Appendix 8o:

Inflation forecasting: Real Price Effects and Input Price Inflation at PR19

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INFLATION FORECASTING: REAL PRICE EFFECTS AND INPUT PRICE INFLATION AT PR19

A report for Yorkshire Water

CONTENTS

1. Executive summary

This report for Yorkshire Water (Yorkshire) sets out our forecasts for underlying input price inflation by price control area and cost category over PR19. Our forecasts (in conjunction with evidence on the scope for efficiency gains) can be used to inform an analysis of real price effects and can further act as supporting evidence for Appointee Tables 24 and 24a.

1.1 Background

As part of their PR19 Business Plans, companies must provide an assessment of real price effects (RPEs) for each of the four wholesale price control areas, split by:

- operating expenditure;
- maintaining the long-term capability of the assets ~ infrastructure;
- maintaining the long-term capability of the assets ~ non-infrastructure;
- other capital expenditure ~ infrastructure; and
- other capital expenditure ~ non-infrastructure.

The RPE data required by Ofwat is set out in Sections B through to E of Appointee Table 24a. Here, companies are required to provide % RPE values, annually over PR19, in the above categories. Ofwat's guidance defines this as follows:

"For wholesale services, the RPE of cost category 'c' in year 't' should be calculated as:

$$RPE_c\,(\%) = (1 plus\ IPI_{c,t}(\%))/(1 plus\ CPIH_t(\%)) - 1$$

Where IPI (input price inflation) is the absolute-level each cost category (e.g. operating expenditure), has increased in year t relative to the previous regulatory year."[1]

Further to the above, companies must also provide evidence for retail IPI, split by:

- total operating expenditure; and
- capex.

[1] *'Delivering Water 2020: Our methodology for the 2019 price review Final guidance on business plan data tables.' Ofwat (December 2017); page 32.*

In the above context, Yorkshire asked us to take forward analysis to inform the input price inflation (IPI) it will face during PR19 within its wholesale and retail price controls. This report sets out the results of our work. Given the inherent uncertainty of forecasting, we make use of a range of methods and evidence, falling into three categories: (i) economic fundamentals; (ii) extrapolations; and (iii) independent third-party forecasts.

This report is structured as follows:

- The reminder of this executive summary provides an **overview of our forecasts**.
- Chapter 2 sets out our methodology in detail, and our resultant forecasts of **underlying IPI**, by price control area and cost type (this includes details of the implied forecasts using the full range of methods we explored).
- Chapter 3 sets out the implied **overall** IPI for Yorkshire in the dimensions required for its Plan.

1.2 Summary of our findings

1.2.1 Underlying gross input price inflation by price control area

We have developed forecasts of the company's underlying IPI at a granular level. Specifically, our approach has been to identify key cost 'types' or categories within each control area (e.g. chemicals, energy etc) and to develop forecasts for each of these costs (using various methods). These are then 'weighted' up (based on the composition of cost) in order to arrive at forecast IPI at the levels stipulated by Ofwat.

OUR APPROACH TO FORECASTING IPI HAS BEEN GRANULAR – STARTING FROM DEVELOPING FORECASTS FOR INDIVIDUAL COST TYPES. AS THERE ARE PROS AND CONS OF THE METHODS WE HAVE USED, WE HAVE PROVIDED YORKSHIRE WITH DETAILED RESULTS, ALLOWING THE COMPANY TO SELECT SPECIFIC METHODS, AS APPROPRIATE.

We have used a wide range of methods to develop our forecasts. These include, for example, developing our own econometric forecasting models; extrapolating prevailing trends; and drawing on third party evidence. There are pros and cons of the approaches we have used and so, in the interests of transparency, we have:

- **Provided Yorkshire with the underlying granular level forecasts for all methods.** This is further supported by a spreadsheet file, in which Yorkshire is able to 'select' from the various methods we used, in order to see how these impact the implied overall forecasts for IPI by control area.
- Within this report, we have **highlighted our views as to the relative merits of the methods** used (noting that the feasibility of methods varies by cost category).

For the purposes of this executive summary, the following tables set out the estimation method and resultant IPI implied by our own *'central'* assumptions, by price control area. Our 'central' forecasts were chosen based on the following considerations:

» In general, our preferred approach are methods based on economic fundamentals - identifying statistical relationships between Yorkshire's underlying inflation and wider measures of UK economic performance.

» Out of the different estimations that are based on the economic fundamentals approach, we prefer the models that produce *robust* statistical results.

- Where we apply a 'wedge' method, we prefer to measure the wedge relative to an inflation metric that shares common drivers with the cost category we are looking at.
- For independent forecasts, we comment on which scenario we think is more probable, given our understanding of the UK's wider economic performance.

The following table summarises the approaches we applied in our 'central case.'

Table 1: Cost categories and estimation methods for central case

Cost category	Estimation method
Wholesale	
Labour	Econometrics based on wages % changes
Energy	BEIS low growth scenario
Chemicals	Econometrics % changes
Other	CPI
Maintenance	Wedge versus GDP
Capex	Wedge versus CPI
Retail	
Labour	Econometrics based on wages in levels
Customer service	Econometrics based on wages in levels
Meter reading	Econometrics based on wages in levels
Doubtful debts	Econometrics – national approach
IT	Wedge versus CPI
Postage	Wedge versus CPI
Business rates	RPI
Other	CPI
Capex	As per opex / or IT inflation

Source: Economic Insight analysis

We should highlight, however, that for planning purposes it would be credible for Yorkshire to depart from our view of the central case. In particular, the extent to which any one particular method is 'superior' to another is finely balanced. Consequently, it would be entirely legitimate for Yorkshire to reach its own views as to which of our various granular forecasts are most robust and appropriate, in the context of its PR19 Plan. We think it is especially important that Yorkshire applies forecasts that it considers are internally consistent with macroeconomic assumptions underpinning other core elements of its Plan.

Applying our 'central case' assumptions, the following tables set out the implied overall IPI forecast, by price control area.

Table 2: Gross input price inflation - wholesale **water resources**

Year / cost category	2020/21	2021/22	2022/23	2023/24	2024/25	Average
Operating expenditure	2.43%	2.28%	2.25%	2.25%	2.34%	2.31%
Maintaining the long-term capability of the assets infrastructure	2.35%	2.54%	2.72%	2.72%	2.72%	2.61%
Maintaining the long-term capability of the assets non-infrastructure	2.35%	2.54%	2.72%	2.72%	2.72%	2.61%
Other capital expenditure ~ infrastructure	3.12%	3.14%	3.14%	3.14%	3.14%	3.14%
Other capital expenditure ~ non-infrastructure	3.12%	3.14%	3.14%	3.14%	3.14%	3.14%

Source: Economic Insight analysis

Table 3: Gross input price inflation - wholesale **water network plus**

Year / cost category	2020/21	2021/22	2022/23	2023/24	2024/25	Average
Operating expenditure	2.21%	2.14%	2.13%	2.14%	2.17%	2.16%
Maintaining the long-term capability of the assets infrastructure	2.35%	2.54%	2.72%	2.72%	2.72%	2.61%
Maintaining the long-term capability of the assets non-infrastructure	2.35%	2.54%	2.72%	2.72%	2.72%	2.61%
Other capital expenditure ~ infrastructure	3.12%	3.14%	3.14%	3.14%	3.14%	3.14%
Other capital expenditure ~ non-infrastructure	3.12%	3.14%	3.14%	3.14%	3.14%	3.14%

Source: Economic Insight analysis

Table 4: Gross input price inflation - wholesale **wastewater network plus**

Year / cost category	2020/21	2021/22	2022/23	2023/24	2024/25	Average
Operating expenditure	2.42%	2.30%	2.27%	2.28%	2.35%	2.32%
Maintaining the long-term capability of the assets infrastructure	2.35%	2.54%	2.72%	2.72%	2.72%	2.61%
Maintaining the long-term capability of the assets non-infrastructure	2.35%	2.54%	2.72%	2.72%	2.72%	2.61%
Other capital expenditure ~ infrastructure	3.12%	3.14%	3.14%	3.14%	3.14%	3.14%
Other capital expenditure ~ non-infrastructure	3.12%	3.14%	3.14%	3.14%	3.14%	3.14%

Source: Economic Insight analysis

Table 5: Gross input price inflation - wholesale **wastewater bioresources**

Year / cost category	2020/21	2021/22	2022/23	2023/24	2024/25	Average
Operating expenditure	2.52%	2.42%	2.38%	2.41%	2.45%	2.44%
Maintaining the long-term capability of the assets infrastructure	2.35%	2.54%	2.72%	2.72%	2.72%	2.61%
Maintaining the long-term capability of the assets non-infrastructure	2.35%	2.54%	2.72%	2.72%	2.72%	2.61%
Other capital expenditure ~ infrastructure	3.12%	3.14%	3.14%	3.14%	3.14%	3.14%
Other capital expenditure ~ non-infrastructure	3.12%	3.14%	3.14%	3.14%	3.14%	3.14%

Source: Economic Insight analysis

Table 6: Gross input price inflation - retail

Year / cost category	2020/21	2021/22	2022/23	2023/24	2024/25	Average
Operating expenditure	1.80%	2.06%	2.01%	2.03%	2.06%	1.99%

Source: Economic Insight analysis[2]

[2] *In relation to 'capex' for retail, we note that this represents a very small proportion of totex. As such, we think it would be credible for Yorkshire to assume IPI consistent with that for opex. Alternatively, it would also be credible to assume capex IPI in line with that for IT costs.*

2. Forecasts of input price inflation

Here, we provide our forecasts of underlying gross IPI for Yorkshire over PR19. Forecasts are provided separately by cost category and price control area, which is in line with Ofwat's data requirements. Our method involves constructing indices of the company's underlying costs over time. We then apply various forecasting approaches using these indices. The main advantage of using indices (rather than Yorkshire's actual costs) is that it avoids erroneously embedding any potential company-specific cost inefficiency in our forecasts.

Our main findings are as follows:

- At the company level, we find **labour cost IPI** could range from 1.45% pa to 2.89% pa**.**
- **Chemical cost** related IPI will likely range from 2.76% pa to 5.43% pa.
- **Energy** IPI is expected to be between 2.09% pa and 4.17% pa.
- In relation to capital costs, we expect underlying inflation to be between **2.31% pa and 3.59% pa for capex**; and between **2.45% pa and 3.74% pa for maintenance.**
- Consistent with the relatively wide ranges above, there is considerable uncertainty inherent in any forecasting. As such, we provide Yorkshire with a range of forecasts for each cost component (where possible, based on econometric approaches; extrapolations; and independent third-party forecasts). Additionally, we comment on which approach we think is more robust, or which scenario is more likely to arise. **The company should use the forecasts that align best with its wider Business Plan** (importantly, the company should ensure that the forecasts it selects are internally consistent with other macroeconomic assumptions it is making across its Plan).

2.1 Approach to deriving forecasts by price control area

The relevant cost categories for which Yorkshire must provide IPI forecasts for **wholesale** are listed in the following table:

Table 7: Cost categories for wholesale price control areas as per Table App24a

Cost category
Opex
Maintaining the long-term capability of the assets - infrastructure
Maintaining the long-term capability of the assets - non-infrastructure
Other capital expenditure - infrastructure
Other capital expenditure - non-infrastructure

Source: Ofwat

Similarly, for **retail,** Yorkshire must provide IPI forecasts across the categories shown below:

Table 8: Cost categories for retail price control area as per Table App24a

Cost category
Opex
Capex

Source: Ofwat

To develop IPI forecasts for total **opex** by price control area, it is first necessary to ascertain the 'mix' of opex (also by price control area) across key cost categories. Accordingly, we split Yorkshire's opex costs in the wholesale control areas into the following categories:

- labour;
- energy;
- chemicals; and
- other.

In term of opex in the retail price control areas, Yorkshire's costs are split into the following categories:

- labour;
- bad debt;
- IT;
- postage;
- meter reading;
- customer services; and
- other.

To develop robust forecasts in the above dimensions, our approach has been as follows:

- For opex, we have developed detailed inflation forecasts **for each key cost category separately.**

- In relation to the various categories of **capital costs**, our approach distinguishes between maintenance and capex (i.e. other capital expenditure). The data does not, however, allow for a further disaggregation between infrastructure and non-infrastructure for forecasting purposes.

- Given that capex will only be a very small proportion of totex, across the retail controls, we think it would be reasonable for Yorkshire to either: (i) assume IPI consistent with forecasts for opex; or (ii) use our IPI forecasts for "IT" related costs.

We generally applied three approaches to forecasting in our work for Yorkshire, as summarised in the following subsections.

2.1.1 Approach 1: economic fundamentals

This is generally our preferred approach, which is based on the analysis of the relationship between input costs (as measured by our indices) and key economic indicators.

- » Some methods are based on the '**wedge**' between input costs and other inflation indicators, such as the Consumer Prices Index (CPI).
- » Other methods are based on **statistical analysis** of the relationship between input costs and economic variables, such as gross domestic product (GDP) growth.

In econometric models, two important statistics to consider when deciding on the robustness/appropriateness of the results and model are:

- **p-value:** for every explanatory variable (including the constant), the p-value is calculated, which is a test against the null hypothesis that the true coefficient is 'zero'. In statistics, to consider that an explanatory variable has a significant effect on the dependent variable, we need to be able to reject the null hypothesis with 95% confidence level. Accordingly, a p-value less than or equal to 5% is an indication that the independent variable is statistically significant.
- **R-squared:** is a measure of the overall fit of the model. In other words, it is a measure of the share of the variance of the dependent variable that is explained by the independent variables in a model. Accordingly, a higher R-squared value is an indication of a strong 'fit' of the model to the data.

2.1.3 Approach 2: extrapolations

Here, we extrapolate existing trends in input costs forward. This approach was widely used by companies at PR14. However, in our view less weight will be placed on such approaches at PR19, relative to other, technically superior, methods.[3]

2.1.4 Approach 3: independent third-party forecasts

Where appropriate, we have taken into account existing forecasts developed by third-parties (e.g. in relation to both labour and energy).

We believe that the combination of the three approaches we have taken will ensure that Yorkshire has a broad and robust evidence base to inform its position on RPEs at PR19. In the rest of this chapter, we now set out our forecasts for each individual cost category in turn.

2.2 Forecasting underlying labour cost inflation

To forecast underlying inflation for labour costs, we looked at the breakdown of staff costs by function / role across each price control area. The specific mix of staff functions / roles within each price control area is based on information provided by Yorkshire and our own extensive knowledge and understanding of labour requirements in the retail part of the supply chain. Specifically, we identified the mix of relevant job functions within each price control area, as defined within the Standard Occupation Classification (SOC) 2011 codes.

The SOC codes are published by the ONS within its Annual Survey of Hours and Earnings (ASHE). The ASHE data contains detailed information on wages by SOC code. So, by looking at employee functions in the water industry by SOC codes, we were able to create *business area specific indices* of underlying wage inflation over time at a granular level. Importantly, this avoids any possibility of conflating underlying inflation with any inefficiency that might be present in the company's actual historical staff costs.

Within the ASHE, SOC codes are published at different levels of aggregation, ranging from 1 to 4 digit SOC codes. The 1 digit SOC codes represent the 'major' or general occupation types (for example, professional occupations or skilled trades occupations groups), and 4 digit SOC codes represent more specific occupations or job roles (for example, civil engineers). Naturally, 1 digit SOC codes would have more reliable wage inflation estimates (in comparison with 4 digit SOC codes) as they are based on a larger sample size.

When developing labour indices for Yorkshire we were mindful of the trade-off between using codes that would be most relevant to job roles in the water and wastewater industry and the precision of the estimates of wage inflation for each role. Accordingly, we created labour indices using both 2 and 3 digit SOC codes, which we consider is most likely to achieve the appropriate balance between these two considerations. (The mix of 2 and 3 digit SOC codes and their associated weights in each of the price control areas that are used to construct our indices for Yorkshire are summarised in Annex A). The following figure shows Yorkshire's labour cost indices

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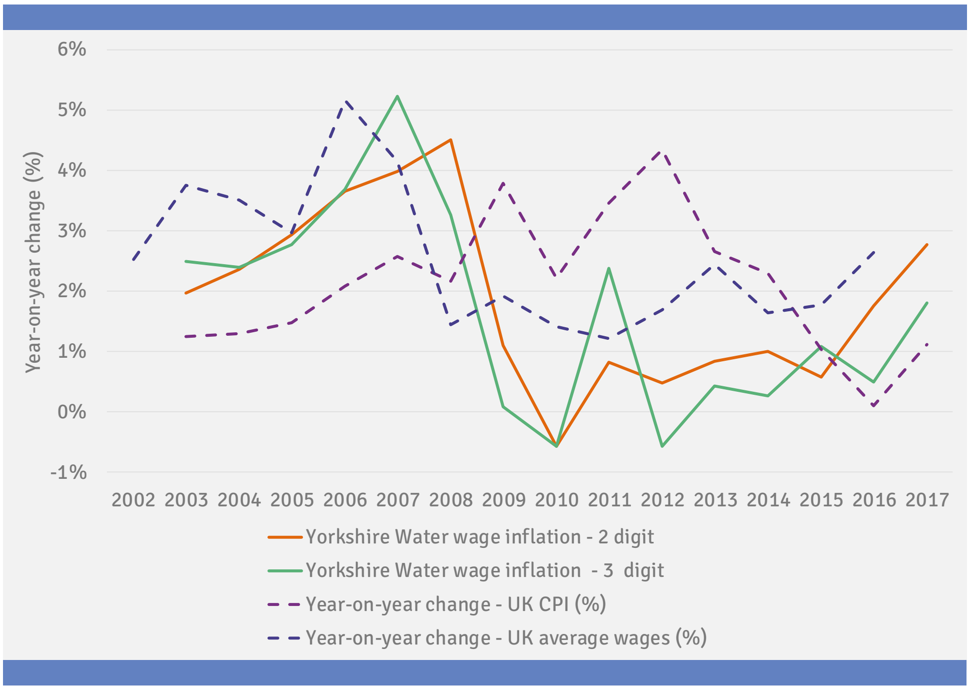
3 *See: 'Delivering Water 2020: Our final methodology for the 2019 price review.' Ofwat (December 2017), page 143.*

for the *company as whole* compared to CPI and overall UK average wage inflation over time, as reported by the ONS. To be consistent with the Office of Budget Responsibility (OBR) forecasts, UK average wage inflation is calculated from wages and salaries data in the National Accounts; and employee numbers from the Labour Force Survey (LFS).

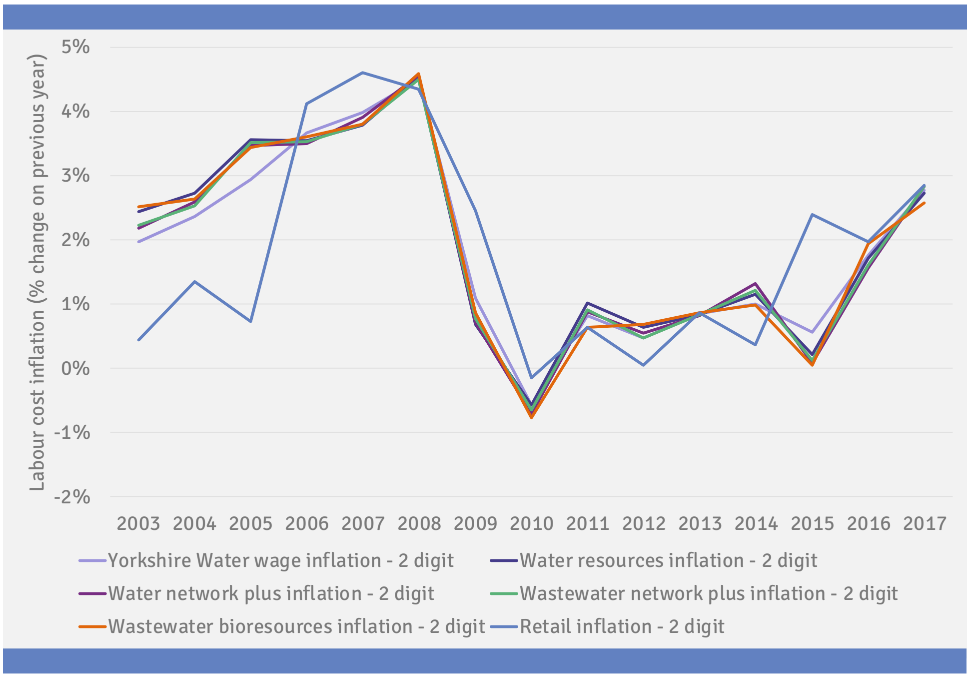
Figure 1: Historical wage inflation



Source: Economic Insight analysis of ONS ASHE data

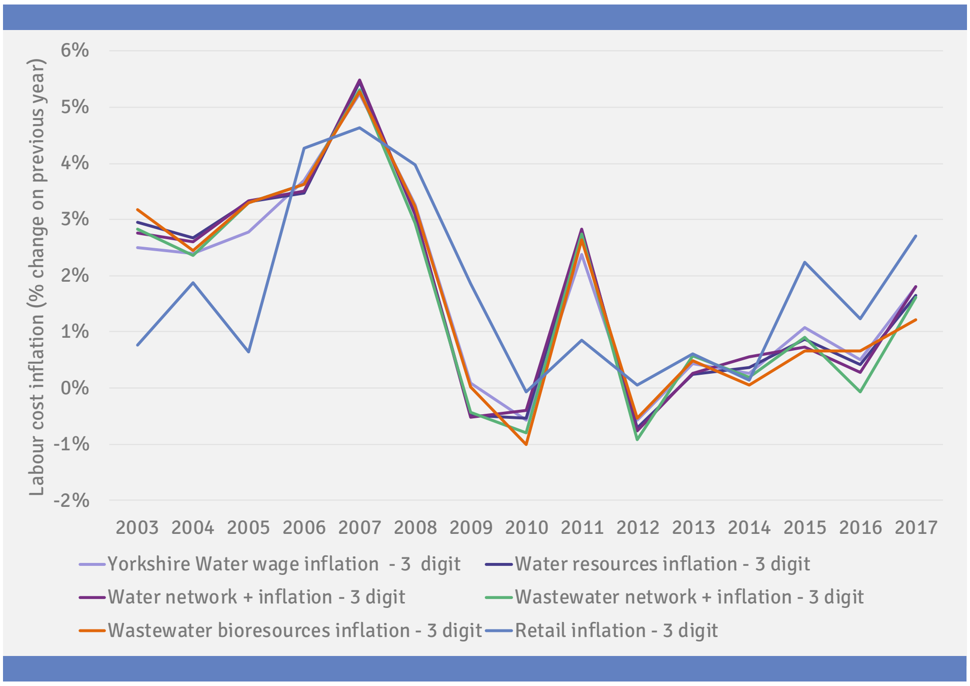
Our Yorkshire wage indices imply underlying inflation of between 1.70% and 1.90% pa *historically.* This is, on average, lower than both CPI and overall UK wage inflation (which is consistent of a wider pattern of falling real wages in the UK economy in recent years). Our Yorkshire labour cost indices for the **individual price control areas** are set out in the following two figures. We show the indices based on 2 and 3 digit SOC codes separately.

Figure 2: Yorkshire Water labour cost inflation – overall company, water (resources and network plus), wastewater (network plus and bioresources) and retail, **2 digit SOC codes**



Source: Economic Insight analysis of ONS ASHE data

Figure 3: Yorkshire Water labour cost inflation – overall company, water (resources and network plus), wastewater (network plus and bioresources) and retail, **3 digit SOC codes**



Source: Economic Insight analysis of ONS ASHE data

As can be seen from the graphs, up until 2008, wage inflation tends to be quite high (ca. 4%) dropping significantly in the aftermath of the financial crisis.

The following subsections set out our forecasts for Yorkshire's underlying labour cost inflation, using the three forecasting methodologies described previously:

- firstly, we set out forecasts derived from **economy-based estimates of wage inflation**, including both the wedge and econometric methodologies;
- secondly, we provide estimates based on an analysis of **past trends** in the wage index;
- thirdly, we discuss **independent third-party** estimates of future UK wage inflation; and
- finally, we summarise the evidence we have analysed and provide our **overall estimates** of underlying labour cost inflation over PR19 by price control area.

2.2.1 Economy-based estimates

Economy-based forecasting of wage inflation is our preferred approach, because this ensures consistency between a view of the general macroeconomy and underlying inflationary pressure (consistent with economic theory). We applied this as follows:

Using the data from the labour cost indices we created for Yorkshire, we explored the relationship between macro measures of the UK's economic performance. Specifically, we used two methods for this step:

1. we identified a historical 'wedge' between our bespoke indices for labour costs and wider inflation measures (in particular, UK average wage inflation and CPI); and

2. we used econometric analysis to identify a statistical relationship between Yorkshire's wage inflation (again, as measured by our index) and macroeconomic performance measures (such as GDP growth).

Subsequently, we assumed that the identified relationship(s) holds in the future – and based on that, developed forecasts for Yorkshire's labour cost inflation using the OBR's official forecasts for growth and inflation in the UK economy. In the following we set out our results.

2.2.1.1 Wedge estimates for labour cost inflation

In this step we calculated the wedge in inflation between our Yorkshire labour cost indices and both: (i) average UK wages; and (ii) CPI inflation. Given that the drivers of Yorkshire labour cost inflation will be more common with the drivers of UK wage inflation than is the case for CPI, we consider the wedge to average UK wage inflation the preferred approach.

The following table shows the size of these wedges for the whole period for which data is available, from 2003 to 2017. In general, Yorkshire's underlying wage inflation (as measured by our index) is below UK average wage inflation (i.e. the wedges are negative), although the difference is slightly less pronounced based on 2 digit SOC codes, rather than 3 digit ones. Yorkshire's underlying wage inflation also tends to be below CPI, although the wedges are smaller in this case.

Table 9: Historical wedge between Yorkshire Water labour cost indices and: (i) average UK wage inflation; and (ii) CPI

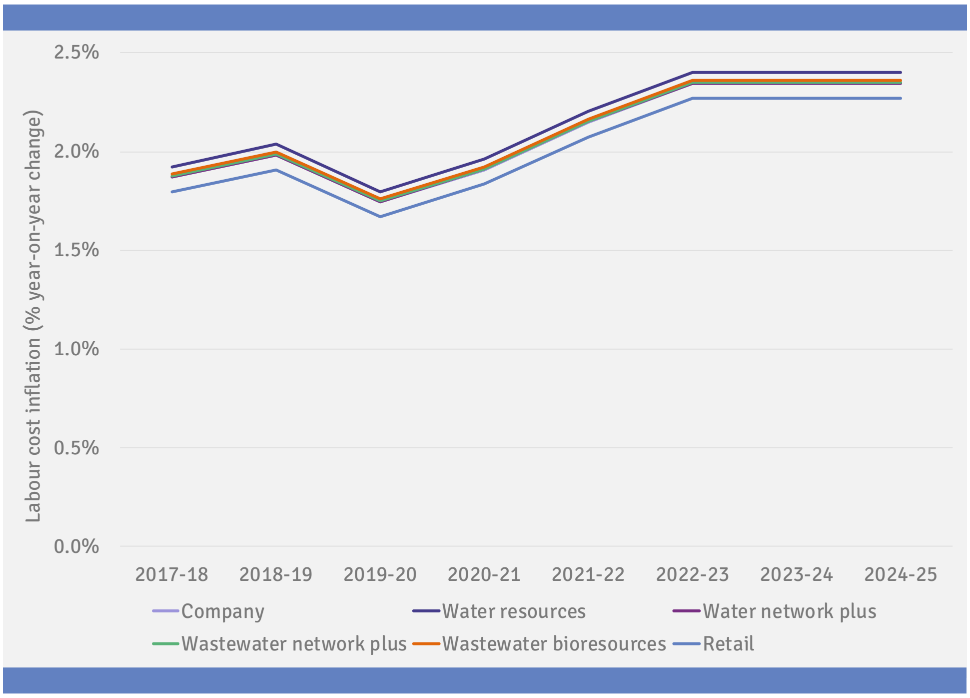
	Company	Water resources	Water network plus	Waste-water network plus	Waste-water bio-resources	Retail
Wedge to average UK wage inflation – 2 digit	-0.67%	-0.62%	-0.67%	-0.67%	-0.66%	-0.75%
Wedge to average UK wage inflation – 3 digit	-0.87%	-0.85%	-0.85%	-0.94%	-0.87%	-0.83%
Wedge to CPI inflation – 2 digit	-0.24%	-0.19%	-0.24%	-0.24%	-0.23%	-0.32%
Wedge to CPI inflation – 3 digit	-0.44%	-0.41%	-0.42%	-0.42%	-0.51%	-0.44%

Source: Economic Insight analysis

To derive underlying labour IPI for Yorkshire, we combined these 'wedges' with the most recent projections for both wage and CPI growth taken from the OBR. These are available up to the year 2022/23. For years beyond 2023, we assumed that wage and CPI growth continue at the level forecast for 2023.

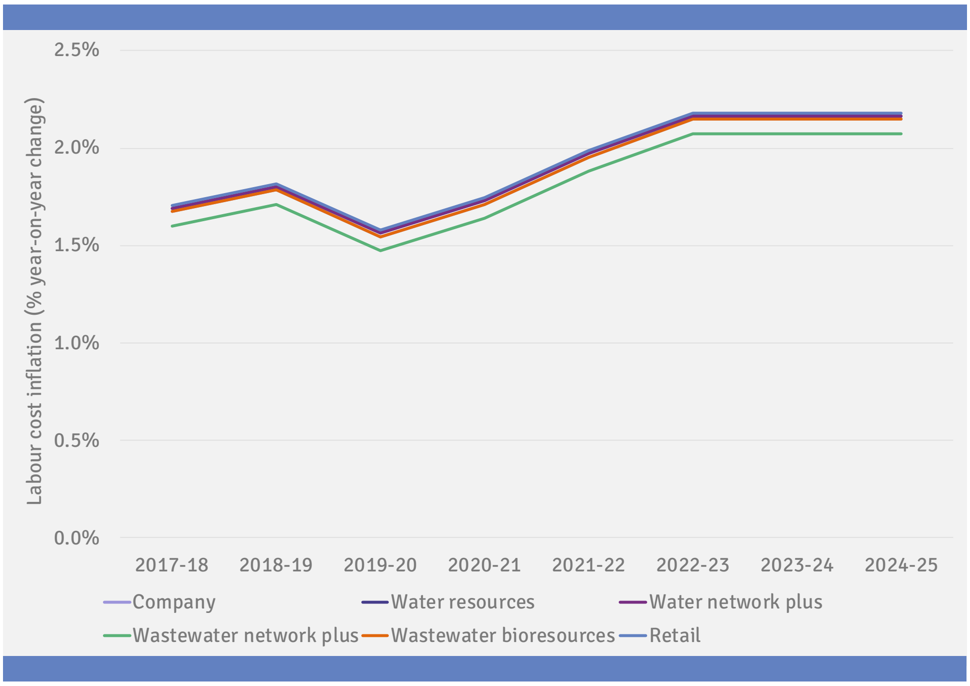
Our overall forecasts using this methodology, with respect to UK wage inflation, are shown in the following figures. Estimates based on 2 digit SOC codes are generally higher than those based on 3 digit SOC codes. Furthermore, estimates based on wage inflation are usually higher than those based on CPI. This is mostly driven by the fact that **the OBR forecasts wage inflation to be higher than CPI** by the early 2020s (i.e. it forecasts real wage growth).

Figure 4: Forecast labour cost inflation – based on wage inflation wedge, **2 digit SOC**



Source: Economic Insight analysis of ONS ASHE data

Figure 5: Forecast labour cost inflation – based on wage inflation wedge, **3 digit SOC**



Source: Economic Insight analysis of ONS ASHE data

As can be seen, forecasts based on the 'wedge' with national wage growth are reasonably consistent across the 2 and 3 digit SOC code indices.

2.2.1.3 Econometric estimates

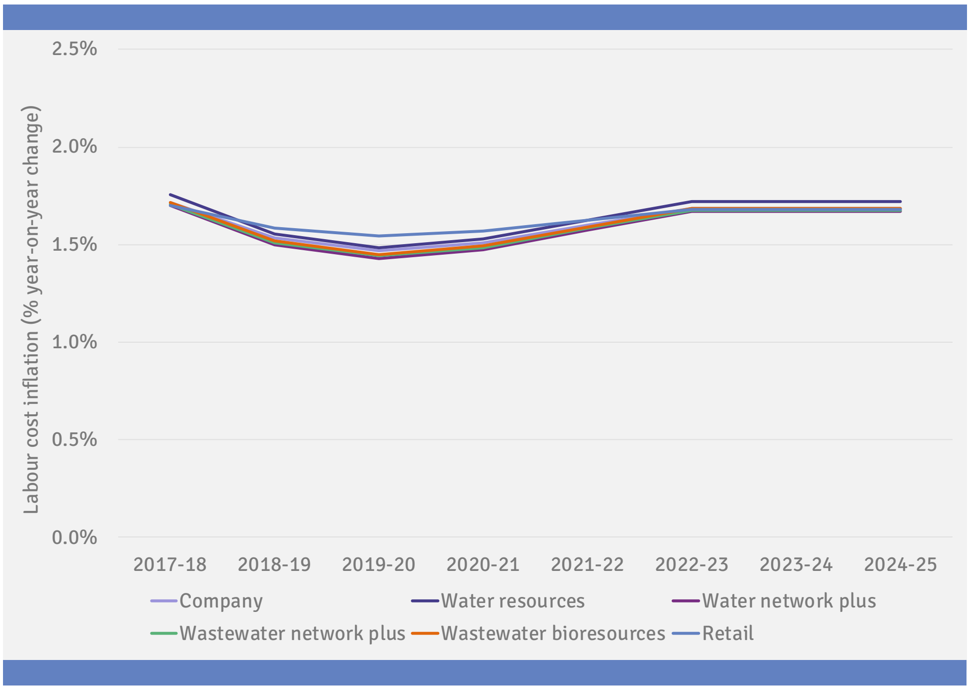
We used econometric analysis to investigate the statistical relationship between our Yorkshire labour cost indices and: (i) UK GDP; and (ii) average UK wages. Variables such as GDP and wages are generally *non-stationary*, meaning that simple regressions of wage levels on GDP can lead to spurious findings of relationships. We addressed this non-stationarity in two ways:

- First, we developed regressions of the *percentage changes* in Yorkshire's labour cost indices on changes in nominal GDP / average UK wages. Our regressions in percentage changes had the following functional forms:

  1) *Yorkshire Water nominal wage growth*$_t$ *= constant +* $\beta \cdot$ *UK nominal GDP growth*$_t$ + ε_t
  2) *Yorkshire Water nominal wage growth*$_t$ *= constant +* $\beta \cdot$ *UK nominal average wage growth*$_t$ + ε_t

The following figures show projected labour cost inflation based on the regression in percentage changes.[4]

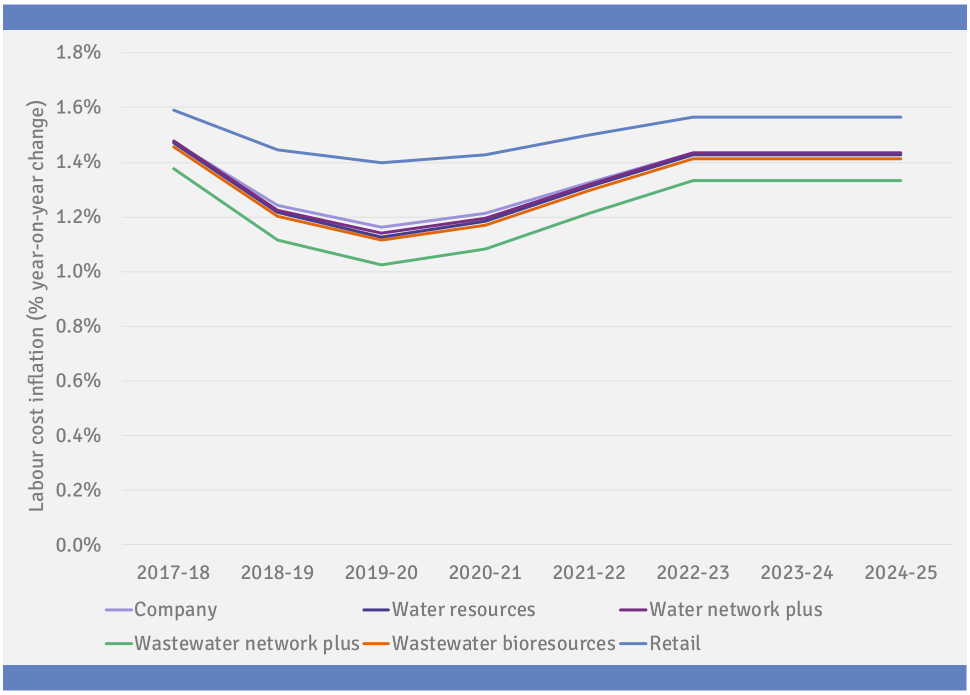
Figure 6: Forecast labour cost inflation - based on nominal GDP (percentage changes), **2 digit SOC**



Source: Economic Insight analysis of ONS ASHE data

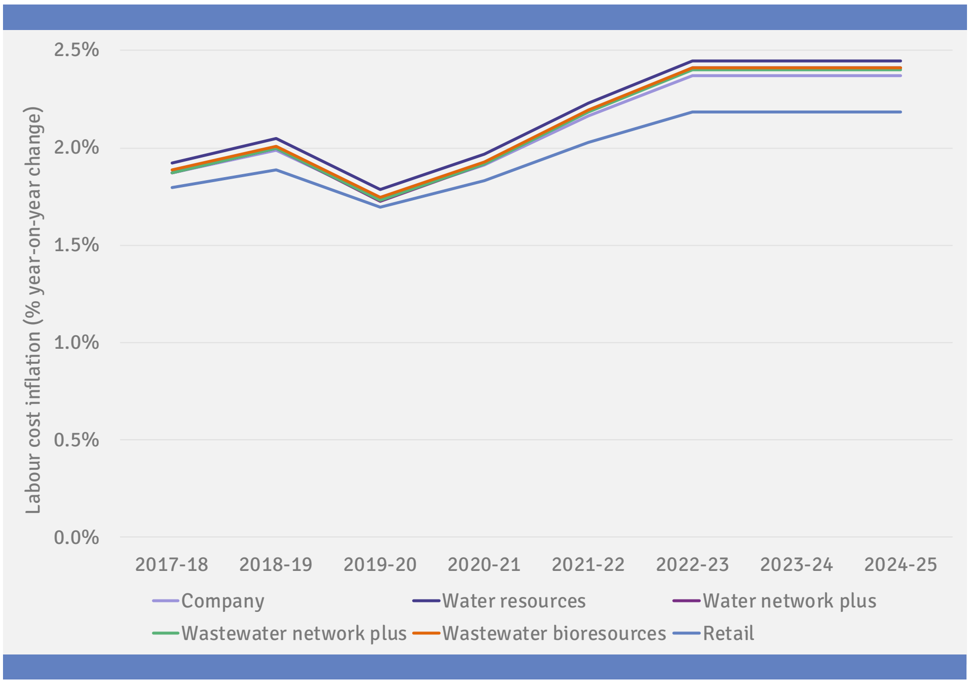
[4] *We note that a key difference in forecast inflation across the control areas are differences in the assumed mix of labour.*

Figure 7: Forecast labour cost inflation - based on nominal GDP (percentage changes), **3 digit SOC**



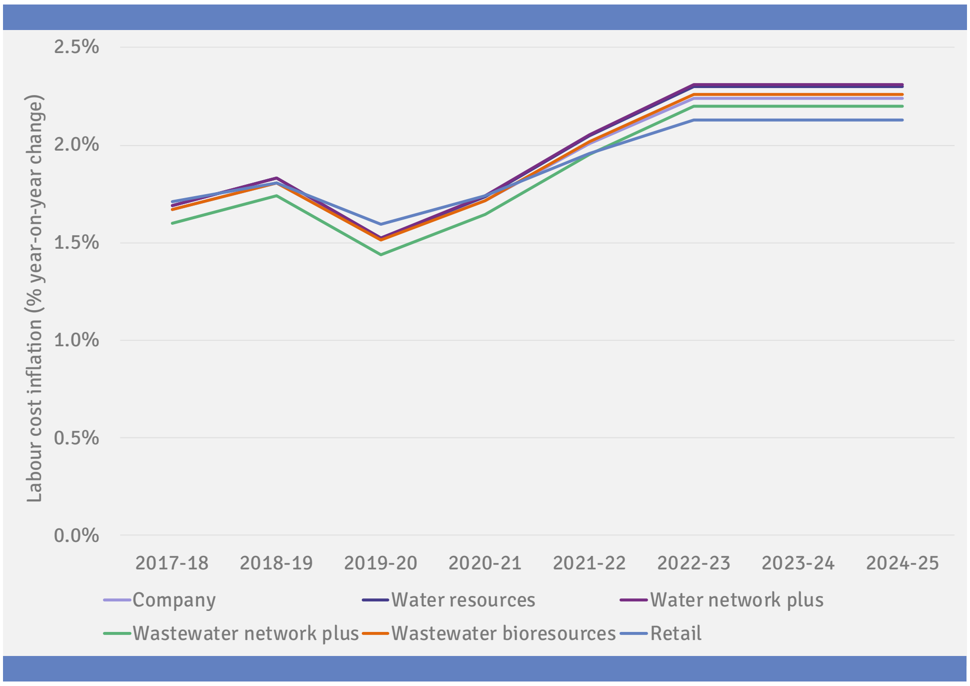
Source: Economic Insight analysis of ONS ASHE data

Figure 8: Forecast labour cost inflation – based on average UK wage (percentage changes), **2 digit SOC**



Source: Economic Insight analysis of ONS ASHE data

Figure 9: Forecast labour cost inflation – based on average UK wage (percentage changes), **3 digit SOC**



Source: Economic Insight analysis of ONS ASHE data

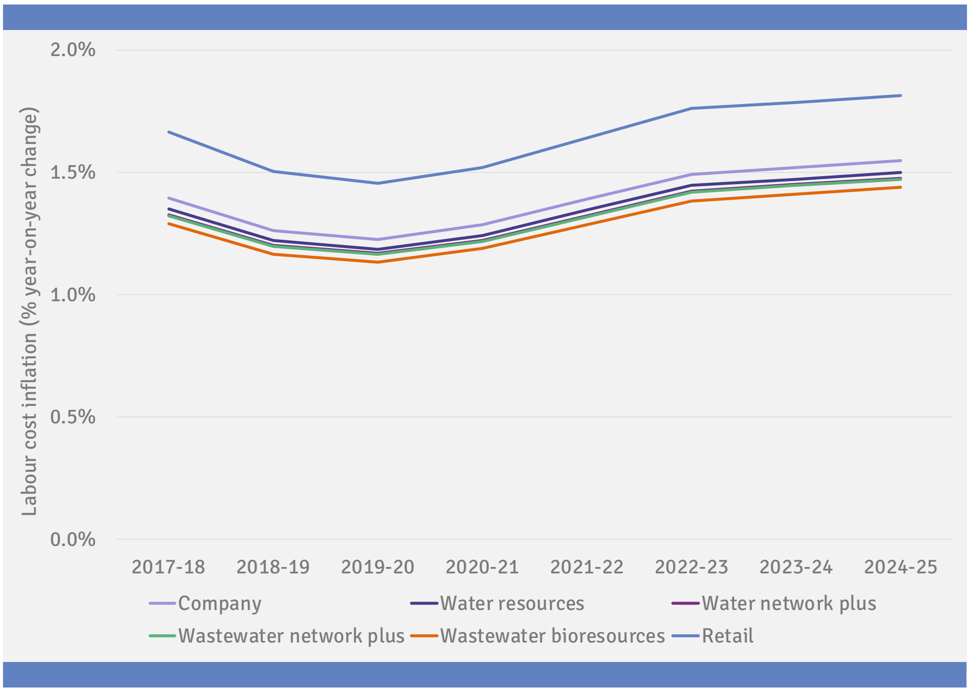
- Second, we regressed levels of Yorkshire's labour cost indices on the level of nominal GDP / average UK wages (both expressed as an index) *and lagged values of Yorkshire's labour cost indices.* The regressions in levels had the following functional forms:

  1) *Yorkshire Water labour cost index*$_t$ *= constant +* $\beta \cdot$ *UK nominal GDP index*$_t$ *+* $\gamma \cdot$ *Yorkshire Water labour cost index*$_{t-1}$ *+* ε_t

  2) *Yorkshire Water labour cost index*$_t$ *= constant +* $\beta \cdot$ *UK average wage index*$_t$ *+* $\gamma \cdot$ *Yorkshire Water labour cost index*$_{t-1}$ *+* ε_t

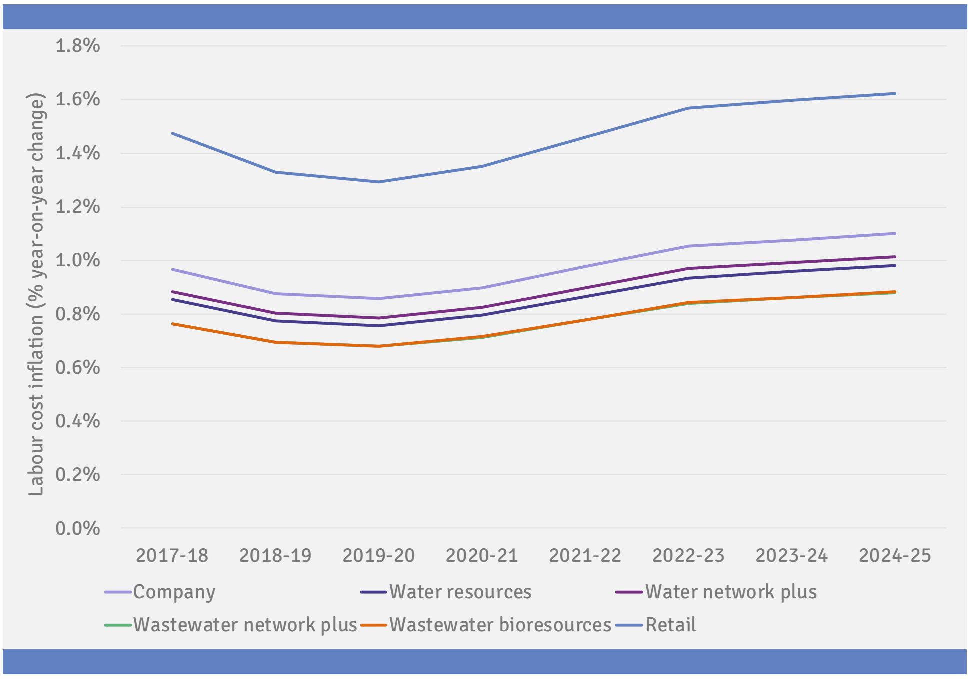
The following figures show projected labour cost inflation based on the regression in levels.

Figure 10: Forecast labour cost inflation - based on nominal GDP (levels), **2 digit SOC**



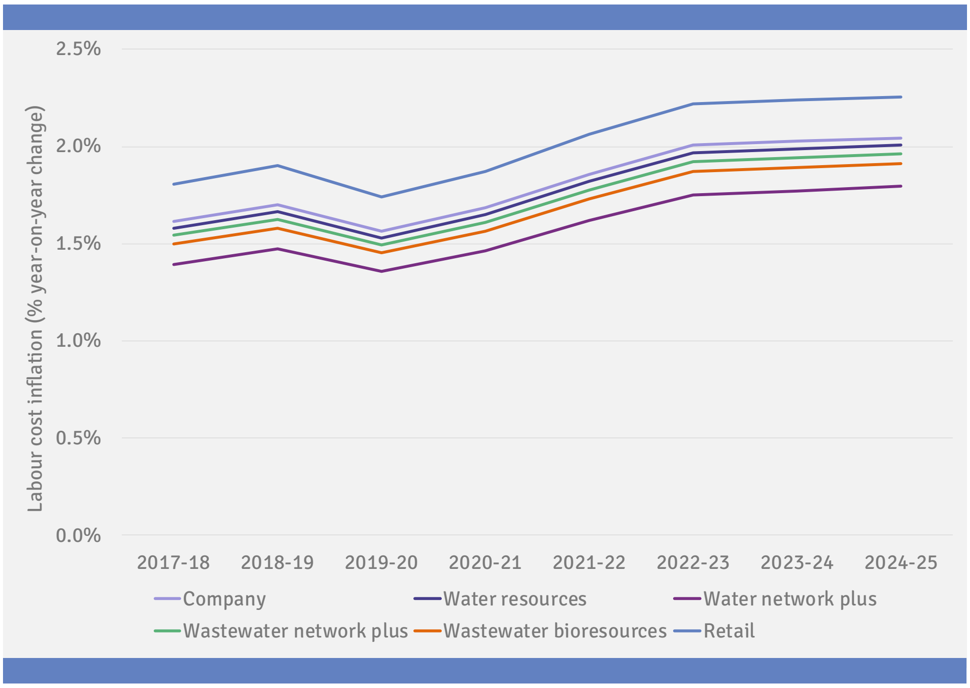
Source: Economic Insight analysis of ONS ASHE data

Figure 11: Forecast labour cost inflation - based on nominal GDP (levels), **3 digit SOC**



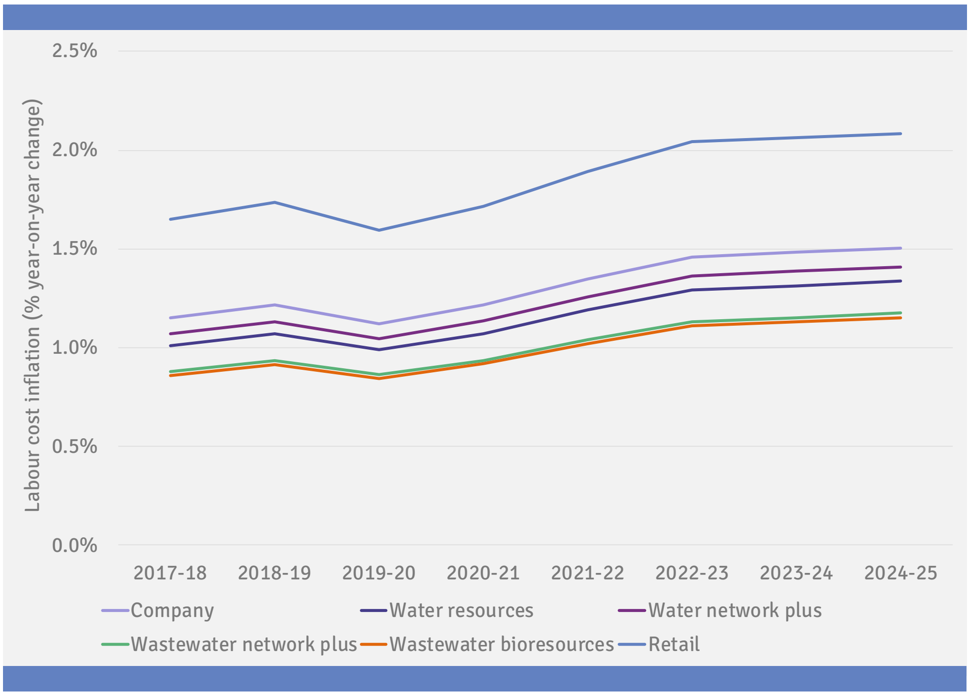
Source: Economic Insight analysis of ONS ASHE data

Figure 12: Forecast labour cost inflation - based on average UK wage (levels), **2 digit SOC**



Source: Economic Insight analysis of ONS ASHE data

Figure 13: Forecast labour cost inflation - based on average UK wage (levels), **3 digit SOC**



Source: Economic Insight analysis of ONS ASHE data

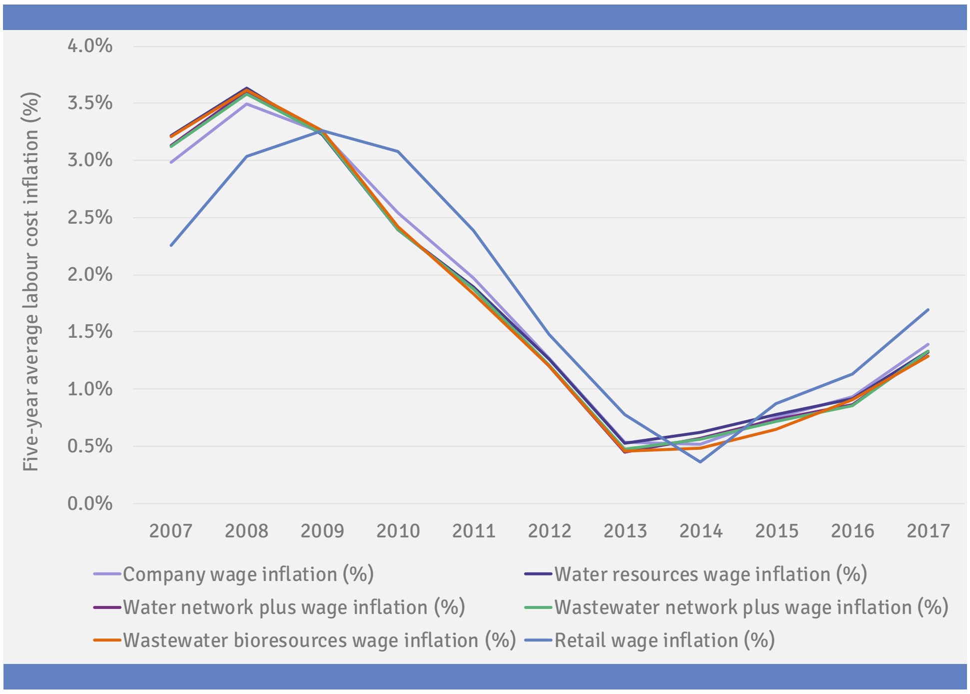
Note that, in general, our overall preference is for regression models in percentage changes, as this allows for easier comparisons to be made between the R^2 of the regressions – since the presence of lagged values of the labour cost index in the levels regression results in high R^2 values across the board. For full model results, see Annex A.

2.2.2 Extrapolating existing trends

The second approach for forecasting wage inflation is to extrapolate forward existing trends in our Yorkshire labour cost indices. We place less weight on this approach than on approaches based on economic fundamentals. This is because, by definition, extrapolations will not reflect expected changes in the broader macroeconomic environment (which are known to strongly drive labour market performance). In particular, extrapolations will not reflect the OBR's expected real wage growth over the medium term.

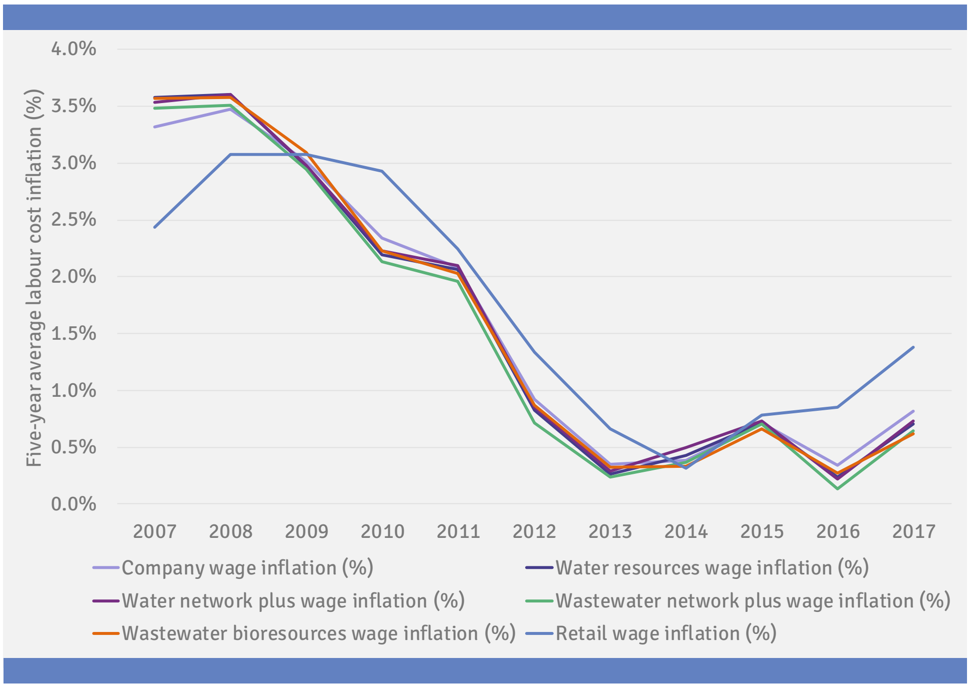
The following figures show five-year rolling averages of the Yorkshire Water wage inflation indices at both the 2 and 3 digit SOC code levels. Both show a prominent downward trend, combined with a levelling off and a slight increase around 2013/14. We note that these trends mirror the performance of the economy over the relevant time-period.

Figure 14: Yorkshire Water wage inflation index – overall company, water (resources and network plus), wastewater (network plus and bioresources) and retail - 5 year rolling average, **2 digit** SOC code



Source: Economic Insight analysis of ONS ASHE data

Figure 15: Yorkshire Water wage inflation index – water, wastewater and retail - 5 year rolling average, **3 digit** SOC code



Source: Economic Insight analysis of ONS ASHE data

In addition to calculating five-year averages for inflation, we have also examined average inflation over the whole period for which data are available (2003 to 2017). This is shown in the following table.

Table 10: Long-term trends in Yorkshire Water labour cost index inflation (% pa)

	Company	Water resources	Water network plus	Waste-water network plus	Waste-water bio-resources	Retail
Whole period – 2 digit	1.88%	1.94%	1.89%	1.89%	1.90%	1.81%
Whole period – 3 digit	1.69%	1.70%	1.71%	1.61%	1.69%	1.72%
Last 5 years – 2 digit	1.39%	1.33%	1.32%	1.33%	1.29%	1.70%
Last 5 years – 3 digit	0.82%	0.71%	0.73%	0.64%	0.62%	1.38%

Source: Economic Insight analysis of ONS ASHE data

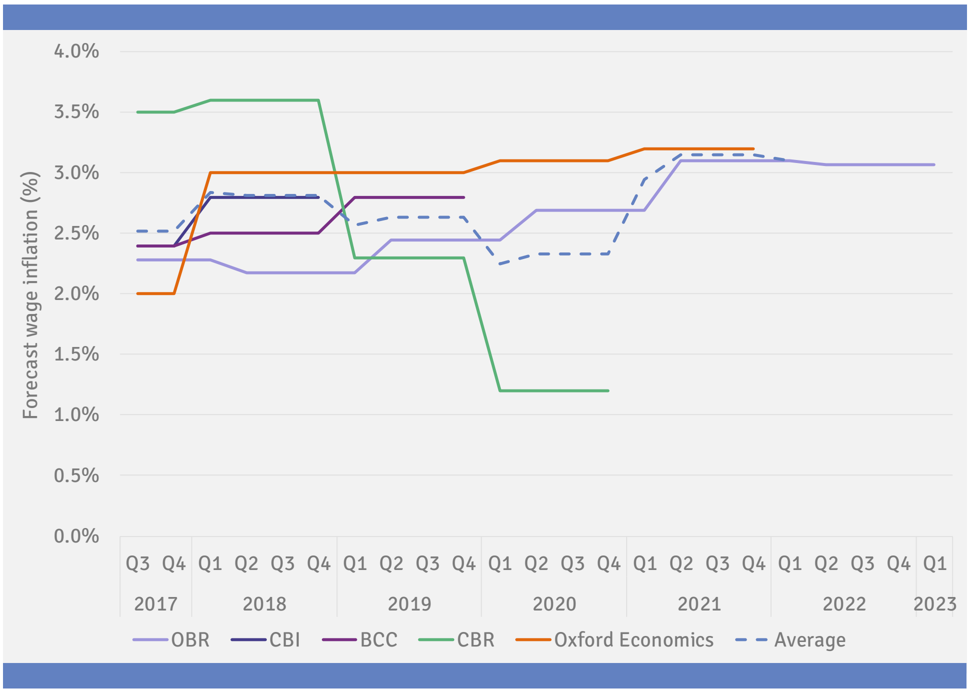
As noted previously, a drawback of all extrapolations is that they ignore the expected impact of changes to the UK's broader economic performance over time. Most specifically in this case, they ignore the OBR's expected upturn in UK wage growth between now and 2023. This limitation is more pronounced in relation to shorter-term data, which is likely to be less representative of future economic conditions. Consequently, if one were to use an extrapolation approach for labour costs, we would advocate placing more weight on data using the whole time-period.

2.2.3 Independent wage growth forecasts

Multiple entities, including Government bodies, publish independent forecasts of future wage growth in the UK. Here, we examined forecasts from the OBR; the Confederation of British Industry (CBI); the British Chamber of Commerce (BCC); the Centre for Business Research (CBR); and Oxford Economics. These are shown in the subsequent figure. We highlight the following:

- None of the forecasts provide projections for the whole of 2020 to 2025 (PR19) period; and only the OBR's and Oxford Economics' forecasts extend beyond 2020.
- Across all of the independent forecasts we have reviewed, the *average* expected UK wage inflation rate is in the range of **2.4%** to **2.9%** per annum (note, this refers to the period up to 2020, as only the OBR and Oxford Economics provide longer-term forecasts).
- Forecasts for 2018/19 are in the range of 2.2% to 3.6% per annum. Most forecasts are relatively stable, although the CBR's suggests a material fall in wages between 2018 and 2019.
- There are differences in forecasted wage growth in 2020. Whereas the OBR's and Oxford Economics' forecasts are in the range of 2.7% to 3.1% per annum, CBR forecasts wage growth to be 1.2%.

Figure 16: Forecast UK wage inflation



Source: OBR, CBI, BCC, CBR and Oxford Economics

While these results are inherently uncertain, we place most weight on the OBR's forecasts, which are used for official purposes.

2.2.4 Summary and overall labour cost inflation for PR19

As set out above, we have used a range of methods to forecast Yorkshire's underlying labour cost inflation across the wholesale and retail price control areas for PR19. The following table provides **a summary of all of these.** All figures are based on the 2 digit SOC code approach, which on balance we consider to be superior. Forecasts based on 3 digit SOC code approach are also reported in Annex B.

Table 11: Our Yorkshire Water labour cost inflation forecasts, 2020-25, **2 digit** SOC codes

Methodology	Wage inflation forecasts (%)	2020/21	2021/22	2022/23	2023/24	2024/25	Avg
Company							
Economy-based	GDP econometrics – levels	1.29%	1.39%	1.50%	1.52%	1.55%	1.45%
	GDP econometrics – changes	1.51%	1.60%	1.69%	1.69%	1.69%	1.63%
	Wage econometrics – levels	1.69%	1.86%	2.01%	2.03%	2.05%	1.92%
	Wage econometrics – changes	1.91%	2.17%	2.37%	2.37%	2.37%	2.24%
	Wedge to UK wages inflation	1.91%	2.15%	2.34%	2.34%	2.34%	2.22%
	Wedge to CPI inflation	1.73%	1.75%	1.76%	1.76%	1.76%	1.75%
Extrapolation	Whole period trend	1.88%	1.88%	1.88%	1.88%	1.88%	1.88%
Third-party	Independent forecasts	2.58%	2.82%	3.02%	3.02%	3.02%	2.89%
Water resources							
Economy-based	GDP econometrics – levels	1.24%	1.35%	1.45%	1.47%	1.50%	1.40%
	GDP econometrics – changes	1.53%	1.63%	1.72%	1.72%	1.72%	1.66%

Methodology	Wage inflation forecasts (%)	2020/21	2021/22	2022/23	2023/24	2024/25	Avg
	Wage econometrics – levels	1.65%	1.82%	1.97%	1.99%	2.01%	1.89%
	Wage econometrics – changes	1.97%	2.23%	2.45%	2.45%	2.45%	2.31%
	Wedge to UK wages inflation	1.96%	2.20%	2.40%	2.40%	2.40%	2.27%
	Wedge to CPI inflation	1.79%	1.81%	1.81%	1.81%	1.81%	1.80%
Extrapolation	Whole period trend	1.94%	1.94%	1.94%	1.94%	1.94%	1.94%
Third-party	Independent forecasts	2.58%	2.82%	3.02%	3.02%	3.02%	2.89%
Water network plus							
Economy-based	GDP econometrics – levels	1.22%	1.32%	1.42%	1.45%	1.48%	1.38%
	GDP econometrics – changes	1.48%	1.57%	1.67%	1.67%	1.67%	1.61%
	Wage econometrics – levels	1.46%	1.62%	1.75%	1.77%	1.79%	1.68%
	Wage econometrics – changes	1.92%	2.19%	2.41%	2.41%	2.41%	2.27%
	Wedge to UK wages inflation	1.91%	2.15%	2.35%	2.35%	2.35%	2.22%
	Wedge to CPI inflation	1.74%	1.76%	1.76%	1.76%	1.76%	1.75%
Extrapolation	Whole period trend	1.89%	1.89%	1.89%	1.89%	1.89%	1.89%
Third-party	Independent forecasts	2.58%	2.82%	3.02%	3.02%	3.02%	2.89%
Wastewater network plus							
Economy-based	GDP econometrics – levels	1.22%	1.32%	1.42%	1.45%	1.47%	1.38%

Methodology	Wage inflation forecasts (%)	2020/21	2021/22	2022/23	2023/24	2024/25	Avg
	GDP econometrics – changes	1.49%	1.58%	1.67%	1.67%	1.67%	1.62%
	Wage econometrics – levels	1.61%	1.78%	1.92%	1.94%	1.96%	1.84%
	Wage econometrics – changes	1.92%	2.18%	2.40%	2.40%	2.40%	2.26%
	Wedge to UK wages inflation	1.91%	2.15%	2.35%	2.35%	2.35%	2.22%
	Wedge to CPI inflation	1.74%	1.76%	1.76%	1.76%	1.76%	1.75%
Extrapolation	Whole period trend	1.89%	1.89%	1.89%	1.89%	1.89%	1.89%
Third-party	Independent forecasts	2.58%	2.82%	3.02%	3.02%	3.02%	2.89%
Wastewater bioresources							
Economy-based	GDP econometrics – levels	1.19%	1.29%	1.39%	1.41%	1.44%	1.34%
	GDP econometrics – changes	1.49%	1.59%	1.68%	1.68%	1.68%	1.63%
	Wage econometrics – levels	1.57%	1.73%	1.87%	1.89%	1.91%	1.79%
	Wage econometrics – changes	1.93%	2.20%	2.41%	2.41%	2.41%	2.27%
	Wedge to UK wages inflation	1.92%	2.17%	2.36%	2.36%	2.36%	2.23%
	Wedge to CPI inflation	1.75%	1.77%	1.77%	1.77%	1.77%	1.77%
Extrapolation	Whole period trend	1.90%	1.90%	1.90%	1.90%	1.90%	1.90%
Third-party	Independent forecasts	2.58%	2.82%	3.02%	3.02%	3.02%	2.89%
Retail							

Methodology	Wage inflation forecasts (%)	2020/21	2021/22	2022/23	2023/24	2024/25	Avg
Economy-based	GDP econometrics – levels	1.52%	1.64%	1.76%	1.79%	1.82%	1.71%
	GDP econometrics – changes	1.57%	1.63%	1.68%	1.68%	1.68%	1.65%
	Wage econometrics – levels	1.87%	2.06%	2.22%	2.24%	2.26%	2.13%
	Wage econometrics – changes	1.83%	2.03%	2.19%	2.19%	2.19%	2.08%
	Wedge to UK wages inflation	1.83%	2.08%	2.27%	2.27%	2.27%	2.14%
	Wedge to CPI inflation	1.66%	1.68%	1.68%	1.68%	1.68%	1.68%
Extrapolation	Whole period trend	1.81%	1.81%	1.81%	1.81%	1.81%	1.81%
Third-party	Independent forecasts	2.58%	2.82%	3.02%	3.02%	3.02%	2.89%

Source: Economic Insight analysis

2.3 Chemicals inflation forecasting

2.3.1 Chemicals in the water and wastewater value chain

Various chemicals are used at multiple stages of the water and wastewater supply chain – and, in totality, constitute an important element of industry costs. The main chemicals used in each of the wholesale price control areas are as follows.

- Water resources.
  - Alkalies and chlorine, including natural sodium carbonate and sulfate.
  - Basic inorganic chemicals.
  - Inorganic chemicals, other than alkalies and chlorine.
  - Lime.
- Water network plus.
  - Alkalies and chlorine, including natural sodium carbonate and sulfate.
  - Basic inorganic chemicals.
  - Carbon black.
  - Industrial gases.
  - Sulfuric acid.

- Wastewater network plus.
  - Alkalies and chlorine, including natural sodium carbonate and sulfate.
  - Water-treating compounds.
  - Inorganic chemicals, other than alkalies and chlorine.
- Wastewater bioresources.
  - Alkalies and chlorine, including natural sodium carbonate and sulfate.
  - Unsupported plastic film, sheet and other shapes.

We have listed the above chemical groups using definitions as per the US Producer Price Index. This is because we have, in turn, used this as the primary source for developing our chemical cost inflation forecasts (because it allows for a more granular approach than the equivalent data published by the ONS). Additionally, given that chemicals are commodities (traded globally), there is a strong argument for using US, rather than UK, data. This has implications for exchange rate adjustments, which we discuss later in this section.

2.3.2 Evidence on key drivers of chemical costs

In practice, chemical costs are affected by a range of drivers. We have reviewed evidence from the academic literature regarding this – which suggests the most important drivers are likely to include:

- **Crude oil** is used in the production of a number of chemicals – and is a key driver of chemical prices. A number of academic papers have analysed this impact. For example, Babula and Somwaru (1992) examined the dynamic effects on agricultural chemicals (and fertiliser) prices of a crude oil price shock. They used monthly data from 1962 to 1990 to construct a vector autoregression (VAR) model of crude oil, industrial chemicals and fertiliser prices. They find that a quarter of an increase in crude oil prices would be passed through to chemical prices.[5]
- **Exchange rates** are widely acknowledged as a driver of commodity prices. For example, Harri et al. (2009) examine the links between exchange rates and several commodities, including agricultural products that use chemicals as inputs. They find that exchange rates play an important role in the determining of prices for all of the commodities they examined.[6] Similarly, Chen et al. (2009) use exchange rates to forecast commodity prices. They find that such forecasts are robust against a ranch of alternative benchmarks (including random walk and autoregressive models).[7]
- There are strong theoretical reasons to expect **economic growth** to have a positive relationship with chemicals and other commodity prices. As economic activity (measured in GDP) increases, it is likely to put pressure on existing supplies. While this will generate a supply-side response, any lag in new suppliers coming on-stream will result in price increases. This relationship has

5 *'Dynamic Impacts of a Shock in Crude Oil Price on Agricultural Chemical and Fertilizer Prices.' R. A. Babula and A. Somwaru, Agribusiness, Vol. 8 No. 3, 243-252 (1992).*
6 *'The Relationship between Oil, Exchange Rates and Commodity Prices.' (2009).*
7 *'Can Exchange Raters Forecast Commodity Prices?' Y.-C. Chen, K. Rogoff and B. Rossi, NBER Working Paper No. 13901 (2009).*

been detailed for other commodities, including food.[8] Interestingly, a related literature examines causality in the *opposite direction*, from commodity prices to economic growth.[9] We think there are good reasons to test whether the relationship between chemical prices and growth is *higher* for the components of GDP that are most intensive in their use of chemicals; in particular, **construction.**

Reflecting the above, our econometric analysis combines oil price inflation, economic growth / activity, and then adjusts this for expected changes in exchange rates.

2.3.3 Economy-based estimates

As explained above, we think that economy-based methods for forecasting (whereby we identify relationships between the inflation measure of interest and other macroeconomic factors) have merit. As such, we explored this approach in relation to chemicals IPI – as follows:

- We developed indices of Yorkshire's chemical commodity costs, based on detailed US data on price inflation for the individual chemical types that are used in each price control area. As per our approach to labour costs, the use of wider economy data (in this case, chemicals commodity prices, rather than actual Yorkshire chemical cost data) avoids inadvertently conflating inefficiency in our forecasts.

- We then collected the historical data on the key underlying drivers of chemical cost inflation, as suggested by economic theory and our review of the available literature.

- We used these data to estimate regressions, examining the statistical relationship between the chemical cost indices and underlying drivers.

- We collected forecast data for the underlying chemical cost drivers, and then used these to generate forecasts of future chemical cost inflation to 2025.

- As our analysis was based on US data, we then adjusted for forecast movements in the £ / $ exchange rate

The mixture of chemicals used in each of the wholesale price control areas is shown in the following table (see overleaf).

[8] *'Global agricultural supply and demand: factors contributing to the recent increase in food commodity prices.' R. Trostle, United States Department of Agriculture (May 2008).*
[9] *'Commodity prices and growth in Africa.' A. Deaton, Journal of Economic Perspectives, Vol. 13 No. 3 (1999).*

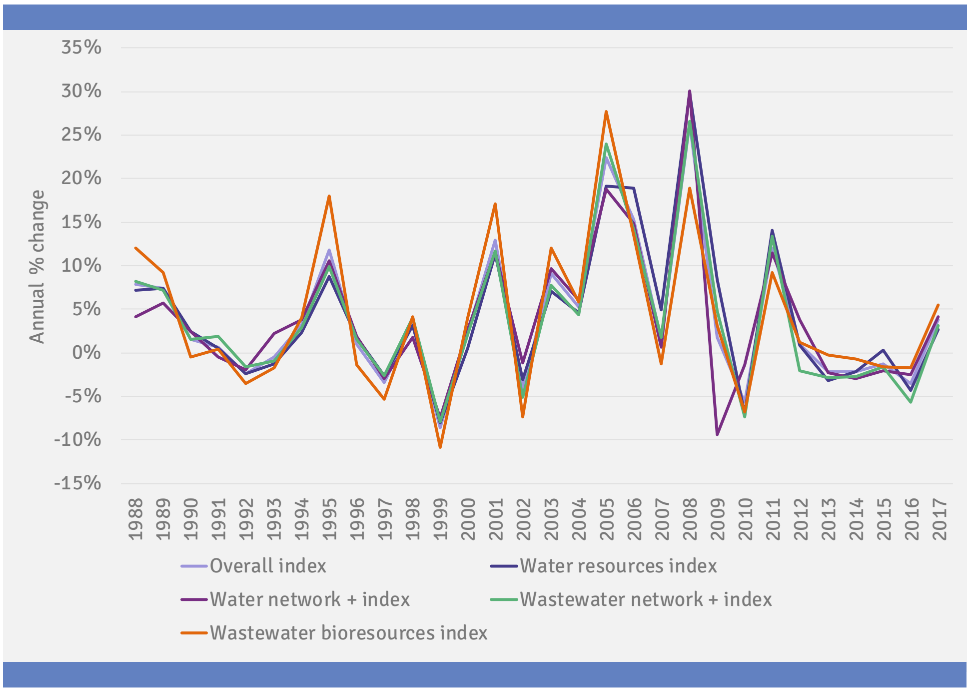
Table 12: Chemicals and associated weights across wholesale price controls

Price control area	Chemical group	Weight
Water resources	Alkalies and chlorine, including natural sodium carbonate and sulfate	25%
	Basic inorganic chemicals	25%
	Inorganic chemicals, other than alkalies and chlorine	25%
	Lime	25%
Water network plus	Alkalies and chlorine, including natural sodium carbonate and sulfate	20%
	Basic inorganic chemicals	20%
	Carbon black	20%
	Industrial gases	20%
	Sulfuric acid	20%
Wastewater network plus	Alkalies and chlorine, including natural sodium carbonate and sulfate	33.33%
	Water-treating compounds	33.33%
	Inorganic chemicals, other than alkalies and chlorine	33.33%
Wastewater bioresources	Alkalies and chlorine, including natural sodium carbonate and sulfate	50%
	Unsupported plastic film, sheet and other shapes	50%

Source: Economic Insight analysis

The resulting indices are shown in the following figure; and cover the timeframe 1988 to 2017.

Figure 17: Chemical cost inflation indices



Source: Economic Insights analysis of US Producer Price Index

2.3.3.1 Collecting historical data on chemical cost drivers

Having generated time series data for our chemicals inflation indices, we then gathered historical data on the drivers of chemical costs. As set out above, our review of the literature suggested that oil prices, GDP growth, and potentially construction activity, were most likely to drive chemical cost inflation.

- Data on **nominal GDP growth** was sourced from the International Monetary Fund (IMF). We collected these data for the US, the UK and the world (although our analysis focused on US data).
- Data on historical **oil prices** (in $ per barrel) was taken from the World Bank.
- We used OECD data to construct a time series for **construction activity**, again for the US and the UK.

2.3.3.2 Estimating regressions

Having compiled time series data on both chemical cost indices for Yorkshire, and the underlying cost drivers, our next step was to estimate regressions of the relationship between them. We included lags of the variables, and examined the impact of different timeframes on the robustness of the regressions.

We note that economic variables (including prices and GDP) are generally *non-stationary* - and tend to trend upwards over time. Unless care is taken, statistical analysis of non-stationary variables can suggest spurious relationships. Consistent with our approach to labour inflation, to address this, we ran regressions in *percentage changes,* alongside regressions in *levels* that included *lags of the dependent variable*.

2.3.3.3 Collecting forecast data for underlying cost drivers

To translate our estimates of the historical relationships between the chemical cost indices and GDP into **forecasts** to 2025, we collected third-party forecast information on the underlying cost drivers.

- Future nominal GDP forecasts were taken from the IMF, and were fully consistent with the historical data from the same source. These forecasts were available until 2022. For 2023 to 2025, we assumed that growth continues at its 2022 level.
- Oil price forecasts were taken from the World Bank, and were also fully consistent with the historical data from the same source. These forecasts were available for every year to 2025.
- We generated our own forecasts for construction. We calculated the long-term average (consistent with the estimation window of our regressions) of the ratio of construction to GDP growth, and then applied this long-term average to the IMF's GDP forecasts.

2.3.3.4 Adjusting for exchange rates

As a final step, since our forecasts were based on US data, we adjusted them for anticipated changes in £/$ exchange rates. We used forecasts from BNP Paribas for years to 2018, and then projected the 2018 level forward to 2025. This is broadly consistent with the OBR's forecasts for the Sterling effective (trade-weighted) exchange rate index, which is flat from 2018.

2.3.3.5 Econometric forecasts

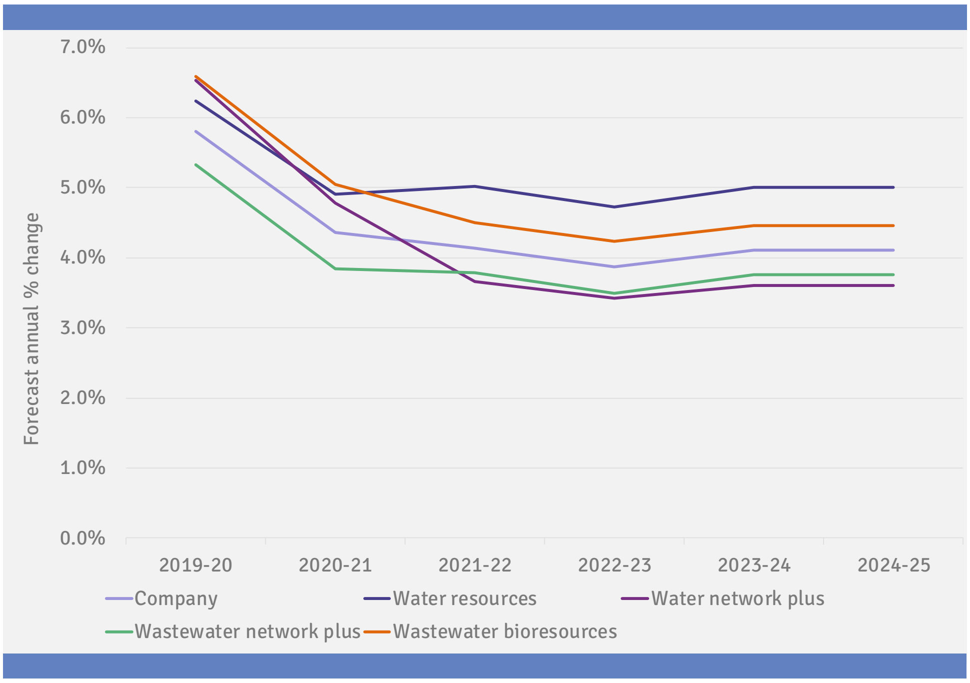
Our regressions in percentage changes and levels had the following functional forms, respectively:

(a) $$\%\Delta\, chemical\ cost\ index_t = \beta_0 + \beta_1 \cdot \%\Delta\, nominal\ GDP_{t-1} + \beta_2 \cdot \%\Delta\, oil\ price_t + \beta_3 \cdot \%\Delta\, oil\ price_{t-1} + \beta_3 \cdot 2008\ year\ dummy + \varepsilon_t$$

(b) $$\%\Delta\, chemical\ cost\ index_t = \beta_0 + \beta_1 \cdot \%\Delta\, nominal\ GDP_t + \beta_2 \cdot \%\Delta\, oil\ price_t + \beta_3 \cdot \%\Delta\, construction_t + \beta_4 \cdot chemical\ cost\ index_{t-1} + \varepsilon_t$$

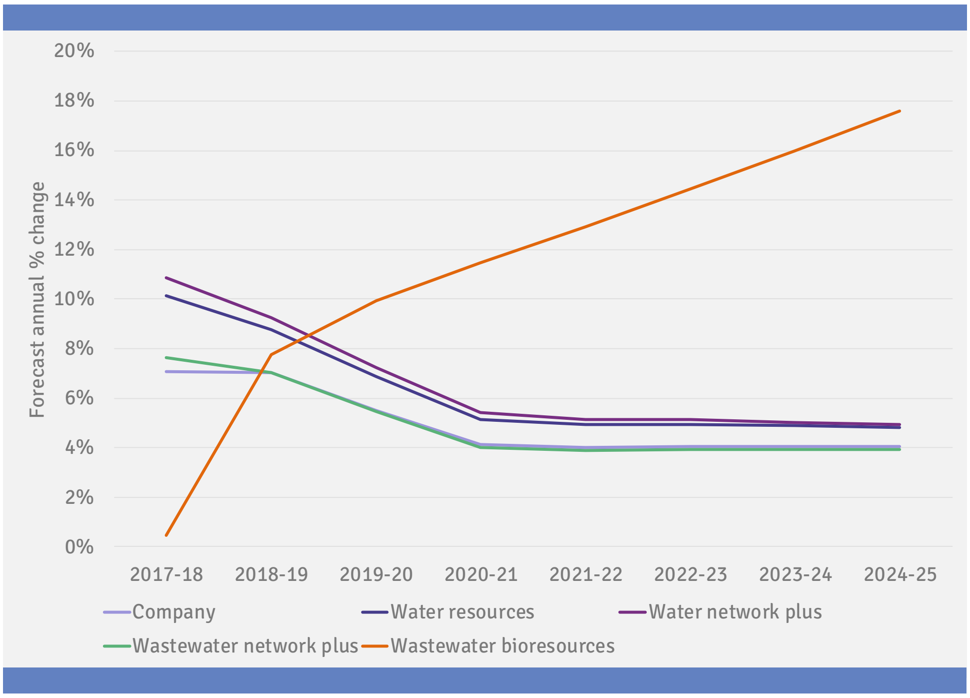
The following figures set out our associated forecasts, based on the econometric models. In forecasts based on percentage changes (Figure 18), the graph shows an initial 'spike' in the period 2019/20, followed by gradually declining inflation out to 2025. This is primarily driven by high forecast outturn oil price inflation for 2017 and 2018, of 23.8% and 5.70% respectively. Due to the lag structure of the model, this drops out of the forecast over time.

Figure 18: Forecasts for Yorkshire Water chemical cost inflation – based on econometrics (percentage changes)



Source: Economic Insight analysis

Figure 19: Forecasts for Yorkshire Water chemical cost inflation – based on econometrics (levels)



Source: Economic Insight analysis

In the figure above, chemical cost inflation for bioresources starts at levels below chemical cost inflation in other price control areas, but is then forecast to increase rapidly (reaching around 17% by 2024/25). This is, in part, due to the different composition of the bioresources chemical index (for example, it includes chemicals in the 'rubber and plastic products' group, that are not included in other price control areas). It is expected, accordingly, to have a different type of relationship with the explanatory variables in comparison with other indices.

2.3.4 Extrapolating existing trends

Our second methodology was to extrapolate forward existing trends in the Yorkshire chemical cost indices. As was the case for our labour cost inflation analysis, we place less weight on this approach than on the evidence based on economic fundamentals. The extrapolation approach constructs forecasts by assuming that future inflation is simply a continuation of the recent past. While this may be appropriate in some circumstances – particularly when underlying cost drivers are expected to be stable over time – an extrapolation approach is clearly less appropriate where cost drivers are expected to change in the future.

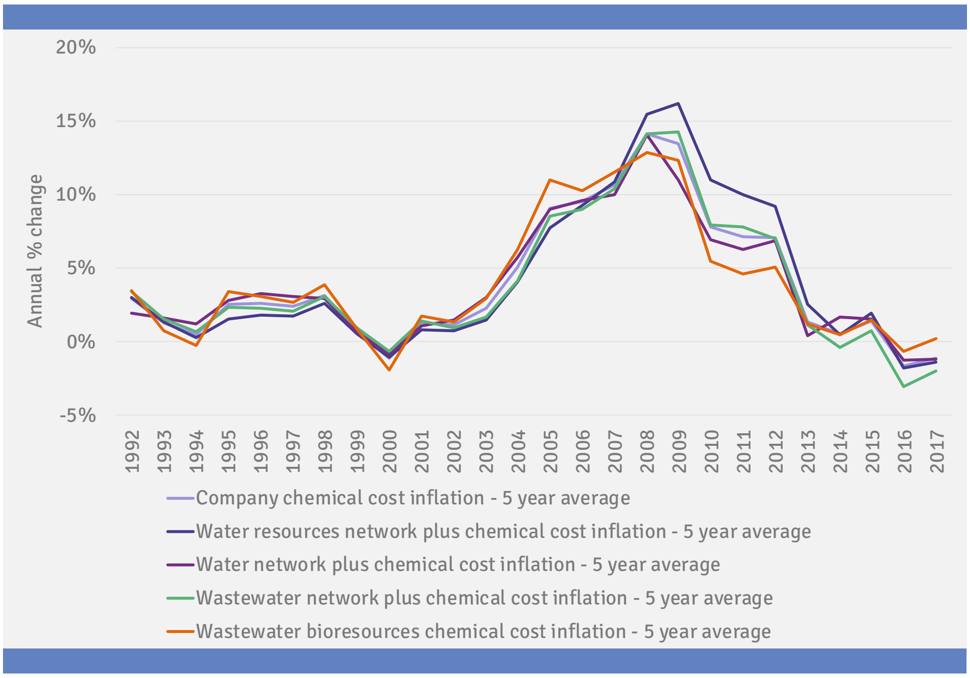
The following table presents average chemical cost inflation for the indices over a range of timeframes. We have also presented rolling five-year averages of the price indices in the figure that follows.

Table 13:: Yorkshire Water chemical price indices, average annual inflation

Time frame	Company	Water resources	Water network plus	Waste-water network plus	Waste-water bio-resources
Last year	-3.56%	-4.37%	-2.50%	-5.68%	-1.70%
Last 5 years	-1.66%	-1.74%	-1.22%	-3.03%	-0.65%
1986-2016	3.88%	4.05%	3.71%	3.67%	4.03%
Consistent with econometrics	5.43%	6.00%	5.25%	4.93%	5.53%

Source: Economic Insight analysis

Figure 20: Yorkshire Water chemical cost inflation, 5 year rolling averages



Source: Economic Insight analysis

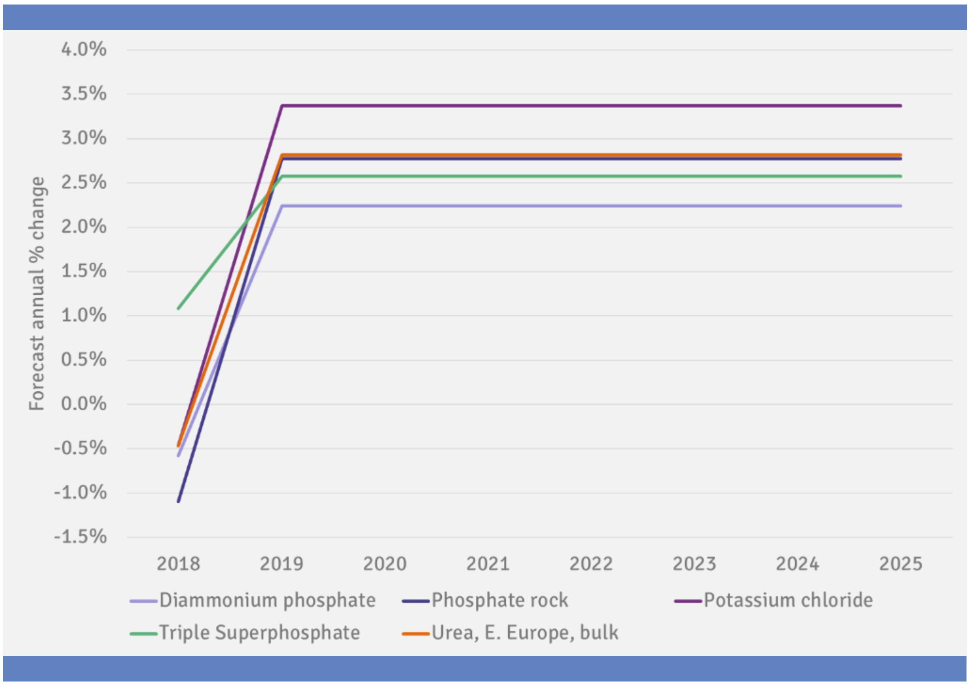
2.3.5 Independent third-party forecasts

We examined independent forecasts of chemical cost inflation, where we looked at forecasts published by the World Bank, as well as drawing on First Economics' report from August 2013 (which provides chemical cost forecasts for the water industry, based on ONS data).[10]

Forecasts from the World Bank are shown in the figure below, and are broadly in the region of 2% to 3% over 2020 to 2025. This compares with First Economics' forecasts of 5% chemical cost inflation for the period from 2015 to 2020, based on an extrapolation approach, using broad chemical categories from ONS data. As we describe above, a limitation with independent forecasts is that they do not reflect the mix of chemicals that are typically used in the water and wastewater industry. They do, however, provide a useful benchmark for expected chemical price inflation in general, over the relevant time period. Overall, these forecasts suggest chemical cost inflation in the range of 1-3.5% pa.

[10] *'Water Industry Input Price Inflation and Frontier Productivity Growth.' First Economics (2013).*

Figure 21: World Bank chemical cost forecasts – adjusted for exchange rate movements



Source: World Bank

2.3.7 Summary and overall chemical cost inflation forecasts

We have presented a range of forecasts for Yorkshire Water's chemical cost inflation over the period 2020-25. The following table draws the resulting estimations together.

Table 14: Our overall Yorkshire Water chemical cost inflation forecasts, 2020-25

Price control area	Scenario	2020 / 21	2021 / 22	2022 / 23	2023 / 24	2024 / 25	Avg
Company	Econometrics (changes)	4.36%	4.13%	3.87%	4.10%	4.10%	4.11%
	Econometrics (levels)	3.70%	3.59%	3.64%	3.64%	3.65%	3.64%
	Trend	5.43%	5.43%	5.43%	5.43%	5.43%	5.43%
	Independent third-party	2.76%	2.76%	2.76%	2.76%	2.76%	2.76%
Water resources	Econometrics (changes)	4.90%	5.02%	4.73%	5.00%	5.00%	4.93%
	Econometrics (levels)	5.13%	4.92%	4.94%	4.88%	4.82%	4.94%
	Trend	6.00%	6.00%	6.00%	6.00%	6.00%	6.00%
	Independent third-party	2.76%	2.76%	2.76%	2.76%	2.76%	2.76%
Water network plus	Econometrics (changes)	4.79%	3.67%	3.42%	3.61%	3.61%	3.82%
	Econometrics (levels)	5.40%	5.14%	5.12%	5.03%	4.94%	5.13%
	Trend	5.25%	5.25%	5.25%	5.25%	5.25%	5.25%
	Independent third-party	2.76%	2.76%	2.76%	2.76%	2.76%	2.76%

Wastewater network plus	Econometrics (changes)	3.85%	3.78%	3.49%	3.76%	3.76%	3.73%
	Econometrics (levels)	4.03%	3.90%	3.95%	3.94%	3.93%	3.95%
	Trend	4.93%	4.93%	4.93%	4.93%	4.93%	4.93%
	Independent third-party	2.76%	2.76%	2.76%	2.76%	2.76%	2.76%
Wastewater bioresources	Econometrics (changes)	5.04%	4.50%	4.23%	4.46%	4.46%	4.54%
	Econometrics (levels)	11.45%	12.92%	14.44%	16.00%	17.59%	14.48%
	Trend	5.53%	5.53%	5.53%	5.53%	5.53%	5.53%
	Independent third-party	2.76%	2.76%	2.76%	2.76%	2.76%	2.76%

Source: Economic Insight analysis

2.5 Energy inflation forecasting

Utilities are amongst the highest users of energy in the UK. As such, changes in energy costs can have an important impact on their overall underlying inflationary pressure. The main energy component for water companies is electricity. The context for deriving energy forecasts over PR19 is one where, in the short-term, there is a general expectation of rising costs – as illustrated in the following text box.

Box 1: Energy costs expected to rise

Rising energy costs have recently been in the news – and not only in relation to domestic consumers and the introduction of an energy price cap on retail consumer prices.[11]

Non-domestic consumers – such as water companies – are set to face much higher energy bills than household consumers. As a recent news article sets out, industrial and commercial businesses in the UK pay significantly above the average compared to other European countries – only Danish businesses pay higher energy bills.

Moreover, the Helm review – an independent review commissioned by the Government on the cost of energy – found that the UK is paying significantly more than it should.

One of the solutions to these rising energy costs is seeking to use less energy from the national grid – that is, for a water company to start generating their own power. However, the costs and benefits of coming off the grid need to be weighed very carefully.

"The very largest energy users will struggle to get their bill down without some kind of Government intervention in the cost base. The levers just can't be pulled by them in the same way as can be done for the vast majority of industrial and commercial consumers," a consultant from Baringa Partners warns.

Source: 'British industry faces an energy cost crisis - and it is set to grow.' The Daily Telegraph (29 October 2017).[12]

For electricity costs forecasts, we look at the range of estimates produced by the Department for Business, Energy and Industrial Strategy (BEIS), which in turn are based on detailed econometric models, as we explain in the following section.

[11] *'Draft Domestic Gas and Electricity (Tariffs Cap) Bill.' Department for Business, Energy and Industrial Strategy (October 2017).*

[12] *http://www.telegraph.co.uk/business/2017/10/29/british-industry-faces-cost-energy-crisis-set-grow/ [accessed 04/01/2018].*

2.5.2 Independent forecasts

BEIS publishes a range of forecasts relating to: UK energy demand and supply; energy prices; as well as projections of carbon dioxide and other greenhouse gas emissions.[13] For each, BEIS' central projection is referred to as the 'reference case', which embeds its best views in relation to drivers including:

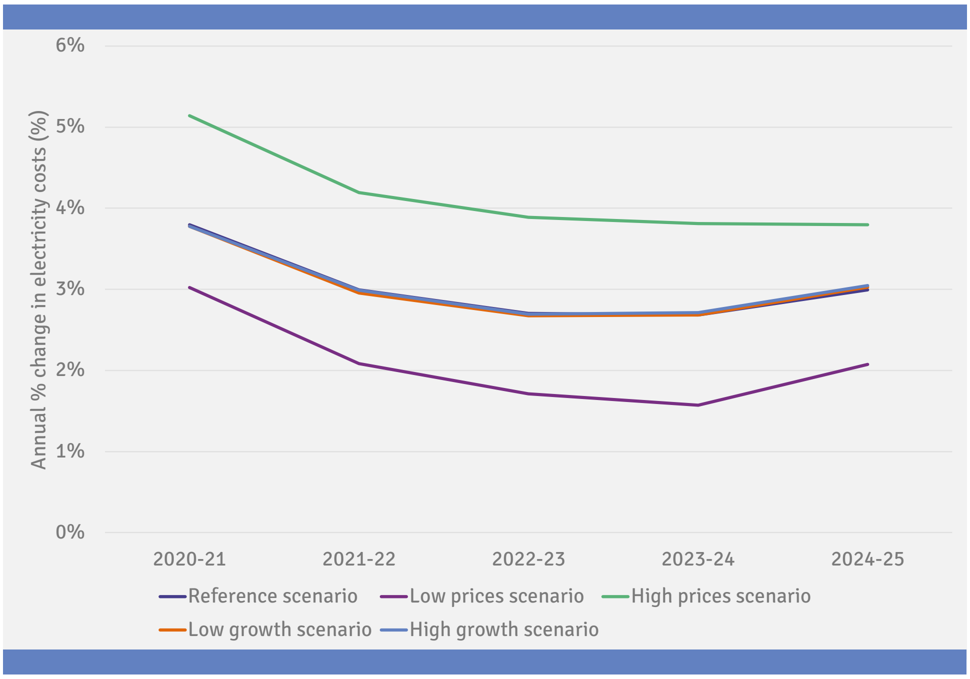
- energy usage patterns;
- fossil fuel prices;
- GDP; and
- population.

BEIS uses statistical techniques to arrive at its projections, based on trends and relationships identified from historical data, adjusting them to take account of implemented, adopted and agreed Government energy policies. Besides the reference scenario, BEIS also sets out projections for the following:

- low and high fossil fuel prices; and
- low and high economic growth.

We consider BEIS's projections to be a credible source of information. In the following graph, we show electricity cost inflation forecasts based on BEIS's different case scenarios over PR19.

Figure 22: Forecast electricity cost inflation – based on BEIS's forecasts



Source: BEIS

Given that the OBR has, in recent Economic and Fiscal Outlook papers, downgraded its projections for the UK's economic performance (and given Brexit uncertainty) it could be reasonably argued that the 'low growth' scenario modelled by BEIS is now more

[13] *'Updated energy and emissions projections 2017.' Department for Business, Energy & Industrial Strategy (January 2018).*

likely. The following table sets out electricity inflation forecasts for Yorkshire, based on BEIS's analysis.

Table 15: Summary of electricity costs inflation for Yorkshire Water, 2020-25

Price control area / year	2020 / 21	2021 / 22	2022 / 23	2023 / 24	2024 / 25	Avg
Reference scenario	3.79%	2.99%	2.70%	2.68%	2.99%	3.03%
Low prices scenario	3.02%	2.09%	1.71%	1.57%	2.08%	2.09%
High prices scenario	5.14%	4.19%	3.89%	3.81%	3.80%	4.17%
Low growth scenario	3.78%	2.96%	2.68%	2.69%	3.03%	3.02%
High growth scenario	3.78%	2.99%	2.70%	2.71%	3.04%	3.04%

Source: Economic Insight analysis

2.6 Forecasting underlying inflation for bad debt

The two key cost drivers of debt costs in the water industry are:

(a) bill size; and
(b) socioeconomic factors (such as deprivation – and thus, relatedly, the wider macroeconomic environment).

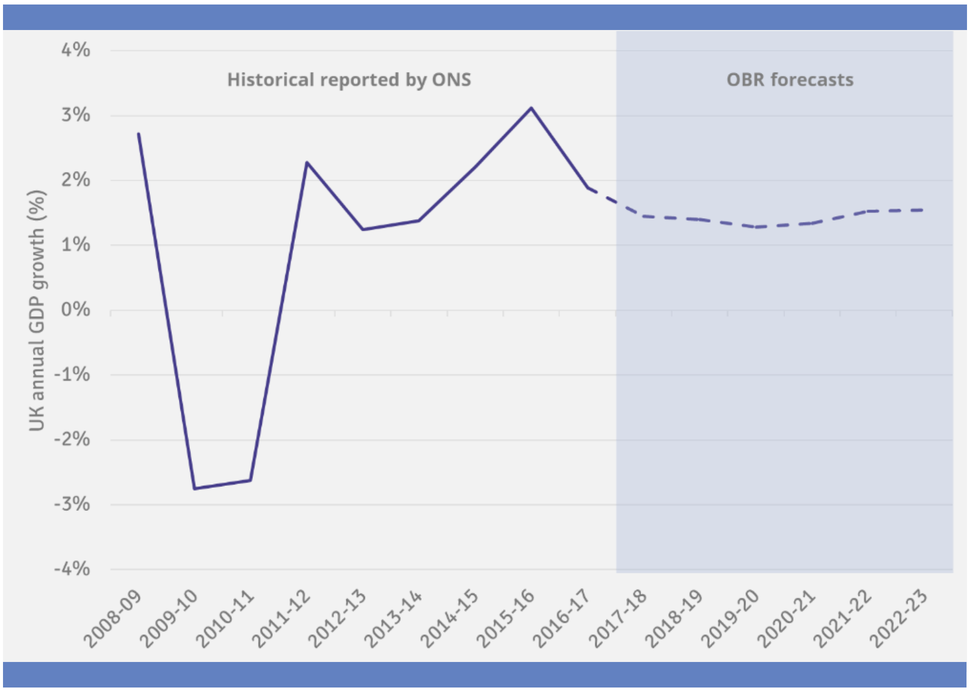
From a retail perspective, in principle, bill size is mainly driven by whatever regulated prices are set at the wholesale level. Accordingly, the IPI relating to bad debt in the retail part of the supply chain is, by large, determined by the 'K factors' as set by Ofwat for the water and wastewater wholesale elements of the PR19 price control.

It is not possible to determine, in advance, what these will be (as they are a function of allowed operating costs, efficiency, capex and the cost of capital). Therefore, one approach for projecting bad debt gross IPI would be to project these costs based on CPIH.[14] The rationale for this is that CPIH is allowed for in the regulatory approach for wholesale. Therefore, by definition, it is an inflationary pressure that flows through to retail.

Nonetheless, the risk of simply assuming CPIH as the basis for projecting doubtful debt IPI is that it ignores the likely impact of changes to the UK's macroeconomic environment during PR19. Specifically, for so long as the UK economy is growing, in totality one might expect inflationary pressure relating to bad debt to be mitigated. Accordingly, the following chart shows the OBR's forecasts for UK GDP growth.

[14] *Which is consumer price inflation including a measure of owner occupiers' housing.*

Figure 23: Historical and projected GDP



Source: ONS and OBR data

As shown above, the OBR expects GDP growth to slow, relative to the recent past, before slowly increasing again from 2020 onwards. Consequently, therefore, one would expect this to provide some mitigation of the impact of IPI relating to bad debt.

To reflect the above, we developed an econometric approach to forecasting bad debt related IPI. To do this, we used historic data (from 2010/11 – 2016/17), and estimated the relationship between bad debt per property; average wholesale bill size per unique customer; and an indicator of the health of regional economies (benefits expenditure). We then used publicly available information to forecast bills and benefits expenditure and, with our econometric model, predicted the annual growth in bad debt per property over PR19.[15]

The doubtful debt IPI projected by our modelling is set out in the following tables. We find that, on average, Yorkshire is likely to face gross IPI of between 1.24% to 1.86% per annum in relation to bad debt.

[15] Note, it is important to understand that models developed for forecasting are distinct from those used for efficiency benchmarking. In particular, in relation to forecasting, we are interested in identifying explanatory variables for which forecasts can be obtained – rather than, as per benchmarking, identifying the 'best' measure of underlying cost drivers outside of management control.

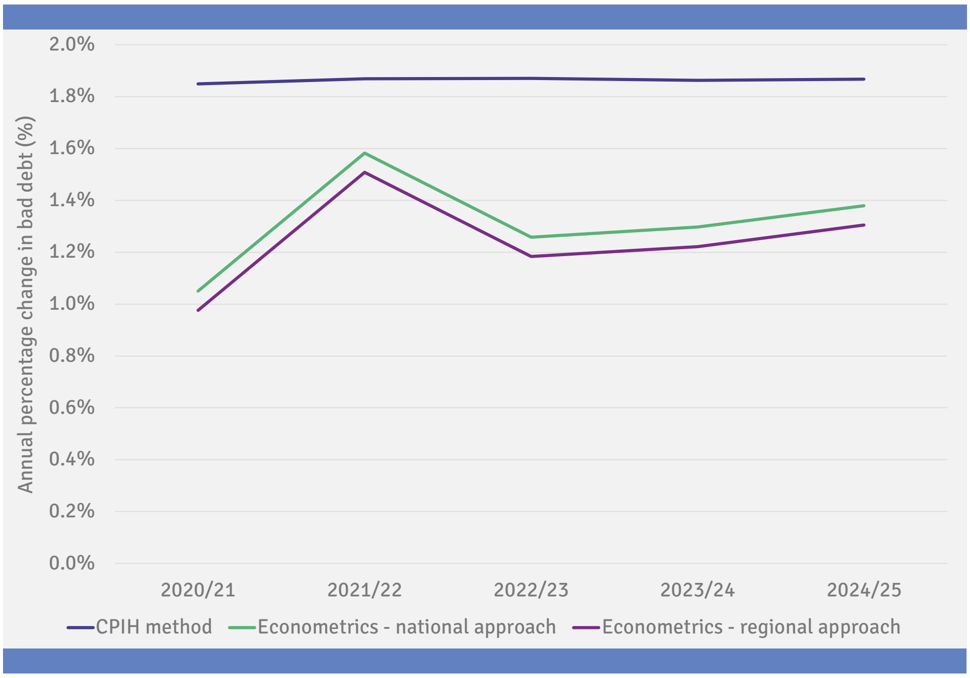
Table 16: Bad debt forecasts using different methodologies

Method	2020/21	2021/22	2022/23	2023/24	2024/25	Average
CPIH	1.85%	1.87%	1.87%	1.86%	1.87%	1.86%
Econometric forecast (national)	1.05%	1.58%	1.26%	1.30%	1.38%	1.31%
Econometric forecast (regional)	0.98%	1.51%	1.18%	1.22%	1.30%	1.24%

Source: Economic Insight analysis of ONS and water companies' data

The following figure shows how our econometric approaches, based on economic fundamentals, compare to a (more simple) CPIH approach. Our modelling reflects the OBR's expected (modest) GDP growth, which of course mitigates bad debt costs for companies over time. This explains why our statistical forecasts are lower than those implied by the CPIH method.

Figure 24: Doubtful debt IPI implied by econometrics versus CPIH

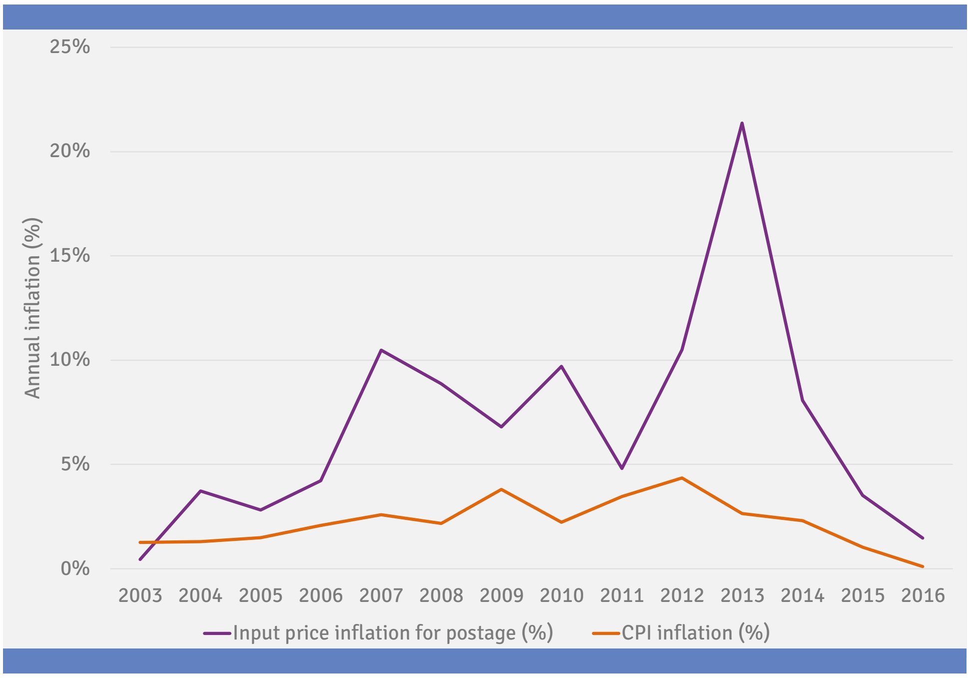


Source: Economic Insight analysis of ONS data

2.8 Postage inflation forecasts

The ONS publishes detailed breakdowns of inflation by individual items within its Retail Price Index (RPI) and CPI measures – one of them being postage costs. We therefore examined historical postage inflation back over 13 years to 2003, which is compared to CPI in the following figure.

Figure 25: Historical postage inflation



Source: Economic Insight analysis of ONS data

Postage inflation has been significantly higher than CPI. This is not surprising, given that Royal Mail Group was freed from price cap regulation in 2011 by Ofcom (and was privatised in 2013).

Similar to other input costs, for postage, we derive the IPI forecasts using both the econometric and extrapolation approaches. Consistent with the 'wedge' methodology, to project postage IPI forward over time, we:

- examined the historic wedge between postage inflation and CPI (which was 4.7% over the 13 years);
- obtained the OBR's forecasts for CPI; and
- then assumed the historical wedge over CPI would hold in order to generate expected postal IPIs.

Our forecasts are summarised in the following table.

Table 17: Yorkshire Water postage cost inflation forecasts, 2020/21 - 2024/25

Postage inflation forecasts (%)	2020/ 21	2021/ 22	2022/ 23	2023/ 24	2024/ 25	Average
GDP econometrics - levels	9.01%	9.06%	9.05%	8.58%	8.16%	8.77%
GDP econometrics - changes	7.38%	7.26%	7.16%	7.16%	7.16%	7.22%
Wedge versus CPI	6.69%	6.71%	6.72%	6.72%	6.72%	6.71%
Whole period trend	6.92%	6.92%	6.92%	6.92%	6.92%	6.92%

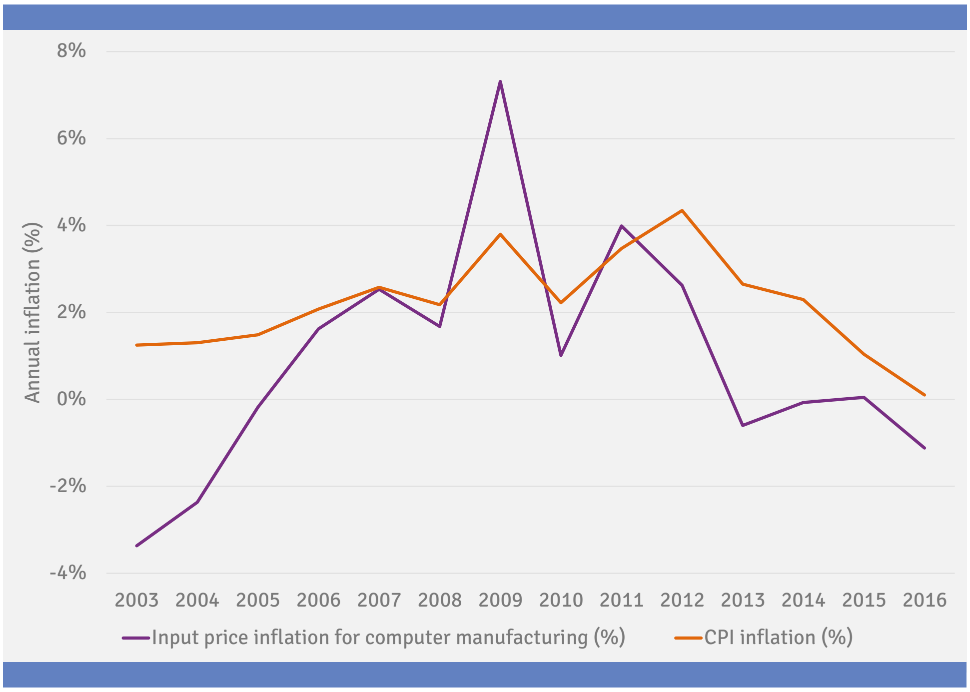
Source: Economic Insight analysis

There is a reasonable prospect that Royal Mail Group will continue to put in price increases that are materially above the longer-term historic average (13 years).

2.9 IT inflation forecasts

In relation to IT related costs, there is more limited 'output price' related information available. We have, therefore, applied the same approaches set out above, but instead have utilised the producer price index, published by the ONS, in relation to '*inputs for the manufacturing of computers*'. We consider this to be the index most relevant to IT. The following chart shows the historical IPI for the manufacturing of computers, compared to CPI inflation.

Figure 26: Historical IT input cost inflation



Source: Economic Insight analysis of ONS data

Over the period 2003 to 2016, input cost inflation for computer manufacturing has averaged 0.94%, which is below the average for the same period for CPI of 2.20%.

To project IT related IPI forward, we have applied the historical wedge between our measure and CPI (-1.30%) to the OBR's CPI forecast, in a manner consistent with the methodology described earlier. The projected figures are included in table below, as well as the results from: (i) our econometrics methodology, which is explained in detail in Annex A; and (ii) a simple extrapolation approach.

Table 18: Yorkshire Water IT cost inflation forecasts, 2020/21 - 2024/25

IT inflation forecasts (%)	2020 / 21	2021 / 22	2022 / 23	2023 / 24	2024 / 25	Avg
GDP econometrics - levels	1.56%	1.68%	1.80%	1.83%	1.86%	1.74%
GDP econometrics - changes	1.34%	1.24%	1.15%	1.15%	1.15%	1.21%
Wedge versus CPI	0.72%	0.73%	0.74%	0.74%	0.74%	0.73%
Whole period trend	0.94%	0.94%	0.94%	0.94%	0.94%	0.94%

Source: Economic Insight analysis

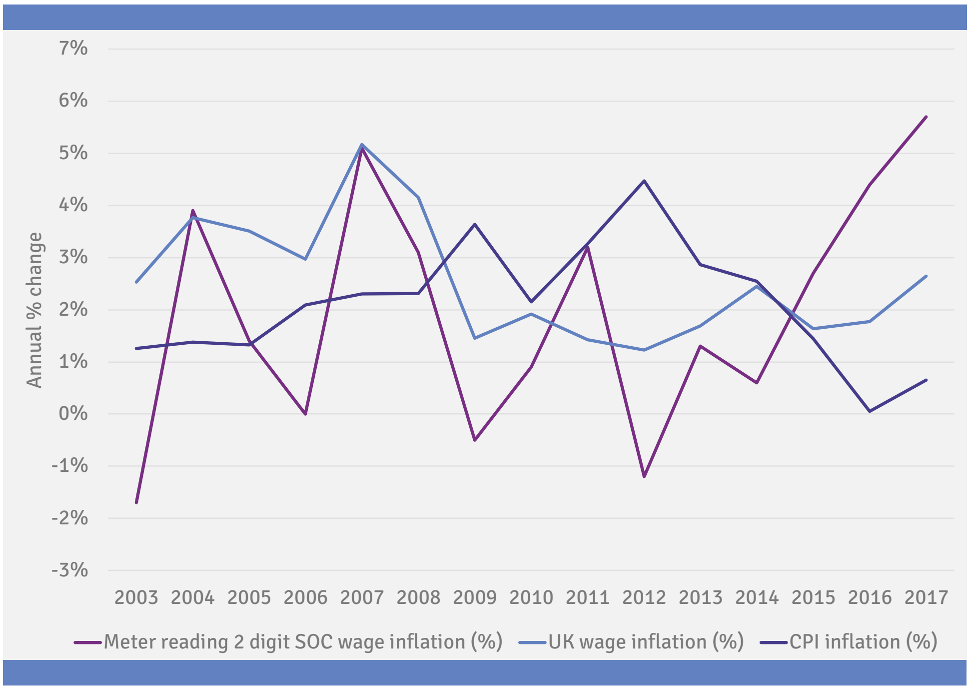
2.10 Meter reading inflation forecasts

For meter reading costs, we are mindful that providing the service involves the utilisation of multiple inputs, including labour, transportation and fuel costs. It is, however, reasonable to assume that it is a labour-intensive service. Accordingly, in this section we discuss inflation forecasts for the labour cost component.

Similar to our approach to forecasting labour cost inflation more broadly, we looked at the SOC code(s) that most closely match the nature of meter reading job roles. We find that meter reading job requirements are highly similar to those for 'Sales Occupations', as identified in the ASHE data. We therefore created a historical wage inflation index based on this, using 2 digit SOC data from the ONS.[16] Using this data, the following figure shows wage inflation for meter reading in comparison to CPI and overall UK average wage inflation over time.

[16] *The 2 digit SOC code is used for the analysis because it is based on a larger sample size, and given that is includes a wider range of sales related occupations, compared to basing the analysis on 3 or 4 digit SOC codes.*

Figure 27: Historical inflation for sales occupations wages



Source: Economic Insight analysis of ONS ASHE data

We find that, over the period 2003-2017, average inflation in relation to meter reading was 1.93%, which is lower than the average CPI and overall UK wage inflation (2.20% and 2.60%, respectively).

As per our approach to labour IPI, we deploy a range of methods to develop forecasts. These are summarised in Table 19 overleaf.

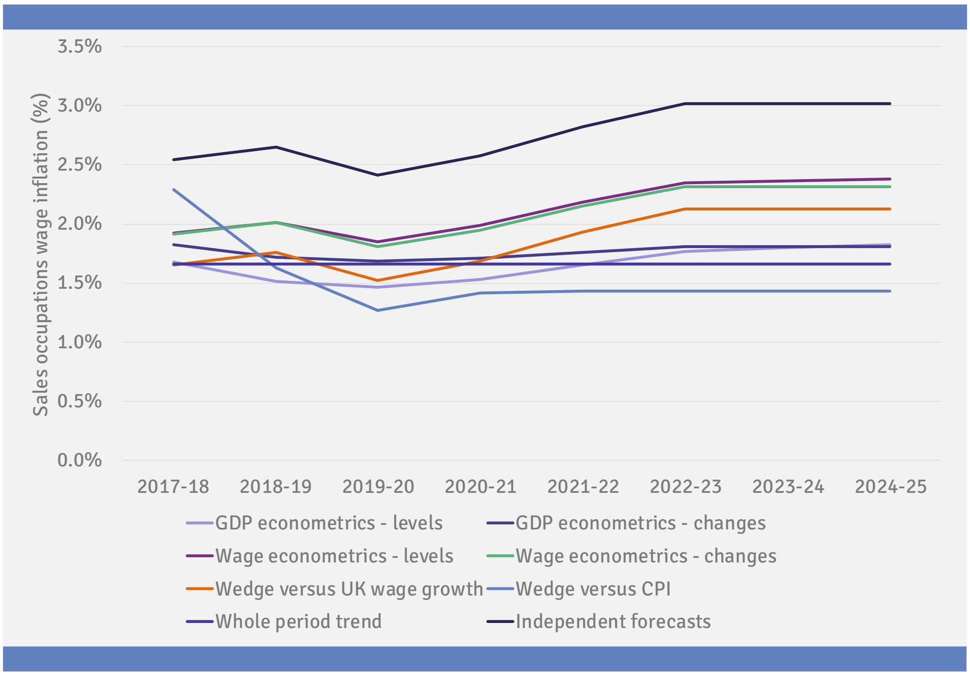
Table 19: Sales occupations wage inflation forecasts, 2020/21 - 2024/25 - 2 digit SOC

Methodology	Wage inflation forecasts (%)	2020/21	2021/22	2022/23	2023/24	2024/25	Average
Economy-based	GDP econometrics – levels	1.53%	1.65%	1.77%	1.80%	1.82%	1.71%
	GDP econometrics – changes	1.71%	1.76%	1.81%	1.81%	1.81%	1.78%
	Wage econometrics – levels	1.98%	2.18%	2.35%	2.36%	2.38%	2.25%
	Wage econometrics – changes	1.95%	2.15%	2.31%	2.31%	2.31%	2.21%
	Wedge to UK wage inflation	1.69%	1.93%	2.13%	2.13%	2.13%	2.00%
	Wedge to CPI inflation	1.41%	1.43%	1.44%	1.44%	1.44%	1.43%
Extrapolation	Whole period trend	1.66%	1.66%	1.66%	1.66%	1.66%	1.66%
Third-party	Independent forecasts	2.58%	2.82%	3.02%	3.02%	3.02%	2.89%

Source: Economic Insight analysis

To get a sense of the range and rank of the results of the different estimation techniques in comparison with each other, we further present them graphically in the following figure.

Figure 28: Forecast sales occupations wage inflation



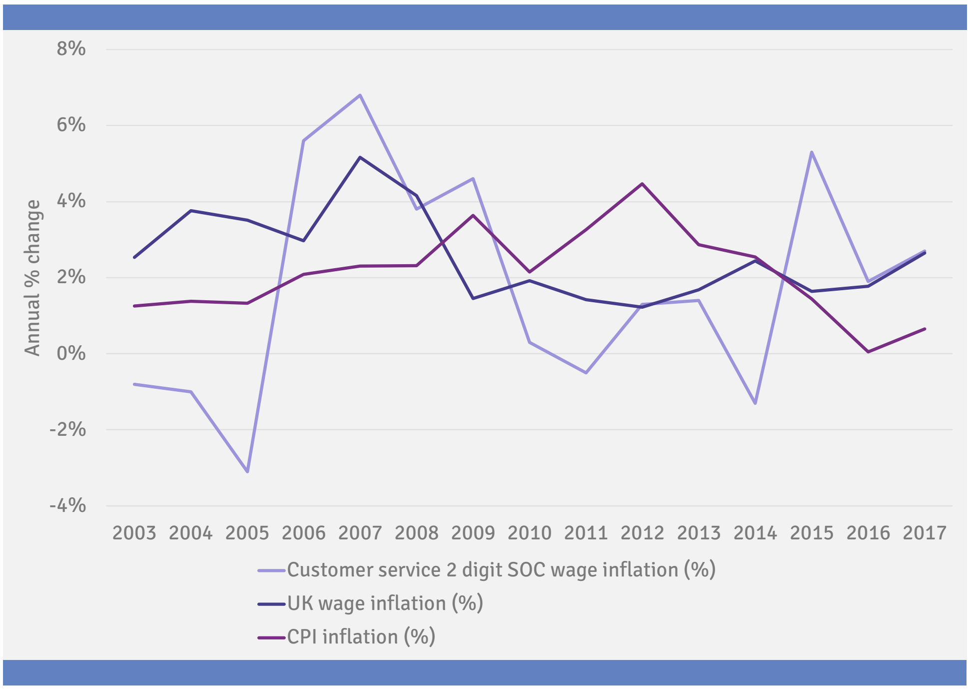
Source: Economic Insight analysis

2.11 Customer services inflation forecast

For customer services, our approach to forecasting IPI was very similar to that for meter reading. That is to say, we assumed that the opex primarily relates to labour costs. We then identified the most relevant categories (SOC codes) within the ASHE data (at the 2 digit level, this was SOC code 72: 'customer service occupations').

Using the above data, the following figure shows the historical trend in IPI, relative to CPI and overall UK average wage inflation, as published by the ONS.

Figure 29: Historical inflation for customer service occupations wages



Source: Economic Insight analysis of ONS ASHE data

The above data indicates inflation for customer services of 1.80% pa on average (2013-2017). Again, this is lower than both CPI and UK wage inflation. Consistent with our reporting set out previously, the following table presents summary results of the various methods used to forecast inflation related to customer service occupations for the period 2020/21 to 2024/25.

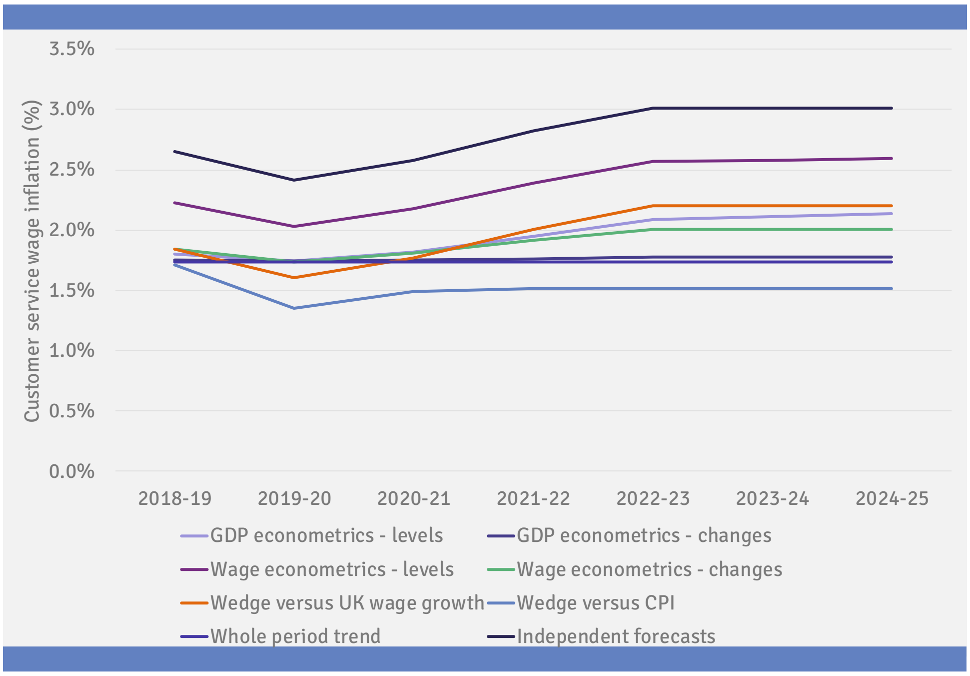
Table 20: Customer service occupations wage inflation forecasts, 2020/21 - 2024/25 - 2 digit SOC

Methodology	Wage inflation forecasts (%)	2020/21	2021/22	2022/23	2023/24	2024/25	Average
Economy-based	GDP econometrics – levels	1.82%	1.95%	2.09%	2.11%	2.14%	2.02%
	GDP econometrics – changes	1.75%	1.77%	1.78%	1.78%	1.78%	1.77%
	Wage econometrics – levels	2.18%	2.39%	2.57%	2.58%	2.59%	2.46%
	Wage econometrics – changes	1.81%	1.92%	2.01%	2.01%	2.01%	1.95%
	Wedge to UK wage inflation	1.77%	2.01%	2.20%	2.20%	2.20%	2.08%
	Wedge to CPI inflation	1.49%	1.51%	1.51%	1.51%	1.51%	1.51%
Extrapolation	Whole period trend	1.74%	1.74%	1.74%	1.74%	1.74%	1.74%
Third-party	Independent forecasts	2.58%	2.82%	3.02%	3.02%	3.02%	2.89%

Source: Economic Insight analysis

The above results are further presented graphically in the following figure.

Figure 30: Forecast customer service occupations wage inflation



Source: Economic Insight analysis of ONS ASHE data

2.12 'Other' (opex) input price inflation

In general, we think it is reasonable to assume that "other" miscellaneous operating expenditures would largely follow the overall inflation in the economy. Accordingly, we assume that CPI inflation represents the most appropriate proxy.

As mentioned previously, the OBR provides forecast CPI up to 2022/23. For the remaining years to 2024/25, we have simply assumed that CPI inflation will persist at the 2023 level. Accordingly, the following table shows projected IPI for 'other' opex.

Table 21: CPI inflation forecast (as used for 'other' opex IPI)

	2020/21	2021/22	2022/23	2023/24	2024/25	Average
CPI	1.98%	2.00%	2.00%	2.00%	2.00%	2.00%

Source: OBR up to 2022/23

2.12.1 Business rates

Within the 'other' cost category, business rates, which are the total amounts that local councils collect from businesses, usually comprise a material cost item. Business rates are indexed in accordance with the retail price index (RPI).

The OBR also provides forecast for RPI up to 2022/23. Similar to our approach elsewhere, for the remaining years we assume that RPI would rise at the same level as of 2022/23. The following table presents our RPI inflation assumption for business rates.

Table 22: RPI inflation forecast

	2020/21	2021/22	2022/23	2023/24	2024/25	Average
RPI	2.92%	2.93%	2.99%	2.99%	2.99%	2.96%

Source: OBR up to 2022/23

2.14 Forecasting underlying inflation for capital costs

The previous subsections set out forecasts for individual elements of opex. In addition to this, and as described in the introductory chapter, Ofwat requires companies to provide inflation forecasts relating to capital costs. Specifically, including the categories of: maintenance / capex; infrastructure and non-infrastructure (and by wholesale price control area).

To explore this, we used data from the Resource Cost Indices, which are published by the Building Cost Information Services (BCIS) of RICS (this data was formerly published by the Department for Business, Innovation and Skills). These indices measure the notional trend of input costs to contractors; and primarily relate to construction work. Categories of work within the data are: building of non-housing; house building; road construction; and general infrastructure.[17]

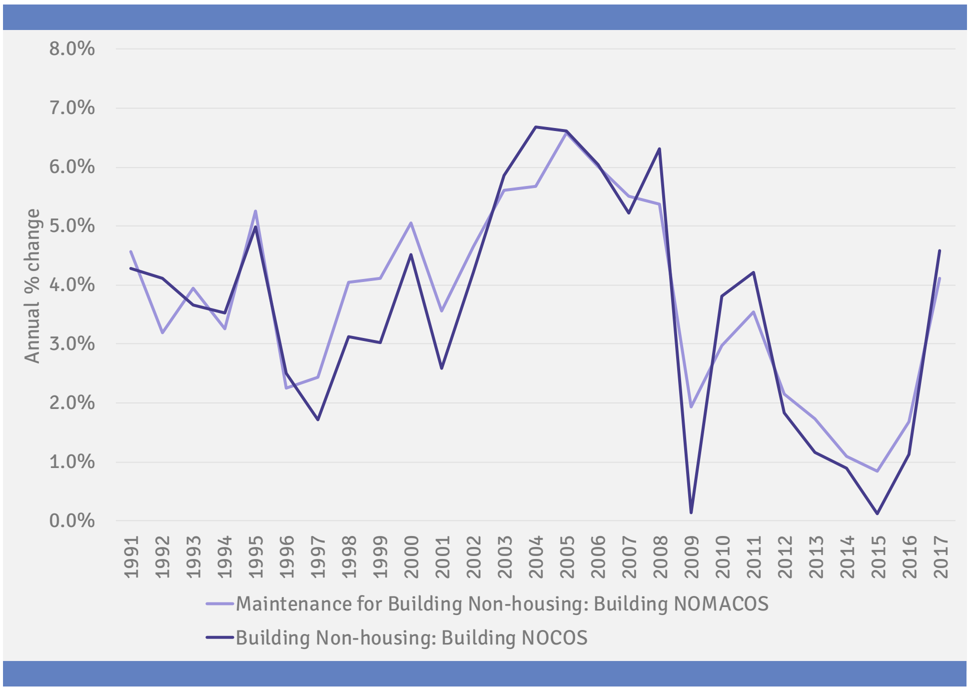
Having reviewed the BCIS data carefully, with reference to the categories required for PR19, we consider the most relevant indices to be:

- Resource Cost Index of Maintenance of Building Non-Housing (NOMACOS): which we use for **capital maintenance** inflation forecasting. We apply inflation forecasts of this index across all price control areas.

- Resource Cost Index of Building Non-Housing (NOCOS): which we use for **capex** inflation forecasting. We apply inflation forecasts of this index across all price control areas.

Accordingly, the following figure shows how these measures have moved historically.

Figure 31: Historical inflation of maintenance and building cost indices, 1991-2017



Source: BCIS Online

[17] *'Resource Cost Indices (formerly BIS).' BCIS (May 2016).*

As can be seen, the impact of the financial crisis on non-house building construction and maintenance inflation was severe. Indeed, it has not yet returned to pre-crisis levels. In the following, we set out how we used these indices to create gross IPI forecasts for capital costs.

2.14.1 Economy-based estimates

In terms of economy-based estimates, the econometric models we estimated based on the relationships between our capital cost indices and GDP were not robust. As such, we focus on the 'wedge' methodology here.

We calculated the wedge between the capital cost indices set out above and both (i) nominal GDP inflation; and (ii) CPI-H inflation. Here, we consider that deriving the forecast using the *wedge to nominal GDP inflation* should be preferred over the *wedge to CPI-H inflation*. This is because the drivers of capital costs are more likely to move in line with GDP than CPI-H.

The following table shows the size of the wedges for the whole period for which data is available, from 1991 to 2017. In general, capital cost inflation is below nominal GDP inflation (i.e. the wedges are negative), whereas it tends to be above CPI-H inflation.

Table 23: Historical wedge between capital cost indices and: (i) nominal GDP inflation; and (ii) CPI-H inflation

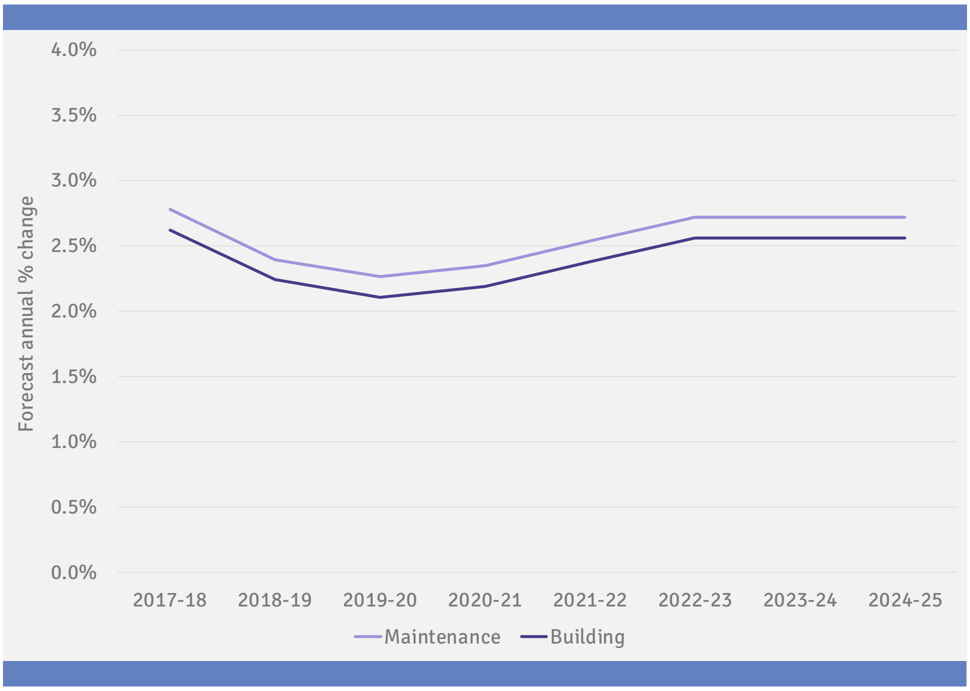
	Wedge to nominal GDP inflation	Wedge to CPI-H inflation
Maintenance	-0.61%	0.60%
Capex	-0.77%	0.46%

Source: Economic Insight analysis

We combined these 'wedges' with the most recent projections for both nominal GDP and CPI growth, taken from the OBR. These are available up to the year 2022/23. Consistent with our approach elsewhere, for years beyond 2023 we assumed that nominal GDP and CPI growth continue at the level forecast for 2022/23. We have further deflated the OBR's CPI forecasts by the historical average 'wedge' between CPI and CPI-H (-0.14%).

Our forecasts based on this methodology are illustrated in the following figure, with respect to nominal GDP inflation. As can be seen, capital related cost inflation is initially forecast to decline slightly – reflecting the downturn in economic activity – followed by a period of slightly rising inflation; before plateauing.

Figure 32: Forecast capital cost inflation – based on nominal GDP wedge



Source: Economic Insight analysis

2.14.2 Extrapolating existing trends

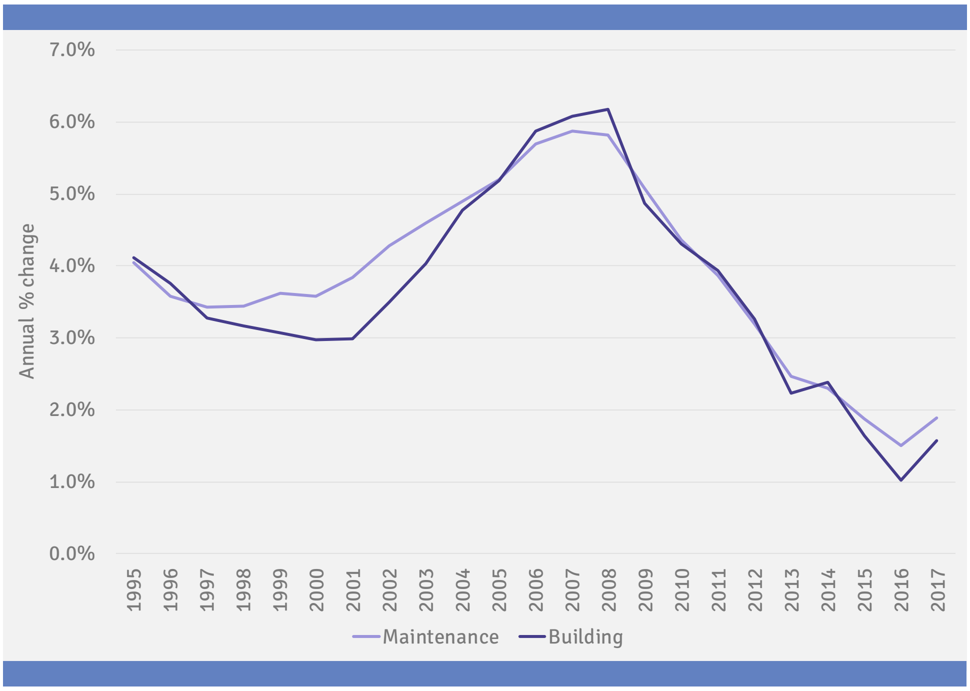
We also examined forecasts based on an extrapolation of existing trends in capital cost inflation. As mentioned elsewhere, one of the major limitations of extrapolations is that they will not account for expected changes in cost drivers, or the broader economy. The following table shows capital cost inflation between 1991 and 2017. We also present five-year rolling averages of the capital cost indices.

Table 24: Capital cost indices, average annual inflation

	1991-2017
Maintenance	3.74%
Capex	3.59%

Source: Economic Insight analysis

Figure 33: Capital cost inflation, 5 year rolling averages



Source: Economic Insight analysis

2.15 Summary of overall capital cost inflation

The following table draws together the estimation results for capital costs forecast. The available data does not provide a reliable basis for further decomposing this between 'infrastructure' and 'non-infrastructure'.

Table 25: Our overall Yorkshire Water capital cost inflation forecasts, 2020-25

	Scenario	2020 / 21	2021 / 22	2022 / 23	2023 / 24	2024 / 25	Average
Maintenance	Econometrics - levels	2.56%	2.73%	2.90%	2.91%	2.92%	2.80%
	Econometrics - changes	3.26%	3.32%	3.38%	3.38%	3.38%	3.35%
	Wedge versus CPI	3.28%	3.30%	3.30%	3.30%	3.30%	3.30%
	Wedge versus CPI-H	2.44%	2.46%	2.46%	2.46%	2.46%	2.45%
	Wedge versus GDP	2.35%	2.54%	2.72%	2.72%	2.72%	2.61%
	Whole period trend	3.74%	3.74%	3.74%	3.74%	3.74%	3.74%
Capex	Econometrics - levels	2.56%	2.73%	2.90%	2.91%	2.92%	2.80%
	Econometrics - changes	3.03%	3.11%	3.18%	3.18%	3.18%	3.14%
	Wedge versus CPI	3.12%	3.14%	3.14%	3.14%	3.14%	3.14%
	Wedge versus CPI-H	2.30%	2.32%	2.32%	2.32%	2.32%	2.31%
	Wedge versus GDP	2.19%	2.38%	2.56%	2.56%	2.56%	2.45%
	Whole period trend	3.59%	3.59%	3.59%	3.59%	3.59%	3.59%

Source: Economic Insight analysis

2.16 Forecasting capital costs in retail

In the retail controls, capex will represent a very small proportion of total costs. As such, we consider it reasonable to adopt a somewhat pragmatic approach. In particular, Yorkshire could:

- assume IPI for capex consistent with our forecasts for opex; or
- could base IPI for capex on our forecasts for IT related costs (which will most likely be the 'main' element of capital costs for retail).

In relation to the latter, the table below re-summarises our forecasts for IT related IPI, using the range of methods we explored.

Table 26: Summary of gross IPI for retail IT (alternative to capital IPI line)

IT inflation forecasts (%)	2020 / 21	2021 / 22	2022 / 23	2023 / 24	2024 / 25	Avg
GDP econometrics – levels	1.56%	1.68%	1.80%	1.83%	1.86%	1.74%
GDP econometrics – changes	1.34%	1.24%	1.15%	1.15%	1.15%	1.21%
Wedge versus CPI	0.72%	0.73%	0.74%	0.74%	0.74%	0.73%
Whole period trend	0.94%	0.94%	0.94%	0.94%	0.94%	0.94%

Source: Economic Insight analysis

3. Summary of our IPI forecasts for Yorkshire Water

In the previous chapter we set out detailed forecasts by 'cost category', using a range of methods. As described in the introductory section of our report, for its Plan, Yorkshire must ultimately come to a view as to the overall IPI it will face in relation to 'opex' and 'capital costs' (using the definitions prescribed by Ofwat) by price control area.

In practice, one's view of overall opex, capital maintenance, or capex IPI will depend on 'which' forecast methods for each (more detailed) category of cost are most appropriate. As we described previously, there are various pros and cons of these (although we consider the 'economy based' methods to have advantages over others, where these are feasible). As such, we have provided Yorkshire with all of our forecasts at the most granular level available. We have further provided the company with a spreadsheet, which allows them to 'select' the forecasting method by cost category – from which the overall forecasts for opex, capital maintenance and capex, are then derived.

In selecting individual forecasts by 'cost type' our recommendation is that Yorkshire should ensure that its overall projections for IPI by control area are consistent with assumptions elsewhere in its Plan. Particularly in relation to the broader UK macroeconomic context over PR19.

Reflecting the above, in this report we do not strongly advocate any single set of numbers that Yorkshire should make use of per se. In the following tables we do, however, set out a 'central case' for IPI by control area, using the cost categories stipulated by Ofwat. Here, by 'central case' we are referring to the range of estimates that, based on our judgment, we think form a reasonable basis for projecting overall inflation. We consider that this therefore provides Yorkshire with a robust reference point that it can either use directly in its Plan, or as a point of comparison, should the company choose to make its own assumptions.

3.2 Water resources

Table 27: Gross input price inflation - wholesale **water resources** **(central case)**

Year / cost category	2020/21	2021/22	2022/23	2023/24	2024/25	Average
Operating expenditure	2.43%	2.28%	2.25%	2.25%	2.34%	2.31%
Maintaining the long-term capability of the assets infrastructure	2.35%	2.54%	2.72%	2.72%	2.72%	2.61%
Maintaining the long-term capability of the assets non-infrastructure	2.35%	2.54%	2.72%	2.72%	2.72%	2.61%
Other capital expenditure ~ infrastructure	3.12%	3.14%	3.14%	3.14%	3.14%	3.14%
Other capital expenditure ~ non-infrastructure	3.12%	3.14%	3.14%	3.14%	3.14%	3.14%

Source: Economic Insight analysis

3.3 Water network plus

Table 28: Gross input price inflation - wholesale **water network plus** **(central case)**

Year / cost category	2020/21	2021/22	2022/23	2023/24	2024/25	Average
Operating expenditure	2.21%	2.14%	2.13%	2.14%	2.17%	2.16%
Maintaining the long-term capability of the assets infrastructure	2.35%	2.54%	2.72%	2.72%	2.72%	2.61%
Maintaining the long-term capability of the assets non-infrastructure	2.35%	2.54%	2.72%	2.72%	2.72%	2.61%
Other capital expenditure ~ infrastructure	3.12%	3.14%	3.14%	3.14%	3.14%	3.14%
Other capital expenditure ~ non-infrastructure	3.12%	3.14%	3.14%	3.14%	3.14%	3.14%

Source: Economic Insight analysis

3.4 Wastewater network plus

Table 29: Gross input price inflation - wholesale **wastewater network plus (central case)**

Year / cost category	2020/21	2021/22	2022/23	2023/24	2024/25	Average
Operating expenditure	2.42%	2.30%	2.27%	2.28%	2.35%	2.32%
Maintaining the long-term capability of the assets infrastructure	2.35%	2.54%	2.72%	2.72%	2.72%	2.61%
Maintaining the long-term capability of the assets non-infrastructure	2.35%	2.54%	2.72%	2.72%	2.72%	2.61%
Other capital expenditure ~ infrastructure	3.12%	3.14%	3.14%	3.14%	3.14%	3.14%
Other capital expenditure ~ non-infrastructure	3.12%	3.14%	3.14%	3.14%	3.14%	3.14%

Source: Economic Insight analysis

3.5 Wastewater bioresources

Table 30: Gross input price inflation - wholesale **wastewater bioresources (central case)**

Year / cost category	2020/21	2021/22	2022/23	2023/24	2024/25	Average
Operating expenditure	2.52%	2.42%	2.38%	2.41%	2.45%	2.44%
Maintaining the long-term capability of the assets infrastructure	2.35%	2.54%	2.72%	2.72%	2.72%	2.61%
Maintaining the long-term capability of the assets non-infrastructure	2.35%	2.54%	2.72%	2.72%	2.72%	2.61%
Other capital expenditure ~ infrastructure	3.12%	3.14%	3.14%	3.14%	3.14%	3.14%
Other capital expenditure ~ non-infrastructure	3.12%	3.14%	3.14%	3.14%	3.14%	3.14%

Source: Economic Insight analysis

3.6 Retail

Table 31: Gross input price inflation - retail (central case)

Year / cost category	2020/21	2021/22	2022/23	2023/24	2024/25	Average
Operating expenditure	1.80%	2.06%	2.01%	2.03%	2.06%	1.99%

Source: Economic Insight analysis

4. Annex A: econometrics

This annex provides more detail on our approach for forecasting the various input costs set out in the main report.

We have used econometric models to forecast the following input costs:

- staff cost inflation; and
- chemical cost inflation.

4.1 Labour cost econometrics

Below, we provide more detail on the econometrics used for the labour cost forecasting.

4.1.1 Labour cost index

Table 32: SOC codes used in Yorkshire Water's labour cost index - 2 digit

SOC	SOC 2010	Water resources	Water network +	Waste-water network +	Waste-water bio-resources	Retail
Corporate managers and directors	11	14%	14%	15%	15%	5%
Other managers and proprietors	12	3%	3%	2%	2%	0%
Science, research, engineering and technology professionals	21	15%	14%	15%	14%	4%
Business, media and public service professionals	24	5%	4%	5%	4%	10%
Science, engineering and technology associate professionals	31	3%	3%	5%	4%	2%
Culture, media and sports occupations	34	0%	0%	0%	0%	0%
Business and public service associate professionals	35	8%	13%	12%	11%	8%
Administrative occupations	41	4%	4%	6%	5%	16%
Secretarial and related occupations	42	1%	0%	2%	2%	0%
Skilled metal, electrical and electronic trades	52	8%	6%	5%	5%	5%

Skilled construction and building trades	53	5%	5%	3%	3%	0%
Textiles, printing and other skilled trades	54	0%	0%	0%	0%	0%
Leisure, travel and related personal service occupations	62	0%	0%	0%	8%	0%
Sales occupations	71	0%	0%	0%	0%	8%
Customer service occupations	72	3%	4%	3%	3%	38%
Process, plant and machine operatives	81	29%	28%	25%	22%	3%
Transport and mobile machine drivers and operatives	82	0%	0%	0%	0%	0%
Elementary administration and service occupations	92	0%	0%	1%	1%	0%

Source: Economic Insight

Table 33: SOC codes used in Yorkshire Water's labour cost index - 3 digit

SOC	SOC 2010	Water resources	Water network +	Waste-water network +	Waste-water bio-resources	Retail
Chief executives and senior officials	111	10%	10%	11%	11%	0%
Functional managers and directors	113	4%	4%	3%	3%	0%
Managers and directors in retail and wholesale	119	0%	0%	0%	0%	4%
Managers and proprietors in other services	125	3%	3%	2%	2%	1%
Natural and social science professionals	211	2%	1%	1%	1%	0%
Engineering professionals	212	11%	11%	11%	11%	0%
Information technology and telecommunications professionals	213	3%	2%	2%	2%	2%
Business, research and administrative professionals	242	3%	3%	3%	3%	2%
Architects, town planners and surveyors	243	0%	0%	1%	0%	8%
Quality and regulatory professionals	246	1%	1%	1%	1%	0%

Media professionals	247	1%	1%	1%	0%	1%
Science, engineering and production technicians	311	3%	3%	4%	3%	1%
Information technology technicians	313	1%	1%	1%	1%	1%
Business, finance and related associate professionals	353	4%	5%	8%	8%	1%
Sales, marketing and related associate professionals	354	1%	5%	2%	1%	0%
Public services and other associate professionals	356	3%	3%	2%	2%	3%
Administrative occupations : Finance	412	0%	1%	0%	0%	4%
Administrative occupations : Records	413	0%	0%	3%	3%	2%
Other administrative occupations	415	1%	1%	1%	1%	0%
Administrative occupations : Office managers and supervisors	416	2%	2%	2%	2%	2%
Secretarial and related occupations	421	1%	0%	2%	2%	2%
Vehicle trades	523	4%	0%	1%	0%	12%
Electrical and	524	4%	6%	4%	4%	0%

electronic trades						
Construction and building trades	531	5%	5%	3%	3%	11%
Leisure and travel services	621	0%	0%	0%	8%	0%
Sales related occupations	712	0%	0%	0%	0%	0%
Customer service occupations	721	1%	1%	1%	1%	0%
Customer service managers and supervisors	722	2%	3%	3%	2%	0%
Process operatives	811	5%	4%	3%	3%	0%
Plant and machine operatives	812	14%	14%	8%	8%	33%
Construction operatives	814	10%	9%	14%	11%	5%
Road transport drivers	821	0%	0%	0%	0%	2%
Elementary administration occupations	921	0%	0%	1%	0%	0%
Elementary security occupations	924	0%	0%	0%	0%	2%

Source: Economic Insight

4.1.2 Regressions in percentage changes

Our regressions in *percentage changes* had the following functional forms:

3) *Yorkshire Water nominal wage growth*$_t$ = *constant* + $\beta \cdot$ *UK nominal GDP growth*$_t$ + ε_t
4) *Yorkshire Water nominal wage growth*$_t$ = *constant* + $\beta \cdot$ *UK nominal average wage growth*$_t$ + ε_t

The tables below show the estimation results for these models.

Table 34: Econometric estimates of the relationship between Yorkshire Water labour cost index and nominal GDP (percentage changes) – 2 digit SOC

	Company	Water resources	Water network +	Wastewater network +	Wastewater bioresources	Retail
Constant	0.0010	-0.0002	-0.0008	-0.0004	-0.0004	0.0066
Standard error	0.0061	0.0059	0.0062	0.0062	0.0064	0.0083
P-value	0.8746	0.9726	0.8989	0.9549	0.9529	0.4408
Nominal GDP	0.4770	0.5230	0.5253	0.5137	0.5174	0.3059
Standard error	0.1424	0.1398	0.1457	0.1447	0.1502	0.1957
P-value	0.0058	0.0028	0.0036	0.0040	0.0049	0.1440
R-squared	46%	52%	50%	49%	48%	16%
F statistic	11.2245	14.0033	13.0032	12.5973	11.8664	2.4438

Source: Economic Insight

Table 35: Econometric estimates of the relationship between Yorkshire Water labour cost index and nominal GDP (percentage changes) – 3 digit SOC

	Company	Water resources	Water network +	Wastewater network +	Wastewater bioresources	Retail
Constant	-0.0058	-0.0078	-0.0074	-0.0092	-0.0078	0.0033
Standard error	0.0064	0.0068	0.0069	0.0068	0.0068	0.0077
P-value	0.3803	0.2743	0.3093	0.2002	0.2748	0.6752
Nominal GDP	0.6049	0.6642	0.6523	0.6779	0.6587	0.3715
Standard error	0.1495	0.1606	0.1632	0.1603	0.1604	0.1800
P-value	0.0016	0.0014	0.0018	0.0012	0.0015	0.0613
R-squared	56%	57%	55%	58%	56%	25%
F statistic	16.3762	17.0985	15.9650	17.8874	16.8736	4.2603

Source: Economic Insight

Table 36: Econometric estimates of the relationship between Yorkshire Water labour cost index and average UK wages (percentage changes) – 2 digit SOC

	Company	Water resources	Water network +	Wastewater network +	Wastewater bioresources	Retail
Constant	-0.0082	-0.0088	-0.0102	-0.0095	-0.0094	-0.0028
Standard error	0.0053	0.0054	0.0054	0.0055	0.0059	0.0086
P-value	0.1517	0.1307	0.0838	0.1073	0.1350	0.7515
Nominal GDP	1.0565	1.1027	1.1384	1.1117	1.1124	0.8175
Standard error	0.1909	0.1944	0.1942	0.1961	0.2110	0.3095
P-value	0.0001	0.0001	0.0001	0.0001	0.0002	0.0215
R-squared	70%	71%	73%	71%	68%	35%
F statistic	30.6390	32.1764	34.3484	32.1477	27.8042	6.9750

Source: Economic Insight

Table 37: Econometric estimates of the relationship between Yorkshire Water labour cost index and average UK wages (percentage changes) – 3 digit SOC

	Company	Water resources	Water network +	Wastewater network +	Wastewater bioresources	Retail
Constant	-0.0139	-0.0161	-0.0163	-0.0164	-0.0150	-0.0056
Standard error	0.0064	0.0071	0.0069	0.0075	0.0075	0.0078
P-value	0.0503	0.0417	0.0349	0.0506	0.0689	0.4894
Nominal GDP	1.2027	1.2969	1.3075	1.2728	1.2453	0.8909
Standard error	0.2285	0.2530	0.2464	0.2702	0.2683	0.2796
P-value	0.0002	0.0003	0.0002	0.0005	0.0006	0.0078
R-squared	68%	67%	68%	63%	62%	44%
F statistic	27.7134	26.2763	28.1522	22.1962	21.5405	10.1535

Source: Economic Insight

4.1.3 Regressions in levels

The regressions in levels had the following functional forms:

3) $\textit{Yorkshire Water labour cost index}_t = \textit{constant} + \beta \cdot \textit{UK nominal GDP index}_t + \gamma \cdot \textit{Yorkshire Water labour cost index}_{t-1} + \varepsilon_t$

4) $\textit{Yorkshire Water labour cost index}_t = \textit{constant} + \beta \cdot \textit{UK average wage index}_t + \gamma \cdot \textit{Yorkshire Water labour cost index}_{t-1} + \varepsilon_t$

The tables below show estimation results for these models.

Table 38: Econometric estimates of the relationship between Yorkshire Water labour cost index and nominal GDP (levels) – 2 digit SOC

	Company	Water resources	Water network +	Wastewater network +	Wastewater bioresources	Retail
Constant	21.7079	22.7875	22.9086	22.7206	22.9666	18.5172
Standard error	6.0810	6.0397	6.4578	6.3494	6.3030	6.4510
P-value	0.0044	0.0031	0.0046	0.0043	0.0039	0.0152
Nominal GDP	0.1281	0.1240	0.1224	0.1206	0.1157	0.1670
Standard error	0.0485	0.0496	0.0507	0.0498	0.0494	0.0521
P-value	0.0229	0.0295	0.0345	0.0339	0.0390	0.0083
Lag	0.6809	0.6801	0.6788	0.6826	0.6874	0.6524
Standard error	0.1015	0.1014	0.1063	0.1044	0.1029	0.1108
P-value	0.0000	0.0000	0.0001	0.0000	0.0000	0.0001
R-squared	98%	98%	98%	98%	98%	98%
F statistic	340.3097	337.1720	288.5072	299.5060	290.0461	313.3793

Source: Economic Insight

Table 39: Econometric estimates of the relationship between Yorkshire Water labour cost index and nominal GDP (levels) – 3 digit SOC

	Company	Water resources	Water network +	Wastewater network +	Wastewater bioresources	Retail
Constant	22.6762	24.0537	23.6334	24.2378	23.4127	19.9671
Standard error	7.4014	7.7502	7.8442	8.2305	7.4353	6.9567
P-value	0.0108	0.0100	0.0118	0.0133	0.0093	0.0152
Nominal GDP	0.0729	0.0642	0.0664	0.0561	0.0535	0.1376
Standard error	0.0512	0.0535	0.0548	0.0530	0.0515	0.0512
P-value	0.1824	0.2555	0.2508	0.3127	0.3211	0.0212
Lag	0.7356	0.7363	0.7369	0.7417	0.7545	0.6751
Standard error	0.1138	0.1175	0.1199	0.1214	0.1123	0.1140
P-value	0.0000	0.0001	0.0001	0.0001	0.0000	0.0001
R-squared	97%	96%	96%	96%	96%	98%
F statistic	184.6983	155.6261	154.4618	133.5866	163.0036	261.5951

Table 40: Econometric estimates of the relationship between Yorkshire Water labour cost index and average UK wages (levels) – 2 digit SOC

	Company	Water resources	Water network +	Wastewater network +	Wastewater bioresources	Retail
Constant	20.1884	20.6379	20.0559	20.8152	20.6045	17.2494
Standard error	6.3833	6.1841	6.7486	6.5540	6.4955	6.1639
P-value	0.0090	0.0066	0.0127	0.0088	0.0089	0.0173
Nominal GDP	0.3005	0.2790	0.1980	0.2666	0.2408	0.4235
Standard error	0.1361	0.1371	0.1587	0.1341	0.1319	0.1316
P-value	0.0494	0.0667	0.2379	0.0722	0.0953	0.0082
Lag	0.5225	0.5465	0.6344	0.5554	0.5864	0.3992
Standard error	0.1893	0.1862	0.2121	0.1868	0.1826	0.1861
P-value	0.0185	0.0136	0.0123	0.0127	0.0083	0.0551
R-squared	98%	98%	98%	98%	98%	98%
F statistic	301.8881	297.4380	216.4895	266.8105	253.5583	314.2452

Source: Economic Insight

Table 41: Econometric estimates of the relationship between Yorkshire Water labour cost index and average UK wages (levels) – 3 digit SOC

	Company	Water resources	Water network +	Wastewater network +	Wastewater bioresources	Retail
Constant	21.2012	22.4062	22.1828	22.6412	21.6325	20.4047
Standard error	7.4082	7.5240	7.5777	8.0938	7.2433	7.0054
P-value	0.0155	0.0126	0.0138	0.0174	0.0124	0.0141
Nominal GDP	0.1413	0.1168	0.1283	0.0952	0.0862	0.3551
Standard error	0.1215	0.1203	0.1236	0.1167	0.1165	0.1304
P-value	0.2695	0.3527	0.3219	0.4318	0.4746	0.0198
Lag	0.6826	0.7010	0.6903	0.7194	0.7405	0.4470
Standard error	0.1793	0.1755	0.1797	0.2179	0.1688	0.1928
P-value	0.0029	0.0021	0.0027	0.0071	0.0011	0.0407
R-squared	97%	96%	96%	96%	96%	98%
F statistic	175.5480	149.6479	149.7743	128.7584	156.1336	264.4235

4.2 Chemical cost econometrics

Below, we provide more detail on the econometrics used for the chemical cost forecasting.

4.2.1 Regressions in percentage changes

We estimated the following set of regressions in **percentage changes**.

(c) $\%\Delta\, chemical\ cost\ index_t = \beta_0 + \beta_1 \cdot \%\Delta\, nominal\ GDP_{t-1} + \beta_2 \cdot \%\Delta\, oil\ price_t + \beta_3 \cdot \%\Delta\, oil\ price_{t-1} + \beta_3 \cdot 2008\ year\ dummy + \varepsilon_t$

The table overleaf presents our preferred regressions, which we used in econometric forecasting.

Table 42: Regressions in percentage changes

	Whole company	Water resources	Water network +	Wastewater network +	Wastewater bio-resources
Constant	-0.0918	-0.1013	-0.0726	-0.1080	-0.0851
Standard error	0.0334	0.0341	0.0277	0.0381	0.0462
P-value	0.0189	0.0128	0.0238	0.0162	0.0926
GDP lag	3.6105	4.2005	2.7731	3.9944	3.4739
Standard error	0.9436	0.9656	0.7837	1.0783	1.3070
P-value	0.0028	0.0012	0.0046	0.0035	0.0223
Oil price	0.1137	0.0621	0.1737	0.1052	0.1137
Standard error	0.0537	0.0550	0.0446	0.0614	0.0744
P-value	0.0579	0.2827	0.0025	0.1144	0.1544
Oil price lag	-0.4421	-0.6491	-0.2590	-0.5539	-0.3064
Standard error	0.2481	0.2539	0.2060	0.2835	0.3436
P-value	0.1023	0.0267	0.2347	0.0766	0.3916
Dummy	0.1456	0.1790	0.1825	0.1486	0.0724
Standard error	0.0566	0.0579	0.0470	0.0646	0.0783
P-value	0.0258	0.0102	0.0025	0.0421	0.3751
R-squared	78%	79%	86%	75%	59%
F statistic	10.7919	11.4927	18.5194	8.9466	4.3960

Source: Economic Insight

4.2.2 Regressions in levels

We estimated the following regressions in **levels**.

(d) $\%\Delta\ chemical\ cost\ index_t = \beta_0 + \beta_1 \cdot \%\Delta\ nominal\ GDP_t + \beta_2 \cdot \%\Delta\ oil\ price_t + \beta_3 \cdot \%\Delta\ construction_t + \beta_4 \cdot chemical\ cost\ index_{t-1} + \varepsilon_t$

The tables overleaf present the results for these regressions, which we used in econometric forecasting.

Table 43: Regressions in levels for whole company

	Whole company	Water resources	Water network +	Wastewater network +	Wastewater bio-resources
Constant	-11.4851	-14.7293	-21.1187	-1.5455	21.0147
Standard error	22.8312	29.4336	25.7874	26.2490	25.6073
P-value	0.6249	0.6266	0.4302	0.9541	0.4293
Lag	0.6028	0.6893	0.7482	0.6473	0.6668
Standard error	0.2029	0.2657	0.2143	0.2234	0.2228
P-value	0.0127	0.0249	0.0051	0.0145	0.0122
GDP	0.2527	0.2224	0.6986	0.0798	0.1014
Standard error	0.4219	0.7010	0.4036	0.4316	0.4127
P-value	0.5614	0.7570	0.1114	0.8566	0.8104
Oil price	0.1433	0.1436	0.1191	0.1437	0.1410
Standard error	0.0426	0.0519	0.0475	0.0491	0.0487
P-value	0.0063	0.0184	0.0292	0.0138	0.0145
Construction	0.1909	0.1579	-0.3098	0.2179	-0.0462
Standard error	0.2788	0.4644	0.2732	0.3209	0.2593
P-value	0.5076	0.7402	0.2810	0.5112	0.8619
R-squared	96%	96%	97%	94%	94%
F statistic	72.9561	67.1854	87.6171	50.0269	51.4772

Source: Economic Insight

4.3 Postage econometrics

The postage cost regression in levels had the following functional form:

1) *Postage cost index$_t$ = constant + β · UK nominal GDP index$_t$ + γ · postage cost index$_{t-1}$ + ε_t*

Our postage costs regression in *percentage changes* had the following functional form:

2) *Nominal postage cost growth$_t$ = constant + β · UK nominal GDP growth$_t$ + ε_t*

The table below shows the estimation results for these two models.

Table 44: Econometric estimates of the relationship between the postage cost index and UK GDP – levels and percentage changes

Model type	Levels regression	Percentage changes regression
Constant	-47.9107	0.0915
Standard error	35.0930	0.0294
P-value	0.1994	0.0090
Nominal GDP	0.5797	-0.6004
Standard error	0.3978	0.6891
P-value	0.1730	0.4007
Lag	0.8657	
Standard error	0.1408	
P-value	0.0001	
R-squared	98%	6%
F statistic	234.2383	0.7592

Source: Economic Insight

4.4 IT econometrics

We use historical data (between 2002 and 2016) to estimate the relationship between an IT cost index and nominal GDP:

- **IT cost index** is calculated from the ONS's Producer Price Indices series, specifically the series relating to the inputs used in the manufacture of computer, electrical and optical products (CDID: MC3G)

- **Nominal GDP** is calculated from the ONS's series for nominal GDP (DCID: YBHA PN2).

As per above, we addressed issues of non-stationarity of variables in the same way and we set out the regression results below.

4.4.1 Regression results

The IT input cost regression in levels had the following functional form:

1) *IT cost index$_t$ = constant + β · UK nominal GDP index$_t$ + γ · IT cost index$_{t-1}$ + ε_t*

Our IT costs regression in *percentage changes* had the following functional form:

2) $\text{Nominal IT cost growth}_t = \text{constant} + \beta \cdot \text{UK nominal GDP growth}_t + \varepsilon_t$

The table overleaf shows the estimation results for these two models.

Table 45: Econometric estimates of the relationship between IT cost index and UK GDP – levels and percentage changes

Model type	Levels regression	Percentage changes regression
Constant	10.9037	0.0292
Standard error	9.6288	0.0140
P-value	0.2815	0.0588
Nominal GDP	0.1308	-0.5313
Standard error	0.0712	0.3271
P-value	0.0934	0.1303
Lag	0.7344	
Standard error	0.1535	
P-value	0.0006	
R-squared	92%	18%
F statistic	67.1248	2.6379

Source: Economic Insight

4.5 Meter reading econometric

We use historical data (between 2002 and 2016) to estimate the relationship between sales occupations wages and (i) nominal GDP; (ii) and average UK wages:

- **Sales occupations wage index** is estimated by matching the 2 digit SOC code 71 with wage data from the ASHE data.
- **Nominal GDP** is calculated from the ONS's series for nominal GDP (series YBHA PN2).
- **UK wage index** is calculated from the National Accounts. This is to ensure consistency between the data used to measure historical relationships and that used to derive forecasts (as the OBR bases its forecast of average earnings on the National Accounts).

Variables such as GDP and wages are generally *non-stationary*, meaning that simple regressions of wage levels on GDP can lead to spurious findings of relationships. We addressed this non-stationarity in two ways:

- First, we developed regression of the *percentage changes* in the sale occupations wage index on changes in nominal GDP / average UK wages.
- Second, we regressed levels of the sales occupation wage index on the level of nominal GDP / average UK wages (both expressed as an index) *and lagged values of the sales occupation wage index.*

The results of our models in levels and in percentage changes are set out in the subsequent sections.

4.5.1 Regression in levels

The sales occupation wage regression in levels had the following functional forms:

1) *Sales occupation wage index$_t$ = constant + β · UK nominal GDP index$_t$ + γ · sales occupation wage index$_{t-1}$ + ε_t*

2) *Sales occupation wage index$_t$ = constant + β · UK average wage index$_t$ + γ · sales occupation wage index$_{t-1}$ + ε_t*

The tables below show estimation results for these models.

Table 46: Econometric estimates of the relationship between sales occupation wage index and nominal GDP (levels)

Model type	2 digit SOC
Constant	41.8919
Standard error	13.1286
P-value	0.0086
Nominal GDP	0.3178
Standard error	0.0823
P-value	0.0027
Lag	0.2399
Standard error	0.2132
P-value	0.2845
R-squared	96%
F statistic	136.8383

Source: Economic Insight

Table 47:Econometric estimates of the relationship between sales occupation wage index and average UK wage (levels)

Model type	2 digit SOC
Constant	47.3841
Standard error	11.0042
P-value	0.0012
Average UK wage	0.7340
Standard error	0.1419
P-value	0.0003
Lag	-0.2482
Standard error	0.2518
P-value	0.3454
R-squared	97%
F statistic	201.9403

Source: Economic Insight

4.5.3 Regression in percentage changes

Our regressions in *percentage changes* had the following functional forms:

1) *Sales occupation nominal wage growth*$_t$ = *constant* + $\beta \cdot$ *UK nominal GDP growth*$_t$ + ε_t

2) *Sales occupation nominal wage growth*$_t$ = *constant* + $\beta \cdot$ *UK average nominal wage growth*$_t$ + ε_t

The tables below show the estimation results for these models.

Table 48: Econometric estimates of the relationship between sales occupation wage index and nominal GDP (percentage changes)

Model type	2 digit SOC
Constant	0.0066
Standard error	0.0116
P-value	0.5814
Nominal GDP	0.2674
Standard error	0.2726
P-value	0.3459
R-squared	7%
F statistic	0.9624

Source: Economic Insight

Table 49: Econometric estimates of the relationship between sales occupation wage index and average UK wage (percentage changes)

Model type	2 digit SOC
Constant	-0.0100
Standard error	0.0117
P-value	0.4117
Average UK wage	1.0211
Standard error	0.4112
P-value	0.0288
R-squared	34%
F statistic	6.1659

Source: Economic Insight

4.6 Customer service econometrics

We use historical data (between 2002 and 2016) to estimate the relationship between sales occupations wages and (i) nominal GDP; (ii) and average UK wages:

- **Customer service occupations wage index** is estimated by matching the 2 digit SOC code 72 with wage data from the ASHE data.
- **Nominal GDP** is calculated from the ONS's series for nominal GDP (series YBHA PN2).

- **UK wage index** is calculated from the National Accounts. This is to ensure consistency between the data used to measure historical relationships and that used to derive forecasts (as the OBR bases its forecast of average earnings on the National Accounts).

Similar to the approach for meter reading costs, the econometric models for customer service occupations and their results are as follows.

4.6.1 Regression in levels

The sales occupation wage regression in levels had the following functional forms:

1) $\textit{Customer service wage index}_t = \textit{constant} + \beta \cdot \textit{UK nominal GDP index}_t$

$+ \gamma \cdot \textit{customer service wage index}_{t-1} + \varepsilon_t$

2) $\textit{Customer service wage index}_t = \textit{constant} + \beta \cdot \textit{UK average wage index}_t$

$+ \gamma \cdot \textit{customer service wage index}_{t-1} + \varepsilon_t$

The tables below show estimation results for these models.

Table 50: Econometric estimates of the relationship between customer service wage index and nominal GDP (levels)

Model type	2 digit SOC
Constant	12.9036
Standard error	7.3778
P-value	0.1081
Nominal GDP	0.2942
Standard error	0.0823
P-value	0.0044
Lag	0.5386
Standard error	0.1467
P-value	0.0037
R-squared	97%
F statistic	168.2850

Source: Economic Insight

Table 51: Econometric estimates of the relationship between sales occupation wage index and average UK wage (levels)

Model type	2 digit SOC
Constant	-0.4485
Standard error	6.2076
P-value	0.9437
Average UK wage	0.5609
Standard error	0.1487
P-value	0.0031
Lag	0.3914
Standard error	0.1761
P-value	0.0482
R-squared	97%
F statistic	178.4641

Source: Economic Insight

4.6.2 Regression in percentage changes

Our regressions in *percentage changes* had the following functional forms:

1) *Customer service nominal wage growth$_t$ = constant + $\beta \cdot$ UK nominal GDP growth$_t$ + ε_t*
2) *Customer service nominal wage growth$_t$ = constant + $\beta \cdot$ UK average nominal wage growth$_t$ + ε_t*

The tables below show the estimation results for these models.

Table 52: Econometric estimates of the relationship between sales occupation wage index and nominal GDP (percentage changes)

Model type	2 digit SOC
Constant	0.0066
Standard error	0.0116
P-value	0.5814
Nominal GDP	0.2674
Standard error	0.2726
P-value	0.3459
R-squared	7%
F statistic	0.9624

Source: Economic Insight

Table 53: Econometric estimates of the relationship between sales occupation wage index and average UK wage (percentage changes)

Model type	2 digit SOC
Constant	-0.0100
Standard error	0.0117
P-value	0.4117
Average UK wage	1.0211
Standard error	0.4112
P-value	0.0288
R-squared	34%
F statistic	6.1659

Source: Economic Insight

5. Annex B: forecasts

This annex provides more detail on the independent forecasts used in the main report, as well as setting out the overall forecast results.

5.1 Independent forecasts

5.1.1 OBR

The following table illustrates the forecasts of economic fundamentals on which some of our econometric forecasts were based.

Table 54: OBR forecasts

	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23
Nominal GDP	4.4%	3.4%	3.0%	2.9%	3.0%	3.2%	3.3%
CPI growth	1.1%	2.9%	2.2%	1.8%	2.0%	2.0%	2.0%
Average earnings	2.9%	2.5%	2.7%	2.4%	2.6%	2.8%	3.0%

Source: OBR March 2018 forecast, note that 2016/17 is outturn data.

5.1.2 World Bank

For certain commodities, we used forecasts from the World Bank, as illustrated in the following table.

Table 55: World Bank forecasts

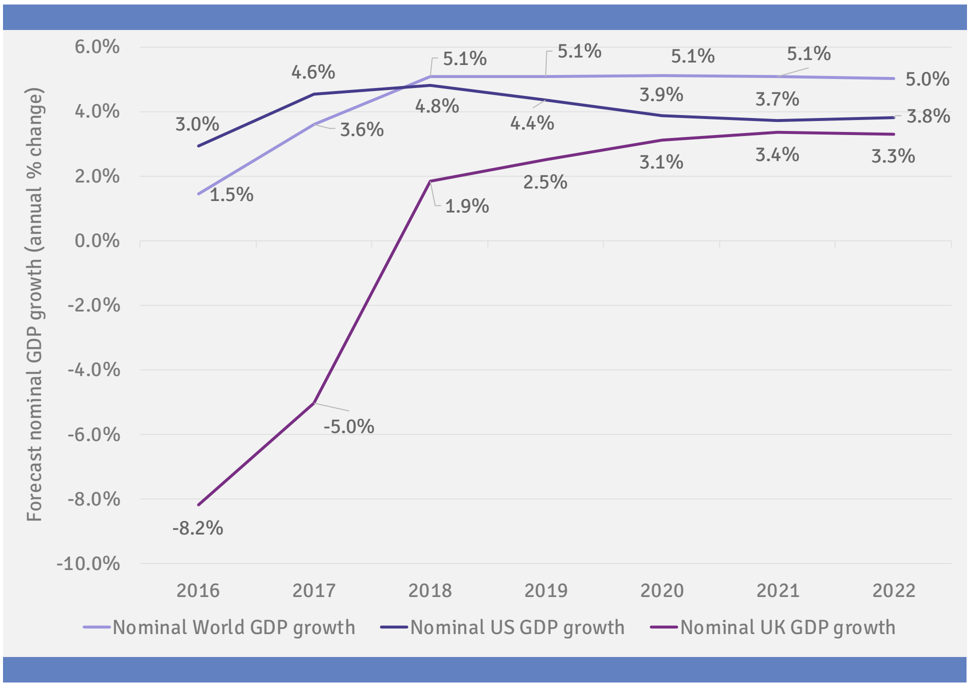
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Oil price ($/barrel)	-15.6%	23.8%	5.7%	5.4%	1.7%	1.6%	1.6%	1.6%	1.6%	1.6%
Diammonium phosphate	-24.74%	0.48%	-0.58%	2.24%	2.24%	2.24%	2.24%	2.24%	2.24%	2.24%
Phosphate rock	-4.51%	-18.87%	-1.10%	2.78%	2.78%	2.78%	2.78%	2.78%	2.78%	2.78%
Potassium chloride	-18.93%	-12.05%	-0.46%	3.37%	3.37%	3.37%	3.37%	3.37%	3.37%	3.37%
Triple Superphosphate	-24.55%	-4.65%	1.08%	2.58%	2.58%	2.58%	2.58%	2.58%	2.58%	2.58%
Urea, E. Europe, bulk	-26.99%	8.41%	-0.46%	2.82%	2.82%	2.82%	2.82%	2.82%	2.82%	2.82%

Source: World Bank Commodities Price Forecast (nominal US dollars), released 26 October 2017, note 2016 is outturn data.

5.1.3 IMF

For some models, we have used US data, as such the forecasts that we used were from the IMF, as illustrated in the following figure.

Figure 34: IMF forecasts



Source: IMF

5.1.4 BNP Paribas

We have based future exchanges on BNP Paribas forecasts to 2018, with expected exchange rates held constant from this point.

Table 56: BNP Paribas forecast pound-dollar exchange rate

	2016	2017	2018
Expected £/$ exchange rate	1.24	1.30	1.29

Source: BNP Paribas

5.2 Labour cost inflation forecasts

The following tables set out the full results for labour cost inflation (3digit SOC), based on all of the methodologies set out in the main report.

Table 57: Yorkshire Water labour cost inflation forecasts, 2020/21 - 2024/25 – 3 digit SOC codes

Methodology	Wage inflation forecasts (%)	2020/21	2021/22	2022/23	2023/24	2024/25	Avg
Company							
Economy-based	GDP econometrics – levels	0.90%	0.98%	1.05%	1.08%	1.10%	1.02%
	GDP econometrics – changes	1.21%	1.33%	1.43%	1.43%	1.43%	1.37%
	Wage econometrics – levels	1.22%	1.35%	1.46%	1.48%	1.51%	1.40%
	Wage econometrics – changes	1.72%	2.01%	2.24%	2.24%	2.24%	2.09%
	Wedge to UK wages inflation	1.71%	1.95%	2.15%	2.15%	2.15%	2.02%
	Wedge to CPI inflation	1.54%	1.56%	1.56%	1.56%	1.56%	1.55%
Extrapolation	Whole period trend	1.69%	1.69%	1.69%	1.69%	1.69%	1.69%
Third-party	Independent forecasts	2.58%	2.82%	3.02%	3.02%	3.02%	2.89%
Water resources							
Economy-based	GDP econometrics – levels	0.80%	0.87%	0.94%	0.96%	0.98%	0.91%

Methodology	Wage inflation forecasts (%)	2020/21	2021/22	2022/23	2023/24	2024/25	Avg
	GDP econometrics – changes	1.18%	1.31%	1.43%	1.43%	1.43%	1.36%
	Wage econometrics – levels	1.07%	1.19%	1.29%	1.31%	1.34%	1.24%
	Wage econometrics – changes	1.74%	2.05%	2.30%	2.30%	2.30%	2.14%
	Wedge to UK wages inflation	1.73%	1.97%	2.17%	2.17%	2.17%	2.04%
	Wedge to CPI inflation	1.55%	1.57%	1.58%	1.58%	1.58%	1.57%
Extrapolation	Whole period trend	1.70%	1.70%	1.70%	1.70%	1.70%	1.70%
Third-party	Independent forecasts	2.58%	2.82%	3.02%	3.02%	3.02%	2.89%
Water network plus							
Economy-based	GDP econometrics – levels	0.83%	0.90%	0.97%	0.99%	1.01%	0.94%
	GDP econometrics – changes	1.19%	1.32%	1.43%	1.43%	1.43%	1.36%
	Wage econometrics – levels	1.13%	1.26%	1.37%	1.39%	1.41%	1.31%
	Wage econometrics – changes	1.74%	2.05%	2.31%	2.31%	2.31%	2.14%
	Wedge to UK wages inflation	1.73%	1.97%	2.17%	2.17%	2.17%	2.04%
	Wedge to CPI inflation	1.56%	1.57%	1.58%	1.58%	1.58%	1.57%
Extrapolation	Whole period trend	1.71%	1.71%	1.71%	1.71%	1.71%	1.71%
Third-party	Independent forecasts	2.58%	2.82%	3.02%	3.02%	3.02%	2.89%
Wastewater network plus							
Economy-based	GDP econometrics – levels	0.71%	0.78%	0.84%	0.86%	0.88%	0.81%

Methodology	Wage inflation forecasts (%)	2020/21	2021/22	2022/23	2023/24	2024/25	Avg
	GDP econometrics – changes	1.08%	1.21%	1.33%	1.33%	1.33%	1.26%
	Wage econometrics – levels	0.94%	1.04%	1.13%	1.15%	1.17%	1.09%
	Wage econometrics – changes	1.65%	1.95%	2.20%	2.20%	2.20%	2.04%
	Wedge to UK wages inflation	1.64%	1.88%	2.08%	2.08%	2.08%	1.95%
	Wedge to CPI inflation	1.46%	1.48%	1.49%	1.49%	1.49%	1.48%
Extrapolation	Whole period trend	1.61%	1.61%	1.61%	1.61%	1.61%	1.61%
Third-party	Independent forecasts	2.58%	2.82%	3.02%	3.02%	3.02%	2.89%
Wastewater bioresources							
Economy-based	GDP econometrics – levels	0.72%	0.78%	0.84%	0.86%	0.88%	0.82%
	GDP econometrics – changes	1.17%	1.30%	1.41%	1.41%	1.41%	1.34%
	Wage econometrics – levels	0.92%	1.02%	1.11%	1.13%	1.15%	1.07%
	Wage econometrics – changes	1.72%	2.02%	2.26%	2.26%	2.26%	2.10%
	Wedge to UK wages inflation	1.71%	1.95%	2.15%	2.15%	2.15%	2.02%
	Wedge to CPI inflation	1.54%	1.56%	1.56%	1.56%	1.56%	1.55%
Extrapolation	Whole period trend	1.69%	1.69%	1.69%	1.69%	1.69%	1.69%
Third-party	Independent forecasts	2.58%	2.82%	3.02%	3.02%	3.02%	2.89%
Retail							
Economy-based	GDP econometrics – levels	1.35%	1.46%	1.57%	1.60%	1.62%	1.52%

Methodology	Wage inflation forecasts (%)	2020/21	2021/22	2022/23	2023/24	2024/25	Avg
	GDP econometrics – changes	1.43%	1.50%	1.57%	1.57%	1.57%	1.52%
	Wage econometrics – levels	1.72%	1.89%	2.04%	2.06%	2.08%	1.96%
	Wage econometrics – changes	1.74%	1.96%	2.13%	2.13%	2.13%	2.02%
	Wedge to UK wages inflation	1.75%	1.99%	2.18%	2.18%	2.18%	2.05%
	Wedge to CPI inflation	1.57%	1.59%	1.59%	1.59%	1.59%	1.59%
Extrapolation	Whole period trend	1.72%	1.72%	1.72%	1.72%	1.72%	1.72%
Third-party	Independent forecasts	2.58%	2.82%	3.02%	3.02%	3.02%	2.89%

Source: Economic Insight analysis

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