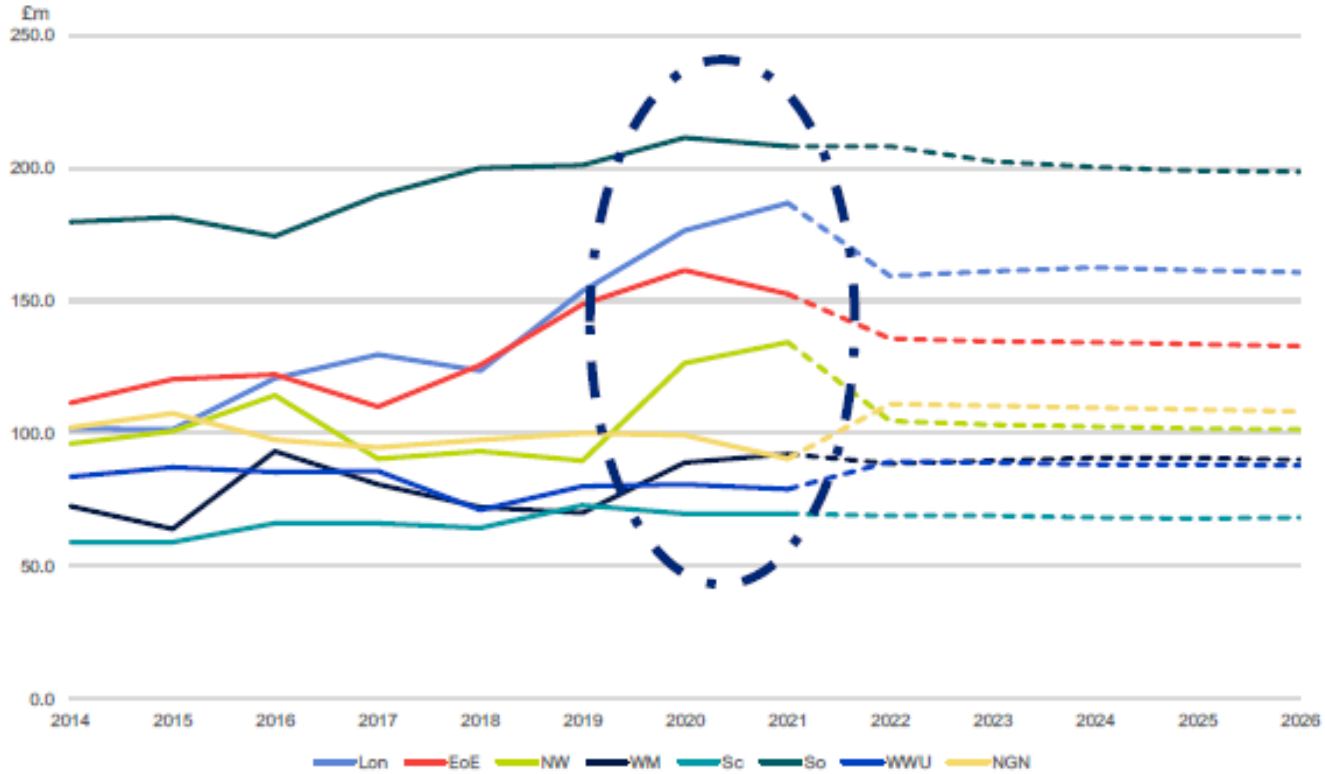
Submitted Repair costs



- General downward trend in costs between GD1 and GD2
- WWU spike due to staff and reinstatement costs – WWU has noted that the number of leaks will not be decreasing but unit costs will be increasing

Trend analysis: Repex

Submitted Repex costs



- Forecast upticks in repex in 2021 and 2022
- Trend stable in GD2 period

Discussion

- We would expect recent and forecast repex to impact emergency, repair, work management and maintenance opex
- Have certain trends been adequately justified?
- Are historic costs – and the elasticity between historic costs and cost drivers – a good predictor of future costs?
- Is there a single time period that is suitable for all regression pools?

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Data adjustments

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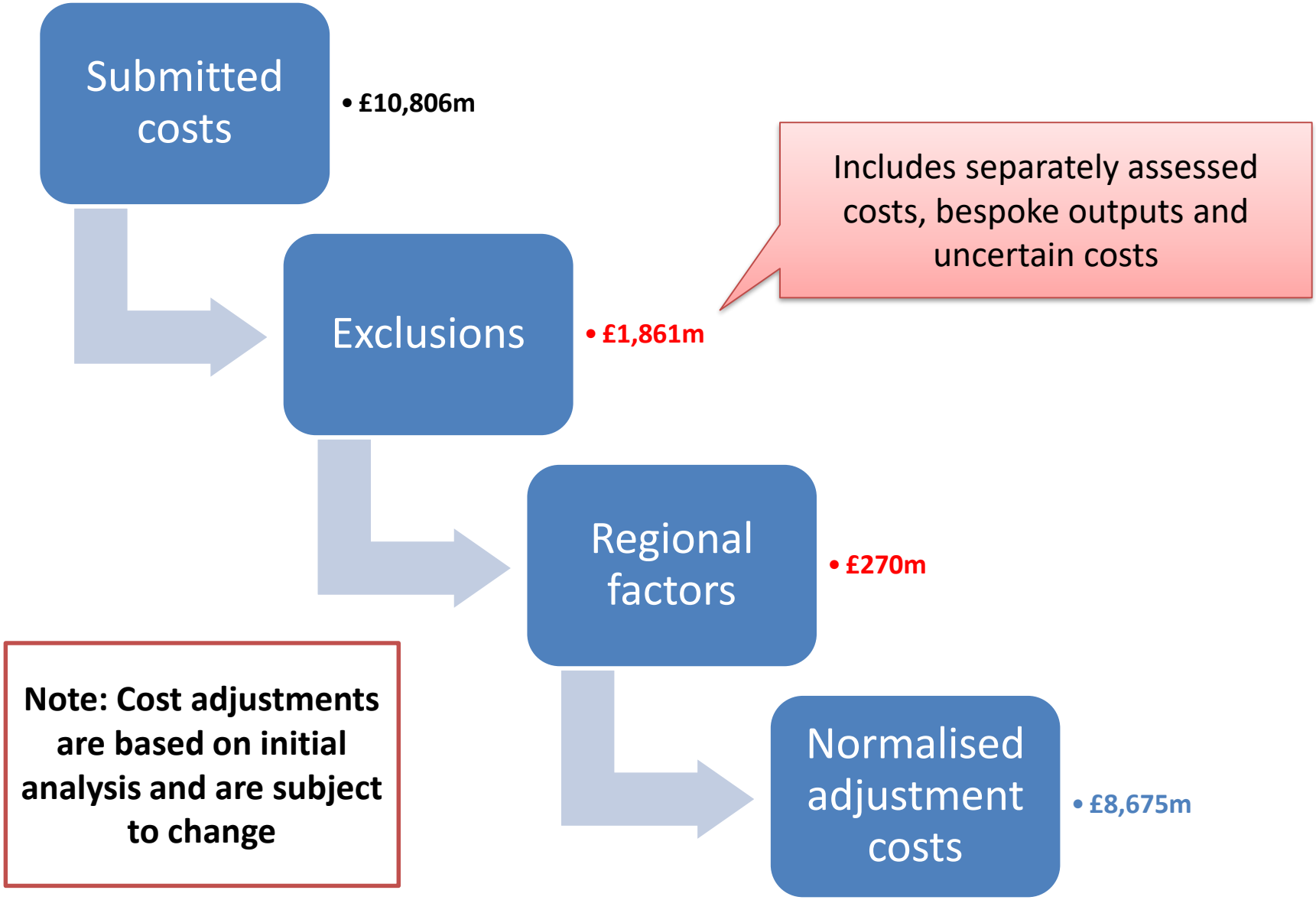
Adjustments process so far

- Review BPDTs (5.18) and supplementary responses from GDNs
- Quantify costs assessed separately in GD1 and remove from GD2 forecasts
- Remove bespoke output and uncertain costs from baseline
- Make regional factor adjustments
- Include normalised adjusted costs in econometric model testing

Adjustments process so far



Note: Cost adjustments are based on initial analysis and are subject to change

Adjustments for separately assessed costs

Cost area	Cost activity	GD1 costs removed (average)	GD2 costs removed (average)
MOBs	Connections (excl. FPNES), Maintenance, Repex	£48m	£72m
Streetworks	Opex, Capex, Repex (various activities)	£26m	£44m
Gasholder demolition	Work Management	£16m	£5m
Land remediation	Work Management	£10m	£8m
FPNES	Connections	£24m	£15m
Growth governors	Reinforcement	£2m	£3m
Other repex	Repex Services not associated with replacement Other policy & condition	£121m	£166m

Separately assessed costs: Issues to resolve

- Smart metering and loss of meter work
  - Further analysis required to ensure data comparability
- Other repex
  - Consider impact of exclusion from repex regression
- Streetworks
  - Consider productivity and administration cost adjustments

Adjustments for bespoke outputs

Bespoke category	Cost activity	GD2 costs removed (average)
Customer vulnerability	Work Management, Emergency, Business Support	£22m
EAP	Work Management, Other Capex, T&P	£20m
Cyber resilience, data sharing	Business Support, Other Capex, Work Management	£8m
Stubs	Repex Other policy & condition (already excluded)	£1.4m
DCC membership	Business Support, Other Capex	£1.1m

Bespoke outputs: Issues to resolve

- In general, GDNs did not exclude costs related to bespoke activities from their baseline totex
- For some bespoke outputs, GDNs have not identified separate costs required to meet that output (either because separate costs are difficult to identify or because the outputs are expected to be met without incurring incremental costs)
- GDN supplementary responses to be reviewed further
- Inconsistencies in reporting (Table 5.18) to be addressed via SQs

Adjustments for uncertain costs

Identifiable adjustments based on review of 5.18:

Bespoke category	Cost activity	GD2 costs removed (average)
NGN: Trans Pennine Rail Electrification	LTS	£4m
NGN: Large load connections	Reinforcement	£1.4m
SGN: Hazardous waste/reinstatement	Repex	£1.3m

Different treatment of uncertain costs across networks:

	Cadent	NGN	SGN	WWU
Hazardous waste/reinstatement		Reopener	Baseline + reopener	Reopener
Fatigue/legislative change	Reopener		Reopener	Reopener
Reinforcement/peaking plant (<7 bar)	Vol driver		Vol driver	
Tier 2A Repex	Vol driver		Vol driver	Vol driver
New Connections	Vol driver		Vol driver	

Uncertain costs: Issues to resolve

- Mixed approaches by GDNs to uncertainty mechanisms
- GDN supplementary responses to be reviewed further
- Inconsistencies in reporting (Table 5.18) to be addressed via SQs

Summary of adjustments so far

Separately assessed costs | Bespoke outputs | Uncertain costs | Company-specific costs

Cost activity	EoE	Lon	NW	WM	NGN	Sc	So	WWU
Work Management	Gasholder demolition Land remediation Vulnerability Fuel poor High rise building plans EAP	Gasholder demolition Land remediation Vulnerability Fuel poor High rise building plans EAP	Gasholder demolition Land remediation Vulnerability Fuel poor High rise building plans EAP	Gasholder demolition Land remediation Vulnerability Fuel poor High rise building plans EAP	Gasholder demolition Land remediation Streetworks	Gasholder demolition Land remediation Streetworks	Gasholder demolition Land remediation	Gasholder demolition Land remediation Streetworks Vulnerability Data sharing EAP
Emergency	CM awareness	CM awareness	CM awareness	CM awareness	Streetworks	Streetworks		Streetworks
Repair	Streetworks	Streetworks	Streetworks	Streetworks	Streetworks	Streetworks	Streetworks	Streetworks
Maintenance	MOBs	MOBs	MOBs	MOBs	MOBs Streetworks	MOBs Streetworks	MOBs	MOBs Streetworks
ODA					Streetworks	Streetworks		Streetworks
Business support						Cyber resilience IT technology readiness Open data sharing DCC Customer vulnerability	Cyber resilience IT technology readiness Open data sharing DCC Customer vulnerability	
LTS, Storage & Entry					Trans Pennine Rail Electrification			
Connections	MOBs Streetworks FPNES	MOBs Streetworks FPNES	MOBs Streetworks FPNES	MOBs Streetworks FPNES	MOBs Streetworks FPNES	MOBs Streetworks FPNES	MOBs Streetworks FPNES	MOBs Streetworks FPNES
Reinforcement	Growth governors	Growth governors Thames Tunnel & IP	Growth governors	Growth governors	Growth governors Streetworks Large load connections	Growth governors Streetworks	Growth governors	Growth governors Streetworks
Transport & Plant		EAP				EAP	EAP	
Other Capex	EAP	EAP	EAP	EAP	Streetworks	Streetworks EAP DCC Cyber resilience IT technology readiness Open data sharing	EAP DCC Cyber resilience IT technology readiness Open data sharing	Streetworks
Repex	MOBs Streetworks Services not associated with mains replacement Other policy & condition	MOBs Streetworks Services not associated with mains replacement Other policy & condition	MOBs Streetworks Services not associated with mains replacement Other policy & condition	MOBs Streetworks Services not associated with mains replacement Other policy & condition	MOBs Streetworks Services not associated with mains replacement Other policy & condition	MOBs Streetworks Services not associated with mains replacement Other policy & condition Hazardous waste	MOBs Streetworks Services not associated with mains replacement Other policy & condition Hazardous waste	MOBs Streetworks Services not associated with mains replacement Other policy & condition

Adjustments for regional factors

Bespoke category	Cost activity	GD1 costs removed (average)	GD2 costs removed (average)
Labour	Various (labour component)	-£66m	-£54m
Sparsity	Emergency, Repair		
Urbanity – reinstatement	Emergency, Repair, Maintenance, ODA		
Urbanity – productivity	Repex, Connections, Reinforcement		

Regional factors: Issues to resolve

- Update regional labour indices
  - Work management %
  - Labour-to-expenditure ratios
- Sparsity
  - Quantification of sparsity impacts on all GDNs

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Regional factors

Follow-up

Sparsity

SQ sent to GDNs

Determine network with largest sparsity impact

Calculate maximum sparsity adjustment (as % of costs)

Scale other networks proportionally based on network indices

Company-specific factors

Company-specific factors submitted (Cadent, SGN)

Opportunity to provide evidence for/against submitted company-specific factors

Ofgem assessment of company-specific factors

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RIIO-GD2 Repex Regression approach

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Overview

- Recap of RIIO-GD1 methodology
- Proposed approach for
  - Identifying the activities to be excluded from regression analysis
  - Updating synthetic unit costs
- Preliminary regression results
- Next steps

GD1 methodology

Overview of GD1 methodology

- Tier 1
- Tier 2A
- Tier 2B & 3
- Steel
- Iron >30m
- Non-rechargeable diversions
- Services assoc. with mains replacement
- Services not assoc. with mains replacement

- MOBs
- Rechargeable diversions
- Other services
- Smart metering

- Vast majority of repex costs (~95%) captured in the regression model in GD1
- Non-regression methods used sparingly, for highly bespoke areas
- Regression model used synthetic cost driver as the explanatory variable (defined in £m) against £m submitted costs
- Synthetic cost driver effectively uses workloads to weight costs to account for different workload mixes

Calculating the synthetic cost driver

- A synthetic cost driver is the explanatory variable in the repex and capex regression
- Synthetic unit costs are a key input into the synthetic cost drivers for the repex and capex (connections & reinforcement) regressions

Synthetic cost driver (£m) = SUMPRODUCT (synthetic unit cost of each activity (£m/unit) * workload volume of each activity (no. of units))

Tier 1 mains	Synthetic unit cost (£/km, 2009/10 prices)	Workloads (km, 2014)	Synthetic costs (£m, 2014)
		Mixed	*£m*
mains <=75mm	80	177.32	14.15
mains >75mm to 125mm	89	255.22	22.65
mains >125mm to 180mm	148	112.45	16.61
mains >180mm to 250mm	251	36.74	9.22
Total			**62.6**

Synthetic cost for 2014 = £62.6m

Method replicated for all asset categories and all years, to give single £m value against which to regress submitted costs

Proposed GD2 approach to activity selection

Starting point

Good fit of the RIIO-GD1 repex regression model

This is the starting point for RIIO-GD2 regression analysis

We have been re-evaluating activities and considering whether there are grounds to remove some of them from regression analysis based on economic, engineering or statistical assessment

Model Development Process - Overview

Phase 0 – Selection of regression cost categories

- Based on:
  - Activity
  - Data quality
  - Cost driver

Phase 1 – Identify preferred models

- Based on:
  - Predictive power (adjusted R-squared)
  - Statistical robustness
  - Economic / engineering rationale
  - Are the results consistent with the rest of the price control?

Phase 2 – Robustness testing for preferred models

- Removal of years / companies from panel
- Random effects
- Within sample forecasting (when appropriate)

Model Development Process – Repex/Capex overview

Phase 0 – Selection of regression cost categories

- Based on:
  - Activity
  - Data quality
  - Cost driver

Phase 0.5 – Calculating synthetic unit costs

Based on:
- Data quality and consistency
- Application of rules based approach
- Consideration of underlying engineering activities

Phase 1 – Identify preferred models

- Based on:
  - Predictive power (adjusted R-squared)
  - Statistical robustness
  - Economic / engineering rationale
  - Are the results consistent with the rest of the price control?

Phase 2 – Robustness testing for preferred models

- Removal of years / companies from panel
- Random effects
- Within sample forecasting (when appropriate)

Model development process – Phase 0

In developing our approach to RIIO-GD2, we re-evaluated the activities included in the RIIO-GD1 regression to consider whether they should remain as part of the bottom-up regression. For each distinct cost category, the following considerations should be taken into account to determine whether we should consider the use of alternative cost approaches:

Activity

- Is the activity broadly similar and repeatable between GDNs?
- Are individual projects / schemes / jobs largely similar or distinct and bespoke?

Data quality

- Is there a full set or nearly full set of observations available to run the regression on?
- Are there any known issues with the consistency of data reporting between GDNs?
- Does one GDN disproportionally dominate the share of industry costs / workloads?

Cost driver

- Can at least one cost driver for the activity be clearly identified from the available data?
- Is there a step change/structural break in costs, workloads or delivery method (i.e. technological change) of the activity that might make history a poor indicator of future costs?

Model development process – assessment guidance

Category	Question	Yes	Maybe / partially	No
Activity	Similar activity between GDNs?	Keep in regression	Judgement call – consult with engineering	Consider excluding activity from regression
Activity	Distinct / bespoke projects?	Consider excluding activity from regression	Test quality of regressions including and excluding cost category	Keep in regression
Data quality	Full or near complete available data set?	Keep in regression	Depends on how close to complete – judgement based on no of observations from different networks/companies	Consider excluding activity from regression
Data quality	Data consistency issues?	Consider excluding activity from regression	Test quality of regression and assess outputs	Keep in regression
Data quality	GDN dominates costs/volumes?	Consider excluding activity from regression	Judgement call – test regression and assess outputs	Keep in regression
Cost driver	Clearly identify driver?	Keep in regression	Can test different possible drivers and assess outputs	Consider excluding activity from regression
Cost driver	Structural break?	Consider excluding activity from regression	Test different length datasets	Keep in regression

Assessment overview – Tier 1 mains (and associated services)

Category	Question	Preliminary view	Notes
Activity	Similar activity between GDNs?	Yes	Highly repeatable, both between GDNs and over time.
Activity	Distinct / bespoke projects?	No	Although projects may vary in size and scope, volumes are sufficiently large that these differences considered to average out on an annual and yearly basis.
Data quality	Full or near complete available data set?	Yes	Full historical and forecast dataset available for all GDNs in all years.
Data quality	Data consistency issues?	Maybe	There are potential differences in how GDNs allocate costs to services and how they attribute overheads. Diameter band costs for replacement should be reasonably well defined though.
Data quality	GDN dominates costs/volumes?	No	All GDNs undertake replacement activity and replacement rates broadly consistent with network size.
Cost driver	Clearly identify driver?	Yes	Workloads and diameter bands are a clear driver of costs and were used as cost driver in GD1. Other cost drivers (technique, location) may be possible to test, depending on data provided through SQs.
Cost driver	Structural break?	No	There is no significant structural break in the nature or volume of the workloads being undertaken. GDNs are forecasting higher costs, but drivers are potentially contestable (i.e. labour cost assumptions), so don't prevent use in regression.
Overall view		**Keep in regression**	**Passes on majority of measures with only question over allocation methodologies. However, regression analysis may smooth out inconsistencies anyway.**

Example

Assessment overview – Other Policy & Condition (and associated services)

Category	Question	Preliminary view	Notes
Activity	Similar activity between GDNs?	Maybe	Specific nature of mains (and potentially assessment methods) may vary by GDN (e.g. which material being replaced). However, on average, activities broadly comparable between GDNs.
Activity	Distinct / bespoke projects?	Yes	Projects based on decommissioning certain materials (i.e. asbestos) may have quite bespoke costs, owing to complexity of operations/additional safety considerations.
Data quality	Full or near complete available data set?	No	Few observations historically or forecast.
Data quality	Data consistency issues?	Maybe	Definitions/classifications for different materials may vary for Policy & Condition mains (e.g. workloads which are not MPDI)
Data quality	GDN dominates costs/volumes?	Maybe	SGN only company with GD1 workloads for MPDI Tier 2B. MPDI Tier 1 has 5 networks from two companies with GD1 workloads.
Cost driver	Clearly identify driver?	Yes	Workloads and diameter bands are a clear driver of costs and were used as cost driver in GD1. Other cost drivers (technique, location) may be possible to test, depending on data provided through SQs.
Cost driver	Structural break?	No	MDPI has been required to be decommissioned since before start of GD1 and volumes are v. low (workloads are replace-on-find in nature).
Overall view		**Exclude from regression analysis and assess through non-regression.**	**Fails to meet a number of categories and workloads are very small. Propose scrutinising needs case through EJP review, including proposed costs and looking at alternative non-regression options for assessing costs.**

Example

Overview of Phase 0 assessment

Category	Include in regression?	Initial comments
Tier 1	Yes	Meets criteria for keeping the activity in regression analysis.
Steel <=2”	Yes	Meets criteria for keeping the activity in regression analysis.
Tier 2A	Test	Potential issues around larger diameter projects being bespoke in nature. Also question about whether requires upfront allowance at all, as covered by VD and volumes are small.
Tier 2B	Test	Potential issues around larger diameter projects being bespoke in nature. Materiality should be assessed. May need to consider a diameter band cut-off within Tier.
Tier 3	Test	Potential issues around larger diameter projects being bespoke in nature. Materiality should be assessed and implications of including established.
Steel mains >2”	Test	Meets most criteria, but significant increase in volumes being proposed, so potential structural break between GD1/GD2. May become relevant depending on overall approach to history vs forecast data.
Iron mains >30m	Yes	Meets criteria for keeping the activity in regression analysis.
Other policy & condition mains	No	Activity potentially more bespoke in nature and relatively few historical data points across industry to base synthetic unit cost update on.
Diversions	No	Activity potentially more bespoke in nature and drivers are quite location-specific.
Cap Replacement	Test	Meets some criteria and activity broadly similar between GDNs. Materiality should be assessed.
MOBs	No	Activity bespoke in nature and heavily influenced by Lon region. To be excluded from regression analysis.
Services not assoc. w/ mains replacement	Test	Generally meets criteria for keeping the activity in regression analysis, although individual activities (e.g. smart metering) may not, so some sub-division should be considered.

Key questions

- What are your views on the evaluation criteria?
- What are your views on our assessment?

Proposed GD2 approach to synthetic unit cost update

Model Development Process – Repex/Capex overview

Phase 0 – Selection of regression cost categories

- Based on:
  - Activity
  - Data quality
  - Cost driver

Phase 0.5 – Calculating synthetic unit costs

Based on:
- Data quality and consistency
- Application of rules based approach
- Consideration of underlying engineering activities

Phase 1 – Identify preferred models

- Based on:
  - Predictive power (adjusted R-squared)
  - Statistical robustness
  - Economic / engineering rationale
  - Are the results consistent with the rest of the price control?

Phase 2 – Robustness testing for preferred models

- Removal of years / companies from panel
- Random effects
- Within sample forecasting (when appropriate)

Synthetic cost driver (£m) = SUMPRODUCT (synthetic unit cost of each activity (£m/unit) * workload volume of each activity (no. of units))

- For RIIO-GD2, we have undertaken an update of synthetic unit costs for repex and capex (reinforcement & connections) activities
- This is based on an assessment of the actual (and forecast) costs for GD1 and GD2
- We apply a series of rules to evaluate where there is sufficient data to produce a representative industry unit cost for a specific activity and use this in our regression models
- Where activities are sufficiently similar in nature, costs and workloads will be aggregated to create a single synthetic unit cost (e.g. Tier 2A & Tier 2B mains replacement)

Phase 0.5 – Proposed synthetic unit cost methodology

Calculate unit costs

For all activities and all GDNs in all years (GD1 and GD2)	Unit costs = submitted costs / submitted workload

Apply rule 1

Minimum number of networks = 2	Same ownership company is ok

Apply rule 2

Outlier test – observations more than 100% from industry average excluded

Apply rule 3-5

Rule 3: Max 40% away from RIIO-1 industry avg. unit cost	Rule 4: Max 40% away from industry avg. unit cost for network	Rule 5: Max 40% away from industry avg. unit cost through the considered period

Synthetic unit cost, same for all GDNs

Summary of preliminary synthetic unit cost update

Mains						
Tier	**Pipe material**	**Diameter**	**Units**	**Updated RIIO-1**	**Updated RIIO-2**	**RIIO-1**
Tier1	Cast Iron	<75mm	£/km	110,472	108,459	104,797
Tier1	Cast Iron	75_125mm	£/km	130,610	153,995	116,526
Tier1	Cast Iron	125_180mm	£/km	197,337	167,798	193,973
Tier1	Cast Iron	180_250mm	£/km	369,492	281,560	329,498
Tier1	Ductile Iron	<75mm	£/km	101,726	114,543	104,797
Tier1	Ductile Iron	75_125mm	£/km	113,841	158,858	116,526
Tier1	Ductile Iron	125_180mm	£/km	188,926	182,365	193,973
Tier1	Ductile Iron	180_250mm	£/km	391,954	293,006	329,498
Tier1	Steel <=2"	All	£/km	121,968	137,669	186,199
Tier2	All	<355mm	£/km	385,186	368,237	308,133
Tier2	All	355_500mm	£/km	863,564	569,632	990,865
Tier3	All	355_500mm	£/km	1,005,602	681,673	990,865
Iron>30m	All	<125mm	£/km	125,977	113,838	193,973
Iron>30m	All	125_180mm	£/km	179,883	145,448	329,498
Iron>30m	All	180_250mm	£/km	276,916	224,913	444,385
Iron>30m	All	250_355mm	£/km	428,337	453,826	659,620
Iron>30m	All	355_500mm	£/km	775,349	751,681	990,865
Services						
Type	**Relay/Transfer**	**Dom./Non-Dom.**	**Units**			**avg.**
Associated	Relay	All	£/service	744	705	1,602
Associated	Transfer	All	£/service	476	445	1,378
Not-Associated	Relay	All	£/service	1,171	1,191	1,602
Reinforcement						
Type	**Mains/Gov.**	**Type**	**Units**			**avg.**
All	Mains	a. <=180mm	£/km	248,559	286,439	180,907
All	Mains	b. >180mm	£/km	411,557	466,397	333,828
Connections						
Type	**Mains/Gov./Serv.**	**Type**	**Units**			**avg.**
All	Mains	a. <=180mm	£/km	96,008	74,464	143,040
All	Services	All	£/service	1,410	1,344	1,027

Note. Updated RIIO-1(2): synthetic unit costs updated using just RIIO-1(2) data.
RIIO-1: synthetic unit costs used in RIIO-GD1. (2018/19 prices)

Discussion points – synthetic unit cost update

- Could we use iron mains with a standardised adjustment as a proxy for steel mains?
- Do you agree with the larger diameter distinction for Tier 2B&3?
- Are there other categories that could be aggregated?
- Should we include separate unit cost calculations for CI&SI and DI for Tier 1?
- Should we only use RIIO-GD1 data for updating the synthetic unit costs?

More generally,

- The proposed methodology would suggest not using the synthetic unit costs approach for some activities (e.g. services not associated with mains replacement, mains reinforcement, connections) due to significant variation between GDNs and outliers
  - What are your thoughts on excluding these activities?

Repex regression model testing and preliminary outputs

List of regressions to test

1. Full core and CBA coverage

All of 1. + 2.

Tier 2B (>355m, plus assoc. services)

Tier 3 (>355m, plus assoc. services)

Steel mains >2" (up to 355mm, plus assoc. services)

(Services not assoc. w/ mains replacement)

Repex1

2. Core repex + higher volume CBA activities

All of 1.

Tier 2B (up to 355mm, plus assoc. services)

Tier 3 (up to 355mm, plus assoc. services)

Tier 2A + assoc. services

Repex2

3. Core repex activities

Tier 1 + assoc. services (separate out cast & spun iron and ductile iron)

Steel <=2" + assoc. services

Iron mains >30m

Tier 2A + assoc. services

Repex3

Results – Historical and RIIO-GD1

Variables	Repex1	Repex2	Repex3	Repex1	Repex2	Repex3
Trend	0.006	0.01	0.016*	0.004	0.008	0.013**
	(0.522)	(0.244)	(0.059)	(0.547)	(0.174)	(0.019)
SyntCost3			0.767***			0.769***
			(0.000)			(0.000)
SyntCost2		0.766***			0.776***	
		(0.000)			(0.000)	
SyntCost1	0.765***			0.775***		
	(0.000)			(0.000)		
Constant	-10.042***	-10.064***	-10.087***	-10.222***	-10.232***	-10.115***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Adj. R2	0.865	0.876	0.885	0.852	0.867	0.875
Obs.	48	48	48	64	64	64

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Similar results across all specifications

Model fit is broadly consistent across specifications

Results – RIIO-GD2 and RIIO-GD1+GD2

Variables	Repex1	Repex2	Repex3	Repex1	Repex2	Repex3
Trend	-0.016	-0.014	-0.011	0.005	0.007**	0.010***
	(0.355)	(0.381)	(0.389)	(0.171)	(0.032)	(0.001)
SyntCost3			0.813***			0.785***
			(0.000)			(0.000)
SyntCost2		0.799***			0.784***	
		(0.000)			(0.000)	
SyntCost1	0.772***			0.773***		
	(0.000)			(0.000)		
Constant	-9.917***	-10.412***	-10.669***	-10.192***	-10.373***	-10.374***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Adj. R2	0.692	0.756	0.832	0.795	0.828	0.86
Obs.	40	40	40	104	104	104

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Results robust to inclusion of GD2 data

Slightly worsened model fit

Next steps

Next steps

- Finalise approach to synthetic unit cost update
- Finalise decision on which activities to drop from regression
- Continue developing non-regression assessment approaches for activities not included in the final regression
- Feed in volume adjustments (where applicable) from the engineering review

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Econometric Modelling

Follow-up

Our ongoing modelling work

All models estimated using data from December BP submissions

Data normalised as per RIIO-GD1 assumptions (regional factors and other adjustments – separately assessed costs, bespoke outputs and uncertain costs)

Four samples: historical, RIIO-GD1, RIIO-GD2 and RIIO-GD1+GD2

Our ongoing modelling work

Level of aggregation

Bottom-up	• RIIO-GD1 models • Emergency = f(max PREs)
Middle-up	• Opex = f(opex CSV) • Capex = f(capex CSV) • Repex = f(workload)
Top-Down	• Totex = f(CSVs)
Pool1	• Asset Management + Operations Management + Business Support Costs + ODAs = f(MEAV)
Pool2	• Emergency + Repairs + Repex Other Services = f (MEAV)/f (CSV) • Emergency + Repairs + Repex Other Services + Operations Management = f (CSV)
Pool3	• Emergency + Repairs + Maintenance + Repex Other Services = f(Maint MEAV)
Pool4 (CostPlus)	• Opex + Capex (excl. reinforcement) + Repex Other Services = f(MEAV) • Opex + Capex (excl. reinforcement) + Repex Other Services = f(CSVs)

All variables in natural logarithm

All specifications include a **time trend**

Business support regressions excluded for now (separate analysis)

Results are **preliminary**

Our ongoing modelling work

Model #	Cost	Driver	Note
1	Work Management	Opex CSV	
2	Work Management	MEAV	
3	Emergency	Emergency CSV	
3a	Emergency	Max PREs (5yr)	
4	Maintenance	Maintenance MEAV	
5	Repairs	Tot. Ext. Cond. Reports	
6	Connections	Connections synthetic costs	
7	Reinforcement	Mains synthetic costs	
~~8~~	~~Business Support Costs~~	~~CSV4~~	~~Customers (.50), Network Length (.50)~~
~~9~~	~~Business Support Costs~~	~~MEAV~~	
10	Repex	Repex synthetic costs	
11	Capex	Capex CSV	
12	Opex	Opex CSV	
13	Totex	Totex CSV	
14	Totex	Maintenance MEAV	
15	Totex	MEAV	
16	Totex	Network Length	
17	Totex	Throughput	
18	Totex	CSV1	Customers (.25), Network Length (.50), Throughput (.25)
19	Pool1	MEAV	
20	Pool2	~~Maintenance~~ MEAV	
21	Pool2A	CSV3	Customers (.22), PREs (.34), Tot. Ext. Cond. Reports (.44)
22	Pool3	Maintenance MEAV	
23	Pool4	MEAV	
24	Pool4	Totex CSV	
25	Pool4	CSV1	Customers (.25), Network Length (.50), Throughput (.25)
26	Pool4	CVS2	Emergency CSV (.08), Tot. Ext. Cond. Reports (.10), Maintenance MEAV (.14), Connections synthetic costs (.07), MEAV (.61)

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Econometric Models Results – Historical Data

Model #	Cost	R^2	RESET test		Model #	Cost	R^2	RESET test	
			CAWG13	CAWG12				CAWG13	CAWG12
1	Work Management	0.206 ↓			14	Totex	0.414 ↓		
2	Work Management	0.140 ↓			15	Totex	0.613 ↓		
3	Emergency	0.831 ↑			16	Totex	0.646 ↓		
3a	Emergency	0.643			17	Totex	0.787 ↓		
4	Maintenance	0.333 ↓			18	Totex	0.764 ↓		
5	Repairs	0.779 ↓			19	Pool1	0.16 ↓		
6	Connections	0.824 ↓			20	Pool2	0.22 ↑		
7	Reinforcement	0.513 ↓			21	Pool2A	0.958 ↑		
10	Repex	0.788 ↓			22	Pool3	0.19 ↑		
11	Capex	0.714 ↓			23	Pool4	0.611 ↓		
12	Opex	0.386 ↓			24	Pool4	0.63 ↓		
13	Totex	0.717 ↓			25	Pool4	0.775 -		
					26	Pool4	0.613 -		

Note. ↑(↓) indicates whether R^2 increased(decreased) compared to CAWG12 models.

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Econometric Models Results – RIIO-GD1 Data

Model #	Cost	R^2	RESET test		Model #	Cost	R^2	RESET test	
			CAWG13	CAWG12				CAWG13	CAWG12
1	Work Management	0.278 ↓			14	Totex	0.318 ↓		
2	Work Management	0.201 ↓			15	Totex	0.527 ↓		
3	Emergency	0.700 ↓			16	Totex	0.578 ↓		
3a	Emergency	0.643			17	Totex	0.717 ↓		
4	Maintenance	0.321 ↓			18	Totex	0.696 ↓		
5	Repairs	0.761 ↓			19	Pool1	0.204 ↑		
6	Connections	0.793 ↓			20	Pool2	0.182 ↑		
7	Reinforcement	0.403 ↓			21	Pool2A	0.913 ↑		
10	Repex	0.755 ↓			22	Pool3	0.145 ↓		
11	Capex	0.608 ↓			23	Pool4	0.549 ↓		
12	Opex	0.435 ↓			24	Pool4	0.633 ↓		
13	Totex	0.69 ↓			25	Pool4	0.714 ↓		
					26	Pool4	0.552 ↓		

Note. ↑(↓) indicates whether R^2 increased(decreased) compared to CAWG12 models.

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Econometric Models Results – RIIO-GD2 Data

Model #	Cost	R^2	RESET test		Model #	Cost	R^2	RESET test	
			CAWG13	CAWG12				CAWG13	CAWG12
1	Work Management	0.632 ↓			14	Totex	0.281 ↑		
2	Work Management	0.491 ↓			15	Totex	0.52 ↑		
3	Emergency	0.759 ↓			16	Totex	0.536 ↑		
3a	Emergency	0.776			17	Totex	0.732 ↑		
4	Maintenance	0.271 ↑			18	Totex	0.678 ↑		
5	Repairs	0.778 ↑			19	Pool1	0.44 ↑		
6	Connections	0.844 ↓			20	Pool2	0.307 ↑		
7	Reinforcement	0.444 ↓			21	Pool2A	0.816 ↓		
10	Repex	0.756 ↑			22	Pool3	0.214 ↓		
11	Capex	0.504 ↓			23	Pool4	0.656 ↑		
12	Opex	0.711 ↑			24	Pool4	0.705 ↑		
13	Totex	0.692 ↑			25	Pool4	0.714 ↑		
					26	Pool4	0.641 ↑		

Note. ↑(↓) indicates whether R^2 increased(decreased) compared to CAWG12 models.

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Econometric Models Results – RIIO-GD1+GD2 Data

Model #	Cost	R^2	RESET test		Model #	Cost	R^2	RESET test	
			CAWG13	CAWG12				CAWG13	CAWG12
1	Work Management	0.414 ↓			14	Totex	0.274 ↓		
2	Work Management	0.325 ↓			15	Totex	0.495 ↓		
3	Emergency	0.803 ↓			16	Totex	0.548 ↓		
3a	Emergency	0.724 ↓			17	Totex	0.703 ↓		
4	Maintenance	0.334			18	Totex	0.672 ↓		
5	Repairs	0.756 ↓			19	Pool1	0.288 ↑		
6	Connections	0.813 ↓			20	Pool2	0.238 ↑		
7	Reinforcement	0.366 ↓			21	Pool2A	0.867 ↑		
10	Repex	0.753 ↑			22	Pool3	0.171 ↓		
11	Capex	0.474 ↓			23	Pool4	0.561 ↑		
12	Opex	0.529 ↑			24	Pool4	0.649 ↑		
13	Totex	0.677 ↓			25	Pool4	0.701 ↓		
					26	Pool4	0.562 ↑		

Note. ↑(↓) indicates whether R^2 increased(decreased) compared to CAWG12 models.

Summary of results

- Overall
  - Estimated coefficients of cost drivers are always statistically significant
  - With respect to results presented at CAWG12:
    - R^2 does not necessarily improve
    - Many models still fail RESET test (5% significance level), although slight improvement when using RIIO-GD2 data only
  - Among the estimated models, those using MEAV as a driver generally exhibit poor performance

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Proposed approach for models selection – An example of Phase 1 and 2 analysis

	Totex Mod. 13	Totex Mod. 18	Totex Mod. 13	Totex Mod. 18	Totex Mod. 13	Totex Mod. 18	Totex Mod. 13	Totex Mod. 18
Totex CSV	0.654*** (0.000)		0.686*** (0.000)		0.719*** (0.000)		0.699*** (0.000)	
CSV1		0.710*** (0.000)		0.697*** (0.000)		0.639*** (0.000)		0.674*** (0.000)
Trend	0.010 (0.341)	0.007 (0.498)	0.013* (0.085)	0.014* (0.067)	-0.024* (0.097)	-0.026* (0.085)	0.000 (0.933)	-0.001 (0.738)
Constant	0.730* (0.099)	-2.878*** (0.000)	0.480 (0.257)	-2.781*** (0.000)	0.737 (0.223)	-1.593* (0.071)	0.511 (0.134)	-2.384*** (0.000)
Adj. R^2	0.717	0.764	0.696	0.690	0.692	0.678	0.677	0.672
Obs.	48	48	64	64	40	40	104	104

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10
Note. CSV1 = Customers (.25), Network Length (.50), Throughput (.25)

Comparison GD1 Totex model vs. alternative model
Are there strong reasons to move away from the status quo?

Proposed approach for models selection – Phase 1 analysis example

- For example, totex model 13 shows a good fit and a sensible (significant) coefficient but fails the RESET test
- How to proceed?
  1. Run alternative specification (quadratic term)
  2. Check statistical significance and model fit

Introducing a quadratic term does not improve model fit substantially and coefficients are not statistically significant

Model 13 could be used even if it fails the RESET test

	Totex Mod. 13	Totex Mod. 13a
Totex CSV	0.699*** (0.000)	-2.908 (2.658)
Totex CSV sq.		0.254 (0.187)
Trend	0.000 (0.933)	0.001 (0.004)
Constant	0.511 (0.134)	13.307 (9.433)
Adj. R^2	0.677	0.680
Obs.	104	104

Proposed approach for models selection – Phase 2 analysis example

- With OLS, we are not exploiting the panel nature of the data
- How to check whether this would be more appropriate?

  1. Run random effects (RE) model
  2. Breusch-Pagan test for random effects

The test suggests the use of random effects

However, no evident differences in results. Thus, OLS could still be the preferred model if they produce more plausible parameter estimates

	Totex Mod. 13 OLS	Totex Mod. 13 RE
Totex CSV	0.699*** (0.000)	0.538*** (0.096)
Trend	0.000 (0.933)	-0.000 (0.679)
Constant	0.511 (0.134)	1.646** (0.679)
Adj. R^2	0.677	(0.683)
Obs.	104	104

Further robustness checks - Choosing Composite Scale Variable (CSV) weights

Using industry cost shares as weights

- Combined with the inclusion of a single CSV measure in the regression model, places restriction on the relative elasticities of the individual cost components
- Doesn't permit relative unit costs of cost components to be different from the relative marginal costs, which may not match reality

Including all of the components of the CSV directly in the model

- Ensures that the estimates of inefficiency (contained within the residual) are purged of the effects of all of the variables
- Could lead to problems of multi-collinearity, and produce non-plausible elasticities on the individual components (e.g. negative elasticities)

Example: Emergency regressions (driver: CSV of customer numbers and total external condition reports)

- Independently of the time period considered, GD1 and econometric approach produced **significant and similar coefficients**
- Regressions using CSV from econometric method did **slightly better at passing RESET test**
- **Same results** from heteroscedasticity and normality tests
- Regressions using CSV from econometric method always had higher adjusted $R^{2,}$ so have **better model fit**

Overall, regressions using the CSV variables from the econometric models did slightly better in diagnostic tests than the CSV used in GD1, but not significantly better

We intend to use econometric approach to CSV as a robustness check

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