
Impact on doubtful debt as a result of changes in deprivation and bill levels over 2015–20: an update

Note prepared for South West Water

26 March 2014

Executive summary

Using its 'risk-based review' of companies' business plans, Ofwat, in assessing South West Water (along with Affinity Water) for 'enhanced status', has requested additional information on South West Water's proposed adjustment on doubtful debt.¹ In particular, Ofwat has requested information on the appropriate adjustment that reflects the impact of changes in deprivation and bill levels over 2015–20.²

As a response to Ofwat's request, Oxera³ examined how changes in deprivation and bill levels over PR14 affect the adjustment on doubtful debt for South West Water. Based on the empirical analysis carried out in that note, Oxera concluded that:

- South West Water's assumptions on the level of doubtful debt over PR14 are not materially different to those predicted by the econometric models; and
- the rate of reduction proposed by South West Water in its doubtful debt is the highest across the industry, when controlling for the level of bills and deprivation at which it currently operates (or has been forecast to operate).

On Thursday 20 March 2014, Ofwat provided feedback on the assumptions underlying some of the modelling approaches in Oxera (2014a). In particular, the following comments were provided.

- In some models, Ofwat noted that the time trend variable, estimated over the historical period, had been retained when predicting the value of doubtful debt over PR14. Ofwat asked whether there is any rationale for such an approach.
- In some models, forecast data had been used to estimate the relationships and Ofwat asked whether there is any evidence (including regulatory precedents) to justify this approach.
- The Index of Multiple Deprivation (IMD) had been projected using gross domestic product (GDP) growth projections. Ofwat queried whether some of

¹ Based on information shared by South West Water.

² Ofwat has also requested additional information from South West Water on two other aspects that are not explicitly addressed in this updated analysis: i) to provide sufficient and convincing evidence to support customers paying for the proposed glide path from current costs to the efficient doubtful debt charge; and ii) to set out the reasoning to support South West Water's view that doubtful debt costs will not change over the period in its area. It is Oxera's understanding that South West Water is examining these issues.

³ Oxera (2014), 'Impact on doubtful debt as a result of changes in deprivation and bill levels over 2015–20', March; hereafter referred to as Oxera (2014a).

the sub-domains of deprivation that combine to produce the IMD—in particular, Income Deprivation Domain and Employment Deprivation Domain—could be more appropriate to be projected forward using the number of benefit claimants from the Department of Work and Pensions (DWP).

In this note, Oxera has further updated the econometric analysis, first undertaken in Oxera (2013),⁴ and subsequently updated in Oxera (2014a), in order to take into account forecast changes (predominantly, reductions) in bill levels and deprivation over PR14, and the above-noted feedback by Ofwat. In addition, South West Water has chosen to remove the glide path assumed in its doubtful debt over PR14.⁵ To this end, four modelling approaches have been adopted in order to examine the sensitivity or robustness of the results to the data considered in the analysis, the deprivation measure employed and the assumption used to project the level of deprivation over the period of analysis. Based on empirical analysis using these modelling approaches, two main conclusions are drawn with regard to South West Water's assumptions on the assumed level of doubtful debt over PR14.

- Overall, across the modelling approaches considered in this note, South West Water's assumptions on the level of doubtful debt over PR14 are lower than those predicted by all the models.
- The rate of reduction proposed by South West Water on its doubtful debt over PR14 is the highest across the industry, when controlling for the level of bills and deprivation at which it currently operates (or has been forecast to operate).

That is, Oxera's conclusions from the previous analysis have not altered compared to the earlier analyses when taking into account the three points raised by Ofwat.

⁴ Oxera (2013), 'Average cost to serve—Effect of bill size and deprivation on doubtful debt', Final report prepared for South West Water, November.

⁵ That is, South West Water's doubtful debt is assumed to be £13.4m (in nominal terms) over PR14.

1 Introduction

In the ongoing PR14 review, Ofwat has assessed household retail activities using an ‘average cost to serve’ (ACTS) approach.⁶ As part of its business plan submission in December 2013, South West Water asked Oxera to examine whether the level of deprivation in the South West Water operational area or the size of the average South West Water household bill could affect the company’s level of doubtful debt.

Based on econometric analysis of overall industry-level data (i.e. across companies in the industry) and sub-company-level data (i.e. across Lower Super Output Area, or LSOAs, in the South West Water operating area), Oxera⁷ showed that there is a statistically significant positive relationship between the level of deprivation (multiple and income deprivation), the size of the average bill, and the level of revenue outstanding or doubtful debt across the companies in the industry.

Oxera (2013) also developed econometric models to estimate what impact deprivation and average bills have on the level of doubtful debt and revenue outstanding, controlling for other factors. This comparison provides a range for the adjustment⁸ to South West Water’s doubtful debt costs in 2012/13 of between £6m and £9m (in 2010/11 prices) because of its operational characteristics.

Using its ‘risk-based review’ of companies’ business plans, Ofwat, in assessing South West Water (along with Affinity Water) for ‘enhanced status’, has requested additional information on South West Water’s proposed adjustment on doubtful debt.⁹ In particular, Ofwat requested information on the appropriate adjustment that reflects the impact of changes in deprivation and bill levels over 2015–20.¹⁰

As a response to Ofwat’s request, Oxera¹¹ examined how changes in deprivation and bill levels over PR14 affect the adjustment on doubtful debt for South West Water. Based on the empirical analysis carried out in that report, Oxera concluded that:

- South West Water’s assumptions on the level of doubtful debt over PR14 are not materially different to that predicted by the econometric models; and
- the rate of reduction proposed by South West Water on its doubtful debt over PR14 is the highest across the industry, when controlling for the level of bills

⁶ Ofwat (2013), ‘Setting price controls for 2015–20 – final methodology and expectations for companies’ business plans’, July.

⁷ Oxera (2013), ‘Average cost to serve—Effect of bill size and deprivation on doubtful debt’, Final report prepared for South West Water, November; hereafter, referred to as Oxera (2013).

⁸ The adjustment for additional costs incurred by South West Water is based on comparing the predicted levels of doubtful debt (or revenue outstanding) from the econometric analysis for South West Water with that of an average company that has average levels of deprivation and doubtful debt, but with South West Water’s customer numbers.

⁹ Based on information shared by South West Water.

¹⁰ Ofwat has also requested additional information from South West Water on two other aspects that are not addressed, at least directly, in this updated analysis: i) to provide sufficient and convincing evidence to support customers paying for the proposed glide path from current costs to the efficient doubtful debt charge; and ii) to set out the reasoning to support South West Water’s view that doubtful debt costs will not change over the period in its area. It is Oxera’s understanding that South West Water is examining these issues.

¹¹ Oxera (2014), ‘Impact on doubtful debt as a result of changes in deprivation and bill levels over 2015–20’, March; hereafter referred to as Oxera (2014a).

and deprivation at which it currently operates (or has been forecast to operate).

On Thursday 20 March 2014, Ofwat provided feedback on the assumptions underlying some of the modelling approaches in Oxera (2014a). In particular:

- in some models, Ofwat noted that the time trend variable, estimated over the historical period, had been retained when predicting the value of doubtful debt over PR14. Ofwat asked whether there is any rationale for such an approach;
- in some models, forecast data had been used to estimate the relationships and Ofwat asked whether there is any evidence (including regulatory precedents) to justify this approach;
- the Index of multiple deprivation (IMD) had been projected forward using gross domestic product (GDP) growth projections. Ofwat queried whether some of the sub-domains of deprivation that combine to produce the IMD—in particular, the Income Deprivation Domain and Employment Deprivation Domain—could be more appropriate to be projected forward using the number of benefit claimants from the Department of Work and Pensions (DWP).

This updated analysis examines how changes in deprivation and bill levels over PR14 affect the adjustment on doubtful debt for South West Water, including examining the comments above. The analysis uses forecast data published by Ofwat on 14 March 2014,¹² and additional information provided by South West Water, as well as data from the DWP on the number of benefit claimants and amount of benefit expenditure.¹³ In addition, South West Water has asked Oxera to remove the glide path assumed in its doubtful debt over PR14¹⁴ as part of this updated analysis.

It should be noted that the timeframe available for the analysis in this note has been relatively limited.

This note, Oxera (2014b), is structured as follows.

- Section 2 is a replication of section 2 in Oxera (2014a) for ease of reference. It considers South West Water's relative position in the industry in terms of the levels of deprivation, average bills, doubtful debt and customer numbers over PR14. This comparison is strengthened by incorporating supporting evidence at the LSOA level carried out in Oxera (2013) to illustrate the nature of South West Water's operating characteristics.
- Section 3 discusses Ofwat's comments on Oxera (2014a) and how these comments are incorporated into the modelling in Oxera (2014b).
- Section 4 discusses results from updating the doubtful debt econometric models developed in Oxera (2013) and Oxera (2014a).¹⁵
- Section 5 concludes.

¹² See <http://www.ofwat.gov.uk/content?id=270d1e9b-ab63-11e3-8760-31cfc651602f>, accessed 14 March 2014.

¹³ Benefits expenditure data for the analysis at the local authority level in 2010 and at the overall UK level over the period of analysis was provided by South West Water based on information from <https://www.gov.uk/government/publications/benefit-expenditure-and-caseload-tables-2013>.

¹⁴ That is, South West Water's doubtful debt is assumed to be £13.4m (in nominal terms) over PR14.

¹⁵ For details, see sections 2, 3 and 4 of Oxera (2013).

- Appendix 1 summarises the estimation results of Oxera’s modelling approaches.
- Appendix 2 summarises the data used in the analysis.

2 Comparison of deprivation, average household bills and doubtful debt across the industry

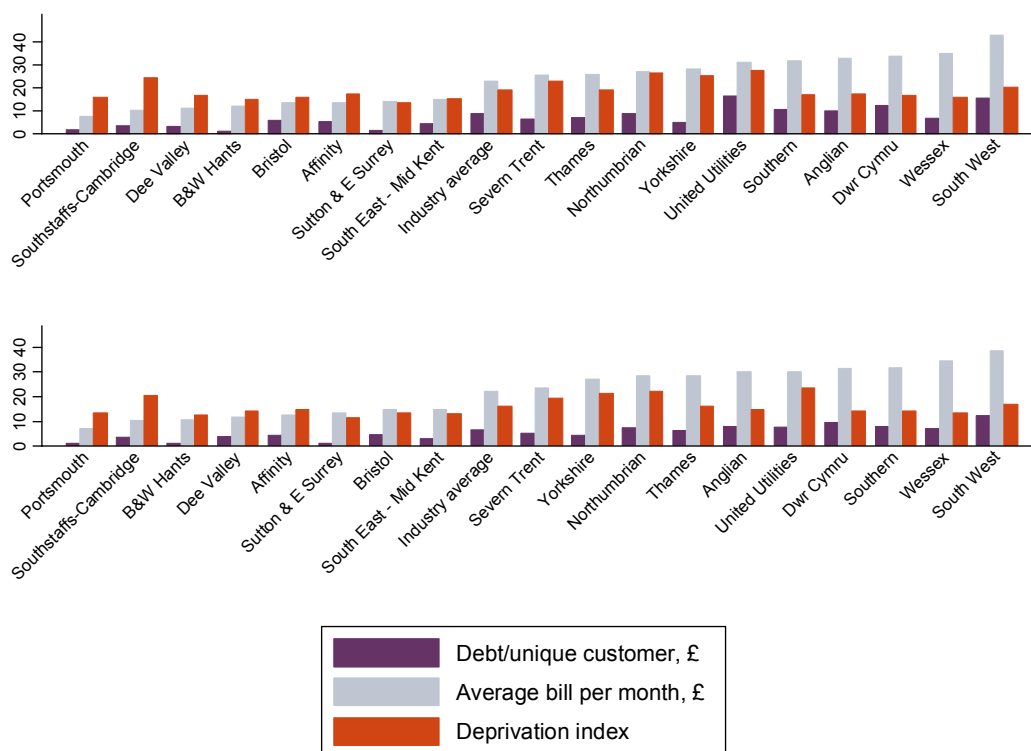
2.1 Industry-wide comparison

In this section, comparisons are made between the companies in the industry, in three areas:

- the level of deprivation in the company area (based on the multiple and income deprivation measures);¹⁶
- the average household bill level;
- the level of doubtful debt.

Companies’ positions on these areas are compared over the historical period between 2007/08 and 2012/13 (in the top half of Figure 2.1), and with the PR14 period between 2015/16 and 2019/20 (in the bottom half of Figure 2.1).

Figure 2.1 Comparison of doubtful debt, bills and deprivation



Source: Oxera, based on data from Ofwat, South West Water and June Returns. Monetary terms are in 2010/11 prices.

¹⁶ In estimating an adjustment on doubtful debt for South West Water, Oxera (2013) considered both multiple and income deprivation because of the company’s operating characteristics. While South West Water scores marginally below the industry average on the Income Deprivation Index at the company level, Oxera (2013) showed that, even when income deprivation was used to proxy customers’ willingness to pay, the resulting adjustment for South West Water was similar to that estimated using the IMD. In addition, Oxera (2013) showed that, at the LSOA level, South West Water operates at possibly extreme levels of income deprivation. See section 2 of the report for details. As such, in updating the econometric models, the analysis contained in this note mainly uses the IMD.

Figure 2.1 shows the following.

- Consistent with the historical period, the area served by South West Water has above-average levels of deprivation when measured by the multiple deprivation score¹⁷ over PR14.¹⁸
- While the average household bill for South West Water is markedly above the average for the industry, it has been proposed that the bill size will be reduced by a much higher rate than for the average company over PR14 (see Table 2.1). Nevertheless, South West Water's average household bill remains the highest in the industry even over PR14.
- While, in the historical period, South West Water has the second-highest level of doubtful debt per unique customer, it has the highest level of doubtful debt per unique customer over the forecast period.

As noted above, South West Water has the highest level of average household bills in the industry. In section 3 of this note, we examine whether South West Water's proposed level of doubtful debt per unique customer over PR14 is consistent with that predicted by an econometric model, taking into account changes in deprivation and bill size (and customer numbers) over PR14.

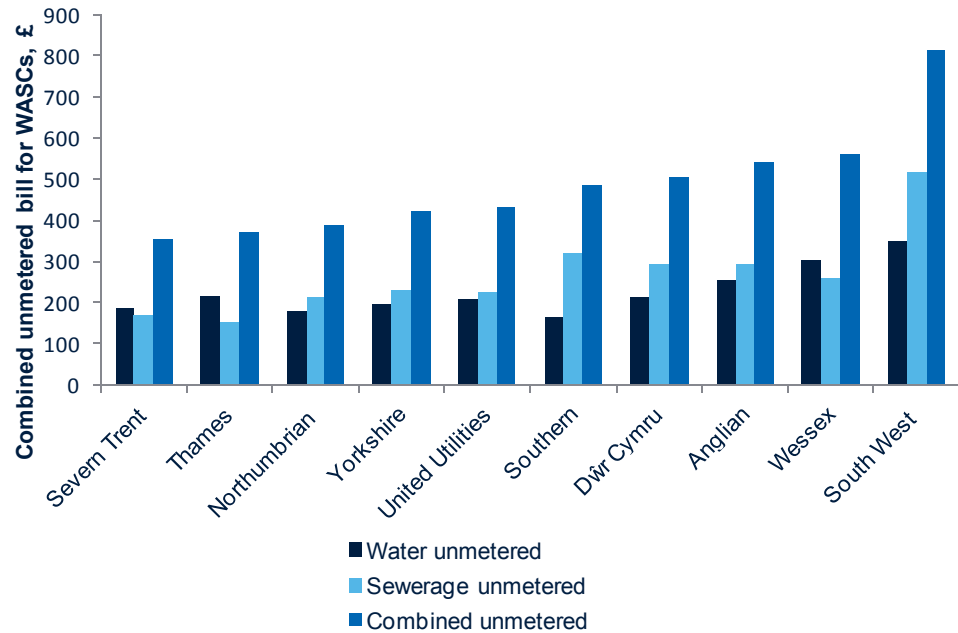
In addition, on household bills for water and sewerage services, based on data on charges and bills in 2013/14 published by Ofwat,¹⁹ Oxera (2013)²⁰ compared the average household bill for unmetered customers for the water and sewerage companies (WASCs) in the industry. This is replicated below.

¹⁷ As defined in the Department for Communities and Local Government (2011), 'English Indices of Deprivation, 2010', March, the IMD is the LSOA-level measure of deprivation comprising seven indices relating to income deprivation, employment deprivation, health deprivation and disability, education skills and training deprivation, barriers to housing and services, living environment deprivation, and crime. Unlike single income deprivation measures, the IMD reflects a range of deprivation types that may be experienced.

¹⁸ Information on multiple and income deprivation is collected and reported every three years by the Department for Communities and Local Government, and is available for England only. Oxera used national GDP to project the deprivation index for years beyond 2009/10 up to 2019/20.

¹⁹ See Ofwat (2013), 'Charges and bills publications 2013–14', available at http://www.ofwat.gov.uk/regulating/charges/prs_web_charges2013-14.

²⁰ For details, see section 2 of Oxera (2013).

Figure 2.2 Comparison of the average household bill for WASCs for unmetered customers in 2013/14 (£)

Note: Data for Northumbrian Water excludes the Essex & Suffolk area served by Northumbrian Water. Ofwat has indicated that household customers served by South West Water will benefit from a government contribution, which will reduce the bill for all households served by South West Water by £50 per year. This has been applied since April 2013.

Source: Comparison based on the average household bill for unmetered customers for each company in 2013/14, as published annually by Ofwat. See Ofwat (2013), 'Charges and bills publications 2013–14', available at http://www.ofwat.gov.uk/regulating/charges/prs_web_charges2013-14. Bills in 2013/14 prices, and Oxera analysis.

Figure 2.2 shows that South West Water has the highest average household bill for unmetered customers by a margin of around £250. This demonstrates the unique operating condition in which South West Water operates.

The comparison between South West Water and an average company, and between the historical and forecast periods, can also be seen in Table 2.1 below.

Table 2.1 Comparison of doubtful debt, bills and deprivation between SWW and industry average

	Average bill size (£m)	Multiple deprivation (national GDP projection)	Multiple deprivation (SWW region-specific GDP projection) ¹	Doubtful debt per unique customer (£m)	Number of unique customers
Comparison over historical period, 2008–13					
South West Water	515	20	20	0.016	844
Industry average	275	19	19	0.009	1,748
Difference between SWW and industry average (%)	87	6	6	80	-52
Comparison over forecast period, 2016–20					
South West Water	463	17	18	0.012	900
Industry average	266	16	17	0.006	1,816
Difference between SWW and industry average (%)	74	6	6	93	-50
Difference within SWW between periods (%)	-10	-13²	-11²	-21	7
Difference within industry average between periods (%)	-3	-13²	-11²	-27	4

Note: Numbers are rounded to the nearest full number. Monetary terms in 2010/11 prices. ¹ South West Water region-specific GDP growth rates were provided by South West Water. ² When benefit expenditure information from the DWP is used to project income and multiple deprivation index levels, deprivation levels are forecast to improve by about 0.4% over the period (i.e. they are largely constant). When using the number of benefit claimants, deprivation levels are forecast to improve by about 7% over the period. In other words, the 11–13% improvement in deprivation levels seen in Table 2.1 is potentially an overestimate due to the previous approach of projecting deprivation levels using GDP growth rates. See section 3 for details.

Source: Oxera, based on data from Ofwat, South West Water and June Returns.

Table 2.1 demonstrates that while South West Water's bill size and deprivation levels are about 87% and 6% higher than those of an average company, South West Water has projected to reduce bills by a higher rate than the average company (10% against 3%). Also, the doubtful debt per unique customer is projected to fall by a smaller rate than that of the average company (21% against 27%). South West Water is also projecting a larger increase in its customer numbers than the industry average (7% against 4%, not shown in the table).

Lastly, the table illustrates the sensitivity of the assumption used to project the IMD over PR14. While it may be more appropriate to use regional-specific GDP growth rates to proxy changes in deprivation levels,²¹ data is not publicly available to enable this. However, when using South West Water region-specific growth rates,²² the rate of change in deprivation levels between periods is different. The sensitivity of this assumption is further examined when re-estimating the adjustments in section 3.

²¹ The relationship between economy growth rates and consumers' propensity to pay could be more complex than using a simple (linear) projection, as assumed in this note.

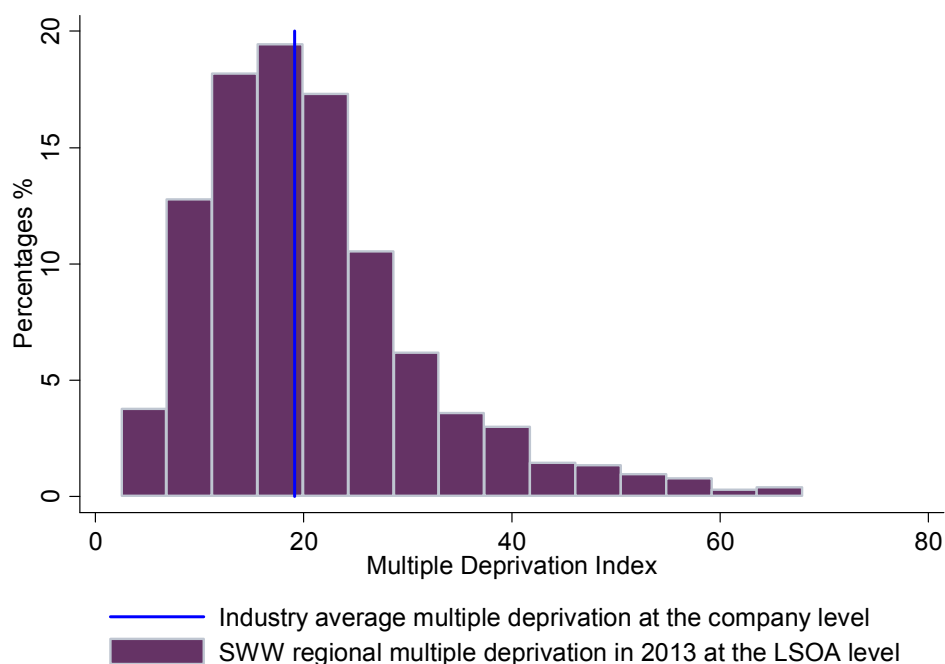
²² Based on data provided by South West Water.

2.2 Analysis using South West Water data at the LSOA level

In Oxera (2013), analysis was also undertaken at the LSOA level within the South West Water operational area. It is important to undertake such analysis in order to cross-check the consistency of the results obtained at the industry level.²³ More importantly, granular data at the LSOA level can identify potential information and results that could have been masked by the analysis at the company level presented in the previous section (for example, by simple averaging of extreme circumstances). Data for this analysis was provided by South West Water.

Figures 2.3 and 2.4 illustrate the wide disparity between the Multiple and Income Deprivation indices served by South West Water at the LSOA level.

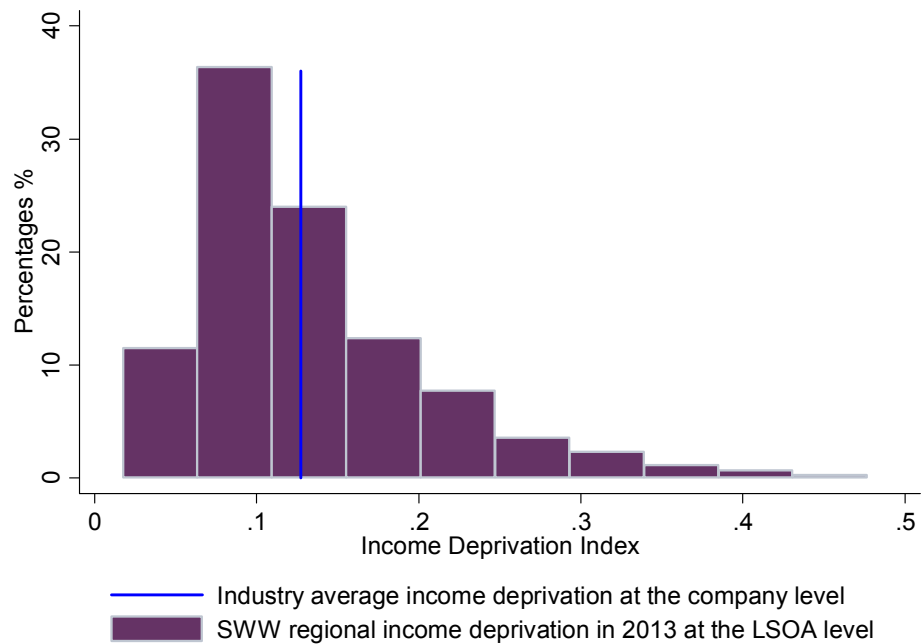
Figure 2.3 Multiple deprivation at the LSOA level



Note: Information on multiple and income deprivation is collected and reported every three years by the Department for Communities and Local Government, and is available for England only. The latest information (from 2010) is available at <http://webarchive.nationalarchives.gov.uk/20120919132719/http://www.communities.gov.uk/publications/corporate/statistics/indices2010>. See, for example, Department for Communities and Local Government (2011), 'The English Indices of Deprivation 2010', March. The industry average index score was calculated by weighting the deprivation index score for each LSOA by the population in that area using the 2011 population census, as published by the ONS and available at <http://www.ons.gov.uk/ons/guide-method/census/2011/census-data/index.html>.

Source: Oxera analysis.

²³ Indeed, Ofwat had asked companies to provide data for each LSOA in their region. See Ofwat (2013), 'Setting price controls for 2015–20 – final methodology and expectations for companies' business plans, July, p. 101.

Figure 2.4 Income deprivation at the LSOA level

Note: Information on multiple and income deprivation is collected and reported every three years by the Department for Communities and Local Government, and is available for England only. The latest information (from 2010) is available at <http://webarchive.nationalarchives.gov.uk/20120919132719/http://www.communities.gov.uk/publications/corporate/statistics/indices2010>. See, for example, Department for Communities and Local Government (2011), 'The English Indices of Deprivation 2010', March. The industry average index score was calculated by weighting the deprivation index score for each LSOA by the population in that area using the 2011 population census, as published by the ONS and available at <http://www.ons.gov.uk/ons/guide-method/census/2011/census-data/index.html>.

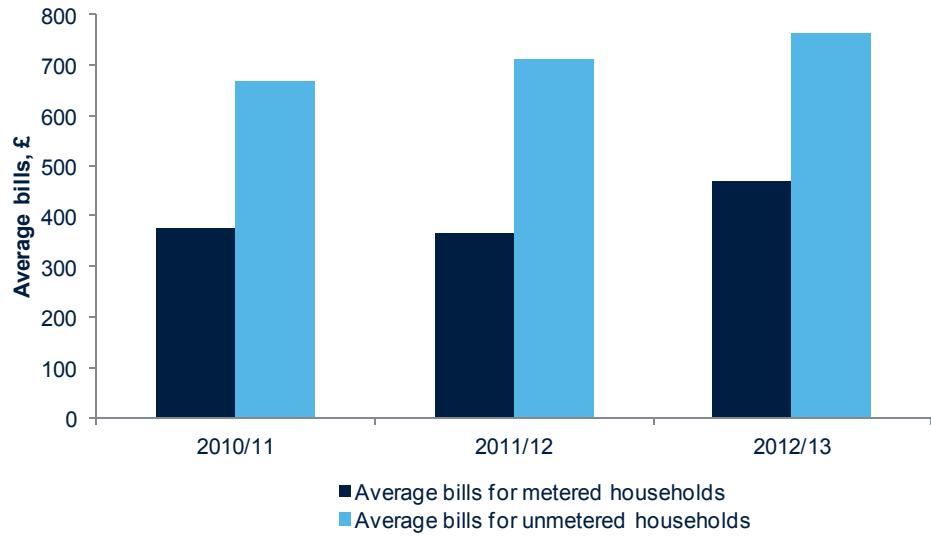
Source: Oxera analysis.

Figures 2.3 and 2.4 show that South West Water operates at possibly extreme levels of deprivation which were masked at the overall company level—in particular:

- on **multiple deprivation**, the average deprivation score is about 19, while levels of deprivation in South West Water's region range between 2.5 and 68;
- on **income deprivation**, the average deprivation score is about 0.13, while levels of income deprivation in South West Water's region range between 0.02 and 0.48.

Finally, at the LSOA level, for those households in debt, the average bill size for unmetered households is twice that of metered households, which may lead to higher levels of doubtful debt. This is illustrated in Figure 2.5 below.

Figure 2.5 Comparison of average household bills for metered and unmetered households in debt between 2010/11 and 2012/13 (£)



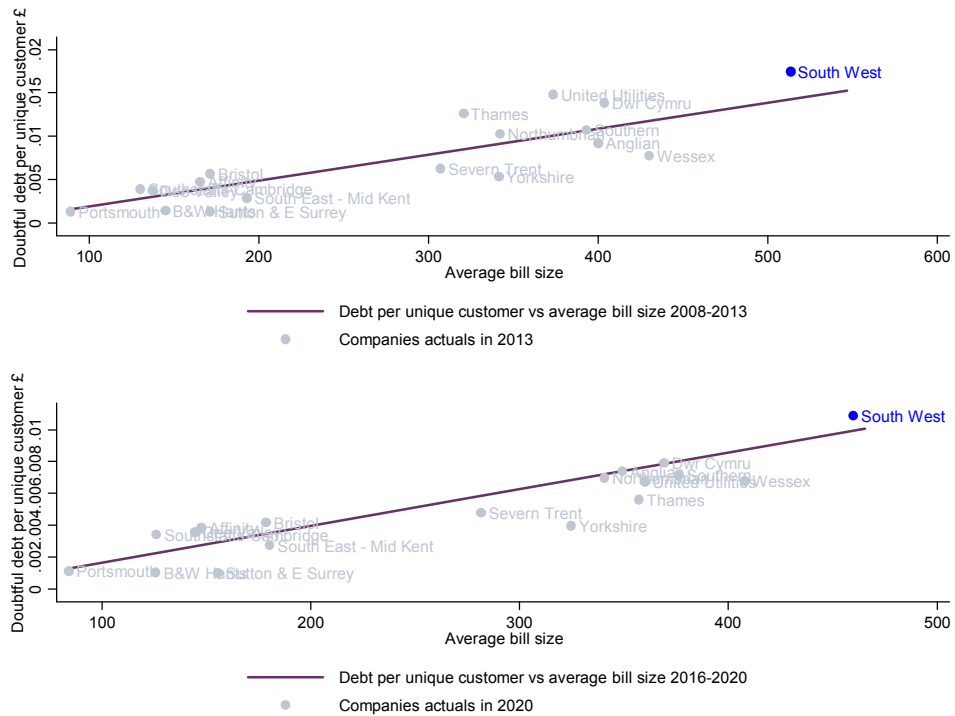
Source: Oxera analysis, using LSOA data in 2010/11, 2011/12 and 2012/13 provided by South West Water.

Using an econometric approach, the next section compares the relationship between the level of doubtful debt and the level of deprivation and the average level of household bills, over the two periods (2008–13 and 2016–20).

2.3 Statistical analysis of doubtful debt between periods

Figure 2.6 examines the relationship between the average bill level and doubtful debt per unique customer between the two periods.

Figure 2.6 Relationship between doubtful debt per unique customer and average bill

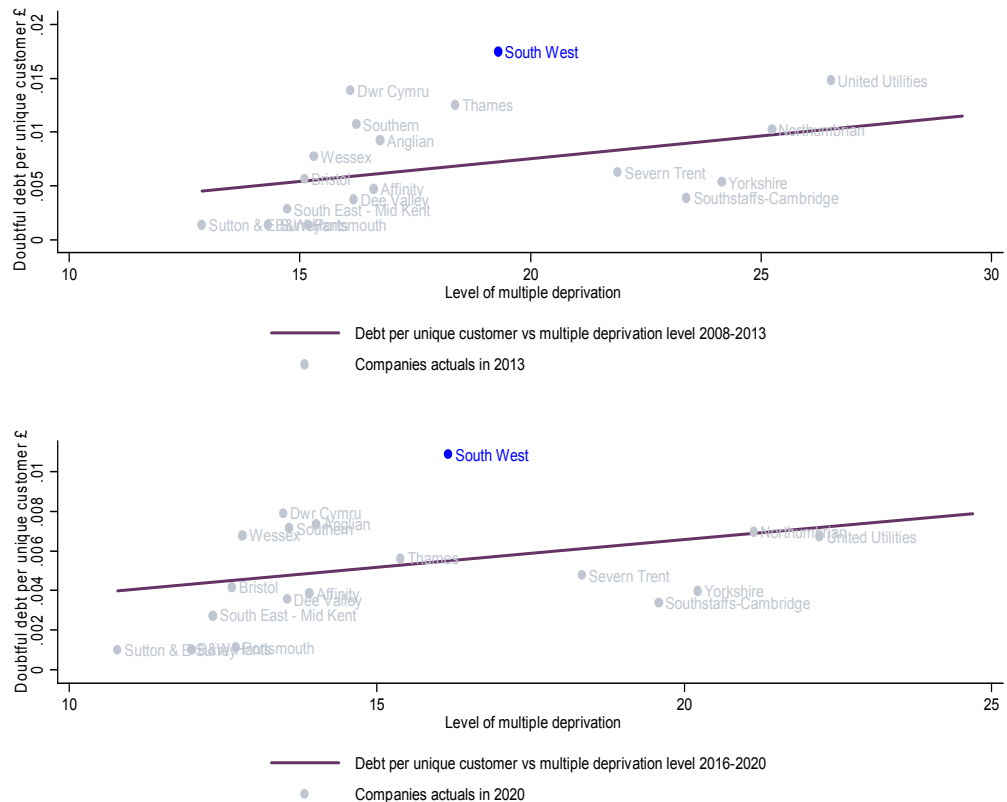


Source: Oxera, based on data from Ofwat, South West Water and June Returns. All monetary terms in 2010/11 prices.

Figure 2.6 shows that a strong positive relationship exists between the average bill level and doubtful debt, expressed per unique customer, in both periods. Also, despite South West Water having a higher than average deprivation level (and the highest bill size across the industry), focusing on the relationship between bill size and doubtful debt alone, South West Water's proposed doubtful debt per unique customer level by the end of the PR14 period is almost in line with that predicted by the model given its bill size (as indicated by South West Water 'sitting' just above the predicted line).

Figure 2.7 compares the level of doubtful debt per unique customer and the IMD score between the periods.

Figure 2.7 Relationship between doubtful debt per unique customer and deprivation level



Source: Oxera, based on data from Ofwat, South West Water and June Returns. The IMD projected using national GDP growth rates forecast over PR14. As noted earlier, the sensitivity of this assumption using the South West Water-region specific growth rate is examined in section 3. All monetary terms in 2010/11 prices.

As shown in Figure 2.7, the upward-sloping line in both periods suggests a positive relationship between doubtful debt per unique customer and the level of multiple deprivation, indicating that higher levels of deprivation are associated with higher levels of doubtful debt (controlling for the size of the company). Furthermore, over PR14, the level of multiple deprivation improves (as indicated by the shift in the data to the left in the figure at the bottom), and this results in lower levels of doubtful debt per unique customer across the industry (as indicated by the downward shift in the data in the figure at the bottom).

3 Comments from Ofwat on Oxera (2014a)

On 19 March, Ofwat provided three comments to South West Water, as follows, on the modelling undertaken in Oxera (2014a),²⁴ and these were discussed on a conference call between Oxera, South West Water and Ofwat on 20 March.

- **Comment 1.** Oxera modelling 'Approach 1' and 'Approach 2' would appear to retain the time trend variable which was present in the original model developed in Oxera (2013). We think this will drive up the value of the doubtful debt adjustment in the forecast and potentially counter any projected fall in deprivation and/or bill size. Can you please confirm these modelling approaches make use of the time trend variable which was present in your original model? If so, can you justify the rationale for why the time trend variable will continue to operate in the future as it has historically, and why it is preferable to using other macro variables in the model?
- **Comment 2.** Oxera modelling 'Approach 3', 'Approach 4' and 'Approach 5' would appear to use forecast data (for 2013/14 to 2019/20). That is, it appears that these approaches generate coefficients based on modelling forecast data (as opposed to generating coefficients based on modelling historic data) and then estimating doubtful debt costs in the future on the basis of forecast changes in deprivation and bills. We do not think it is a standard approach to model on the basis of forecasts. Can you provide any evidence (including regulatory precedents) to justify the use of forecast data in a model for these purposes?
- **Comment 3.** Oxera have looked at changes in deprivation by projecting forward the IMD using GDP growth projections. While we consider the IMD to constitute an acceptable measure for explaining cross-sectional differences between companies, we have doubts about using it to explain changes in deprivation over time. This is because it is comprised of a number of domains which are difficult to forecast changes in over time to arrive at a change in the overall index. Consequently, we have doubts about using the IMD (and growth projections) as the basis for forecasting changes in deprivation over time. Can SWT provide any evidence to justify the use of the IMD (projected forward using growth forecasts) as its measure of changing deprivation over time rather than the use of a subset of the IMD (such as the income and/or employment domains of the IMD, projected forward using an alternative measure, such as DWP data on numbers of benefit expenditure)?

The above comments are considered below.

3.1 Comment 1: estimating separate trends

In Oxera (2014a), 'Approach 1' uses the historical estimated trend of around 4% per annum to project forward, and 'Approach 2' uses the estimated trend (based on historical data and forecast data for South West Water) of around 2% per annum to project forward.

The use of time trend is intended to pick up residual drivers of doubtful debt over the period not included in the modelling (i.e. drivers of doubtful debt over and above bill levels and deprivation over the period of analysis). Using the estimated historical trend to project forward assumes that such auxiliary factors will continue to have the same impact over PR14.

²⁴ Information shared by South West Water.

Such an approach might be reasonable if one considers the past (i.e. data between 2007/08 and 2012/13) to be a reasonable predictor of the future (i.e. over PR14) and there are no significant ‘structural breaks’ (i.e. no major changes in the estimated relationships). Given data during the recessionary period considered in the analysis,²⁵ and recent improvements in the economic outlook, this assumption might be worth re-examining.

As such, in Approaches I and III considered in section 4, the historical period is used to estimate the relationship between doubtful debt and deprivation and customer bills, while separate trends are estimated over the historical and forecast periods. Using this approach, the trend over the forecast period is around –4% per annum.

3.2 Comment 2: the use of forecast data

‘Standard’ or textbook econometric modelling tends to use historical data to estimate relationships between costs and cost drivers, and to use these relationships to project forward. This is in a large part because one of the purposes of the econometric modelling is to provide forecasts which do not exist. Alternatively, out-of-sample (or the forecast) data can be held back to test whether the model fit (based on historical data) is appropriate for the forecast period. However, in the current context, water companies have provided forecast data based on detailed bottom-up projections. As such, this forecast information provides additional information that is not usually available and which can be used in the modelling, provided that the results using forecast data make economic and statistical sense (comparable and consistent with those using historical data).

In RIIO-GD1, Ofgem undertook its cost efficiency assessment using both modelling of historical data and modelling of two years of forecast data.²⁶ Ofgem also examined the full eight-year forecast period of RIIO-GD1, but considered that the statistical results suggested that the modelling over the full forecast period was less reliable than using forecasts over the first two years of the historical data.

We decided to reject the 8 year forecast models because most of these models performed poorly in respect of data quality and regression diagnostics relative to our historical and 2 year forecast models (the criteria we use to evaluate regression models in RIIO-GD1 are listed in our step-by-step guide for cost assessment). In particular, more 8 year forecast models failed our statistical tests than historical or 2 year forecast models.

In its final determinations for the gas distribution networks, Ofgem decided to use the average result across the range of its modelling; namely, top-down total expenditure (TOTEX) econometric modelling using historical data, top-down TOTEX econometric modelling using forecast data, bottom-up TOTEX modelling using historical data, and bottom-up TOTEX modelling using forecast data, stating:²⁷

we prefer to rely on the wider set of evidence than placing emphasis on any one modelling approach.

²⁵ That is, the recession during the financial crisis in 2008 and 2009, and the double-dip recession that took place from Q4 2011 to Q2 2012. See, for example, information on GDP published by Eurostat here <http://goo.gl/WZTMI7>, accessed 22 March 2014.

²⁶ Ofgem (2012), ‘RIIO-GD1: Final Proposals - Supporting document - Cost efficiency: Final decision - supplementary appendices’, December.

²⁷ Ofgem (2012), ‘RIIO-GD1: Final Proposals – Overview: Final decision’, December.

In the ongoing RIIO-ED1 price review, Ofgem has examined the electricity distribution network operators' (DNOs') relative efficiency using both bottom-up and top-down approaches.²⁸ In informing its fast-track decision, Ofgem has indicated that it has carried out various sensitivity analyses to its core top-down econometric models based on historical data, including modelling using 13 years of both historical and forecast data.²⁹

These regulatory precedents suggest that an appropriate approach is to examine the forecast period and assess whether the model results are reliable when compared to those using historical data. As detailed in section 4, Oxera undertook a series of statistical tests with regard to the modelling of the forecast data. These statistical tests indicate that the modelling of forecast data was robust (comparable to those using historical data only) and, thus, as per Ofgem's approach in RIIO-GD1 and RIIO-ED1, should be considered alongside the modelling based on historical data (which was also found to be statistically robust). As such, approaches II and IV, presented in section 4, use both historical and forecast data in the modelling.

3.3 Comment 3: projecting deprivation levels of companies

In Oxera (2014a), in part, to provide a relatively optimistic projection of improvements in deprivation, Oxera used a somewhat extreme assumption of a one-to-one relationship between GDP and deprivation when projecting deprivation. That is, Oxera assumed that for every 1% improvement in GDP, deprivation would similarly improve by 1%. However, deprivation tends to be relatively 'sticky'. For example, data on benefits expenditure from the DWP seems to indicate that, in real terms, benefits expenditure at the overall UK level is forecast to be largely constant over PR14 (i.e. an improvement of about 0.4% over the forecast period). Similarly, the total number of benefit claimants is predicted to fall by around 1.2% per annum over the forecast period (2013/14 to 2019/20), although the number of claimants with respect to Jobseeker's Allowance, housing, incapacity and income support, etc. is predicted to fall by around 7% per annum over the forecast period (2013/14 to 2019/20).³⁰ South West Water indicated that this issue is further reflected in a Plymouth Business School report for it.³¹ This report noted that, while GDP is expected to grow, forecasts do not predict a significant fall in the household debt-income ratio. As a result, there is unlikely to be a significant improvement in the ability of household customers to pay debts in the short to medium term.

In this update, two amendments have been made to the assumption employed in Oxera (2014a):

- the income domain of IMD has been used as a measure of the proportion of the population in an area that are part of income-deprived families.³² Also, consistent with the analysis undertaken in Oxera (2013) and Oxera (2014a), the IMD is also used as a measure of deprivation;

²⁸ Ofgem (2013), 'RIIO-ED1 Business Plan Expenditure Assessment – Methodology and Results', December.

²⁹ Ofgem (2013), 'RIIO-ED1 Business Plan Expenditure Assessment – Methodology and Results', December, section 8.

³⁰ Benefits expenditure data for the analysis at the local authority level in 2010 and at the overall UK level over the period of analysis based on information from <https://www.gov.uk/government/publications/benefit-expenditure-and-caseload-tables-2013> was provided by South West Water.

³¹ Based on information provided by South West Water.

³² Oxera also considered using the employment domain of IMD. When examining the relationship between income domain and employment domain, it appears that the two indices are strongly linearly related. As such, results from employing either domain are expected to be similar, and thus only income domain is considered in the updated analysis.

- income deprivation is projected forward using DWP data on benefits expenditure.³³

In the time available, data on the number of benefit claimants over time at the local authority level was not found to be available. Instead, benefits expenditure, at the local authority and overall UK levels, were used. This may result in an under-estimation of deprivation over the forecast period, given the government's reduction in benefit payments and the introduction of the universal credit cap.³⁴

In order to forecast deprivation, the relationship between income deprivation and benefits expenditure at the local authority level in 2010 was examined. This shows that, for every 1% increase in benefits expenditure, deprivation increases by 0.4%.³⁵ The 95% confidence interval around the point estimate of 0.4 was compact between 0.35 and 0.46.³⁶ It is then assumed that deprivation increases by 0.4% for every 1% forecast growth in benefits expenditure (and vice versa).

In addition, a cross-check was undertaken using the number of claimants over time to project forward.³⁷ The results and conclusions discussed in section 4 remain valid under this approach. This is probably because any difference in the assumed downward trend in deprivation results in an amended coefficient estimate on the time trend over the forecast period, such that the overall results remain unchanged.

4 Re-estimating the adjustment on doubtful debt reflecting changes in bills and deprivation over PR14

This section re-examines the adjustment on doubtful debt for South West Water taking into account changes in deprivation and bill levels over PR14. First, the Oxera (2013) results (based on historical data) and Oxera (2014a) results (based on historical and forecast data) are summarised for comparison purposes.

4.1 The adjustment on doubtful debt using historical data

In Oxera (2013),³⁸ using econometric models based on doubtful debt, an adjustment to South West Water's retail costs was estimated at between £6m and £9m (in 2010/11 prices).

These ranges were derived by comparing the level of doubtful debt for South West Water with the level of doubtful debt for an average company in the industry serving the same number of unique customers as South West Water—

³³ Benefits expenditure data for the analysis at the local authority level in 2010 and at the overall UK level over the period of analysis based on information from <https://www.gov.uk/government/publications/benefit-expenditure-and-caseload-tables-2013> was provided by South West Water.

³⁴ As the future expenditure may reduce (or remain stable) without a reduction in the number of benefit claimants. See for example, discussions on benefits cap and welfare system reforms in <https://www.gov.uk/government/policies/simplifying-the-welfare-system-and-making-sure-work-pays#impact>; accessed 22 March 2014.

³⁵ Modelling of the relationship between income deprivation and benefits expenditure in 2010 at the local authority level was examined in logarithmic form. The resulting coefficient on benefits expenditure was 0.4 which was statistically significant at 1%. As modelling was carried out in logarithmic form, the coefficient is interpreted as an elasticity estimate between benefits expenditure and income deprivation.

³⁶ Oxera also examined the year-on-year relationship between benefits expenditure and deprivation (between 2001 and 2010) at the local authority level from the DWP. The relationship was relatively poorer in terms of statistical fit (the coefficient on benefits expenditure was close to zero and statistically insignificant), compared with cross-sectional analysis in 2010, and as such, results from this analysis were ignored.

³⁷ In particular, the number of claimants with respect to Jobseeker's Allowance, housing, incapacity and income support, etc.

³⁸ See section 4 of Oxera (2013).

i.e. a company that serves an area with average levels of income deprivation and charges the average bill level.

In Oxera (2014a),³⁹ based on five modelling approaches considered in the note, Oxera concluded that:

- South West Water's assumptions on the level of doubtful debt over PR14 are not materially different to those predicted by the econometric models, and
- the rate of reduction proposed by South West Water in its doubtful debt is the highest across the industry, when controlling for the level of bills and deprivation at which it currently operates (or has been forecast to operate).

4.2 The adjustment on doubtful debt accounting for changes in the level of bills and deprivation levels over the PR14 period

In this section, the modelling and adjustments from the Oxera (2013) and Oxera (2014a) econometric models are updated to consider changes in the level of bills and deprivation levels over the PR14 period, and the comments from Ofwat on Oxera (2014a) discussed in section 3.

The starting point for this analysis was the approach discussed in section 4 of Oxera (2013), as set out below for ease of reference.

- The analysis models doubtful debt per unique customer explained using the level of deprivation and bill size in the company area.
- Taking historical (actual performance) data between 2007/08 and 2012/13, the analysis was carried out in logarithms and using an approach that controls for company effects and noise in the analysis; namely, a random effects panel data model. This model was confirmed to be statistically valid for the dataset.⁴⁰

In response to Ofwat's request, as part of its 'risk-based review' of companies' business plans, to reflect the impact of changes in bills and deprivation, Oxera (2014a) extended the (2013) analysis to include historical and forecast data based on data published by Ofwat on its website. The forecast data used in Oxera (2014a) relates to bill levels, deprivation levels, doubtful debt and unique customers.

Given the discussion in section 3, and the modelling undertaken in Oxera (2014a), the following modelling approaches are examined:

- **Approach I:** using income deprivation, this approach modelled historical data between 2007/08 and 2012/13 to estimate the relationship between doubtful debt and deprivation and customer bills, while separate trends are estimated over the historical and forecast period. In addition, income deprivation was projected forward using forecast benefits expenditure and the historical relationship between benefits expenditure and income deprivation, which suggested that a 1% increase in benefits expenditure could result in a 0.4% increase in deprivation levels (and vice versa).

³⁹ See section 4 of Oxera (2014a).

⁴⁰ Based on Breusch–Pagan test for company effects in the dataset; see Breusch, T.S. and Pagan, A.R. (1979), 'A Simple Test for Heteroscedasticity and Random Coefficient Variation', *Econometrica*, Econometric Society, 47:5, pp. 1287–94, September.

- **Approach II:** using income deprivation, this approach modelled historical and forecast data. In addition, income deprivation was projected forward using the same approach as in Approach I.
- **Approach III:** using the IMD, this approach modelled historical data between 2007/08 and 2012/13 to estimate the relationship between doubtful debt and deprivation and customer bills, while separate trends were estimated over the historical and forecast period. In addition, the IMD was projected forward using the same approach as in Approach I (as IMD and income deprivation are highly correlated).
- **Approach IV:** using the IMD, this approach modelled historical and forecast. In addition, the IMD was projected forward using the same approach as in Approach I.

Before examining the updated results from/implications of these four approaches, Table 4.1 shows the estimation results from the modelling of the doubtful debt per unique customer when the data is extended up to 2019/20 and deprivation levels are projected using benefits expenditure data as discussed above (i.e. Approaches II and IV, estimated using both ordinary least squares (OLS) and random effects). (In addition, the estimation results from all the four modelling approaches above are presented in Appendix 1, under the preferred estimation method of random effects, while Appendix 2 summarises the data used in the analysis).

Table 4.1 Results of the doubtful debt per unique customer model, when deprivation is projected using benefits expenditure data

Variables (in logarithms except for 'Time trend')	Approach I OLS (income deprivation)	Approach II Random effects (income deprivation) ¹	Approach IV OLS (multiple deprivation)	Approach IV Random effects ¹ (multiple deprivation)
Average bill levels	1.118***	1.042***	1.083***	0.891***
Multiple deprivation			0.699***	1.707***
Time trend	-0.0193***	-0.0187***	-0.0203***	-0.0195***
Income deprivation	0.728***	1.051***		
Constant	-9.775***	-8.685***	-13.13***	-15.00***
R-squared, N	0.71, 234	0.70, 234	0.71, 234	0.65, 234

Note: *** imply significance at 0.1%. ¹ Statistical testing indicates that the random effects model is more appropriate than pooled OLS for the given dataset and model specification. The results from this model seek to control for company-specific factors that do not vary over time.

Source: Oxera, based on data from Ofwat, South West Water, DWP and June Returns.

The modelling results are consistent with those presented in section 4 of Oxera (2013) and section 3 of Oxera (2013a), except for the coefficient on the time trend variable, under both Multiple and Income Deprivation indices, although the model fit in terms of R-squared improves marginally when forecast data is integrated with historical data. Critically:

- in the OLS and random effects models using multiple deprivation (Models 1 and 2 of Oxera (2013a)), the level of average household bill and the IMD are statistically significant at the 1% level of significance, indicating a strong relationship with doubtful debt per unique customer;

- the coefficient on the time trend (which is statistically significant) indicates that, over the 13-year period, the level of doubtful debt per unique customer across the industry has or is forecast to improve by around 2% per annum depending on the deprivation measure.

Based on a statistical test, the random effects model is still found to be statistically valid and appropriate for the current dataset. Moreover, it is able to control for company effects and noise in the modelling. The estimated coefficients from the model also make economic sense. Hence, the predicted levels of doubtful debt for South West Water and for an average company are estimated using the random effects model. The model results under the different approaches provide a cross-check to the rate of reduction assumed by South West Water when changes in bill levels and deprivation over PR14 are considered.

In addition, as noted in section 3.2, Oxera undertook a series of statistical tests with regard to the modelling of the forecast data. The results of these tests are presented in Table 4.3.

Table 4.3 Summary of the results of statistical tests using historical and forecast data

	Approach II	Approach IV
Coefficients significant?	✓	✓
Coefficients intuitive?	✓	✓
R-squared reasonable?	✓	✓
Heteroscedasticity: Breusch–Pagan/Cook–Weisberg, White test, quantile regression?	(✓)	(✓)
Functional specification of the model is correct: RESET, Linktest, quantile regression?	(✓)	(✓)
Is the estimation technique (i.e. a random effects model) appropriate? ¹	✓	✓

Note: For each test, if the probability value is below 0.05 (or 5%), the ‘null hypothesis’ of the test is rejected. If the null hypothesis is rejected, the assumptions of the model are statistically sound—this is recorded as ‘✓’, or otherwise recorded as ‘x’. (✓) indicates that the issue is minor as the model passes some of the statistical tests applied to examine the issue but not necessarily all. An R-squared value above 0.65 is assumed to be reasonable. ¹ A specific Lagrangian Multiplier test (Breusch–Pagan test) is applied where, if the null hypothesis of no random effects is rejected, an OLS model is deemed not to be appropriate.

Source: Oxera.

The statistical test results indicate that the modelling of forecast data enable sound economic and statistical sense, is robust (comparable to those using historical data only—see Appendix A3 of Oxera (2013)) and, thus, as per Ofgem’s approach in RIIO-GD1 and RIIO-ED1, should be considered alongside the modelling based on historical data only (which was also found to be statistically robust—see Appendix 3 of Oxera 2013).

Table 4.4 shows the results for South West Water and an average company with average characteristics in terms of levels of deprivation and bill levels, using the doubtful debt per unique customer model across the four modelling approaches. (Predicted levels and confidence intervals take into account the company-specific effects from the random effects panel data model; see Baltagi, 2013.⁴¹)

⁴¹ Baltagi, B.H. (2013), ‘Econometric Analysis of Panel Data’, Section 2.5, fifth edition, Wiley.

	2016	2017	2018	2019	2020	Total over K5	Confidence interval:		Are SWW's assumptions on doubtful debt:		CAGR between 2015 and 2020 (%)	Average reduction between 2015 and 2020 (%)
							lower limit	upper limit	below that predicted by the model?	materially different from that predicted by the model?		
Average results across the approaches¹												
Average of predicted doubtful debt from the model for SWW across the approaches (£m)	12	11	11	11	10	55	42	71	Yes	No	-3	-3

Note: CAGR, compound average growth rate. All monetary terms in 2010/11 prices. ¹ While simple averaging of results is non-standard, it is carried out here to cross-check South West Water's assumptions on the level of doubtful debt across the approaches.

Source: Oxera analysis, using data from Ofwat, South West Water, DWP and June Returns.

Table 4.4 shows the following.

- South West Water's proposed doubtful debt over PR14 is lower than those predicted by all the models, although the difference is not statistically significant.⁴²
- In terms of the rate of reduction,⁴³ South West Water's proposed rate of reduction, at 6% per annum, is at the upper end of the range predicted by the model under all the approaches. However, the assumed levels of doubtful debt by South West Water are, in some cases, higher than that predicted by the model over the period, and the difference in rate of reductions could be a consequence of this.

Oxera also undertook quantile regression, estimating the relationship between doubtful debt per unique customer and bill size and deprivation levels for specific subsets or quantiles (e.g. first decile, median, top quartile) of the dataset.⁴⁴ The coefficients estimated for the time trend variable across different quantiles of the data can be used to understand whether some companies have assumed different rates of reduction of doubtful debt per unique customer over PR14, controlling for the levels of bill size and deprivation at which they operate (or have been forecast to operate).

The results of the quantile regression (at 10%, 25%, 50%, 75%, 85%, 90% and 95%) indicate that the highest rate of reduction assumed by the companies over PR14 is about 6%. This matches the reduction rate assumed by South West Water over PR14. In other words, this seems to indicate that, accounting for the level of bill size and deprivation, and changes in these over PR14, no company has assumed a higher rate of reduction in doubtful debt than South West Water. However, as noted above, the assumed levels of doubtful debt by South West Water and other companies, and their historical position on this measure, should be considered, to provide a more robust comparison.

5 Conclusion

In this note, Oxera has updated the econometric analysis, first undertaken in Oxera (2013), and subsequently updated in Oxera (2014a), in order to take into account forecast changes (predominantly, reductions) in bill levels and deprivation, and the feedback by Ofwat on some of the modelling assumptions considered in Oxera (2014a). To this end, four modelling approaches have been adopted in order to examine the sensitivity or robustness of the results to the data considered in the analysis and the assumptions used to project the level of deprivation over the period of analysis. Based on empirical analysis using these modelling approaches, two main conclusions are drawn with regard to South West Water's assumptions on the assumed level of doubtful debt over PR14, which are consistent with the findings presented in Oxera (2014a).

- Overall, across the modelling approaches considered in this note, South West Water's assumptions on the level of doubtful debt over PR14 are lower than those predicted by all the models.

⁴² Based on a 95% confidence interval about the level of doubtful debt predicted by the model for South West Water's characteristics.

⁴³ As measured by the CAGR or average reduction between 2015 and 2020.

⁴⁴ Quantile regression may also be used to test for non-linearity in the model. On the whole, the coefficients of customer bills and deprivation in the models varied little across the quantiles (at the 95% level of confidence), suggesting that non-linearity is not a serious concern.

- The rate of reduction proposed by South West Water on its doubtful debt over PR14 is the highest across the industry when controlling for the level of bills and deprivation at which it currently operates (or has been forecast to) operate.
-

A1 Model estimation results

Table 4.1 shows the estimation results from the four modelling approaches discussed in section 4.2. For ease of reference, the approaches examined are set out below.

- **Approach I:** using income deprivation, this approach modelled historical data between 2007/08 and 2012/13 to estimate the relationship between doubtful debt and deprivation and customer bills, while separate trends are estimated over the historical and forecast period. In addition, income deprivation was projected forward using forecast benefits expenditure and the historical relationship between benefits expenditure and income deprivation, which suggested that a 1% increase in benefits expenditure could result in a 0.4% increase in deprivation levels (and vice versa). (See Table A1.2 for the regression output.)
- **Approach II:** using income deprivation, this approach modelled historical and forecast data for all the companies. In addition, income deprivation was projected forward using the same approach as in Approach I.
- **Approach III:** using the IMD, this approach modelled historical data between 2007/08 and 2012/13 to estimate the relationship between doubtful debt and deprivation and customer bills, while separate trends were estimated over the historical and forecast period. In addition, the IMD was projected forward using the same approach as in Approach I (as the IMD and income deprivation are highly correlated).
- **Approach IV:** using IMD, this approach modelled historical and forecast data for all the companies. In addition, the IMD was projected forward using the same approach as in Approach I.

Table A1.1 Results of Oxera's modelling approaches¹

Variables (in logarithms except for the time trend and dummy variables)	Approach I	Approach II	Approach III	Approach IV
Average bill levels	1.035 ²	1.042***	0.964 ³	0.891***
Income deprivation	0.998 ²	1.051***		
Time trend over historical period	0.023***		0.019 ³	
Time trend over forecast period	-0.066***		-0.062***	
Dummy variable for forecast period	0.316***		0.300***	
Multiple deprivation			1.118***	1.707***
Time trend over the entire period		-0.019***		-0.019***
Constant	-8.857***	-8.685***	-13.785***	-15.001***
R-squared, N	0.72, 234	0.70, 234	0.70, 234	0.65, 234

Note: Dependent variable in all the approaches is (the logarithm of) doubtful debt per unique customer. *, **, *** imply significance at 20%, 10%, 5%, 1%, 0.1%, respectively. [doesn't match?] ¹ All the approaches are estimated using a random effects model, as statistical testing indicates that it is more appropriate than pooled OLS for the given dataset and model specification. The results from this model seek to control for company-specific factors that do not vary over time. ² The coefficients of average bill

levels and income deprivation come from historical data and are constrained under this approach.³ The coefficients of average bills levels and the IMD come from historical data and are constrained under this approach. Source: Oxera, based on data from Ofwat, South West Water, DWP and June Returns.

Table 4.1 shows results from the econometric model that estimates the relationship between benefits expenditure and income deprivation at the local authority level in 2010. As noted above (and in section 4 of the note), in the four modelling approaches, income or multiple deprivation was projected forward using forecast benefits expenditure and the historical relationship between benefits expenditure and income deprivation. This suggested that a 1% increase in benefits expenditure could result in a 0.4% increase in deprivation levels (and vice versa). (See coefficient on benefits expenditure in Table A1.2.)

Table A1.2 Relationship between benefits expenditure and income deprivation at the local authority level in 2010

Variables (in logarithms)	Income deprivation
Benefits expenditure	0.406***
Constant	-4.449***
R-squared, N	0.40, 326

Note:*** implies significance at 0.1%. Analysis is based on income deprivation in 2010 (from the Department for Communities and Local Government) regressed against the average of benefits expenditure in 2009/10 and 2010/11 (from DWP) at the local authority level. The model is estimated using OLS. The range of the coefficient on benefits expenditure is compact between 0.35 and 0.46. The year-on-year data on benefits expenditure and income deprivation estimated a poor model fit, and thus the results from this are ignored.

Source: Oxera, based on data from South West Water, DWP and DCLG.

A2 Summary of the data used for the analysis

Table A2.1 describes the data used in the econometric models developed in section 4.2.

Table A2.1 Input data used in the modelling

Data	Description	Source	Comment
Doubtful debt	Water and sewerage	JAR: T21, L18 and T22, L17	Data for 2011/12 and 2012/13 was based on industry datashares provided by South West Water
Number of measured and unmeasured households connected	Measured and unmeasured for water and sewerage Used in constructing unique customers	JAR: T7, L3–5 and T13, L3–4	Forecast data from companies' business plans over PR14 was based on data published by Ofwat on 14 March 2014. See http://www.ofwat.gov.uk/content?id=270d1e9b-ab63-11e3-8760-31cfc651602f .
Average bills	Water and sewerage Available from 2007/08 onwards A combined average bill was constructed	Ofwat's Charges and Bills publications	Forecast data from companies' business plans over PR14 was based on data published by Ofwat on 14 March 2014. See http://www.ofwat.gov.uk/content?id=270d1e9b-ab63-11e3-8760-31cfc651602f .
Deprivation index (multiple and income, 2010)	Available at a LSOA level for England only (not Wales) Reported every three years Index was mapped to the companies' service areas based on the 2011 population census	Department for Communities and Local Government (DCLG)	Data sourced from https://www.gov.uk/government/publications/english-indices-of-deprivation-2010 and http://www.ons.gov.uk/ons/publications/reference-tables.html?edition=tc_m%3A77-284349 ; accessed on 7 August 2013.
Benefits expenditure; number of benefits claimants	Historical and forecast benefit expenditure and caseload data 2013. In particular, data contained in spreadsheets 'Outturn and Forecast: Autumn Statement 2013' and 'Benefit expenditure by local authority from 2000/01 to 2012/13'. Data provided by South West Water	DWP	Data sourced from https://www.gov.uk/government/publications/benefit-expenditure-and-caseload-tables-2013 ; accessed on 25 March 2014

Note: JAR refers to the June Returns, which were previously collected and published by Ofwat each year. LSOA data within the South West Water operational area was provided by South West Water for the years 2010/11, 2011/12 and 2012/13.

Source: Oxera analysis, based on data from SWW, DWP, DCLG and Ofwat.