Asset risk premium relative to debt risk premium

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Executive summary

As part of the Energy Networks Association's response to Ofgem's RIIO−2 Sector Specific Methodology ('SSMD'), in March 2019 Oxera submitted evidence to Ofgem on how its proposed allowance on the cost of equity compared with the pricing of risk for these companies in the debt markets (the 'Oxera ARP−DRP report').[1] We explained that the ARP−DRP differential can be used as a cross-check for the appropriate level of the allowed cost of equity.

In this report, we update the analysis presented in the Oxera ARP−DRP report and the 2019 cost of equity update,[2] by (i) including the newly available data from the bond markets; (ii) adopting a revised approach to the risk-free rate set out in a recent Oxera submission to the CMA;[3] and (iii) improving the methodologies used for our analysis in response to Ofgem's concerns set out in the RIIO−2 SSMD.

In sum, three main conclusions can be drawn from this report:

- The benchmarks for ARP−DRP can be employed not only as a cross-check to cost of equity, but also to obtain **conservative estimates** of the allowed WACC, because of the downward bias in asset beta estimation.
- After adequately addressing Ofgem's concerns set out in the RIIO−2 SSMD, our findings reveal more information to support the conclusion that Ofgem's RIIO−2 cost of equity allowances in the Draft Determination **falls below** that implied by (i) contemporaneous market evidence for the cost of debt and the risk-free rate; and (ii) a mixture of contemporaneous market evidence and regulatory precedent on the asset beta and the TMR.[4] This conclusion is based on the finding that the ARP−DRP differential implied by Ofgem's allowances is low compared to those implied by the traded yields of energy bonds over the *six-month* period preceding the RIIO−2 Draft Determination.
- Our updated analysis, incorporating various methodological improvements, finds that the ARP−DRP differentials implied by past regulatory allowances for energy companies (i.e. RIIO−1, NIE RP5 and NIE RP6) were **broadly in line** with those implied by contemporaneous market evidence around the corresponding determinations.

In line with Ofgem's comments in the Sector Specific Methodology Decision,[5] we believe that the appropriate benchmark for the ARP−DRP differential should be derived from contemporaneous market evidence. Therefore, in this report, we focus solely on the UK utilities analysis, where the DRPs are calculated based on the daily traded yields of individual utilities bonds, over the six-month period preceding the publishing date of regulatory determinations.[6]

In this report, we show that the ARP−DRP differential has a role above and beyond a cross-check in the estimation of cost of equity parameters. In

[1] Oxera (2019), 'Risk premium on assets relative to debt', 25 March.
[2] Oxera (2019), 'The cost of equity for RIIO−2', August.
[3] For Oxera's revised approach to the risk-free rate see Oxera (2020), 'Are sovereign yields the risk-free rate for the CAPM?', 20 May.
[4] We set out our methodology in more details in Appendix A2.1.
[5] Ofgem (2019), 'RIIO−2 Sector Specific Methodology – Finance', p. 125.
[6] To estimate ARPs for our sample of comparators, we use the market asset beta for listed companies, and the allowed asset beta assumed by the regulator in the most recent energy regulatory precedent (e.g. for RIIO−2 this is NIE RP6) for unlisted companies. The methodology underpinning our analysis is further detailed in Appendix A2.1. While our sample of comparators mostly consists of unlisted firms, we test for the robustness of our asset beta assumption in Appendix A2.4. We show that that our conclusion remain unchanged under various alternative asset beta assumptions.

particular, the ARP−DRP framework provides important additional information for the assessment of financeability.

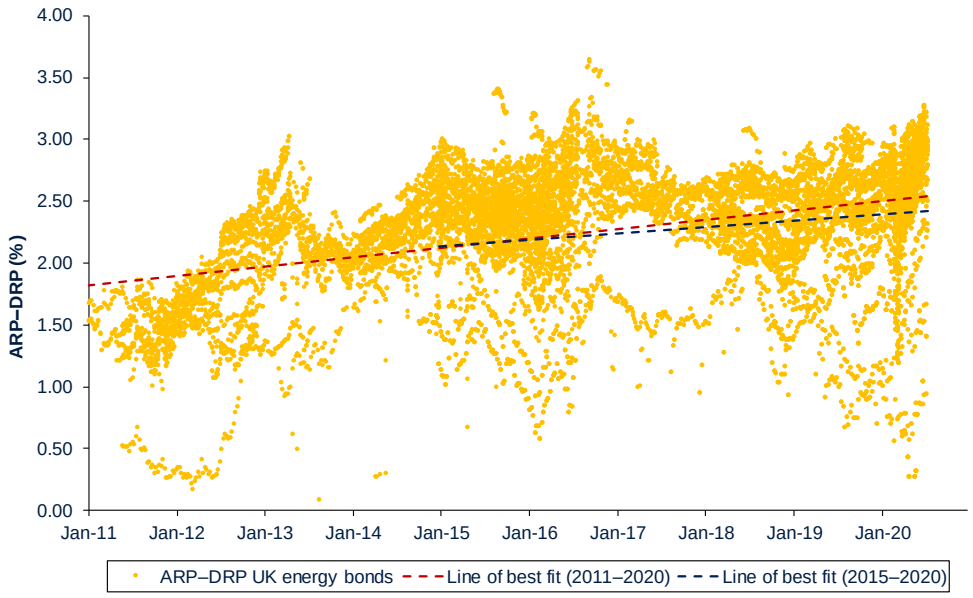
The ARP−DRP 'delta' is designed in a similar fashion to the nominal post-maintenance interest cover ratio (PMICR), which is used by credit rating agencies to assess the companies' debt financeability, through the measurement of their return on assets relative to debt. It is a useful addition to the PMICR, as it assess the companies' equity financeability.

The ARP−DRP framework allows for financeability assessment in a way that is **neutral with respect to the treatment of inflation**. In other words, the ARP−DRP delta derived from nominal parameter values will be the same irrespective of whether RPI-real or CPIH-real parameter values are used.

This allows the underlying financeability of the RIIO−2 proposals to be evaluated without the confounding influence of the switch from RPI to CPIH indexation. This is an important advantage given the impediment to comparability created by the use of these indexes.

In response to Ofgem's concern that our analysis presumes a constant ARP−DRP, we have analysed how ARP−DRP differentials implied by our comparator set evolved over time. In section 3, we show that the ARP−DRP differentials implied by UK energy bonds have increased over time. This is illustrated in Figure 1.1 below. This upward time trend is consistently observed at five-year and ten-year horizons.

Figure 1.1 ARP−DRP differential implied by UK energy bonds



Note: The methodology underpinning this figure is further explained in the note to Figure 3.1.

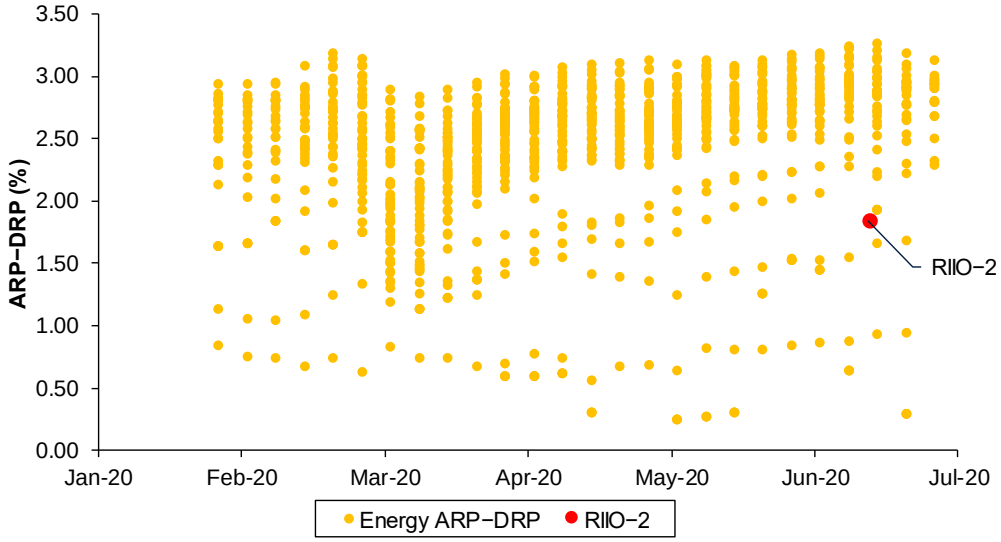
Source: Oxera analysis

The observed increase in the ARP−DRP differentials over time highlights the importance of using contemporaneous market evidence as the appropriate benchmark for the assessment of Ofgem's implied ARP−DRP. Therefore, in this report we draw our conclusions from the ARP−DRP implied by traded yields of energy bonds over the *six-month* period preceding the RIIO−2 Draft

Determination (as opposed to the yield at bond issuance previously used). We set out our approach in more details in section 3.

Figure 1.2 below illustrates that the ARP−DRP differential implied by Ofgem's RIIO−2 draft determination falls significantly below the recent market evidence. Specifically, Ofgem's midpoint allowance falls below the 15th percentile of the empirical distribution of market evidence from the last six months. This indicates that Ofgem's RIIO−2 allowances for the cost of equity are too low relative to that implied by contemporaneous market evidence.

Figure 1.2 Comparison of Ofgem's ARP−DRP differential to the ARP−DRP differential implied by contemporaneous evidence on UK energy bonds

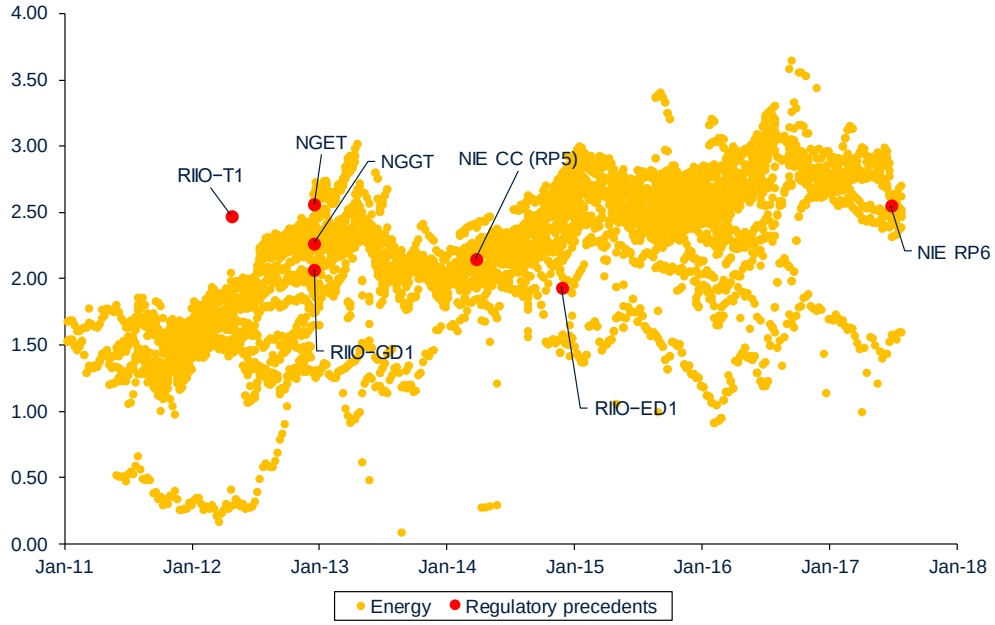


Note: The methodology underpinning this figure is further explained in the note to Figure 3.2.

Source: Oxera analysis.

In contrast to the ARP−DRP differential implied by RIIO−2 draft determination, Figure 1.3 illustrates that the ARP−DRP differentials implied by past regulatory allowances for energy companies were broadly in line with those implied by contemporaneous market evidence around the corresponding determinations.

Figure 1.3 Comparison of UK regulatory precedents to the ARP−DRP differential implied by contemporaneous evidence on UK energy bonds



Note: The methodology underpinning this figure is further explained in the note to Figure 3.3.

Source: Oxera analysis.

As illustrated in Table 1.1, our updated ARP−DRP analysis shows that the ARP−DRP implied by Ofgem's proposed cost of equity for RIIO−2 lies in the bottom 15% of the empirical distribution of that implied by contemporaneous market evidence (e.g. traded yields of energy bonds over the six-month period preceding the RIIO−2 Draft Determination). This suggests that Ofgem would need to increase the cost of equity allowances to be in line with the cost of equity implied by contemporaneous market evidence from UK energy bonds. This conclusion remains unchanged under various sensitivity tests and cross-checks. At 60% gearing, the median implies a mid-point cost of equity estimate of 6.35% (CPIH-real).[7] This represents an increase of 215 bp relative to Ofgem's mid-point allowance of 4.2%.

This 15th percentile (and therefore the implied of cost of equity uplift of 215 bp) is a conservative estimate, as it also suffers from downward attenuation bias. In section 2.3, we explain why conventional analysis of the ARP−DRP differential and the cost of equity has a downwards attenuation bias arising from measurement errors in the independent variable.

Correcting for this would place Ofgem's implied ARP−DRP differential at a lower percentile ranking within the distribution of market evidence. Moreover, accounting for Ofgem's proposed 25 bp adjustment for the expected versus actual returns,[8] places Ofgem's proposed allowance even lower in the distribution, in the bottom 14%.

[7] The mid-point cost of equity of 6.34% (CPIH-real) at 60% gearing is estimated based on: the median ARP−DRP differential implied by contemporaneous market evidence, as well as the risk-free rate and DRP implied by Oxera's parameters set out in the latest cost of equity update.
[8] Ofgem (2020), 'RIIO−2 Draft Determination: Finance Annex', July 2020, p. 83, para. 3.153.

Table 1.1 Percentile ranking of Ofgem's ARP−DRP differential

	Oxera March 2019 report	This report	Change
Approach 1	9.9%	15.0%	5.1%
Approach 2	16.6%	3.1%	–13.5%

Source: Oxera analysis.

The low percentile ranking of Ofgem's implied ARP−DRP differential is the result of a series of methodological errors introduced in the RIIO−2 draft determination, *all* of which have led to a reduction in the allowed cost of equity. These methodological changes include:

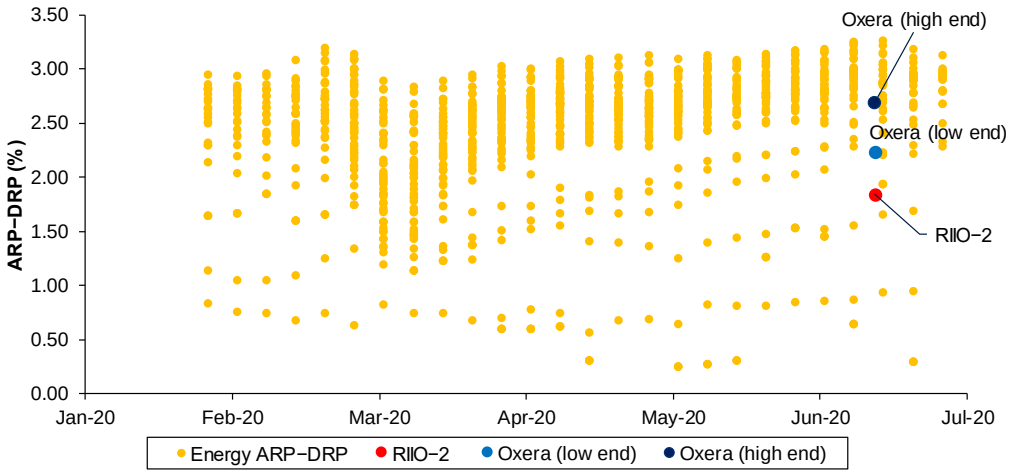
- restating historical TMR based on an experimental index for historical CPI, which results in a lower estimated TMR;
- increasing the weight on the geometric average historical return, thereby moving further away from the correct (Cooper) estimator, resulting in a lower TMR;
- moving to spot yields on government bonds, which lowers the estimated RfR;
- using a debt beta of 0.125 where previously Ofgem used zero, which artificially deflates the notional equity beta;
- reducing the allowed return below the mean estimate of the cost of equity to reflect expected outperformance.

In the latest cost of equity report,[9] Oxera has corrected Ofgem's methodological errors and updated the analysis based on recent market evidence. Oxera's updated cost of equity report supports an allowance in the range of 6.00–7.08%. In the latest cost of equity report, we explain that the ARP−DRP framework is a superior cost of equity cross-check compared to other cross-checks used by Ofgem. [10]

Figure 1.4 shows that the ARP−DRP differential implied by Oxera's recommended cost of equity range is more in line with recent market evidence, being placed between the 24th percentile (low end) and the 58th percentile (high end) of the empirical distribution of the ARP−DRP implied by contemporaneous market data (e.g. traded yields of energy bonds over the six-month period preceding the RIIO−2 Draft Determination).

[9] Oxera (2020), 'The cost of equity for RIIO−2', September.
[10] Oxera (2020), 'The cost of equity for RIIO−2', September.

Figure 1.4 Comparison of the ARP−DRP differentials implied by Ofgem's and Oxera's estimates to the ARP−DRP differential implied by contemporaneous evidence on UK energy bonds



Note: The methodology underpinning this analysis is further explained in the detailed note to Figure 3.5.

Source: Oxera analysis.

In section 4, we provide responses to Ofgem's comments on the ARP−DRP framework, set out in the RIIO−2 Sector Specific Methodology Decision. Having carefully addressed these comments, we show that our conclusion, namely that Ofgem's RIIO−2 allowances for the cost of equity are too low relative to those implied by contemporaneous market evidence, remains unchanged.

1 Introduction

As part of the Energy Network Association's response to Ofgem's RIIO−2 Sector Specific Methodology, in March 2019 Oxera submitted evidence to Ofgem on how calculations of the cost of equity for companies in regulated sectors compared with the pricing of risk for these companies in the debt markets (the 'Oxera ARP−DRP report').[11] The evidence provided a new way to check whether the cost of equity calculated for RIIO−2 was at an appropriate level relative to the forward-looking cost of debt for energy networks.

1.1 The Oxera ARP−DRP report

In the Oxera ARP−DRP report, we estimated the differential between asset and debt risk premium allowed under previous regulatory determinations and observed from bonds issued by utilities.[12] We then compared the ARP−DRP implied by Ofgem's proposed cost of equity to those implied by previous regulatory determinations and market evidence.

The asset risk premium (ARP) reflects the excess return required by investors in return for providing capital to risky assets. The ARP is calculated using the following formula:

Asset risk premium

$$ARP = \beta_a \cdot ERP$$

$\boldsymbol{ARP}$ asset risk premium; $\boldsymbol{\beta_a}$ asset beta; $\boldsymbol{ERP}$ equity risk premium

The debt risk premium (DRP) reflects the excess return required by investors in return for acquiring risky debt. It can be calculated using two approaches:[13]

Measuring the debt risk premium

Approach 1:

$$DRP = YTM - expected\ loss - RfR$$

Approach 2:

$$DRP = \beta_d \cdot ERP$$

$\boldsymbol{DRP}$ debt risk premium; $\boldsymbol{YTM}$ yield to maturity; $\boldsymbol{RfR}$ risk-free rate; $\boldsymbol{\beta_d}$ debt beta; $\boldsymbol{ERP}$ equity risk premium

The analysis in the Oxera ARP−DRP report showed that the cost of equity implied by Ofgem's RIIO−2 Sector Specific Methodology Consultation ('RIIO−2 SSMC') was in the bottom 15% of the distribution of previous regulatory determinations and the bottom 10% of the market evidence from UK utility bonds.[14] The report calculated that the differential between the asset and debt risk premiums implied by the cost of equity assumed by Ofgem in the sector-specific consultation was around 60 bp.[15] The evidence suggested that Ofgem's proposed cost of equity allowance was well below what an investor would require for holding the equity of regulated networks. Such a low level of ARP−DRP differential is not surprising if one considers that the cost of equity proposed in Ofgem's SSMD is the lowest since privatisation and reflects

[11] Oxera (2019), 'Risk premium on assets relative to debt', 25 March.
[12] Oxera (2019), 'Risk premium on assets relative to debt', 25 March.
[13] For greater detail on the difference between the two approaches conceptually, see Oxera (2019), 'Risk premium on assets relative to debt', 25 March, pp. 6−7.
[14] Oxera (2019), 'Risk premium on assets relative to debt', 25 March, p. 16 and p. 19.
[15] Using a debt beta assumption of 0.05.

changes in five components of the cost of capital, the cumulative impact of which is to reduce the allowed return to the companies.

Moreover, accounting for Ofgem's proposed adjustment for the expected versus actual returns placed Ofgem's proposed allowance even lower in the distribution, in the bottom 5th percentile.[16]

The cross-check was also applied to our original proposed range for the cost of equity for RIIO−2.[17] Our original proposed cost of equity range for RIIO−2 implied an ARP−DRP differential in the 30th to 45th percentile of our UK utilities analysis and 60th to 65th percentile of previous regulatory precedents.[18] This is more in line with what investors expect on average.

We estimated that Ofgem would need to increase its proposed cost of equity allowance by 150 bp to 200 bp to be more in line with the market evidence presented in our first report.[19] This adjustment would have placed Ofgem in the 40th to 60th percentile of our UK utilities analysis.

1.2 Developments since our first report

In May 2019, Ofgem published its RIIO−2 Sector Specific Methodology Decision ('RIIO−2 SSMD'), where it updated its recommended cost of equity range for RIIO−2. In the RIIO−2 SSMD, Ofgem comments on the various responses to its consultation, including the Oxera ARP−DRP report.[20]

In the SSMD, Ofgem agreed with the principle that the risk premium required by debt holders must be less than the risk premium required by equity holders.[21]

> We acknowledge the principle set out by Oxera and note that the ARP calculated by Oxera is higher than the DRP. We consider our approach is consistent with this principle. We note that Oxera's argument does not focus on the absolute difference.

In the SSMD, Ofgem continued to refer to the ARP−DRP framework in the 'second step' of setting the allowed return on equity, alongside other cross-checks.[22] However, the implications of the ARP−DRP framework go beyond cost of equity estimation, as the framework also provides important additional information for the assessment of financeability. We discuss the implications of the ARP−DRP framework for financeability assessments in section 2.4.

In November 2019, we published an update to our recommended range for the cost of equity for RIIO−2. In this update, we showed that Ofgem's updated cost of equity (before the adjustment for expected versus actual returns) increased the CPIH-deflated cost of equity by 30 bp to 4.8%. This increased the differential between the asset and debt risk premiums to 80–85 bp. The updated differential fell just below the bottom 25% of ARP−DRP differentials observed in the market for the UK utility bonds since 2010. Applying the expected versus actual return adjustment proposed by Ofgem's resulted in the allowed ARP−DRP within the bottom 10% of the datasets mentioned above.

On 9 July 2020, Ofgem published its Draft Determination for RIIO−2.

[16] Ofgem's working assumptions on the expected outperformance on cost of equity is 50 bp. See Ofgem (2019), 'RIIO−2 Sector Specific Methodology Decision – Finance', p. 77, para. 3.301.
[17] Oxera (2019), 'Risk premium on assets relative to debt', 25 March, p. 23.
[18] Oxera (2019), 'Risk premium on assets relative to debt', 25 March, p. 23.
[19] Oxera (2019), 'Risk premium on assets relative to debt', 25 March, pp. 23−4.
[20] Ofgem (2019), 'RIIO−2 Sector Specific Methodology Decision – Finance', 24 May, Appendix 2.
[21] Ofgem (2019), 'RIIO−2 Sector Specific Methodology Decision – Finance', p. 124.
[22] Ofgem (2019), 'RIIO−2 Sector Specific Methodology Decision – Finance', p. 65.

1.3 Scope of this report

In this report, we provide new evidence concerning why the ARP−DRP framework merits greater weight than the cross-checks for the allowed cost of equity considered by Ofgem. We also highlight the benefits of using this approach for the assessment of financeability and describe how the ARP−DRP framework can be used to obtain conservative estimates of the WACC that are in line with contemporaneous market evidence.

Moreover, we update the analysis presented in the Oxera ARP−DRP report to reflect the revised approach to the risk-free rate presented in recent Oxera work presented to the CMA as part of the PR19 appeal and the revised cost of capital parameters set out in Ofgem's Draft Determination. In line with Ofgem's comments in the Sector Specific Methodology Decision,[23] we believe that the appropriate benchmark for the ARP−DRP differential should be derived from contemporaneous market evidence, and not regulatory precedents. Therefore, in this report we remove the UK regulatory precedent analysis and focus solely on the UK utilities analysis, where the DRPs are calculated based on the yield of individual utilities bonds. We also respond to Ofgem's comments on the Oxera asset risk premium report in its RIIO−2 SSMD.[24]

The rest of this report is structured as follows:

- section 2.1 briefly summarises the ARP−DRP framework adopted in the Oxera ARP−DRP report;
- section 2.2 sets out our amendment to the estimation of the risk-free rate, as explained in the Oxera risk-free rate and gearing report;
- section 2.3 explains how the ARP−DRP framework can be used to benchmark Ofgem's allowances against market evidence and derive conservative estimates of cost of capital, due to the downward attenuation bias that is present in the ARP estimation;
- section 2.4 explains the benefits of this approach for the assessment of financeability;
- section 3 updates the UK utilities bond analysis originally set out in the Oxera ARP−DRP report. The updated analysis reflects, among other things, the revised approach to the risk-free rate presented in recent Oxera work,[25] as well as the methodological improvements and adjustments to our sample of comparators in response to Ofgem's concerns;
- section 4 responds to Ofgem's comments on the Oxera ARP−DRP report.

[23] Ofgem (2019), 'RIIO−2 Sector Specific Methodology – Finance', p. 125
[24] Oxera (2020), 'Are sovereign yields the risk-free rate for the CAPM?', 20 May.
[25] For Oxera's revised approach to the risk-free rate, see Oxera (2020), 'Are sovereign yields the risk-free rate for the CAPM?', 20 May.

2 The role of the ARP−DRP framework in assessing the WACC and financeability

In this section, we show that the ARP−DRP framework can be employed not only as a cross-check to cost of equity, but also to obtain conservative estimates of the WACC that are in line with market evidence, and to test for financeability.

It is important to highlight that the ARP−DRP framework has distinct advantages over and above the conventional cost of capital approach. For example, in the conventional approach, the cost of capital is calculated by regressing unlevered equity returns on the market index. As described earlier, market returns are measured with noise generating a downward bias in the estimated betas.[26] The ARP−DRP methodology, proposed by Oxera, corrects for these biases in DRP (but not ARP), which provides a more conservative measure of the cost of equity.

The section opens with a summary of the original ARP−DRP implementation methodology (section 2.1), then moves on to describe the adjustments we made to the framework in light of the new evidence available on the risk-free rate, presented at the recent PR19 CMA appeal hearing (section 2.2). Next, we describe how the ARP−DRP framework can be used to obtain conservative estimates of the WACC that are in line with market evidence (section 2.3), and to draw conclusions about the company's financeability (section 2.4).

2.1 Summary of our original application of the ARP−DRP framework

In our original ARP−DRP report and the 2019 cost of equity update, we focused on using the ARP−DRP differential as a cross-check for the appropriateness of the cost of equity parameters proposed by Ofgem and Oxera. Our analysis can be summarised as follows.

First, we calculated the ARP−DRP differential for each utility bond issuance and regulatory precedent in our comparator set. The respective sources of data are summarised in Table 2.1.

Table 2.1 Original implementation methodology for the ARP−DRP cross-check

		Approach 1	Approach 2
Total market return	[A]	Regulatory precedents	
Risk-free rate	[B]	Market yields on government bonds	
Equity risk premium	[C]	[A] – [B]	
Asset beta	[D]	Estimates based on market data / Reg precedents[1]	
Asset risk premium	[E]	[C] · [D]	
Risk-free rate	[F]	Market yields on government bonds	
Debt risk premium	[G]	Market: YTM – [F] – Expected loss[2]	Reg precedents: β_d · [C]
ARP−DRP differential	[H]	[E] – [G]	

Note: [1] In our analysis of UK utility bond issuances, we used the market asset beta for listed companies, and the allowed asset beta from regulatory precedents for unlisted companies. In our UK regulatory precedent analysis, we used the allowed asset beta of the corresponding regulatory precedent. In both analyses, we adjust the allowed asset beta to be consistent with a

[26] See, for example: Jegadeesh, N., Noh, J., Pukthuanthong, K., Roll, R., and Wang, J. (2019). 'Empirical tests of asset pricing models with individual assets: Resolving the errors-in-variables bias in risk premium estimation', *Journal of Financial Economics*, **133**:2, pp. 273−98.

debt beta of 0.05. [2] We assumed an expected loss of 30 bp for senior unsecured debt and 20 bp for senior secured debt. See Oxera (2019), 'Risk premium on assets relative to debt', 25 March, p. 11.

Source: Oxera analysis.

Second, we repeated the same calculations as in the first step, using the cost of equity parameters (i.e. risk-free rate, asset beta, debt beta and TMR) proposed by Ofgem and Oxera.

Finally, we examined how the ARP−DRP differential of the Ofgem proposals fits in the empirical distribution of the ARP−DRP differentials estimated in the first step.

This cross-check adds value to the discussions on cost of equity, as it is intuitive, and introduces new information that can be directly observed from the market (e.g. risk-free rate, asset beta for listed companies, and debt spread).

The last point above is especially important, as the appropriate benchmark for Ofgem's ARP−DRP differential has to be derived from contemporaneous market evidence. This also motivates the placing of greater weight on the UK utilities analysis, which relies on the traded yield of utilities bonds directly observed in the capital market, and hence maximises the amount of new data that is introduced to the cost of equity analysis.

2.2 Amendment to the estimation of the risk-free rate

In our report on the risk-free rate and gearing dated 20 May 2020, we noted that the 'unexplained' risk premium observed in market cost of debt was in fact a result of the use of spot yield on government bonds as a proxy for the risk-free rate in the CAPM framework, which understates the true risk-free rate:[27]

> after correcting for the CMA's mistake of using embedded debt when testing the MM proposition, what the CMA considers to be a systematic risk premium is largely, if not wholly, attributable to the risk-free rate parameter being underestimated.

This implies that with the correct (and higher) risk-free parameter, the CAPM-implied cost of debt will converge with the cost of debt observed in the market.

Having reviewed theoretical and empirical evidence on the issue, we concluded that an upward adjustment of 50 to 100 bp would be appropriate in most circumstances, although the adjustment would vary over time and would sometimes lie outside this range. We have reflected this finding in the implementation of the ARP−DRP framework in this report, applying an adjustment of +50 bp to the yield on government bonds.[28]

As a result of this adjustment, the CAPM-implied DRP under Approach 2 also converges with the market-observed DRP under Approach 1.

2.3 Employing the ARP−DRP framework for a conservative WACC estimation

We believe that the ARP−DRP differential has a role above and beyond a cross-check in the estimation of cost of equity parameters. In particular, with

[27] Oxera (2020), 'Are sovereign yields the risk-free rate for the CAPM?', 20 May.
[28] We chose to apply the lower bound of our recommended range, because our recommended range is derived based on long-term averages of empirical estimates. Using the lower bound would minimise the number of observation that have negative DRPs during periods when the convenience yield on government bonds is low. We note that +50 bp represents a conservative assumption for the required risk-free adjustments.

the assistance of Professor Julian Franks and Professor Vikrant Vig from the London Business School, we tested a hypothesis that the ARP−DRP differential can be used to obtain conservative estimates of the WACC based on additional information from debt markets, and hence increase the robustness of the cost of equity estimate. We set out this theoretical framework in section 2.3.1 below.

2.3.1 Theoretical underpinning

In this section, we explain the mathematical intuition for how the ARP−DRP differential can be used to obtain conservative estimates of the WACC based on additional information from debt markets, and hence increase the robustness of the cost of equity estimate.

In essence, the academic literature and econometrics textbooks suggest that a form of regression bias—namely attenuation bias—would have biased the regression coefficients of CAPM-based models (i.e. the equity beta and debt beta) towards zero.[29] For example, Jegadeesh et al. (2019) simulated various market pricing models, calibrating the simulation parameters using actual market data. Their findings show that:[30]

> in simulations with a single factor model, […] the OLS estimates with individual stocks are significantly biased towards zero, even when betas are estimated with about ten years of daily data.

The authors also show that, adopting a CAPM framework, the OLS estimate of beta from the simulation is biased towards zero by 20% relative to the true risk premium.[31] The authors further note that the magnitude of the bias is greater than 5% even when they estimate betas over 2520 days, or ten years.[32]

The downward attenuation bias in the CAPM-estimated asset beta ($\widehat{\beta_a}$), is caused by the presence of measurement errors in the independent variable (i.e. market returns).[33, 34] Further explanation on the attenuation bias is provided in Box 2.1 below.

Appendix A1 provides the mathematical reasoning for how the ARP−DRP framework can be used to eliminate the measurement errors that lead to downward-biased estimations of asset beta.[35] This way, the cost of capital

[29] We note that Oxera's debt beta of 0.05 is an unbiased estimate, based on the methodology set out in Schaefer and Strebulaev (2008). See Schaefer, S. M., and Strebulaev, I. A. (2008), 'Structural models of credit risk are useful: Evidence from hedge ratios on corporate bonds', *Journal of Financial Economics*, **90**:1, pp. 1–19.
[30] Jegadeesh, N., Noh, J., Pukthuanthong, K., Roll, R., and Wang, J. (2019). 'Empirical tests of asset pricing models with individual assets: Resolving the errors-in-variables bias in risk premium estimation', *Journal of Financial Economics*, **133**:2, pp. 273−98.
[31] Ibid, Table 2. The authors state that 'The OLS estimate [of beta] is biased towards zero by 20% relative to the ex ante risk premium and by 21% relative to the ex post risk premium, respectively, which are statistically significantly different from zero.'
[32] Ibid, p.6.
[33] The asset beta (βa) is subject to attenuation bias, as it is equal to the weighted average of the equity beta (βe) and debt beta (βd), which are derived from regressions based on the same independent variables (i.e. market returns). The decomposition of the asset beta is presented in the following equation: βa=(E/(D+E))*βe+(D/(D+E))* βd,where, '$\boldsymbol{\beta a}$' is asset beta; '$\boldsymbol{E}$' is market-value of equity; '$\boldsymbol{D}$' is market-value of debt, '$\boldsymbol{\beta e}$' is equity beta; and '$\boldsymbol{\beta d}$' is debt beta.
[34] To the extent that regulatory asset beta is based on coefficients deriving from regression models, the attenuation bias in the estimated asset beta would be present across our sample of comparators.
[35] The downward bias in beta estimations is cancelled by constructing the ARP/DRP ratio—which under Approach 2 is mathematically equivalent to the true ratio of asset beta to debt beta. The downward bias in beta estimations is cancelled out because both the estimations of debt beta and asset beta are derived from regression models with similar specifications, based on the same independent variable (i.e. market returns). See the detailed mathematical derivations in Appendix A1.

derived from the ARP−DRP framework is more robust than those derived from the conventional cost of capital estimation methods.

While the application of this correction is outside the scope of this report, it lays out the theoretical underpinning that highlights the distinct advantage of the ARP−DRP framework in cost of capital estimations.

Without the correction mentioned above, under Approach 1 where the DRP is calculated from yields on traded bonds, the downward bias in $\widehat{\beta_a}$ has led to downward biased estimates of ARP and the ARP−DRP differential for our comparator set.

Based on this reasoning, our current analysis of Ofgem's implied ARP−DRP differential overstates the ranking in the true distribution of the ARP−DRP of comparators. This is because, if we correct for this downward bias in $\widehat{\beta_a}$, the ARP−DRP differential for our comparator set would be higher and Ofgem's implied ARP−DRP differential would be at a lower percentile ranking compared with the benchmarks.

Considering the implications of this theoretical framework for the estimation of cost of capital, we set out our recommendations in section 2.3.2 below.

Box 2.1 Attenuation bias in econometrics

Conceptual explanation

Regression dilution, also known as regression attenuation, is the biasing of the regression slope towards zero (the underestimation of its absolute value), caused by errors in the independent variable.

The attenuation bias is a statistical phenomenon whereby a random measurement error in the values of an independent variable (X) causes an attenuation or 'flattening' of the slope of the line describing the relation between the independent variables (X) and an outcome (Y) of interest. The greater the variance in the (X) measurement, the closer the estimated slope approaches zero instead of the true value.

Mathematical explanation

The extent of the bias in the estimate of the error-prone regression slope ($\widehat{\beta}$) for a variable measured with random error ($\widehat{X}$) is quantified as follows:

Observed slope ($\widehat{\beta}$) = True slope (β)* $\frac{Variance\ (\ true\ X)}{Variance\ (true\ X) + Variance\ (random\ error)}$

It follows that: Observed slope ($\widehat{\beta}$) = True slope (β)* $\frac{Variance\ (\ true\ X)}{Variance\ (observed\ (\widehat{X}))}$

The ratio of variation in error-free (true) X values to the variation in the observed error-prone ($\widehat{X}$) values is known as the attenuation factor, or intra-class correlation.

Because the variation in observed values is greater than the variation in error-free values due to the presence of random error, the ratio will be lower than one, and the estimated regression coefficient ($\widehat{\beta}$) will be proportionally lower than the actual coefficient, thus resulting in attenuation bias.

Source: Chen, X., Hong, H., and Nekipelov, D. (2007), 'Measurement error models', *Journal of Economic Literature*, 2011, **49**:4, 901−37; Draper, N. R., and Smith, H. (1998), *Applied Regression Analysis* (3rd ed.), Wiley, p. 19.

2.3.2 Our recommendation

While Oxera has previously not specified an absolute benchmark for the ARP−DRP differential, we believe that the appropriate benchmark for the ARP−DRP differential has to be derived on the basis of market data. In this report, we recommend that Ofgem sets its allowance at least at the 50th

percentile of the ARP−DRP distribution implied by contemporaneous market evidence. We note that this recommendation is in line with Oxera's updated cost of equity range of 6.00–7.08%, which places between the 24th percentile (low end) and the 58th percentile (high end) of the empirical distribution of contemporaneous market data. As explained in section 2.3.1 above, Oxera's cost of equity range is conservative, because of the downward attenuation bias in asset beta estimation.

The ARP−DRP framework provides robust benchmarks for setting the allowed WACC. We also show in Figure 3.2 that, controlling for the time variation in the ARP−DRP differentials, Ofgem's allowance still falls towards the lower end of the distribution of that implied by contemporaneous evidence.

2.4 Implications for RIIO−2 financeability

The ARP−DRP differential is an useful addition to the PMICR, in the assessment of the underlying financeability of RIIO−2 proposals.

An advantage of comparing the ARP−DRP 'delta' to market benchmarks is that it provides a way to compare financeability in a way that is **neutral with respect to the treatment of inflation**. In other words, the ARP−DRP delta derived from nominal parameter values will be the same as that derived from RPI-real or CPIH-real parameter values. In practice, any adjustments for inflation are made to the risk-free rate and TMR, while the differential between the excess return for debt (i.e. DRP) and the excess return for the assets (i.e. ARP), cancels out the impact of inflation.

This allows the financeability of the RIIO−2 proposals to be evaluated without the confounding influence of the switch from RPI to CPIH indexation.

The salience of the ARP−DRP framework to the assessment of financeability can be seen by comparing the metric's design to that of the nominal post-maintenance interest cover ratio (PMICR). According to Fitch, PMICR is defined as follows:[36]

$$PMICR = \frac{Allowed\ return}{Nominal\ CoD \cdot g} = \frac{(ARP + RfR)}{(DRP + RfR + E(Loss)) \cdot g}$$

It can be seen that similar to ARP−DRP, the PMICR relates the return on assets to that on debt. However, ARP−DRP has some practical advantages over PMICR. For example, the ARP−DRP compares risk premiums rather than total returns, which makes it neutral with respect to the choice of inflation index.

[36] Fitch (2020), 'Corporate rating criteria', 1 May, p. 61.

3 Updated evidence from the UK utilities bonds

3.1 Updates since the Oxera ARP−DRP report

In this section, we update our analysis of the ARP−DRP differential implied by yields on the bonds issued by UK utilities companies. In line with Ofgem's comments in the Sector Specific Methodology Decision,[37] we believe that the appropriate benchmark for the ARP−DRP differential should be derived from contemporaneous market evidence. Therefore, the findings presented in this report are based on the analysis of the ARP−DRP differentials implied by UK utilities bonds, where the DRPs are calculated based on the traded yields of individual bonds (Approach 1).

In this report, we update the analysis presented in the Oxera ARP−DRP report and the 2019 cost of equity update,[38] by (i) including the newly available data from the bond markets; (ii) adopting a revised approach to the risk-free rate set out in a recent Oxera submission to the CMA;[39] and (iii) introducing additional methodological improvements to make better use of the available market data.

Specifically, we make the following changes to our UK utilities analysis.[40]

- First, we update our analysis of the ARP−DRP differential, by using the **daily traded yields** for UK energy bonds (as opposed to the yield upon issuance) over the six months preceding the publication date of the RIIO−2 Draft Determination (9 July 2020). This update improves the robustness of our UK utilities analysis, as it: (i) allows for increased transparency on how the ARP−DRP differentials implied by market yields evolve over time; (ii) enables comparisons between Ofgem's implied ARP−DRP differential and that implied by contemporaneous market evidence; and (iii) increases the size of our comparators set by considering multiple data points for every bond.[41]
- Second, we adjust our estimate of the risk-free rate upward by 50 bp, in light of the evidence presented in our risk-free rate and gearing report dated 20 May 2020.[42] As illustrated in Appendix A2.4, the magnitude of this adjustment does not materially affect the percentile ranking of Ofgem's allowance in the empirical distribution.
- Third, to address Ofgem's concern that the listed companies in our sample rely '*upon a TMR drawn from regulatory precedents while empirical beta estimates are time-sensitive*', we calculate time-varying TMR by interpolating the TMR allowances from different regulatory determinations. For example, the TMR for November 2010 is an interpolation between the TMR allowance set by Ofgem in DPCR5 (December 2009) and RIIO-T1 (April 2012). This update allows us to have time-varying asset betas and TMRs for listed companies in our comparator set.

[37] Ofgem (2019), 'RIIO−2 Sector Specific Methodology – Finance', p. 125.
[38] Oxera (2019), 'The cost of equity for RIIO−2'.
[39] For Oxera's revised approach to the risk-free rate see Oxera (2020), 'Are sovereign yields the risk-free rate for the CAPM?', 20 May.
[40] See Appendix A3.1 for detailed description of methodology.
[41] Under Approach 1, debt risk premium is estimated based on the following formula: $DRP = YTM - expected\ loss - RfR$. Our updated analysis uses traded yields of UK utilities bonds (as opposed to the yields upon issuance) to calculate DRPs for our sample of comparators.
[42] Ofgem (2019), 'RIIO−2 Sector Specific Methodology – Finance', p. 125.

- Finally, we make the following adjustments to the utilities bonds in our analysis sample.[43]
  - We add bonds issued by UK energy companies after 29 March 2019, the cut-off date assumed in the Oxera ARP−DRP report. The new sample now includes bonds issued from January 2010 to July 2020.
  - We remove bonds issued by Centrica, SSE and Heathrow. The first two companies were removed in light of the recent analysis conducted on the RIIO−2 cost of equity.[44] Heathrow bonds were removed in response to Ofgem's concern with regards to demand risks, specific to the aviation sector (see section 4.3.4).
  - We remove all bonds issued by water companies to increase the comparability between our comparator set and Ofgem's implied ARP−DRP. In Appendix A2.4, we demonstrate that adding these observations into the sample will not affect our conclusions.
  - We use contemporaneous market evidence where possible, focusing on the ARP−DRP implied by traded yields of energy bonds over the six-month period preceding the RIIO−2 Draft Determination, as the appropriate benchmark for Ofgem's implied ARP−DRP differential. As explained above, DRPs are calculated based on the traded yields of individual bonds. To estimate ARPs for our sample of comparators, we use the market asset beta for listed companies, and the allowed asset beta assumed by the regulator in the most recent energy regulatory precedent (e.g. for RIIO−2 this is NIE RP6) for unlisted companies. The methodology is further detailed in Appendix A2.1.[45]

As before, we place more weight on the results from Approach 1 (i.e. estimating DRP using observed bond yields). Results obtained under Approach 2 (i.e. estimating DRP using assumed debt beta and ERP) are considered as a cross-check.

We present the main results from our updated analysis in section 3.2 below. In Appendix A2.1 of this report, we further explain the detailed methodology underpinning our analysis, and in Appendix A2.4 we present the results from various sensitivity tests to cross-check the robustness of our main results.

Moreover, as an additional cross-check for the findings of our main analysis, we have also estimated the ARP−DRP differentials implied by UK utilities bonds based on their *yield at issuance*. This approach is similar to that adopted in the original Oxera ARP−DRP report. The detailed methodology and results underpinning this analysis are also presented in Appendix A3.

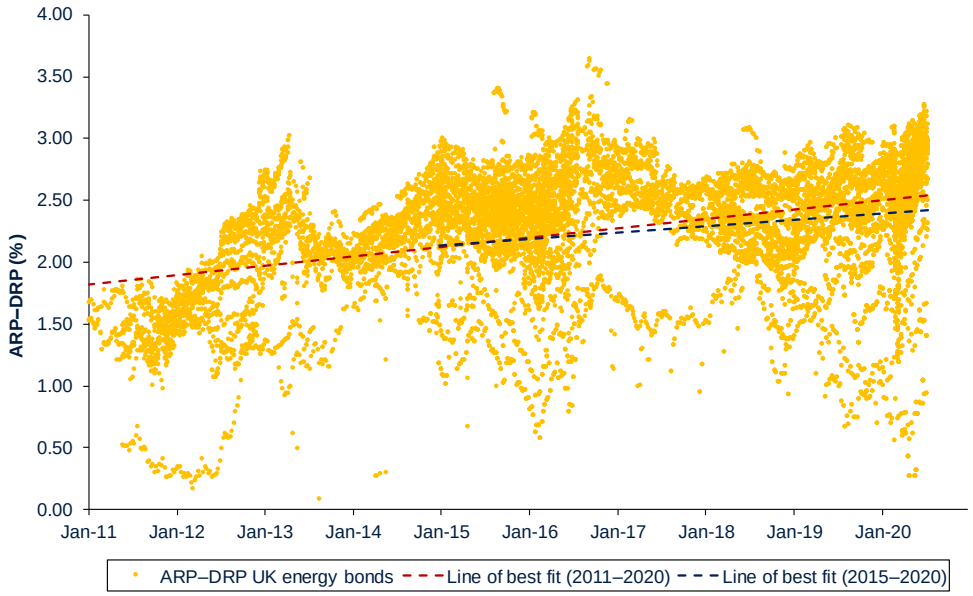
We observe that our conclusion, namely that Ofgem's RIIO−2 allowances for the cost of equity are too low relative to that implied by contemporaneous market evidence, remains unchanged with respect to all sensitivity tests and cross-checks.

[43] After these adjustments, our updated comparator set consists of 20 unique bonds issued by UK energy and water companies.
[44] Oxera (2020), 'The cost of equity for RIIO−2', September.
[45] While our sample of comparators mostly consists of unlisted firms, we test for the robustness of our asset beta assumption in Appendix A2.4. We show that that our conclusion remain unchanged under various alternative asset beta assumptions.

3.2 Summary of main results

In response to Ofgem's concern that our analysis presumes a constant ARP−DRP, we have analysed how ARP−DRP differentials implied by our comparator set evolved over time. Figure 3.1 below shows that the ARP−DRP differentials implied by UK energy bonds have increased over time. This upward time trend is consistently observed at five-year and ten-year horizons.

Figure 3.1 ARP−DRP differential implied by UK energy bonds



Note: The ARP−DRP differentials presented in this figure are calculated under Approach 1, based on weekly averages of daily traded yields of UK energy bonds. We adjust the yield on RPI-linked bonds by 3% and CPIH-linked bonds by 2%, using the Fisher equation. As per our previous analysis in the Oxera ARP−DRP report, we assume an expected loss of 30 bp for senior unsecured debt and 20 bp for senior secured debt. The risk-free rate for individual bonds in our sample of comparators is based on the yield on maturity-matched Bank of England zero-coupon government liability, adjusted upward by 50 bp. To estimate the asset risk premium we use the market asset beta for listed companies, and the allowed asset beta from the most recent regulatory precedents for unlisted companies. As explained before, we calculate time-varying TMR by interpolating the TMR allowances from different regulatory determinations. This methodology is consistently applied to our sample of comparators. The red-dotted line represents the line of best fit for the extended time series starting from January 2011 to July 2020. The blue-dotted line represents the line of best fit drawn over the last five years from January 2015 to July 2020. The upward trend of the ARP−DRP differentials implied by UK energy bonds over time, is clearly observed in both cases.

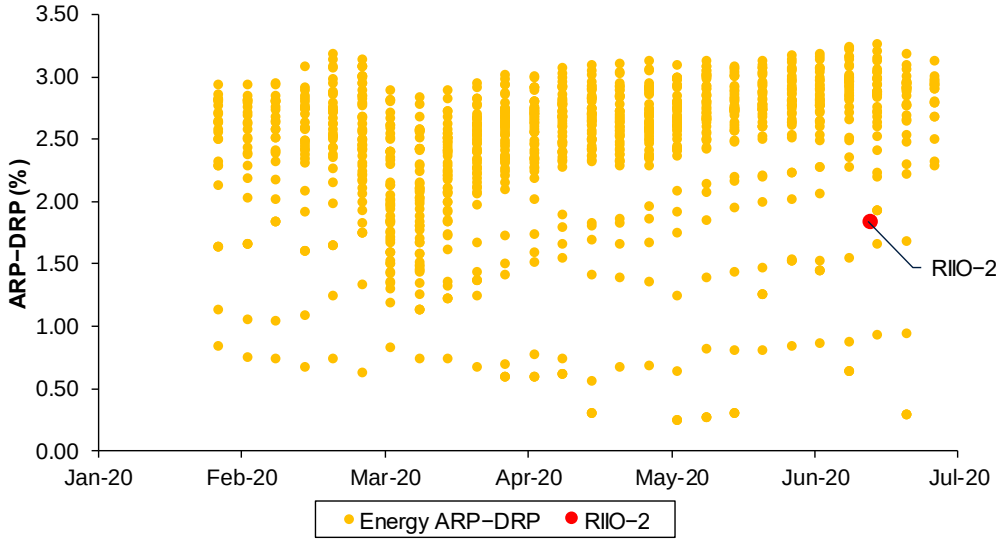
Source: Oxera analysis.

The observed increase in the ARP−DRP differentials over time highlights the importance of using contemporaneous market evidence as the appropriate benchmark for the assessment of Ofgem's implied ARP−DRP. Therefore, in this report we draw our conclusions from the ARP−DRP implied by traded yields of energy bonds over the *six-month* period preceding the RIIO−2 Draft Determination (as opposed to the yield at bond issuance used previously).

Figure 3.2 below illustrates that the ARP−DRP differential implied by Ofgem's RIIO−2 draft determination falls significantly below the recent market evidence. Specifically, Ofgem's midpoint allowance falls below the 15th percentile of the empirical distribution of market evidence from the last six months. This indicates that Ofgem's RIIO−2 allowances for the cost of equity are too low relative to that implied by (i) contemporaneous market evidence for the cost of

debt and the risk-free rate; and (ii) a mixture of contemporaneous market evidence and regulatory precedent on the asset beta and the TMR.

Figure 3.2 Comparison of Ofgem's ARP−DRP differential to the ARP−DRP differential implied by contemporaneous evidence on UK energy bonds

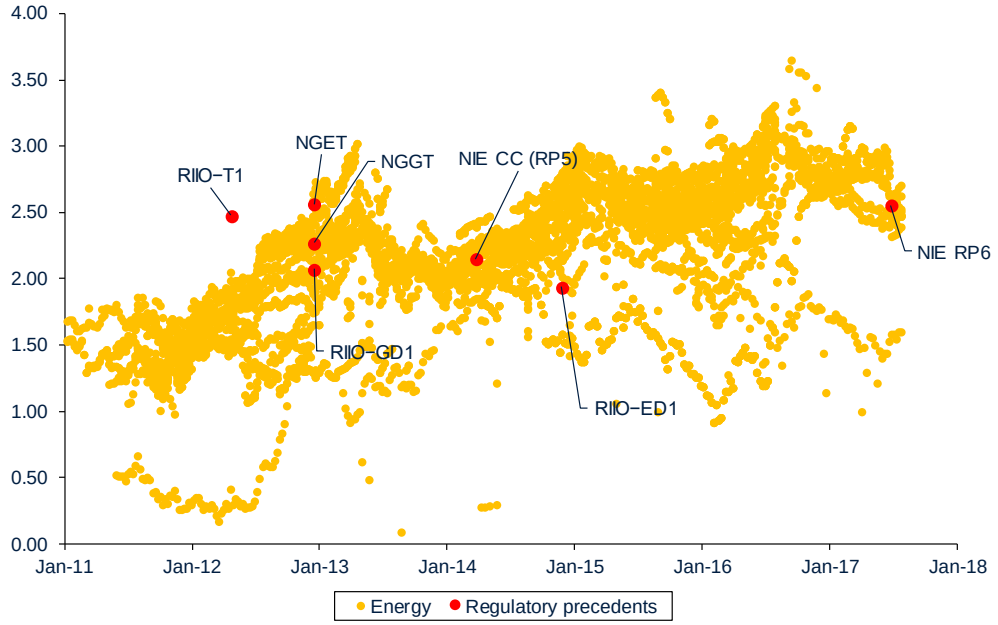


Note: The ARP−DRP differentials presented in this figure are calculated under Approach 1, based on weekly averages of daily traded yields of UK energy bonds. We adjust the yield on RPI-linked bonds by 3% and CPIH-linked bonds by 2%, using the Fisher equation. This is a conservative assumption, as inflation fell significantly since the beginning of 2020. Therefore, we have overestimated the YTM and DRP of inflation-linked bonds, thereby underestimating their ARP−DRP. The ARP−DRP differential implied by RIIO−2 is calculated under Approach 1, and it represents the difference between the asset risk premium and debt risk premium. Specifically, as explained in section 2.1, ARP is the product of asset beta (re-estimated using a debt beta of 0.05) and equity risk premium (calculated from Ofgem's allowed TMR, spot yield of 20-year index-linked gilts, and an upward risk-free rate adjustment of 50 bp). Ofgem's DRP is estimated by subtracting the yield on maturity-matched Bank of England zero-coupon government liability, adjusted upward by 50 bp, and the expected loss of 30 bp, from the average yield on the iBoxx A and BBB ten-year+ indices as of 9 July 2020. This is consistent with the methodology applied to the comparators sample.

Source: Oxera analysis.

In contrast to the ARP−DRP implied by RIIO−2 draft determination, Figure 3.3 illustrates that the ARP−DRP differentials implied by past regulatory allowances for energy companies were broadly in line with those implied by contemporaneous market evidence around the corresponding determinations.

Figure 3.3 Comparison of UK regulatory precedents to the ARP−DRP differential implied by contemporaneous evidence on UK energy bonds



Note: The ARP−DRP differentials presented in this figure are calculated under Approach 1, based on weekly averages of daily traded yields of UK energy bonds. The ARP−DRP differentials implied by regulatory precedents are calculated under Approach 1, as the difference between the asset risk premium and debt risk premium. While the ARPs are estimated based on the cost of capital parameters set out in the past determinations, the DRPs are estimated based on the prevailing market yield on the iBoxx indices and government bonds as of the publication dates of the determinations. This is consistent with the methodology used to estimate Ofgem's implied ARP−DRP for RIIO−2 draft determination.

Source: Oxera analysis.

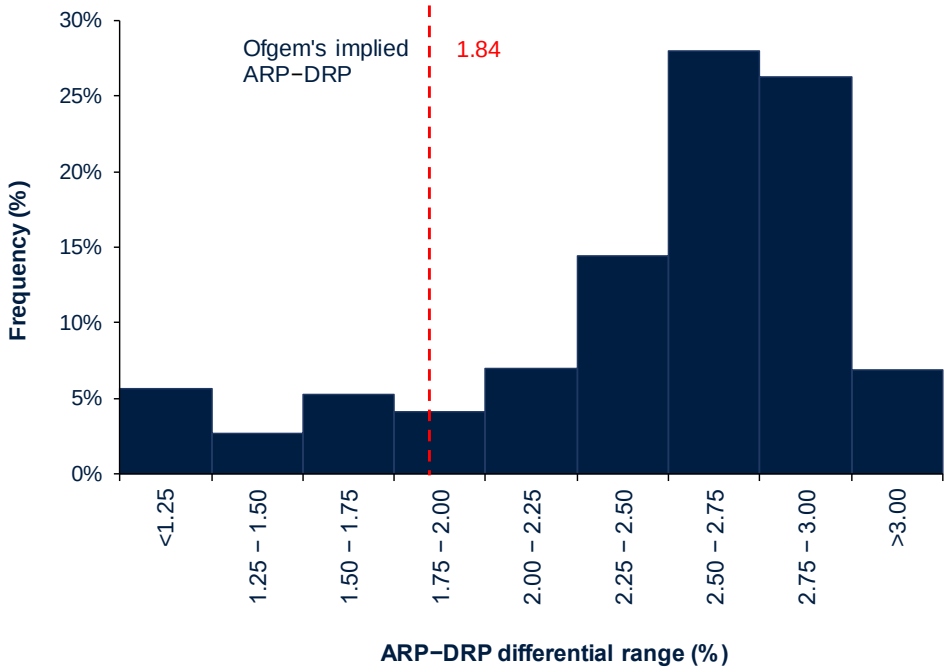
Figure 3.4 below plots the distribution of the ARP−DRP differentials implied by traded yields of energy bonds over the six months preceding the publication date of the RIIO−2 Draft Determination. Using the same underlying data as Figure 3.2, Figure 3.4 arrives at the same conclusion that Ofgem's proposals for RIIO−2 lie in the bottom 15% of the distribution.[46] This suggests that Ofgem would need to increase the cost of equity allowances to be in line with the cost of equity implied by the contemporaneous market evidence from UK energy bonds.

We note that this 15th percentile is a conservative estimate, as it also suffers from the downward attenuation bias.[47] In section 2.3, we explain why conventional analysis of the ARP−DRP differential and the cost of equity has a downwards attenuation bias arising from estimation errors that are present in the ARP estimation. Correcting for this would place Ofgem's implied ARP−DRP differential at a lower percentile ranking within the distribution of ARP−DRP implied by contemporaneous market evidence.

[46] This conclusion is robust to sensitivities on the time horizon used for the empirical distribution of market evidence. For instance, if we plot the distribution of the ARP−DRP differentials implied by traded yields of energy bonds over a five-year period preceding the RIIO−2 Draft Determination (as opposed to six months), Ofgem's midpoint allowance would lie in the bottom 14.8% of the distribution.

[47] As explained in section 2.3.1, under Approach 1 under which the DRP is calculated from yields on traded bonds, the downward bias in the observed asset beta (βa) has led to downward biased estimates of ARP and the ARP−DRP differential for our comparator set.

Figure 3.4 Distribution of the ARP−DRP differential implied by contemporaneous evidence on UK energy bonds



Note: This chart shows ARP−DRP differentials based on weekly averages of daily traded yields of UK energy bonds over the six-month period preceding the publication date of the RIIO−2 Draft Determination. Ofgem's ARP−DRP differential falls in the bottom 15% of the distribution. This conclusion is robust to sensitivities on the time horizon used for the empirical distribution of market evidence. For instance, if we plot the distribution of the ARP−DRP differentials implied by traded yields of energy bonds over a five-year period preceding the RIIO−2 Draft Determination (as opposed to six months), Ofgem's midpoint allowance would lie in the bottom 14.8% of the distribution.

Source: Oxera analysis.

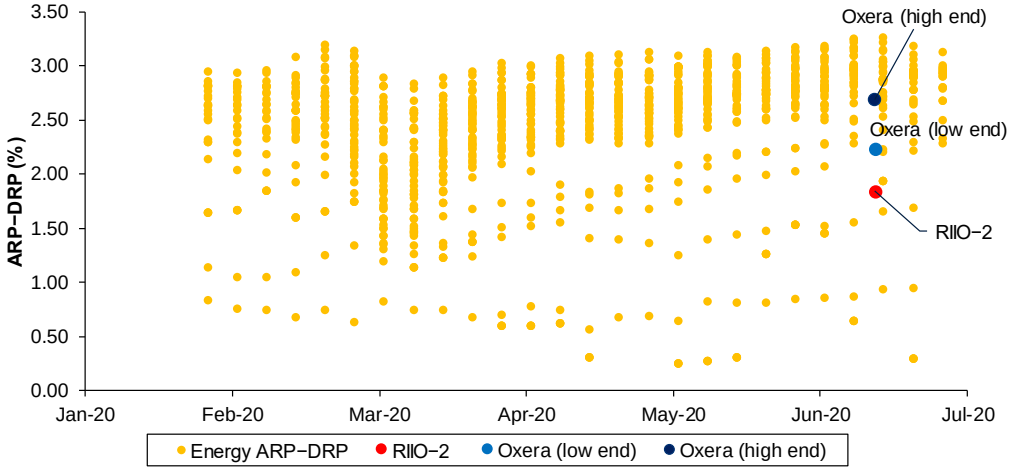
The low percentile ranking of Ofgem's implied ARP−DRP differential has resulted from a series of methodological errors introduced in the RIIO−2 draft determination, *all* of which have led to a reduction in the allowed cost of equity. These methodological changes include:

- restating historical TMR based on an experimental index for historical CPI, which results in a lower estimated TMR;
- increasing the weight on the geometric average historical return, thereby moving further away from the correct (Cooper) estimator, resulting in a lower TMR;
- moving to spot yields on government bonds, which lowers the estimated RfR;
- using a debt beta of 0.125 where previously Ofgem used zero, which artificially deflates the notional equity beta;
- reducing the allowed return below the mean estimate of the cost of equity to reflect expected outperformance.

In the latest cost of equity report,[48] Oxera has corrected Ofgem's methodological errors and updated the analysis based on recent market evidence. Oxera's updated cost of equity report supports an allowance in the range of 6.00–7.08%. In the latest cost of equity report, we explain that the ARP−DRP framework is a superior cost of equity cross-check compared to other cross-checks used by Ofgem. [49]

Figure 3.5 shows that the ARP−DRP differential implied by Oxera's recommended cost of equity range is more in line with recent market evidence, as it places between the 24th percentile (low end) and the 58th percentile (high end) of the ARP−DRP implied by contemporaneous market evidence (e.g. traded yields of energy bonds over the six-month period preceding the publication date of the RIIO−2 Draft Determination).

Figure 3.5 Comparison of the ARP−DRP differentials implied by Ofgem's and Oxera's estimates to the ARP−DRP differential implied by contemporaneous evidence on UK energy bonds



Note: The ARP−DRP differentials presented in this figure are calculated under Approach 1, based on weekly averages of daily traded yields of UK energy bonds. The ARP−DRP differentials implied by Ofgem's RIIO−2 allowance and Oxera's cost of equity range are calculated under Approach 1, as the difference between the asset risk premium and debt risk premium. While the ARPs are based on parameters set out respectively in Ofgem's RIIO−2 draft determination and Oxera's latest cost of equity report, the DRPs are based on prevailing market yield on the iBoxx indices and government bonds.

Source: Oxera analysis

As illustrated in Table 3.1, our updated analysis shows that Ofgem's implied ARP−DRP is 78 bp lower than the median ARP−DRP derived from contemporaneous market data. At 60% gearing, the median implies a mid-point cost of equity estimate of 6.35% (CPIH-real).[50]

This represents an increase of 215 bp relative to Ofgem's mid-point allowance of 4.2%. Due to the attenuation bias in the benchmarks, this is a conservative estimate of the size of the increase required to place the RIIO−2 allowance in line with contemporaneous market benchmarks.

[48] Oxera (2020), 'The cost of equity for RIIO−2', September.
[49] Oxera (2020), 'The cost of equity for RIIO−2', September.
[50] The mid-point cost of equity of 6.34% (CPIH-real) at 60% gearing is estimated based on: the median ARP−DRP differential implied by contemporaneous market evidence, as well as the risk-free rate and DRP implied by Oxera's parameters set out in the latest cost of equity update.

In contrast, Oxera's updated cost of equity report supports an allowance in the range of 6.00–7.08%, which is broadly in line with market evidence.

Table 3.1 Comparing Oxera's and Ofgem's ARP−DRP differentials to that implied by contemporaneous market evidence

	ARP−DRP under Approach 1 (%)
Median ARP−DRP implied by contemporaneous market data	2.62%
Ofgem's ARP−DRP for RIIO−2	1.84%
Oxera's ARP−DRP based on the low end of the CoE range	2.24%
Oxera's ARP−DRP based on the high end of the CoE range	2.69%

Source: Oxera analysis.

4 Response to Ofgem's comments on ARP−DRP

In its draft determination Ofgem has made several comments on Oxera's ARP−DRP analysis. These comments can be grouped into three categories:

- Ofgem believes that Oxera's conclusions assume that past decisions on cost of capital were either accurate or biased downwards;
- Ofgem has not found that the theoretical underpinnings of the analysis were explained to the required level of detail;
- Ofgem believed that a broader empirical evidence base should be provided to demonstrate the robustness of the conclusions with respect to the main parameters of the analysis.

We have carefully considered Ofgem's comments and provide responses to all of them in the rest of this section.

4.1 Response to Ofgem's comments concerning past regulatory precedents

For the avoidance of doubt, the ARP−DRP analysis does not seek to revisit past determinations. We consider that they were unbiased and accurate ex ante estimates at the time of the price control, given the extensive analysis that goes into each determination. Therefore, we view the regulatory precedents as relevant data points.

We further increase the robustness of the ARP−DRP analysis to estimation error by pooling TMRs from determinations across sectors and over time and by introducing the methodological improvements explained in the previous sections.

4.1.1 Consistency with previous price control settlements

Ofgem suggests that the low value of the ARP−DRP implied by past regulatory precedents is inconsistent with the fact that these determinations were not appealed.[51]

> Oxera's analysis implies that previous price control settlements were too low, compared to market data. Raising doubts as to why this precedent was not successfully challenged at the time, based on the same prevailing 'market evidence' to which Oxera refer.

As demonstrated in Figure 3.3, the ARP−DRP differentials implied by past regulatory determinations were in line with those implied by the contemporaneous market evidence around the corresponding determinations. This finding is consistent with our view that past regulatory precedents were unbiased and accurate ex ante estimates at the time of the price control. Therefore, the fact that those allowances were not challenged at the time validates the ARP−DRP framework.

4.1.2 Appropriateness of benchmarking RIIO−2 against regulatory precedent

One of the overarching ideas put forward by Ofgem in RIIO−2 is that the allowances in the past price controls had been excessively high. Accepting this

[51] Ofgem (2019), 'RIIO−2 Sector Specific Methodology Decision – Finance', p. 125.

premise would imply that one cannot rely on past regulatory precedents to benchmark the current allowances. According to Ofgem,

> Oxera's analysis leads to a conclusion that assumptions for TMR [**comment 1**] and equity beta [**comment 2**] are lower than regulatory precedent. However, this leads us back to the same issues that we address in the TMR and equity beta generally, with the same underlying explanation as to why these are different from precedent.

Comment 1: using TMR from regulatory precedents

While Ofgem is correct that our analysis draws from allowed TMRs in the past, we have presented empirical evidence in our 2019 cost of equity update to justify the view that TMR is largely stable over time.[52] On this basis, we consider it appropriate to rely on TMR from regulatory precedents. The ARP−DRP framework is robust with respect to the change in the treatment of inflation in RIIO−2 and allows for time series comparisons to be undertaken based on a consistent definition of inflation over time.

Comment 2: using equity beta from regulatory precedents

We believe that using asset betas derived from equity betas from regulatory precedents to derive some of the benchmarks does not invalidate our conclusion—namely that Ofgem's RIIO−2 allowances for the cost of equity are too low relative to the cost of equity implied by contemporaneous market evidence.

For illustration, for Ofgem's implied ARP−DRP differential to fall at the 50th percentile of the empirical distribution, we need to assume an average asset beta of 0.25 for our contemporaneous comparators, [53] which is implausibly low.[54]

4.1.3 Appropriateness of cost of debt allowance in the past determinations

Continuing with the theme that the past regulatory allowances may have been excessive, Ofgem notes that:[55]

> Oxera did not consider in detail whether the allowance for the cost of debt may in the past [determinations] have been too high.

Indeed, we have not examined this particular question, as our analysis does not use the regulatory cost of debt allowance.

Under Approach 1, we use the YTM of issued bonds, expected loss and market risk-free rate (with an upward adjustment of 50 bp) to calculate the DRP. Under Approach 2, we use Oxera's assumption (0.05, main result) and Ofgem's assumptions (0.15, sensitivity test) of debt beta, as well as estimated ERPs. Therefore, the present analysis is independent of the past regulatory cost of debt allowances.

[52] Oxera (2019), 'The cost of equity for RIIO−2'.
[53] Equivalently an equity beta of 0.55, under a debt beta of 0.05 and notional gearing of 60%.
[54] For reference, on the publication date (9 July 2020) of the RIIO−2 Draft Determination, we estimate that National Grid (the only listed energy company in our UK comparator set out in the 2020 Oxera Cost of Equity Update) has a five-year asset beta of 0.37, which is 30% higher than the hypothetical asset beta of 0.25.
[55] Ofgem (2019), 'RIIO−2 Sector Specific Methodology Decision – Finance', p. 125.

4.2 Response to Ofgem's comments concerning theoretical underpinnings of the ARP−DRP framework

4.2.1 Effect of embedded debt, indexation and inflation

Ofgem expresses a concern that the conclusions of the ARP−DRP analysis cannot be applied in the RIIO−2 context, due to reliance on nominal parameters values:[56]

> Oxera's approaches are limited due to a reliance on a nominal spot cost of debt and a nominal spot cost of equity. This therefore ignores embedded debt [**comment 1**] and the impact of indexation [**comment 2**] on the future ARP−DRP differential. It also ignores the treatment of inflation [**comment 3**] and requires adjustments that might be subjective [emphasis added]

This particular quote can be broken down into three topics: treatment of embedded debt, treatment of indexation and treatment of inflation. We examine each in turn below.

Comment 1: treatment of embedded debt

While Ofgem is correct in its observation that we have not included embedded debt in our analysis, both Ofwat and the CMA noted that including the cost of embedded debt into consideration of WACC is incompatible with the Modigliani−Miller principles:[57]

> […] embedded debt is outside the Modigliani-Miller framework; its inclusion could be expected to result in an upwards-sloping WACC function as gearing increases.

As mentioned in section 2.4, the ARP−DRP framework allows for a clearer analysis of the drivers of financeability pressure because it compares the asset risk premium to the premium on new debt, without confounding the issue of out- or underperformance in relation to the historic cost of fixed rate debt, which varies from company to company and over time. Once the baseline comparison of the ARP−DRP has been undertaken, the incremental financeability pressure provided by the relatively high cost of embedded debt can be assessed.

Comment 2: treatment of indexation

It is not entirely clear what indexation Ofgem was referring to. Our interpretation of this comment is that Ofgem is concerned that the ARP−DRP percentile ranking estimated by Oxera could change in the future, due to the impact of the equity and debt indexation mechanisms.

While we agree with Ofgem that, as a result of indexation, the RIIO−2 implied ARP−DRP percentile ranking is likely to change in the future, the direction of change remains unclear. Depending on the changes of yield on index-linked Gilts and iBoxx indices, the RIIO−2 implied ARP−DRP percentile rank may go higher or lower.

Having this uncertainty in mind, our analysis has focused on comparing the RIIO−2 implied ARP−DRP as at the publication date of the RIIO−2 Draft Determination (9 July 2020) to the ARP−DRP implied by contemporaneous market evidence. As discussed in section 3.2, our findings show that Ofgem's

[56] Ofgem (2019), 'RIIO−2 Sector Specific Methodology Decision – Finance', p. 125.
[57] Ofwat (2020), 'Reference of the PR19 final determinations: Risk and return – response to common issues in companies' statements of case', May, para. 3.81; and CMA (2020), 'NATS (En Route) Plc/CAA Regulatory Appeal: Provisional findings report', 24 March, Appendix D, para. 14.

allowances fall towards the lower end of the distribution of the ARP−DRP implied by contemporaneous evidence.

Comment 3: treatment of inflation

As mentioned in section 2.4, the ARP−DRP differential is neutral with respect to the treatment of inflation. In other words, the ARP−DRP differential derived from nominal parameter values will be the same as that derived from RPI-real or CPIH-real parameter values. This is because in practice, any adjustments for inflation are made to the risk-free rate and TMR, while the excess return above the risk-free rate for debt (i.e. DRP) or for the assets as a whole (i.e. ARP) is not affected by inflation. We show this in a stylised example in section 4.3.4 below.

This characteristic of inflation neutrality is an important advantage of the ARP−DRP framework, as it makes the ARP−DRP differential an useful metric to assess financeability, without the confounding the influence of the RPI-CPIH transition.

4.2.2 The relationship between actual gearing and DRP

Ofgem highlights that further detail on the underlying data would be beneficial, particularly, on the level of gearing:[58]

> There is an absence of information around the specifics of the Oxera approach, for example the level of actual gearing, given the relationship Oxera demonstrate between gearing and the DRP.

Rather than controlling for gearing, our analysis has controlled for credit rating. This is because, we consider credit rating to be a more comprehensive measure of the riskiness of debt, particularly as it accounts for other factors that affect DRP, such as debt structure and securitisation.

There is also clear evidence, directly observable from the yield of iBoxx indices for different credit rating categories, that credit rating has strong explanatory power over yield spread, and DRP. Moreover, empirical evidence suggests that the relationship between gearing and DRP is less pronounced compared to the relationship between DRP and credit rating. Sometimes highly geared companies can also issue bonds with high credit ratings. For example, in 2018, Anglian Water, which had an actual gearing of 78.5% (that is 16 percentage-points higher than the PR14 notional gearing of 62.5%),[59] was able to issue a securitised bond at A-rating.

Our analysis of the bonds issued by the UK utilities (see section 2) features bonds with rating from A to BBB−.

Table 4.1 below illustrates how the DRPs implied by UK utilities bonds vary with the credit rating and gearing of the issuing firm. The table provides two insights into the comparison between gearing and credit rating.

- First, the minimum, maximum and average DRP increases as credit rating drops. By contrast, the changes in DRP are less pronounced as gearing increases. This shows that, compared to gearing, credit rating has more explanatory power over DRP.

[58] Ofgem (2019), 'RIIO−2 Sector Specific Methodology Decision – Finance', p. 126.
[59] Anglian Water (2018), 'Annual Performance Report 2018', p. 32.

- Second, the variation (measured by standard deviation) in DRP reduces at a high credit rating (A). Such a pattern cannot be observed for bonds with low gearing (41−50%).

In conclusion, empirical evidence suggests that the relationship between gearing and DRP is less pronounced, and controlling for credit rating as opposed to gearing, better explains the variation in DRP.

Table 4.1 Summary statistics of the DRP for UK utilities bonds, by credit rating categories and gearing of issuing firm

	Gearing (%)		
	41–50	**51–55**	**56–65**
Summary statistics DRP (%)			
Minimum	0.02	0.08	0.00
Maximum	1.46	1.68	1.82
Mean	0.66	0.83	0.57
Standard deviation	0.48	0.46	0.40

	Credit ratings		
	A	**BBB+**	**BBB−**
Summary statistics DRP (%)			
Minimum	0.004	0.02	0.21
Maximum	1.07	1.82	2.06
Mean	0.41	0.72	0.83
Standard deviation	0.28	0.49	0.45

Note: The table above includes the yield at issuance for all energy bonds (except for those issued by SSE and Centrica) and water bonds issued between 2010 and 2020. We have used notional gearing for unlisted companies, and actual gearing for listed companies.

Source: Oxera analysis.

4.2.3 Magnitude of the ARP−DRP spread

We acknowledge the following comment from Ofgem:[60]

> […] [W]e note that Oxera's argument does not focus on the absolute difference [between ARP and DRP].

While Oxera has previously not specified an absolute benchmark for ARP−DRP differential, we believe that the appropriate benchmark for the ARP−DRP differential has to be derived on the basis of market data.

Given that the ARP−DRP differential in the benchmark data varies significantly over time, it would be unreasonable to specify an absolute benchmark with no regard to prevailing market conditions. For instance, in section 3 we show that the ARP−DRP differential for UK energy bonds has increased over time.

As set out in section 2.3.2, in this report we recommend that Ofgem sets its allowance at least at the 50th percentile of the distribution of market evidence.

At 60% gearing, the 50th percentile implies a mid-point cost of equity estimate of 6.35% (CPIH-real). This represents an increase of 215 bp relative to Ofgem's mid-point allowance of 4.2%.

[60] Ofgem (2019), 'RIIO−2 Sector Specific Methodology Decision – Finance', p. 124.

We have also explained that, because of the attenuation bias in asset beta estimation, the ARP−DRP differential implied by the benchmarks would lead to a conservative estimation of the allowed WACC.

4.3 Response to Ofgem's comments concerning robustness of analysis across time, comparator sets and alternative assumptions concerning the cost of capital

4.3.1 The use of US data

Ofgem expresses a concern as to the applicability of the US data to the markets.[61]

> The use of US company data limits comparability. There are differences in gearing, calculation of beta to a different relative index and an assumption on how equity returns differ between UK and the US (1% differential).

While we believe that the US data can provide valuable insights, in this report we have focused exclusively on the UK data to narrow the scope of the analysis.

Excluding the US data has increased Ofgem's percentile ranking relative to the benchmarks.

4.3.2 The variation of the ARP−DRP differential over time

Ofgem questions the robustness of the ARP−DRP framework on the grounds that it appears to presume a constant ARP−DRP.[62]

> […] Oxera's analysis […] assumes that the differential between the ARP and DRP should be constant over time.

As discussed in section 3.2, in this report we show that the ARP−DRP differential for UK energy bonds has increased over time.

The observed change in the ARP−DRP differentials over time highlights the importance of using contemporaneous market evidence as the appropriate benchmark for the assessment of Ofgem's implied ARP−DRP differentials. Therefore, in this report we draw our conclusions from the ARP−DRP implied by traded yields of energy bonds over the six-month period preceding the RIIO−2 Draft Determination (as opposed to the yield at bond issuance previously used).

4.3.3 Use of unlisted companies, time sensitivity of asset betas and TMR

Ofgem has expressed concerns that the ARP−DRP analysis cannot be used to derive precise estimates for a particular point of time.[63]

> We note that unlisted companies represent 74 out of 86 data points within the sample and that the asset beta and TMR are therefore based on regulatory precedent. The other [12] data points [on] listed companies [in the UK utilities analysis] rely upon a TMR drawn from regulatory precedent, while empirical beta estimates are time-sensitive, so we would be cautious about using these to derive a robust specific point estimate.

As explained in section 3, we updated the UK utilities analysis to calculate a time-varying TMR by interpolating the TMR allowances from different

[61] Ofgem (2019), 'RIIO−2 Sector Specific Methodology Decision – Finance', p. 126.
[62] Ofgem (2019), 'RIIO−2 Sector Specific Methodology Decision – Finance', p. 125.
[63] Ofgem (2019), 'RIIO−2 Sector Specific Methodology Decision – Finance', p. 125.

regulatory determinations. This update enables time-varying asset betas and TMRs for listed companies in our comparator set.

As explained in section 3.1, we have improved the methodology of the UK utilities analysis, which now uses the daily traded yields for UK energy bonds (as opposed to the yield upon issuance) over the six months preceding the publication date of the RIIO−2 Draft Determination (9 July 2020).

This update improves the robustness of the UK utilities analysis, as it: (i) allows for increased transparency on how the ARP−DRP differentials implied by market yields evolve over time; (ii) enables comparisons between Ofgem's implied ARP−DRP differential and the ARP−DRP implied by contemporaneous evidence (e.g. traded yields of energy bonds over the six-month period preceding the RIIO−2 Draft Determination); and (iii) increases the size of the comparator set by considering multiple data points (time series) for every bond.[64]

As reported in Figure 3.4, the ranking of the ARP−DRP differential implied by Ofgem's draft determination is benchmarked at the 15th percentile of the distribution of market evidence.

We also note that we do not draw conclusions based on the ARP−DRP differentials implied by listed companies only for two reasons.

First, after excluding SSE and Centrica from our sample, National Grid is the only listed company left. Focusing solely on the bonds issued by National Grid compromises the robustness of our analysis.

Second, National Grid issued various inflation-linked bonds, which would have led to the underestimate of the implied ARP−DRP. As discussed in the note to Figure 3.2, in our analysis we adjust the yield on RPI-linked bonds by 3% and CPIH-linked bonds by 2%, using the Fisher equation. As inflation fell significantly since the beginning of 2020, this assumption overestimated the YTM and DRP of inflation-linked bonds, thereby underestimating their ARP−DRP. Indeed, the ARP-DRP implied by three inflation-linked bonds issued by National Grid fell below those implied by Ofgem's RIIO−2 allowances.

4.3.4 Inflation and risk assessment

Ofgem has expressed a concern that the ARP−DRP framework does not include inflation or the differences in risks across sectors.[65]

> Inflation and risk assessment issues are therefore a notable omission from Oxera's suggested solution. For example, demand risk is a factor in other sectors (aviation and telecoms).

As explained in section 4.2.1, the ARP−DRP differential is neutral with respect to inflation. As we demonstrate in a stylised example in Table 4.2 below, the ARP−DRP differential remains unchanged when calculated using nominal, CPIH-real or RPI-real parameters, as long as the treatment of inflation is consistent across each parameter used. Rather than being an omission, this is an important advantage of using the ARP−DRP framework, especially when the regulatory approach to indexation of price controls has changed over time.

[64] Our comparator set now has 5188 data points (time series of traded yield) from 27 unique energy bonds.
[65] Ofgem (2019), 'RIIO−2 Sector Specific Methodology Decision – Finance', p. 125.

Table 4.2 Effect of the inflation assumption on ARP−DRP differential

	Calculation	Nominal	RPI-real	CPI-real
Inflation rate	[A]	n/a	3%	2%
Risk-free rate	[B]	1%	–2%	–1%
TMR	[C]	8%	5%	6%
ERP	[D] = [C] – [B]	7%	7%	7%
β_a	[E]	0.5	0.5	0.5
ARP	[F] = [D] x [E]	3.5%	3.5%	3.5%
YTM	[G]	2%	–1%	0%
Expected loss	[H]	0.3%	0.3%	0.3%
DRP	[I] = [G] – [B] – [H]	0.7%	0.7%	0.7%
ARP−DRP differential	[J] = [F] – [I]	2.8%	2.8%	2.8%

Source: Oxera analysis.

With respect to risk assessment, Ofgem's comment appears to suggest that other sectors may be inherently riskier than energy, which could result in the ARP−DRP differentials for those sectors be higher than those in energy.

In this report, to address Ofgem's concerns, we only considered energy bonds in our UK utilities analysis. We also excluded bonds issued by SSE and Centrica, which could potentially face higher demand risks than regulated utilities, due to their significant non-regulated activities.

4.3.5 Debt premium adjustment

Ofgem expressed a concern that the tenor of the debt index used for the analysis of regulatory precedents is longer than that exhibited by some industries represented in the sample of precedents:[66]

> An assumption of 10yrs+ for the debt premium adjustment [in Oxera's regulatory precedent analysis] may misrepresent risk—for example, in telecoms, the debt tenor may be as short as 7yrs.

To reiterate, this comment applies to the UK regulatory precedent analysis only. As explained in section 1.3, in this report we have dropped the UK regulatory precedent analysis to focus solely on the UK utilities analysis. In the updated UK utilities analysis, we only consider bonds issued by energy companies.

Even for the UK regulatory precedent analysis, shorter debt tenor (as pointed out by Ofgem) would result in lower DRP (and higher ARP−DRP) under a upward sloping yield curve. As a result, Ofgem's ARP−DRP differential would fall at an even lower percentile rank within the distribution.

4.3.6 Debt beta

Ofgem expressed concerns that Oxera has not conducted the analysis under Approach 2 (i.e. where DRP is calculated as a product of debt beta and ERP), assuming a debt beta of 0.15.[67]

> Approach 2 appears to be sensitive to the debt beta assumption and Oxera did not provide evidence for debt betas up to 0.15 as per our consultation.

[66] Ofgem (2019), 'RIIO−2 Sector Specific Methodology Decision – Finance', p. 125.
[67] Ofgem (2019), 'RIIO−2 Sector Specific Methodology Decision – Finance', p. 125.

This analysis had not been conducted in the Oxera ARP−DRP report, as Oxera does not believe that a debt beta assumption of 0.15 is appropriate.[68] Moreover, the Oxera ARP−DRP report did acknowledge the limitations of Approach 2, and did not present the results under this approach in the main body of the report.[69]

Notwithstanding the points above, to address Ofgem's concerns we present sensitivities, assuming a debt beta of 0.15. Under this sensitivity, the ARP−DRP differential implied by Ofgem's proposed allowance increases to 17th percentile under Approach 1 and 7th percentile under Approach 2, in the distributions of the market evidence from UK utilities bonds.

These results show that the debt beta assumption, as long as it is applied consistently across the comparators, does not have a material impact on our conclusions, namely that Ofgem's cost of equity allowance is low relative to the market evidence. See Appendix A2.4 (sensitivities for utility bond analysis) for further details.

4.4 Debt transaction costs

Ofgem observed that the ARP−DRP framework may produce inconsistent results if debt transaction costs are not accounted for consistently across all observations (including proposed allowance under RIIO−2).

> Ofgem has also included debt transaction costs implicitly within the iBoxx index in the past, so there is a potential inconsistency with the Oxera approach.

For the avoidance of doubt, all the cost of debt estimates used in this analysis exclude transaction costs. Therefore, the Oxera analysis is internally consistent.

As explained in section 4.1.3 above, we do not rely on the regulatory allowance to estimate DRP. Instead, we use the spot yield on traded bonds for our UK utilities analysis, and spot yield on iBoxx indices for our UK regulatory precedent analysis.

[68] Oxera (2019), 'Estimating debt beta for regulated entities', 8 June.
[69] Oxera (2019), 'Risk premium on assets relative to debt', 25 March, pp. 6–7.

A1 Mathematical derivation of the ARP−DRP measure for benchmarking

This section sets out the mathematical formulation of the theoretical ARP−DRP framework.

Notation:

β_d true (unobserved) debt beta
β_a true (unobserved) asset beta
λ measurement bias
$\widehat{\beta_d} = \lambda\beta_d$ OLS estimate of debt beta
$\widehat{\beta_a} = \lambda\beta_a$ OLS estimate of asset beta
YTM yield to maturity on a bond of a given company
$E(\widehat{loss})$ estimate of expected loss
$\widehat{R_f}$ risk-free rate estimate
YTM_s yield on sovereign bonds
$\hat{\theta}$ estimate of convenience yield

Mathematical derivation of the ARP−DRP measure for benchmarking:

As explained in Section 2.3, the downward attenuation bias in the CAPM-estimated asset beta ($\widehat{\beta_a}$), is caused by the presence of measurement errors in the independent variable (i.e. market returns).[70,]

The downward bias in beta estimations is cancelled by constructing the ARP/DRP ratio—which under Approach 2 is mathematically equivalent to the true ratio of asset beta to debt beta. The downward bias in beta estimations is cancelled out because both the estimations of debt beta and asset beta are derived from regression models with similar specifications, based on the same independent variable (i.e. market returns). By implication, the measurement error embedded in the regressor, which leads to attenuation bias in asset and debt beta estimates will be the same.

$\text{ARP/DRP ratio} = \frac{\widehat{\beta_a}}{\widehat{\beta_d}} = \frac{\lambda\beta_a}{\lambda\beta_d} = \frac{\beta_a}{\beta_d}$, measurement bias λ cancels out.

This leads to the following estimation of ARP, which is free of measurement bias λ:

$$\text{ARP} = \frac{\beta_a}{\beta_d} DRP = \frac{\beta_a}{\beta_d}\left(YTM - E(\widehat{loss}) - \widehat{R_f}\right) = \frac{\beta_a}{\beta_d}(YTM - E(\widehat{loss}) - YTM_s - \hat{\theta})$$

Consequently, the following equation is applicable in estimating the ARP−DRP differential:

$$\Delta = \text{ARP} - \text{DRP} = \frac{\beta_a}{\beta_d} DRP - DRP = DRP\left(\frac{\beta_a}{\beta_d} - 1\right) = (YTM - E(\widehat{loss}) - YTM_s - \hat{\theta})\left(\frac{\beta_a}{\beta_d} - 1\right)$$

Assuming that $E(\widehat{loss})$ and $\hat{\theta}$ are unbiased estimates, the delta measure is unbiased. Both ARP and DRP used to calculate the delta would also be unbiased.

[70] The asset beta (βa) is subject to attenuation bias, as it is equal to the weighted average of the equity beta (βe) and debt beta (βd), which are derived from regressions based on the same independent variables (i.e. market returns). The decomposition of the asset beta is presented in the following equation: βa=(E/(D+E))*βe+(D/(D+E))* βd,where, '$\boldsymbol{\beta a}$' is asset beta; '$\boldsymbol{E}$' is market-value of equity; '$\boldsymbol{D}$' is market-value of debt, '$\boldsymbol{\beta e}$' is equity beta; and '$\boldsymbol{\beta d}$' is debt beta.

A2 Detailed methodologies, summary statistics and sensitivity analysis of the UK utilities bonds analysis based on traded yields

As mentioned in section 4 above, Ofgem expressed a view that additional detail is required to assess the implications of the ARP−DRP analysis. In this section we disclose additional detail concerning the methodology and data underpinning the present analysis.

Our main analysis of the ARP−DRP differential implied by yields on the bonds issued by UK utilities, is based on the daily traded yields for UK energy bonds (as opposed to the yield upon issuance previously used) over the six months preceding the publication date of the RIIO−2 Draft Determination (9 July 2020). This approach allows us to estimate the daily ARP−DRP differentials for each energy bond over the six-month period.

This methodological improvement enhances the robustness of our results, as it: (i) minimises the time-lags between regulatory determinations and market DRPs; [71] and (ii) increases our comparator set by considering multiple data points for every bond.

A2.1 Detailed methodology

The methodology we have used in the UK utilities bonds analysis is as follows:

- Select the appropriate bonds. We look at bonds issued in public markets by UK energy companies (excluding SSE and Centrica) from 2010 onwards. We remove the bonds that are not actively traded during the six months preceding the RIIO−2 Draft Determination (9 July 2020).[72]
- For each day, we estimate the risk-free rate based on yield of Bank of England zero-coupon government liability with matching maturity to the length of each energy bond.[73] We adjust the risk-free rate upward by 50 bp, in light of the evidence presented in our risk-free rate and gearing report dated 20 May 2020.[74]
- Subtract the adjusted risk-free rate from the traded yields to obtain the daily credit spread for the six-month period.[75]

[71] As explained before, asset risk premium (ARP) for each bond in our comparator sample, is calculated as the product of the asset beta (Ba) and the equity risk premium (ERP). For listed companies, we use market data to estimate the two-year daily asset beta. For companies without listed equity, we use the asset beta assumed by the regulator in the most recent regulatory precedent. By using daily traded yields (as opposed to the yield of issuance) to estimate the debt risk premium, we minimise the time-lags between regulatory precedents and market DRPs. This adjustment increases the comparability between the asset risk premium and debt risk premium for our set of comparators.
[72] Following this filtering, we have 5,130 data points from 27 unique energy bonds.
[73] Due to quantitative easing, the UK yield curve is now downward-sloping at the long end. Thus, for bonds with a term longer than where the yield curve peaks, the DRP would be higher for longer-term bonds than shorter-term bonds all else being equal. We believe this to be an overestimate of the DRP for these bonds, as a longer time to maturity for a bond usually results in a higher cost of debt due to a higher maturity premium. We therefore take the top of the yield curve as the risk-free rate in order to reduce any overestimation of the DRP.
[74] Ofgem (2019), 'RIIO−2 Sector Specific Methodology – Finance', p. 125.
[75] Traded yields are extracted from Bloomberg. We adjust the traded yields for inflation-linked debt using the Fisher equation, as Bloomberg reports the nominal yields without accounting for inflation. For simplicity, we assume that expected RPI inflation equals 3% and expected CPI inflation equals 2%.

- After estimating the daily credit spread for each bond, we subtract an expected loss of 30 bp for senior unsecured debt and 20 bp for senior secured debt, to obtain the daily DRP.
- The first step in the estimation of the asset risk premium (ARP) for each bond in our comparator sample, is to obtain the relevant asset beta. For listed companies, we use market data to estimate the two-year daily asset beta.[76] For companies without listed equity, we use the asset beta assumed by the regulator in the most recent energy regulatory precedent (e.g. for RIIO−2 this is NIE RP6), re-estimated using a debt beta of 0.05. We present an alternative estimate of asset beta in this Appendix, where we take an average of the asset betas across all UK energy regulatory precedents (adjusted to be consistent with a debt beta of 0.05) published over the past ten years. While our sample of comparators mostly consists of unlisted firms, we test for the robustness of our asset beta assumption in Appendix A2.4 and section 5.1.2. We show that that our conclusion remain unchanged under various alternative asset beta assumptions. For instance, we have introduce a sensitivity where we take the average of the re-estimated asset betas[77] across all UK energy regulatory precedents published over the past ten years. As illustrated in Figure A2.4 below, in this sensitivity Ofgem's ARP−DRP differential implied by the midpoint allowance is benchmarked at the 11th percentile of the ARP−DRP implied by contemporaneous market evidence. Moreover, as explained in Section 4.1.2, for Ofgem's implied ARP−DRP differential to fall at the 50th percentile of the empirical distribution, we need to assume an average asset beta of 0.25 for our contemporaneous comparators, which is implausibly low.
- We calculate time-varying TMR by interpolating the TMR allowances from different regulatory determinations. For example, the TMR for November 2010 is an interpolation between the TMR allowance set by Ofgem on DPCR5 (December 2009) and RIIO-T1 (April 2012). This update allows us to have time-varying asset betas and TMRs for listed companies in our comparator set.
- We use the adjusted risk-free rate, the asset beta and the time-varying TMR from the previous steps, to estimate the ARP.
- Finally, we compare our calculated ARP to DRP for each bond, and summarise our results.

We consider results based on Approach 1 (i.e. estimating DRP using observed bond yields) as the primary body of evidence. Results obtained under Approach 2 (i.e. estimating DRP using assumed debt beta of 0.05 and ERP) are considered as a cross-check.

As explained in section 3, we make the following adjustments to the comparators sample in our updated UK utilities bonds analysis:

- We add bonds issued by UK energy companies after 29 March 2019, the cut-off dated assumed in the Oxera ARP−DRP report;
- We remove bonds issued by Centrica, SSE and Heathrow. The first two companies were removed in light of the recent analysis conducted on the RIIO−2 cost of equity. Heathrow bonds were removed in response to

[76] We estimate the equity beta using the FTSE All-share index as the proxy for the market. We assume a debt beta of 0.05. We obtain the asset beta using the two-year average gearing, where gearing is estimated using the following equation: $Gearing = Net\ debt / Market\ capitalisation$.
[77] Re-estimated using the published notional gearing and a debt beta of 0.05.

Ofgem's concern with regards to demand risks, specific to the aviation sector (see section 4.3.4);

- We remove all bonds issued by water companies to increase the comparability of our sample with Ofgem's ARP−DRP differential derived from the midpoint allowance set out in the RIIO−2 draft determination. In Appendix A2.4, we demonstrate that adding these observations into the sample will not affect our conclusions;
- We use contemporaneous market evidence where possible, focusing on the ARP−DRP implied by traded yields of energy bonds over the six-month period preceding the RIIO−2 Draft Determination, as the appropriate benchmark to compare the percentile ranking of Ofgem's implied ARP−DRP differential. Our findings are robust to sensitivities on the time horizon used for the empirical distribution of market evidence.

A2.2 Summary statistics

Some descriptive statistics of the sample of bonds used are shown below.

Figure A2.1 Summary statistics of UK utilities sample

		Length of bond			
	Full sample	**<5y**	**5−10y**	**10−15y**	**>15y**
Sample size	5,130	122	664	1,540	2,804
Mean differential	2.43	2.36	2.26	2.40	2.49
Median differential	2.62	2.44	2.34	2.68	2.64

Source: Oxera analysis.

A2.3 Results under Approach 2

This subsection provides an alternative approach for calculating the debt risk premium. We use 'Approach 2' for estimating the debt risk premium as a cross-check to the findings obtained under Approach 1.

The ARP−DRP differential under Approach 2 is the difference between the asset beta and debt beta of a company, multiplied by the ERP. Approach 2 is a bottom-up approach to directly estimate the compensation for bearing systematic risk and is expected to generate different results to Approach 1 because typically there is a residual component of the credit spread that cannot be explained by expected loss or the debt beta.[78]

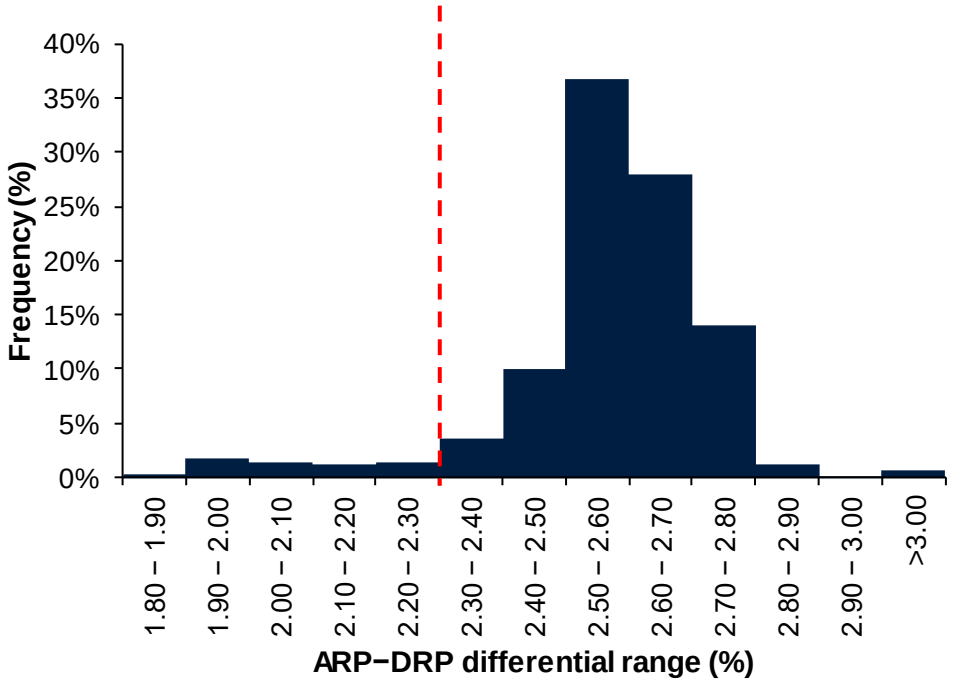
The ARP−DRP analysis under Approach 2, is based on a debt beta assumption of 0.05. To increase the comparability between Approach 1 and Approach 2 under the updated UK utilities analysis, we consider the daily ARP−DRP differential for UK energy bonds over the six month preceding the publication date of the RIIO−2 Draft Determination (9 July 2020).

Under Approach 2, our analysis shows that Ofgem's ARP−DRP differential implied by the midpoint allowance, is benchmarked at the bottom 3.1% of the empirical distribution based on contemporaneous market evidence.

Our results show that, using Approach 2, Ofgem's midpoint allowance is well below what the empirical evidence suggests an investor would expect on average. This is consistent with results obtained under Approach 1.

[78] Webber, L., and Churm, R. (2007), 'Decomposing corporate bond spreads', *Bank of England Quarterly Bulletin* Q4, pp. 533–41.

Figure A2.2 Summary of the ARP−DRP cross-check under Approach 2



Source: Oxera analysis.

A2.4 Sensitivity tests

In this subsection we illustrate the effect of running sensitivities on key parameters of the analysis as well as including the observations we have removed from the sample of comparators (as explained in section 3). We show that our conclusions remain unchanged as Ofgem's allowances are still low relative to market evidence. The sensitivity tests are presented in in either scatter plots or histograms, and the chart presentation does not affect the percentile rankings (in bold) set out in the paragraphs below.

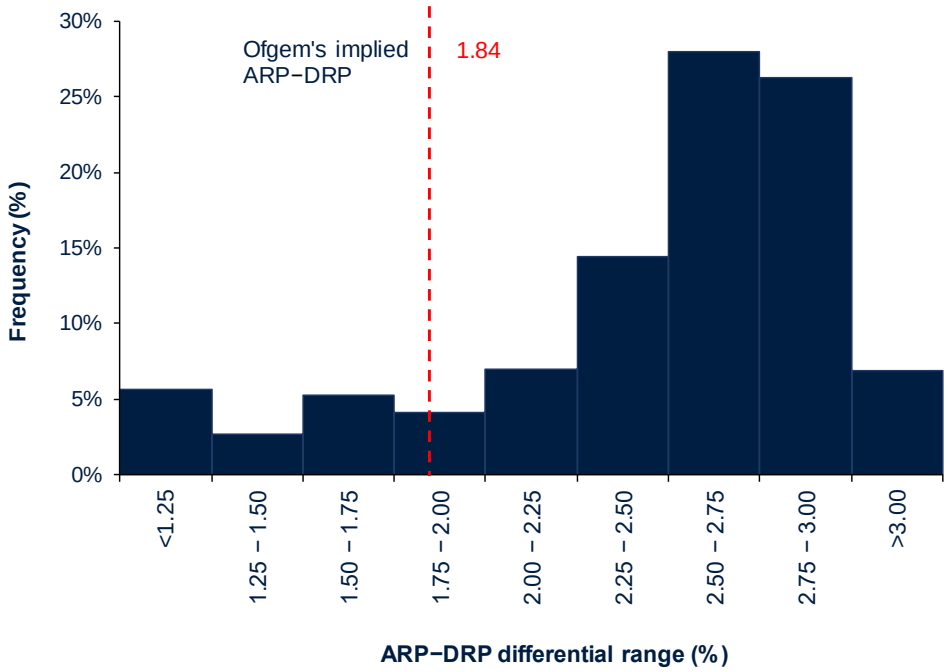
Using average asset beta across all UK energy regulatory precedents published after 2010, instead of asset beta from NIE RP6 (Approach 1)

As explained before in our baseline analysis we use the asset beta assumed by the regulator in the most recent energy regulatory precedent (i.e. for RIIO−2 this is NIE RP6) re-estimated using a debt beta of 0.05 for unlisted firms, and market asset beta for listed companies.

We present an alternative estimate of asset beta in this Appendix, taking the average of the asset betas across all UK energy regulatory precedents published over the past ten years, re-estimated using a debt beta of 0.05.

As illustrated in Figure A2.4 below, in this sensitivity Ofgem's ARP−DRP differential implied by the midpoint allowance is benchmarked at the **11th percentile** of the ARP−DRP implied by contemporaneous market evidence. This is well below what the empirical evidence suggests an investor would expect on average.

Figure A2.3 Distribution of the ARP−DRP differential implied by contemporaneous evidence on UK energy bonds (asset betas averaged across all UK energy regulatory precedents)



Source: Oxera analysis

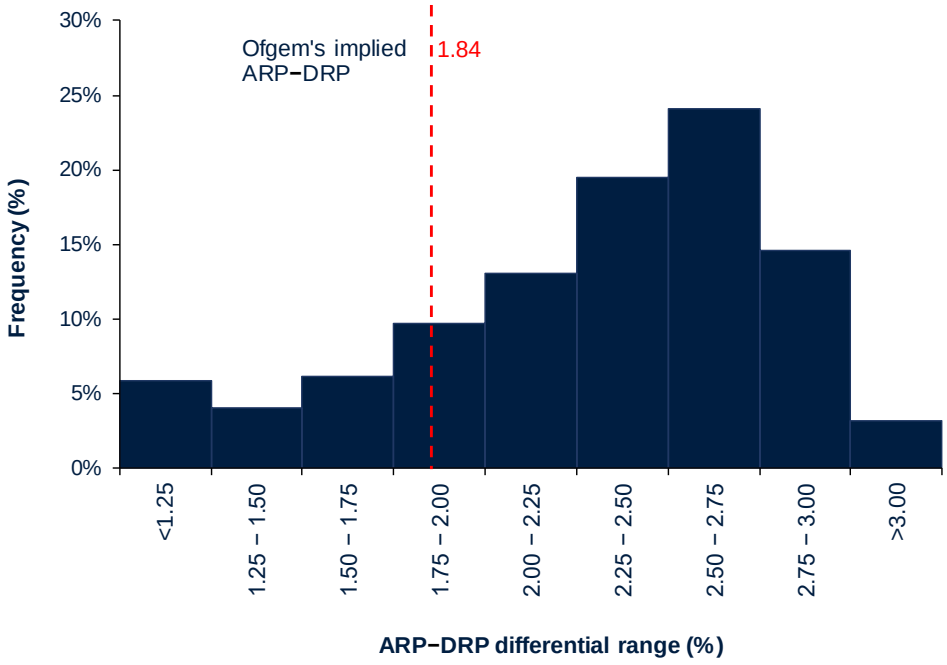
Including water bonds in the list of comparators (Approach 1)

As explained before, we removed all bonds issued by water companies and bonds issued by Heathrow, SSE and Centrica, to increase the comparability of our sample with RIIO−2 and account for the increase in ARP−DRP over time.

As illustrated in Figure A2.4, the ARP−DRP differential implied by the yields on bonds issued by water companies are mostly above that implied by the RIIO−2 determination.

Adding these observations into the sample will not affect our conclusions, as Ofgem's midpoint allowance is benchmarked at the bottom **20th percentile** of the empirical distribution of ARP−DRP implied by contemporaneous market evidence, which is well below what investors would expect on average.

Figure A2.4 Distribution of the ARP−DRP differential implied by contemporaneous evidence on UK energy and water bonds



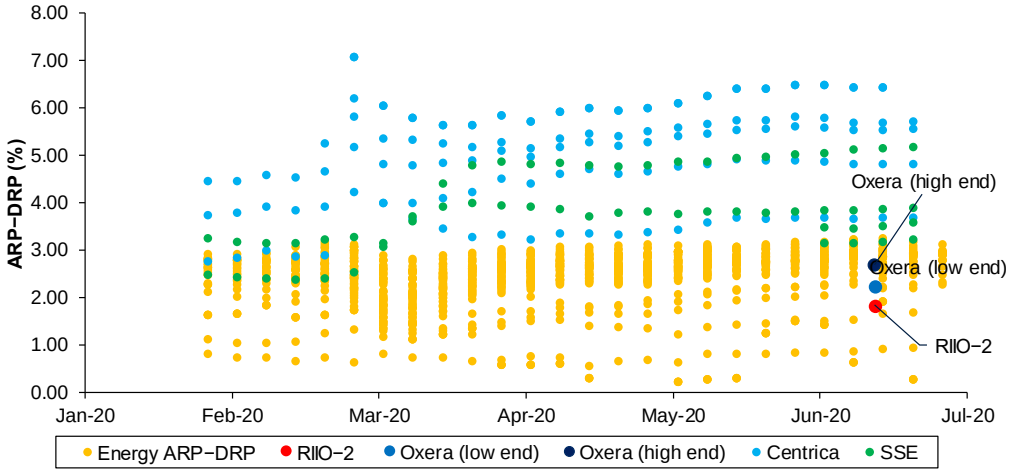
Note: The ARP−DRP differentials presented in this figure are calculated under Approach 1, based on the daily traded yields of bonds issued by the UK utilities.

Source: Oxera analysis.

Including SSE and Centrica bonds in the list of comparators (Approach 1)

As explained in section 3, our UK utilities analysis excludes bonds issued by SSE and Centrica. One could make the argument that SSE and Centrica do not represent valid comparators for the ARP−DRP analysis, due to the significant exposure of these companies to non-regulated activities. In this subsection we illustrate the effect of including these observations. As can be seen in Figure A2.5, including bonds issued by these two companies does not change our conclusion that Ofgem's RIIO−2 allowances for the cost of equity are too low relative to the ARP−DRP implied by contemporaneous market evidence.

Figure A2.5 Comparison of the ARP−DRP differentials implied by Ofgem and Oxera CoE estimates to the ARP−DRP differential implied by contemporaneous evidence on UK energy bonds (including SSE and Centrica)



Source: Oxera analysis.

Including SSE and Centrica in the sample of comparators will further reduce the percentile rank of Ofgem's midpoint allowance to the **bottom 13%** of the empirical distribution.

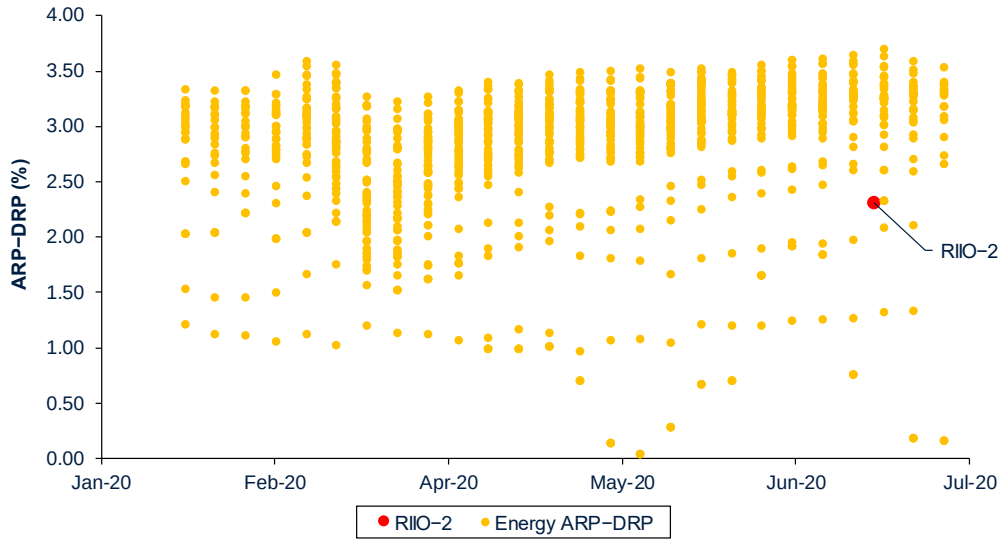
Assuming a debt beta of 0.15 (Approach 1 and 2)

In this subsection we provide sensitivities assuming a debt beta of 0.15 instead of 0.05. The conclusions are not sensitive to the debt beta assumed. This finding is consistent when using both Approach 1 and Approach 2.

Under Approach 1, Ofgem's midpoint allowance still lies in the **bottom 17.1%** of the empirical distribution, while, for Approach 2, Ofgem's implied differential is benchmarked at the **7th percentile** of market evidence.

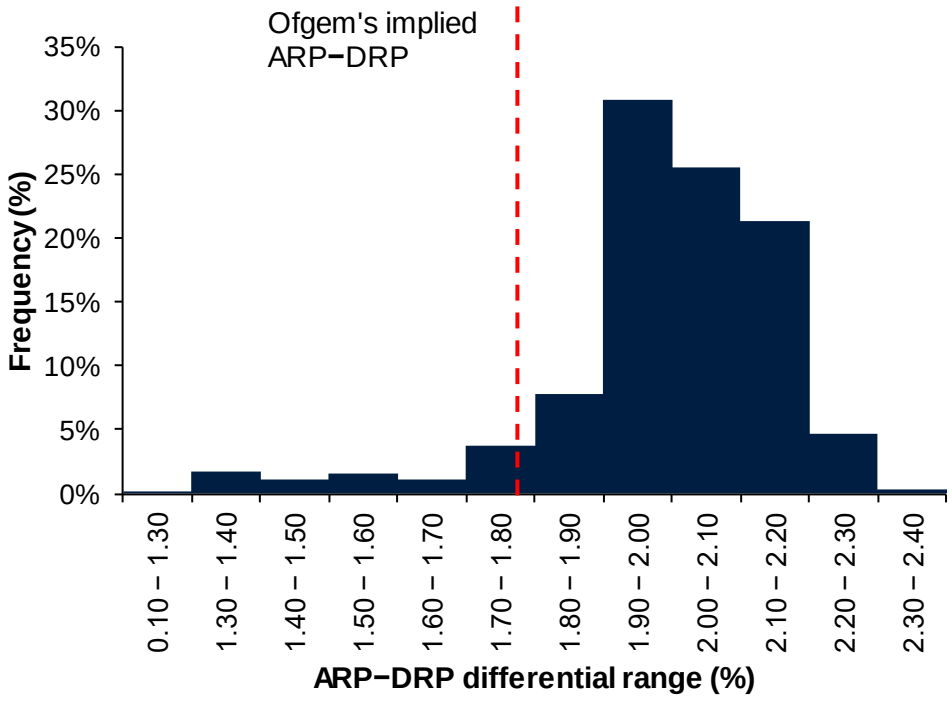
These results show that the debt beta assumption, as long as applied consistently across the comparators, does not have a material impact on the conclusions, namely that Ofgem's cost of equity allowance is low relative to the market evidence

Figure A2.6 ARP−DRP differential under Approach 1 implied by UK energy bonds and RIIO−2 Draft Determination (debt beta of 0.15)



Source: Oxera analysis.

Figure A2.7 Summary of the ARP−DRP cross-check under Approach 2 (debt beta of 0.15)



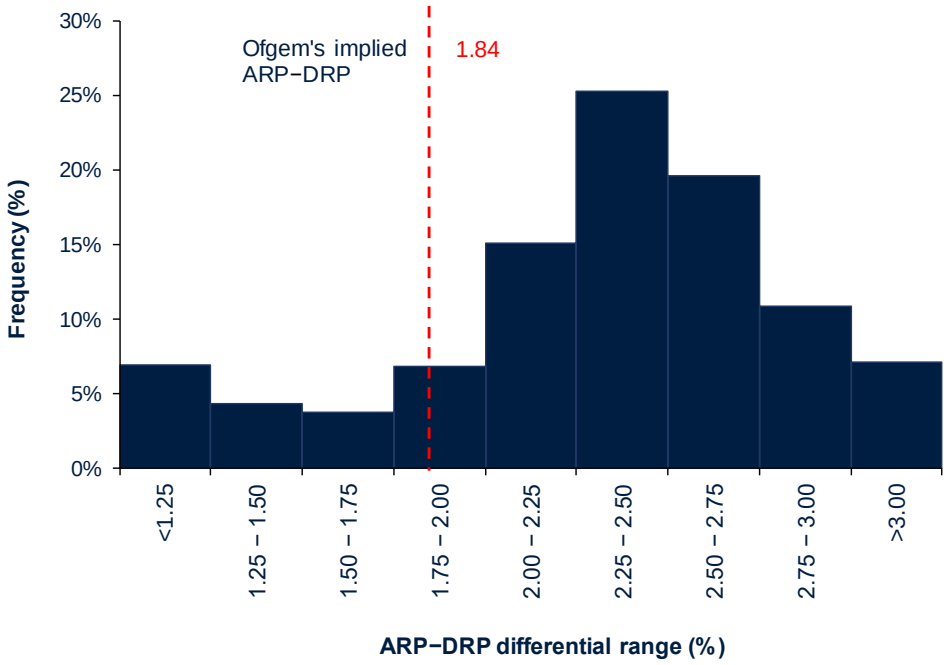
Source: Oxera analysis.

The effect of the risk-free rate adjustment on the percentile ranking of Ofgem's allowance

As mentioned above, we have applied an adjustment to the yields on government bonds to derive the appropriate estimate of the risk-free rate for use in the CAPM. The methodological and theoretical underpinnings of this adjustment are described in Oxera's submission to the CMA as part of the PR19 appeal process. In that submission we have estimated the magnitude of the appropriate adjustment to be between 50 and 100 bp. As illustrated in Figure A2.8, the magnitude of this adjustment does not materially affect the percentile ranking of Ofgem's allowance in the empirical distribution. In the sensitivity where we do not apply any adjustment to the yields on government bonds, the ARP−DRP differential is still benchmarked well below recent market evidence. Specifically, Ofgem's ARP−DRP lies in the **bottom 17%** of the empirical distribution.

The reason for the low impact of this adjustment on the outcome of the analysis is that the adjustment applies to all ARP−DRP differentials simultaneously. Therefore, the relative position of each observation is largely unaffected.

Figure A2.8 The effect of the risk-free rate adjustment on the percentile ranking of Ofgem's allowance (no convenience yield)



Source: Oxera analysis.

A3 Results of the UK utilities bonds analysis based on yields at issuance

As an additional cross-check to the findings of our main analysis, we have also estimated the ARP−DRP differentials implied by UK utilities bonds based on the yield at issuance as opposed to the traded yields for our sample of comparators. This approach is similar to that adopted in the original Oxera ARP−DRP report, and to some extent circumvents the lack of liquidity for some bonds we considered in the traded yields analysis.

This analysis uses bonds issued by energy companies after 2015. We estimate the DRP and ARP for each company at the issuance date of each bond, and calculate the difference between the two.

We observe that our conclusion remains unchanged, namely that Ofgem's cost of equity allowance is low relative to the market evidence.

A3.1 Detailed methodology

The methodology we have used in the UK utilities bonds analysis is as follows:

- We select the appropriate bonds. We look at bonds issued in public markets by UK energy companies from 2015 onwards;
- We estimate the risk-free rate based on yield of Bank of England zero coupon government liability with matching maturity to the length of the utility bonds as at the date of issuance for each bond. Adjust the risk-free rate upward by 50 bp, in light of the evidence presented in our risk-free rate and gearing report dated 20 May 2020;
- We subtract the adjusted risk-free rate from the yield to maturity *on the issue date* in order to obtain the credit spread;
- After estimating the credit spread for each bond, we subtract an expected loss of 30 bp for senior unsecured debt and 20 bp for senior secured debt, to obtain the DRP;
- To estimate ARP, we use market data based on the two-year daily asset beta as at the date of issuance for listed companies. For companies without listed equity, we use the asset beta assumed by the regulator in the most recent regulatory precedent as at the issuance date of each bond, re-estimated using a debt beta of 0.05;
- We calculate time-varying TMR by interpolating the TMR allowances from different regulatory determinations;
- We use the adjusted risk-free rate, the asset beta and the time-varying TMR from the previous steps, to estimate the ARP.
- Finally, we compare our calculated ARP to DRP for each bond, and summarise our results.

A3.2 Summary statistics

Some descriptive statistics of the sample of bonds used are shown below.

Figure A3.1 Summary statistics of UK utilities sample

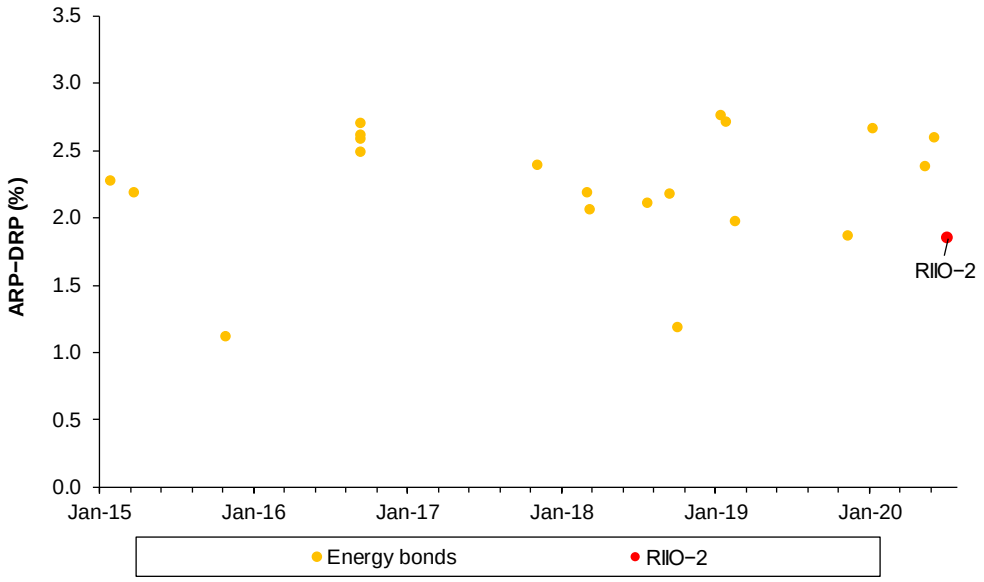
		Length of bond		
	Full sample	≥5 years	≥10 years	≥15 years
Sample size	20	19	14	9
Mean differential	2.25	2.27	2.37	2.42
Median differential	2.33	2.38	2.38	2.49

Source: Oxera analysis.

A3.3 Summary of results

First, the ARP−DRP differential implied by Ofgem's draft determination falls below the recent market evidence. This is illustrated in Figure A3.2 below.

Figure A3.2 ARP−DRP differential implied by UK energy bonds (based on yields at issuance), and RIIO−2 Draft Determination



Note: The ARP−DRP differentials presented in this figure are calculated under Approach 1, based on the yields of bonds as of the issuance dates for energy companies in our sample.

Source: Oxera analysis.

It can be seen that, out of the sample of 20 energy bonds issued over the last five years, only two implied an ARP−DRP differential lower than that implied by Ofgem's RIIO−2 allowances. This suggests that Ofgem's cost of equity allowance is lower than the ARP−DRP implied by contemporaneous market evidence.

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