The cost of equity for RIIO-ED2

Prepared for Energy Networks Association

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Contents

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Figures and tables

Executive Summary

On 17 December 2020, Ofgem published its initial RIIO-ED2 Decision, followed by the finance annex on 11 March 2021. The overall strategy, as described by Ofgem, is to follow the RIIO-2 Financial Determinations (FD). At the time of writing, the RIIO-2 FD is under appeal with the CMA by multiple energy networks. Our report[1] updates the market data through 31 May 2021 and also draws on arguments used in Oxera's September 2020 report on RIIO-2, as well as subsequent research. Our analysis supports a range of 5.81–6.87% (CPIH-real) for the cost of equity at 60% gearing. In contrast, Ofgem proposes a regulatory cost of equity of 4.65% at 60% gearing, from which a 25bps outperformance wedge is deducted. In addition to empirical support for our proposed cost of equity, this report also addresses the differences between Ofgem's and Oxera's estimates. We conclude that Ofgem has made errors that result in a significant underestimate of the cost of equity.

Risk-free rate

We have updated our methodology to estimate the risk-free rate (RfR) from the September 2020 report.[2] This new methodology builds on our work submitted to the Competition and Markets Authority (CMA) on whether sovereign yields are a good proxy for the rate of return on a zero-beta asset. Importantly, the capital asset pricing model (CAPM) defines the RfR as the rate of return on a zero-beta asset and assumes that investors borrow and lend at the RfR. Ofgem's estimate of –1.16% (CPIH-real) using spot yields on government bonds violates this assumption, as non-government investors cannot borrow at such rates. This issue did not arise in previous regulatory periods because historically, Ofgem estimated the RfR by adding a spread to spot government yields. Its earlier methodology implicitly converted government bond yields into a realistic RfR. It no longer adds such a wedge, creating a downward bias in its estimates and therefore violating the CAPM assumption of an estimate of the expected return on a riskless asset.

We present two methods for calculating the RfR. The first method ('bottom-up'), adds a convenience premium to government bond yields, resulting in a useable risk free rate. The second ('top-down') starts with high-grade corporate debt and nets out the small premium for default risk, as well as adjusting for liquidity. We take the six-month trailing average of the government bond and high-grade corporate debt yields to decrease any impact of market volatility. The methodology differs slightly from our last update, as we now take a six-month trailing average of government bond yields, rather than the spot yield, for the bottom-up approach. Taking a longer average would further mitigate short-term volatility of yields. Both methods yield similar estimates for the RfR, although we put more weight on the bottom-up method due to challenges with underlying market data for the top-down approach. Once the value of the RfR is fixed at the start of RIIO-2, it can subsequently be indexed for changes in government bond yields on an annual basis throughout RIIO-2.

In its Final Determination for RIIO-T2 and GD2, Ofgem used SONIA swap rates as a cross-check for RfR.[3] However, long-term SONIA swap rates are inappropriate cross-checks for the risk-free rate to use in the CAPM, as the SONIA swap rates are distorted downwards by swap-specific factors and

[1] Prepared on behalf of the following ENA Electricity Distribution Operator members: Electricity North West, Northern Powergrid, Scottish & Southern Electricity Networks, SP Energy Networks, Western Power Distribution, and UK Power Networks.
[2] Oxera (2020), 'The cost of equity for RIIO-2, Q3 2020 update', 4 September.
[3] Ofgem (2021), 'RIIO-2 Final Determinations – Finance Annex (REVISED)', 3 February, Table 8.

capital market imperfections, such as limits to arbitrage and demand for interest rate hedging from pension funds.

Total market return

As in the 2019 and 2020 Oxera reports, we rely on historical evidence from Dimson, Marsh, and Staunton (DMS) as the primary source of input. We also examine forward-looking evidence, and within this category of evidence give most weight to the Oxera implementation of the Bank of England dividend discount model (DDM). Our estimates continue to support a TMR estimate of 7.0–7.5% (CPIH-real).

The use of long-term historical evidence requires reliable inflation data. Since the 2020 edition of DMS, the book has deflated the nominal returns with an inflation series that is a hybrid of RPI and CPI inflation. The hybrid inflation series creates problems when using long-term market data, which has been noted by the Office for National Statistics (ONS). We therefore do not use the real returns directly from DMS.

For comparability of long-term market data, one must instead deflate the nominal returns by a consistent inflation series. There are two possible methods for doing so:

1. adding the forecast RPI–CPIH wedge to RPI-real historical returns restated using today's RPI methodology (which is Oxera's preferred approach);
2. deflating nominal returns by CPI inflation, adjusted for bias in the historical estimates of CPI.

The second approach is subject to a much higher degree of uncertainty because for periods prior to 1997 the CPI series was estimated ex post. We consider that it is more robust to start with the official RPI historical series and then to consider any adjustments to the RPI series.

Ofgem instead uses unadjusted estimates of historical CPI from the ONS. As discussed further in the report, this creates a series of inflation data that is inconsistent across time.

Moreover, Ofgem uses geometric averaging with a subjective uplift to estimate the arithmetic average TMR. In doing so, it is proposing to set a return lower than the actual arithmetic average observed in the data, which has the result of embedding a downward bias to the value of the regulated business and undercompensating investors. We consider that it is more appropriate to estimate the arithmetic average directly based on annual returns.

Risk and beta

The 2019 and 2020 Oxera reports estimated an asset beta range of 0.38–0.41 based on a debt beta of 0.05.

In terms of debt beta, our estimates continue to point to a maximum debt beta of 0.05. In addition to mathematical errors made in their debt beta calculation, Ofgem/CEPA (citing an earlier NERA study) misrepresented the arguments in

Fama and French (1993),[4] who actually estimated a debt beta of 0 (or even negative) for nearly all firms, rather than 0.22, as claimed by CEPA.[5]

In this report, we estimate spot five-year asset betas as at 31 December 2019.[6] We continue to find that the market evidence on beta supports a clear differential between energy networks and water companies. Indeed, Ofgem/CEPA's own data suggest that energy companies are riskier than water companies. As regards Ofgem/CEPA's expanded sample of European comparators, Ofgem places no weight on the beta estimates for these companies (which also appear to suffer from downward bias due to the illiquidity of two of the six stocks in the sample).

To derive our beta range, we first use National Grid's five-year asset beta as the low end of our estimate and the EU energy comparator average five-year asset beta as the high end. This translates into an asset beta range of 0.37–0.40. Next, we re-gear these asset betas to derive equity betas at the notional level of gearing. This results in an equity beta range of 0.85–0.93 (at 60% notional gearing). We consider this range to be conservative, given that more recent data suggests that asset betas have risen sharply.

Separately, we consider multiple pieces of evidence that suggest the CAPM systematically underestimates the cost of equity (CoE), such as recent academic research, quantifying the volatility created by political/regulatory risk, and linking this to risk associated with skewness in returns. In all, our evidence supports the conclusion that our equity beta estimate of 0.85–0.93 is conservative, given that the CAPM likely ignores relevant risk exposures in practice.

Cross-checks

The cross-checks section considers the evidence on cross-checks provided by Ofgem at ET/GT/GD2. Ofgem has, in the Final Determinations, used this evidence to argue that it has 'aimed up' on the CoE relative to the overall parameter estimates. Although Ofgem has not repeated this procedure at this stage of the ED2 process, it does confirm its position that the cross-checks are relevant for ED2. We therefore discuss, in Appendices A1 and A2, the cross-checks in detail and how they were used incorrectly to conclude that the CoE at ET/GT/GD2 was 'aimed up'.

An important cross-check is to use the step 1 CoE inputs and test whether these model inputs fit the MM model of a weighted average cost of capital (WACC) that is invariant to gearing. Ofgem's inputs for the RfR, debt beta, cost of debt and TMR result in a WACC that exhibits a strong positive relationship with gearing. In other words, its model inputs appear to violate the MM model. This is because there are errors in the Ofgem calculation, which uses the historical cost of debt instead of the current cost of debt that is assumed in the MM model. Correcting for this error, as well as the error in the RfR discussed above, produces a WACC that is not very sensitive to changes in gearing.

[4] Fama, E.F. and French, K.R. (1993), 'Common risk factors in the returns on stocks and bonds', *Journal of Financial Economics*, **33**:1, pp. 3–56.
[5] CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', report for the UK Regulators Network, 2 December, available at: https://www.ukrn.org.uk/wp-content/uploads/2019/12/CEPAReport_UKRN_DebtBeta_Final.pdf (last accessed 4 June 2021).
[6] We find a sharp increase in the two- and five-year asset betas of the sample using more recent data, which is likely to be linked to the economic disruption caused by the shutdowns related to the COVID-19 pandemic. As it is not clear how long this disruption will persist, we apply a cut-off date of 31 December 2019 for our beta estimation in this report.

Our review of the analysis of infrastructure funds, offshore transmission owner (OFTO) rates of return, and investment manager forecasts suggests that these cross-checks are unreliable data points.

We also considered Ofgem's use of estimated premia over regulated asset value, or market-to-asset ratios (MAR). We noted in our report submitted to the CMA in May 2020 that company-specific expected outperformance—along with other items, such as the non-regulated portion of the business, accrued dividends, and expected takeover premium—can more than explain the premia for Severn Trent and United Utilities.[7] In other words, the premia can be explained without the argument that the allowed return on equity is too high or that investors expect sector-wide outperformance. Current data continue to support this view, and the recent acquisitions of Western Power Distribution and Bristol Water by companies operating in the same sectors and geographic areas are not reflective of the market value of other regulated assets.

We note that the two listed water companies are the only 'pure play' companies in CEPA's analysis, as the others are also engaged in other business. CEPA itself criticises a decomposition approach in other parts of its analysis, and is therefore inconsistent in including NG, SSE, and PNN in its MAR analysis. We further show that one can generate higher valuations if the market expects a slight relaxation in regulatory pressures on the allowed cost of equity post-RIIO-2.

Nevertheless, in light of the uncertainty in apportioning components of equity market valuations to individual elements of the regulated settlement, there is no reason to depart from the position as stated in previous CMA assessments and the UKRN cost of capital study—evidence from traded market premia does not provide a reliable guide to the cost of equity used by investors in regulated utilities.

None of these cross-checks is directly comparable with Ofgem's CAPM analysis. In contrast, the comparison we have undertaken between the allowed return on assets and the pricing of risk within the debt market is a test of internal consistency between different elements of the capital structure for the same company. A cross-check that is directly comparable to the CoE for companies regulated under RIIO-2 should be given more weight.

This report uses the ARP–DRP differential to cross-check the CoE under T2 and GD2 Final Determinations, which shows that Ofgem's allowed return is significantly below contemporaneous market evidence.

Required equity returns for RIIO-2

Our report presents multiple pieces of evidence that the CAPM-implied CoE systematically underestimates an appropriate return on equity for regulated energy companies in the UK. Even so, we note that this is currently the preferred regulatory approach. Therefore, based on the newly available evidence on the CAPM parameters, we recommend updating the CoE range to 5.81–6.87% CPIH-real. This information is summarised in the table below.

[7] Oxera (2020), 'What explains the equity market valuations of listed water companies?', 20 May.

Table 1 Summary of RIIO-2 cost of equity estimates

	Oxera 2020		Current evidence		Change	
	Low	High	Low	High	Low	High
Real TMR (%)	7.00	7.50	7.00	7.50	-	-
Real RfR (%)	–1.00	–1.00	–0.93	–0.93	0.07	0.07
ERP (%)	8.00	8.50	7.93	8.43	–0.07	–0.07
Asset beta	0.38	0.41	0.37	0.40	–0.01	–0.01
Debt beta	0.05	0.05	0.05	0.05	-	-
Equity beta at 60% gearing	0.88	0.95	0.85	0.93	–0.03	–0.02
Real CoE at 60% gearing (%)	**6.00**	**7.08**	**5.81**	**6.87**	**–0.19**	**–0.21**

Note: All figures are presented in CPIH-real terms and do not include a 25bp downward adjustment for expected outperformance as advocated by Ofgem. For the RfR, we use a point estimate of –0.93% in the low and high scenarios, which is the midpoint of the –1.08% to –0.77% range from section 3.8. The use of a single point estimate is in line with the Oxera 2020 report, as well as the CMA's use of a single point estimate in the PR19 appeal. The real CoE at 60% gearing may not equal the sum of its components due to rounding.

Source: Oxera analysis.

1 Introduction

In November 2019, Oxera published a report ('the 2019 Oxera report') that featured estimates of the CoE for RIIO-2, as commissioned by the Energy Networks Association. In September 2020, Oxera published a report ('the 2020 Oxera report') that provided updated estimates of the CoE for RIIO-2. This report serves as an update to the 2020 Oxera report and reflects new evidence from capital markets, as well as updates based on, or in response to, further thinking and evidence presented by Ofgem in its Final Determinations for electricity transmission (ET), gas distribution (GD) and gas transmission (GT). In its SSMD for ED2, Ofgem frequently refers to its Final Determinations for ET, GD and GT. We therefore predominantly refer to Ofgem's Final Determinations for ET, GD and GT throughout this report. This report also incorporates the CMA's PR19 Final Determinations for the water appeals where appropriate.

The report is structured as follows.

- Section 2 presents the updated inflation forecasts (published by the Office for Budget Responsibility, OBR) that are used to convert nominal values into real values.
- Section 3 discusses the estimation of the RfR.
- Section 4 provides our assessment of the appropriate TMR range. We also consider a range of cross-checks to the TMR.
- Section 5 considers the latest evidence on equity betas, debt betas and gearing to derive an estimate of the asset beta for the energy networks affected by RIIO-2. It also considers other risks priced by investors in the energy sector that may not be properly reflected in an equity beta estimate, such as the impact of political and regulatory risk and resulting skewness in returns.
- Section 6 combines the evidence from the previous three sections to provide an updated CAPM-based CoE range for RIIO-2.
- Section 7 concludes with a discussion of how to select a point estimate for the cost of capital that maximises consumer welfare when there is uncertainty about the underlying parameters of the cost of capital.
- Appendix A1 responds to the cross-checks considered by Ofgem as part of its Final Determinations for ET, GD and GT.
- Appendix A2 responds to the cross-checks considered by Ofgem, which are not discussed in section 4, to determine the TMR range.
- Appendix A3 provides more detail on the inflation indicators used to deflate historical equity market returns.
- Appendix A4 considers a number of approaches that can be used to estimate the appropriate debt beta.

The analysis provided in this report is based on data up to end May 2021 and may change by the time that RIIO-ED2 begins.[8]

[8] This is true for RfR and inflation. Our beta estimates have a cut-off date of 31 December 2019. For TMR, the analysis of historical returns uses DMS 2021 and the survey evidence from Fernandez et al. (2020). The dividend discount model and regulatory precedents include data up to 31 March 2021.

2 Inflation forecasts

In setting price controls for regulated entities, regulators have to control for inflation in several parts of the calculation. Different regulators take different approaches, and the approach chosen can have a material impact on both consumers and shareholders.

In the RIIO-2 price control, CPIH inflation is used to index the allowed returns. That is, the regulatory asset value (RAV) is indexed to CPIH and the cost of capital assumption is expressed in CPIH-real terms.

For consistency, throughout this report, our estimates are presented in CPIH-real terms unless stated otherwise. To calculate these metrics, we either deflate nominal input data using RPI inflation and add a RPI–CPIH inflation forecast wedge, or we deflate nominal data directly by forecast CPIH inflation. The RPI–CPIH wedge is estimated using the most recent long-term inflation forecasts provided by the OBR,[9] as presented in Table 2.1. CPI is taken as a proxy for CPIH inflation.

Table 2.1 OBR inflation forecasts

	2020	2021	2022	2023	2024	2025
CPI	0.9	1.5	1.8	1.9	1.9	2.0
RPI	1.5	2.5	2.0	2.4	2.7	3.0

Source: Oxera replication of Office for Budget Responsibility (2021), 'Economic and Fiscal Outlook', March, p. 80.

In the Sector Specific Methodology Decision, 0.976% is estimated for the implied CPIH–RPI wedge in 2025 based on the OBR forecast as at November 2020.[10] In this report, we use the most recent inflation forecast as at March 2021 to estimate an implied CPIH–RPI wedge of 0.954% in 2025.

[9] Office for Budget Responsibility (2021), 'Economic and Fiscal Outlook', March.
[10] Ofgem (2021), 'RIIO-ED2 Sector Specific Methodology Decision: Annex 3 Finance', 11 March, Appendix 2.

3 Market parameters: the risk-free rate, total market return, and equity risk premium

3.1 Risk-free rate

The 2020 Oxera report presented an updated methodology for calculating the RfR. This research built on a May 2020 Oxera report that investigated the relationship between sovereign yields and the CAPM.[11] In this report, we presented two methods for calculating the RfR: adding a convenience premium to government bond yields, consistent with Ofgem's earlier methodology ('bottom-up'); and starting with high-grade corporate debt and netting out small premia for risks such as default risk and liquidity risk ('top-down'). Both methods yielded similar estimates for the RfR.

Below, we follow the same general approach, using updated market data with a cut-off date of the end of May 2021. The methodology differs from our September 2020 update, as we now take a six-month trailing average of government bond yields, rather than the spot yield, for the bottom-up approach. Taking a longer-term average can mitigate short-term volatility of yields.

3.2 The convenience premium

The CAPM defines the RfR as the rate of return on a zero-beta asset and assumes that investors borrow and lend at the RfR. Government bonds have special properties (noted in detail below) that create additional demand for these instruments. In other words, market participants have reasons to hold government bonds that go beyond the rate of return expected on these instruments. Bond yields and bond prices are inversely related, so when this additional demand pushes the price higher, the bond yield falls below a normal market-clearing price based solely on risk-free cash flows. These effects are collectively known as the convenience premium, and push the rate of return on bonds below a true RfR based on a zero-beta asset.

3.2.1 Evidence on the convenience premium and its size

There is a substantial amount of evidence from the academic literature that explicitly supports the use of an RfR for the CAPM that is higher than the yield on government bonds. For example, Krishnamurthy and Vissing-Jorgensen (2012) concluded that:[12]

> Treasury interest rates are not an appropriate benchmark for 'riskless' rates. **Cost of capital computations using the capital asset pricing model should use a higher riskless rate than the Treasury rate**; a company with a beta of zero cannot raise funds at the Treasury rate. [Emphasis added]

Berk and DeMarzo (2014) also explained that:[13]

> practitioners sometimes use [risk-free] rates from the **highest quality corporate bonds** in place of Treasury rates. [Emphasis added]

[11] Oxera (2020), 'Are sovereign yields the risk-free rate for the CAPM?', prepared for the Energy Networks Association, 20 May.
[12] Krishnamurthy, A. and Vissing-Jorgensen, A. (2012), 'The Aggregate Demand for Treasury Debt', *Journal of Political Economy*, **120**:2, April, pp. 233–67.
[13] Berk, J. and DeMarzo, P. (2014), *Corporate Finance*, third ed., Pearson, p. 404.

According to Feldhütter and Lando (2008), the magnitude of the convenience premium varies over time and can range from 30–90bp.[14] They explained the convenience premium as follows:[15]

> **The premium is a convenience yield on holding Treasury securities arising from**, among other things, (a) repo specialness due to the ability to borrow money at less than the GC repo rates, (b) that Treasuries are an important instrument for hedging interest rate risk, (c) that Treasury securities must be purchased by financial institutions to fulfil regulatory requirements, (d) that the amount of capital required to be held by a bank is significantly smaller to support an investment in Treasury securities relative to other securities with negligible default risk, and to a lesser extent (e) the ability to absorb a larger number of transactions without dramatically affecting the price. [Emphasis added]

Similarly, Krishnamurthy and Vissing-Jorgensen (2012) estimated the average of the liquidity component of the convenience premium to be 46bp from 1926 to 2008.[16]

Koijen and Yogo (2020) developed a pricing model to study sources of variation in exchange rates, long-term yields, and stock prices across 36 countries from 2002 to 2017.[17] Their model found that, in the absence of special-status demand for US assets by foreign investors and foreign exchange reserves, the US long-term yield would be 215bp higher. In other words, the authors found evidence consistent with a significant convenience premium for US Treasuries between 2002 and 2017.

Longstaff (2004) also examined the 'flight to liquidity' premium in Treasury bond prices by comparing them with prices of bonds issued by the Resolution Funding Corporation (REFCORP), a US government agency, which are guaranteed by the Treasury.[18] Using the yield data from April 1991 to March 2001, Longstaff found a premium in Treasury bonds relating to:

- changes in consumer confidence;
- the amount of Treasury debt available to investors;
- the flows into equity and money market mutual funds.

Longstaff concluded that these features of Treasury bonds directly affect their value.

Using a methodology that is broadly consistent with that set out in Longstaff (2004), we also estimate the size of this premium since 2010.

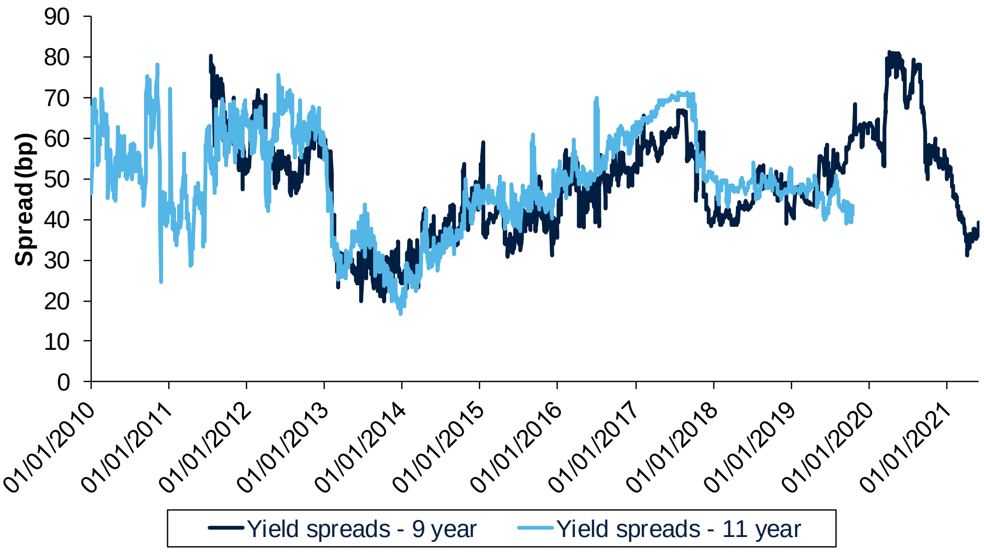
Figure 3.1 below shows that the long-term convenience premiums implied by the spreads of nine-year and 11-year REFCORP bonds from 2010 to date are on average 49bp and 50bp respectively.[19] It can be seen that the 11-year

[14] Feldhütter, P. and Lando, D. (2008), 'Decomposing swap spreads', *Journal of Financial Economics*, **88**:2, pp. 375–405.
[15] Ibid., p. 378.
[16] Krishnamurthy and Vissing-Jorgensen (2012), op. cit.
[17] Koijen, R.S. and Yogo, M. (2020), 'Exchange rates and asset prices in a global demand system', No. w27342, National Bureau of Economic Research.
[18] Longstaff, F.A. (2002), 'The flight-to-liquidity premium in US Treasury bond prices', No. w9312, National Bureau of Economic Research.
[19] Due to data limitations, it is not possible to reconstruct times series of spreads for maturities longer than 11 years. For illustration, as of 1 January 2010, there were only six out of 41 outstanding REFCORP bond strips that had maturities greater than or equal to 20 years. As of 19 October 2010, all outstanding REFCORP bond strips had maturities less than 20 years.

spreads have reduced significantly since early 2020 when the COVID-19 pandemic began, and are currently below their long-term average.

These estimates are consistent with the upward adjustment of 50–100bp that we recommended in our May 2020 report, which is added to the yield of 20-year index-linked gilts (ILGs) to estimate the true RfR for the CAPM.[20]

Figure 3.1 Evolution of yield spreads of nine-year and 11-year zero-coupon REFCORP bonds strips since 2010



Note: Assumes a cut-off date of 27 May 2021. The yield spreads at a given point in time are calculated by averaging the daily spreads across all outstanding REFCORP bond strips that have maturities equal to the target maturities at that time (i.e. nine-year and 11-year). The spreads are calculated based on the USD US Treasury Bonds/Notes (FMC 82) Zero Coupon Yield curve, which has maturities available at yearly intervals between one year and ten years, and also at 15 years, 20 years and 30 years. The gaps between these maturities are linearly interpolated.

The nine-year spreads series are not available until 20 July 2011, as no REFCORP bond strips have maturities shorter than or equal to nine years before that date. The 11-year spreads series are not available after 17 October 2019, as no REFCORP bond strips have maturities longer than or equal to 11 years after that date. Due to data limitations, it is not possible to reconstruct times series of spreads for maturities longer than 11 years. For illustration, as of 1 January 2010, there are only six out of 41 outstanding REFCORP bond strips that have maturities greater than or equal to 20 years. As of 19 October 2010, all outstanding REFCORP bond strips have maturities less than 20 years.

Source: Oxera analysis using Bloomberg data.

3.2.2 Negative beta on government bonds supports the existence of the convenience premium

As observed by the CMA, the RfR is the representation of the return required on a 'zero-beta' asset within the CAPM.[21] Therefore, the evidence of negative betas in government bonds shows that the yield on government bonds is not an appropriate proxy for the RfR, and supports the existence of a convenience premium. Evidence from the US Federal Reserve highlights that:[22]

[20] See Oxera (2020), 'Review of the CMA PR19 provisional findings', 26 October, p. 14; and Oxera (2020), 'Are sovereign yields the risk-free rate for the CAPM?', 20 May, p. 2.
[21] Competition and Markets Authority (2020), 'Anglian Water Services Limited, Bristol Water plc, Northumbrian Water Limited and Yorkshire Water Services Limited price determinations – Provisional findings', 29 September, para. 9.38.
[22] Federal Reserve (2019), 'Monetary Policy, Price Stability, and Equilibrium Bond Yields: Success and Consequences', 12 November, speech by Vice Chair Richard H. Clarida.

> [s]ince the late 1990s, the empirical correlation between bond and stock returns has **typically been negative** (the bond return beta to stocks has averaged negative 0.2). [Emphasis added]

On this basis, the Federal Reserve adds:

> [W]e would expect **the equilibrium yield on bonds to be lower than otherwise**, as investors should bid up their price to reflect their value as a hedge against equity risk (relative to their value when the bond beta to stocks was positive). [Emphasis added]

The conclusion that a true zero-beta asset must have higher equilibrium expected return than the yield on government bonds is consistent with the Federal Reserve's view that the negative betas of government bonds have led to a lower equilibrium yield.

This conclusion from the Federal Reserve is also consistent with and additional to the findings in Feldhütter and Lando (2008), in which the authors explained that the convenience premium pushes the yields on government bonds below the required rate of return for a zero-beta asset.[23]

The Federal Reserve's view on the negative beta for government bonds originates from two academic papers: Campbell, Sunderam and Viceira (CSV) (2017), and Campbell, Pflueger and Viceira (CPV) (2020). The analysis of the CSV paper also shows that the negative correlations are driven by the flight-to-safety effect of government bonds, a concept that is consistent with our emphasis on the convenience premium attached to government bonds:[24]

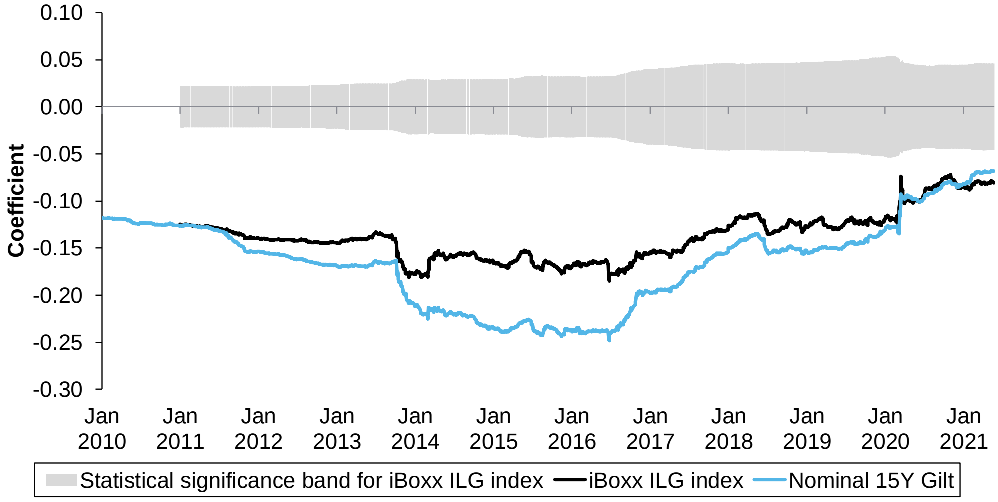
> [W]hen bonds' real returns have hedging value to consumers, the model implies that bond and stock risk premia are negatively correlated.

For the UK, we find that the correlation between government bond return and equity return is consistently and significantly negative using daily return data.[25]

Specifically, we implement five-year rolling regressions, regressing the daily return on bond indices (for both nominal and ILG bond indices) against the daily return on an equity market index (i.e. FTSE All-Share index). The series of coefficients and a statistical significance band can be found in Figure 3.2 below. Where the regression coefficients fall outside the statistical significance band (coloured in grey), these coefficients are statistically significant at a 5% significance level. It can be seen that, since 2010, there has been a persistent and significant negative correlation between daily gilt returns (for both nominal gilts and ILGs) and daily equity market returns.

[23] Feldhütter and Lando (2008), op. cit., p. 378.
[24] Campbell, J.Y., Pflueger, C. and Viceira, L.M. (2020), 'Macroeconomic drivers of bond and equity risks', *Journal of Political Economy*, **128**:8, pp. 3148–85.
[25] Oxera (2020), 'Review of the CMA PR19 provisional findings', 26 October, p. 13.

Figure 3.2 Coefficients and statistical significance band for five-year rolling regression of return on UK gilts against return on FTSE All-Share index



Note: Assumes a cut-off date of 27 May 2021. These coefficients are calculated by regressing the daily return on bond indices against the daily return on the FTSE All-Share index. The two bond indices considered are the iBoxx ILG index (iBoxx ILG index) and the UK Benchmark 15-year index (Nominal 15Y Gilt). All indices are stated on a total return basis.

We use the iBoxx ILG index, which covers ILGs with different maturities. The price data of this index has been available only since the beginning of 2006. As a result, the five-year coefficients and the significance bands are available from 2011 onwards.

Source: Oxera analysis using data from Thomas Reuters Datastream and Markit iBoxx.

3.3 Evidence of high corporate risk-free rates

The CAPM assumes that all investors can borrow at the same RfR. However, in reality, even investors with the highest creditworthiness face significantly higher borrowing rates than those faced by the governments with high credit ratings.

Berk and DeMarzo (2014) also commented on the issue in a section on 'Determining the risk-free rate' in the third edition of their book *Corporate Finance*:[26]

> The risk-free interest rate in the CAPM corresponds to the risk-free rate at which investors can both borrow and save. We generally determine the risk-free saving rate using the yields on U.S. Treasury securities. Most **investors, however, must pay a substantially higher rate to borrow funds**. In mid-2012, for example**,** even the highest credit quality borrowers had to pay almost 0.30% over U.S. Treasury rates on short-term loans. Even if a loan is essentially risk-free, this premium compensates lenders for the difference in liquidity compared with an investment in Treasuries. [Emphasis added]

Berk and DeMarzo also gave the following examples:[27]

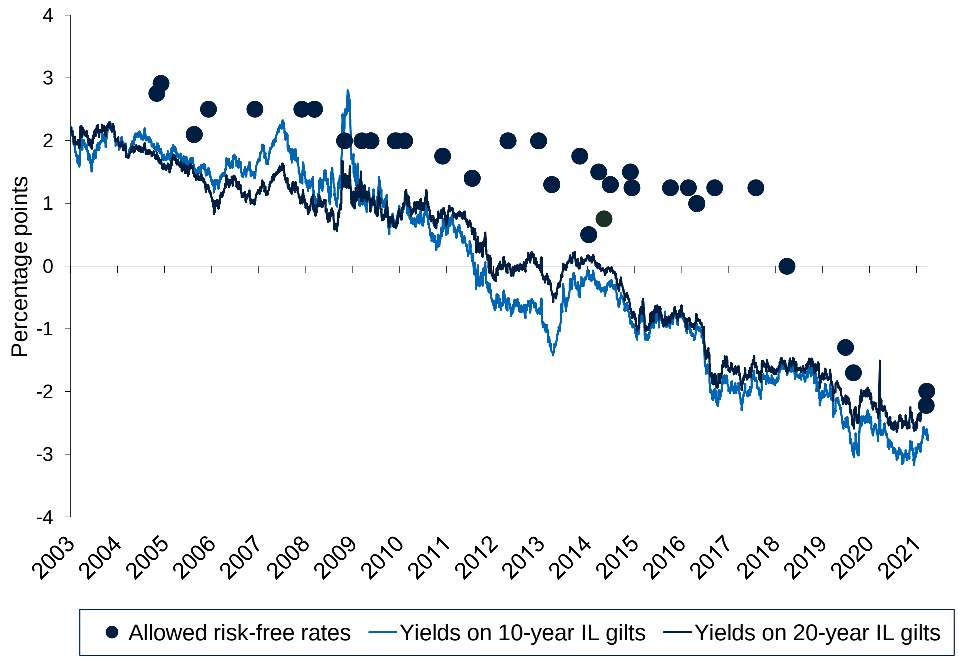
> short-term margin loans from a broker are often **1–2**% higher than the rates paid on short-term Treasury securities. Banks, pension funds, and other investors with large amounts of collateral can borrow at rates that are generally within **1%** of the rate on risk-free securities. [Emphasis added]

[26] Berk and DeMarzo (2014), op. cit., p. 404.
[27] Ibid., p. 398.

3.4 The issue of risk-free rate underestimation has not emerged during previous price controls due to the regulatory practice of setting the risk-free rate higher than spot yields on government bonds

Ofgem is concerned that using yields on AAA-rated bond indices as an input to estimate the RfR in a price control setting is a departure from past regulatory practice.[28] As we set out in our first RfR report submitted to the CMA, the issue of underestimation of RfR was not raised in the past due to the regulatory practice of setting an RfR higher than the spot yield on ILGs.[29] Figure 3.3 presents the difference between historical regulatory RfR allowances in the UK and spot yields on government bonds.

Figure 3.3 Regulatory precedents on the risk-free rate



Source: Oxera analysis based on past regulatory determinations. This excludes Ofwat's PR19 Final Determinations and Ofgem's RIIO-2 Final Determinations, as they are being contested.

It can be seen that before 2019 the regulatory allowance for the RfR was set above the spot yields on government bonds. The average gap was 149bp over 10Y ILGs and 131bp over 20Y ILGs. The gap had previously avoided the underestimation of the RfR in the CAPM framework.

These allowances were not explicitly set to compensate for the convenience yield and the gap between the risk-free financing rates available to sovereigns and investors. However, they worked to ensure that the imperfection of the spot sovereign yields as a proxy for the RfR in the CAPM was mitigated.

To allow the RfR to be more responsive to current market conditions during the RIIO-2 control, Ofgem has introduced the CoE indexation mechanism. However, under this new approach it is an error to use the spot rates of the ILGs to represent the RfR in the CAPM.

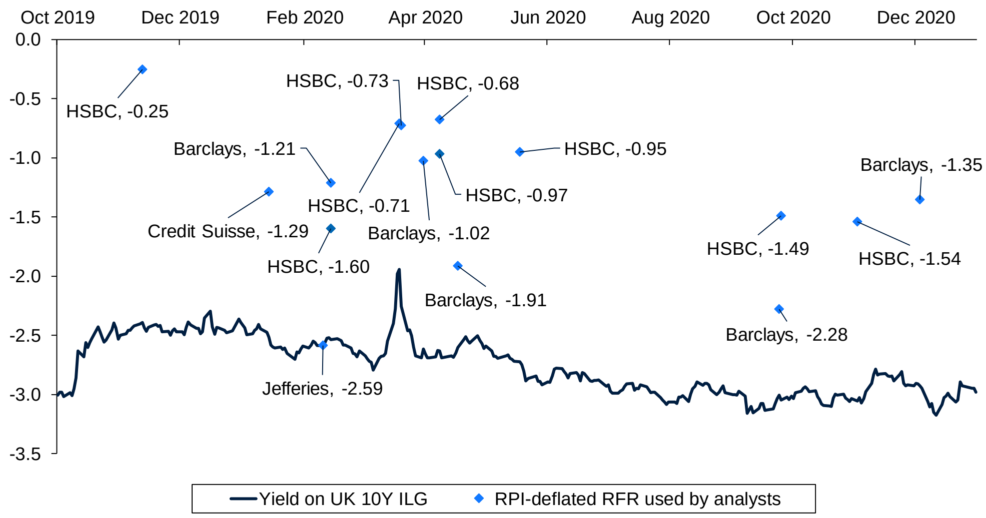
[28] Ofgem (2020), 'Letter from Ofgem to the CMA regarding Anglian Water Services Limited, Bristol Water plc, Northumbrian Water Limited and Yorkshire Water Services Limited price determinations: Provisional Findings', para. 28.
[29] Oxera (2020), 'Are sovereign yields the risk-free rate for the CAPM?', 20 May, p. 16.

3.5 The risk-free rates assumed by equity analysts are generally higher than the yield on government bonds

In this section, we show that, as a cross-check, equity analysts use RfRs for the CAPM that are higher than the yield on government bonds. Specifically, as set out in our RfR report and subsequent notes to the CMA, we show that the RPI-deflated RfRs adopted by equity analysts covering listed UK utilities are nearly always higher than the yields on ten-year ILGs.[30] The difference ranges between 0bp and 214bp and averages at 101bp.[31] This is shown in Figure 3.4. Note, further, that our averaging method attributes significant weight to Jefferies, which does not adjust from the ILG yield. Removing this data point results in an average spread of 135bp.

In sum, evidence from equity analysts shows that the RfRs adopted by market participants are significantly higher than the yield on government bonds.

Figure 3.4 Daily yields on ten-year ILGs and RPI-deflated risk-free rates adopted by sell-side analysts on the Oxera UK comparators



Note: Oxera UK comparators include National Grid, Pennon, United Utilities, Severn Trent and SSE. We used the ten-year tenor of the ILGs, as Jefferies and HSBC explicitly disclose using this maturity in their analysis. Barclays and Credit Suisse do not disclose the maturity for the RfR assumed in their analysis.

Source: Jefferies (2020), 'Utilities. When the Facts Change…Upgrade UU to Buy', 10 February; HSBC (2019), 'Pennon Group. Buy: Capital allocation – a point of inflection', 12 November; HSBC (2020), 'Pennon Group. Buy: FD accepted, waste purchasers queue up', 14 February; HSBC (2020), 'National Grid. Upgrade to Buy: A truly defensive play', 19 March; HSBC (2020), 'Pennon Group. Pure play company with Viridor sale', 20 March; HSBC (2020), 'SSE. Dividend disruption premium', 8 April; HSBC (2020), 'United Utilities. Upgrade to Buy: Financial prudence, high visibility', 8 April; HSBC (2020), 'Severn Trent. Hold: Value creation and ESG showcasing', 18 May; HSBC (2020), 'Pennon Group. Buy: Trading in line; Waste proceeds update at H1', 25 September; HSBC (2020), 'United Utilities. Downgrade to Hold: Challenging times', 2 November; Credit Suisse (2020), 'National Grid. Risk discount dissipating', 14 January; Barclays (2020), 'Pennon Group / Severn Trent. Happy Valentine's Day Ofwat – and could CMA referrals be a match for Ofgem?', 14 February; Barclays (2020), 'Severn Trent. Severn Trent in line for 2020 but 2021 may see some downgrades', 31 March; Barclays (2020), 'Severn Trent / United Utilities. Ofwat consults on providing temporary liquidity', 17 April; Barclays (2020), 'United

[30] Oxera (2020), 'Risk-free rate used by equity analysts', 14 September; and Oxera (2020), 'Are sovereign yields the risk-free rate for the CAPM?', 20 May, section 4.
[31] The average is calculated as follows: first, the RfRs are averaged for each broker (i.e. HSBC, Barclays, Jefferies and Credit Suisse). The resulting estimates are then averaged across all brokers. See Oxera (2020), 'Are sovereign yields the risk-free rate for the CAPM?', 20 May, Figure 4.1.

Utilities. Trading Statement, no bad debt issues yet', 24 September; Barclays (2020), 'National Grid / SSE. RIIO-2 a major catalyst for NG and SSE?', 3 December.

3.6 Long-term SONIA swap rates are inappropriate cross-checks for the risk-free rate

In this section, we consider the proposal by Ofgem to use the SONIA swap rate as a proxy for the RfR in the CAPM, in the context of the RIIO-ED2 price control.

In its Final Determinations for RIIO-T2 and RIIO-GD2, Ofgem commented on, among other things, the potential benchmarks that can be used to estimate the RfR in the CAPM. It considered the 20-year SONIA swap rate to be a potential measure of the nominal RfR.

In a report published by the Bank of England dated 3 June 2021, the Bank concluded that:[32]

> The SONIA OIS market is considered DLT [Deep, Liquid and Transparent] at the following maturities: 1-10, 12, 15, 20, 25, 30, 40 and 50 years.

While this report provides evidence on the liquidity of SONIA swaps, other evidence still suggests that long-term SONIA swap rates are inappropriate cross-checks for the risk-free rate in the context of the RIIO-ED2 price control.

First, the 20-year SONIA swap will have a duration that is shorter than the 20-year zero-coupon nominal gilt Ofgem presented as a comparison, owing to the periodic payments associated with swaps. A longer maturity swap would be required to match the duration of the 20-year zero-coupon gilt.

Second, a wide body of academic literature has studied how capital market imperfection and supply–demand imbalances (i.e. swap-specific factors) distort swap rates downwards.

Boyarchenko et al. (2018) focus on limits to arbitrage resulting from the more stringent regulatory requirements for swap dealers. Specifically, they argue that exogenous factors narrowed spreads. These factors included, for example: increased swapping of fixed-rate debt into floating-rate debt; and increased demand by insurance and pension funds to match the extending durations of their liabilities as longer-term government yields declined. Higher capital requirements reduced incentives for market participants to enter into arbitrage trades that would have counteracted the effects of exogenous shocks.[33] The authors conclude that, given the balance sheet costs for the dealers, spreads must reach more negative levels to generate an adequate risk-adjusted return on equity for dealers. The authors' conclusions are supported by the observations of Chowdhury and Wurm (2017) on the UK swap market:[34]

> More puzzling, perhaps, the strong inversion of swap spreads across maturities and persistent, negative long-term swap spreads suggest the presence of unexploited arbitrage opportunities. Increased regulation motivating end-of-quarter bond sell-offs by banks and large-scale QE-induced tightness of the

[32] Bank of England (2021), 'Deep, liquid, and transparent (DLT) assessment of the Sterling Overnight Index Average (SONIA) Overnight Index Swap (OIS) market - June 2021', 3 June.
[33] Boyarchenko, N., Gupta, P., Steele, N. and Yen, J. (2018), 'Negative swap spreads', *Federal Reserve Bank of New York Economic Policy Review*.
[34] Chowdhury, S. and Wurm, M.A. (2017), 'Modelling and Forecasting Interest Rate Swap Spreads', *Moody's Analytics risk perspectives,* available at: https://www.moodysanalytics.com/risk-perspectives-magazine/managing-disruption/principles-and-practices/modeling-and-forecasting-interest-rate-swap-spreads (last accessed 30 June 2021).

> repo market, resulting in **costlier and thus unprofitable hedges**, are the most likely explanations for reduced **dealer appetite** to participate in such agreements. [Emphasis added]

For the euro market, where the supply of interest rate swaps is lower, Domanski et al. (2017) explain that the impact of demand-driven pressure on the swap spreads can be extremely significant:[35]

> [W]hen [the] long-term interest rate fell sharply in December 2008, Dutch pension funds' coverage ratios fell to about 95 percent, and their attempts to close their interest rate gaps via the use of swaps were associated with a **31 percent cumulative decline** in the 50-year swap rate in just two days (3-4 December). [Emphasis added]

Reinforcing the work of Boyarchenko et al. (2018), Klinger and Sundaresan (2019) offer a demand-driven explanation for the negative swap spreads of long-maturity bonds. The authors develop a model in which underfunded pension plans' demand for duration hedging leads them to create demand for the fixed rate in swaps with long maturities. The authors explain that:[36]

> Pension funds have long-term liabilities in the form of unfunded pension claims and invest in a portfolio of assets, such as stocks, as well as in other long-term assets, like government bonds. They can balance their asset-liability duration by investing in long-term bonds or by receiving fixed in an IRS [interest-rate swap] with long maturity. Our theory predicts that, **if pension funds are underfunded, they prefer to hedge their duration risk with IRS rather than buying Treasuries**, which may be not feasible given their funding status. The preference for IRS to hedge duration risk arises because the swap requires only modest investment to cover margins, whereas buying a government bond to match duration requires outright investment. **This demand, when coupled with dealer balance sheet constraints [as set out in Boyarchenko et al. (2018)], results in negative swap spreads**. [Emphasis added]

Empirically, the authors also find that the aggregate funding status of defined benefit pension plans is a significant explanatory variable of 30-year swap spreads in the USA, providing further evidence that spreads are affected by swap-specific factors and are not a good proxy variable for the RfR.

Jermann (2020) develops a theoretical framework explaining long-term negative swap spreads under limited arbitrage. Consistent with explanations focusing on capital market inefficiencies, this theory assumes frictions limiting the size of dealers' fixed-income portfolios and derives negative swap spreads even in the absence of demand-side effects.[37]

In conclusion, a variety of swap-specific factors have been explored in the academic literature on negative swap rates. This literature shows that swap-specific factors distort swap rates as a suitable proxy for the RfR for use in the CAPM. These distorting effects are more pronounced for long-maturity swaps. Therefore, we do not consider the 20-year SONIA swap rate to be the appropriate proxy for the RfR in the context of the RIIO-ED2 price control.

We further note that the negative swap rate implies even lower yields based on 20-year SONIA swaps than for 20-year government bonds, when the latter are already biased downward due to the convenience premium. It is therefore inappropriate for Ofgem to use the 20-year SONIA swap rates, which are

[35] Domanski, D., Shin, H.S. and Sushko, V. (2017), 'The hunt for duration: not waving but drowning?', *IMF Economic Review*, pp. 113–53.
[36] Klingler and Sundaresan (2019), 'An explanation of negative swap spreads: Demand for duration from underfunded pension plans', pp. 675–710.
[37] Jermann, U. (2020), 'Negative Swap Spreads and Limited Arbitrage', *Review of Finance*, pp. 212–38.

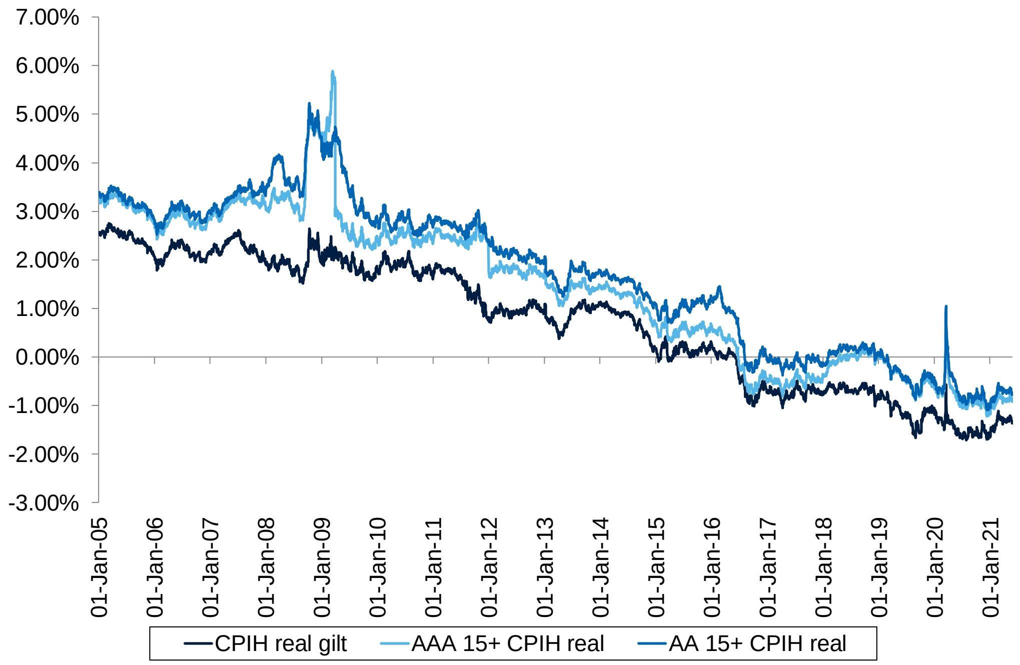
derivatives subject to capital market imperfection and supply–demand imbalances, as the cross-checks for the long-term RfR for the CAPM.

3.7 Top-down approach

In line with the recommendation in Berk and DeMarzo (2014), this section focuses on the market evidence on the yields of 'highest quality corporate bonds'. In particular, we present the yields on AAA-rated corporate bonds, as well as their spreads over UK ILGs. We also consider the yields on AA-rated bonds as a cross-check.

Figure 3.5 presents yields on indices of sterling-denominated AAA and AA corporate bonds with 15+ years to maturity. These yields have consistently had a positive spread relative to government bonds of comparable maturity.

Figure 3.5 Real yields on corporate and government bonds



Note: The yields of iBoxx corporate bond indices are deflated using the average of 15-year and 20-year ILG-implied inflations from the Bank of England, adjusted for the RPI–CPIH wedge.

Source: Oxera analysis based on data from IHS Markit and Bank of England.

Table 3.1 below indicates that the AAA spread has ranged between 44bp and 47bp in the last six months, which is low in comparison to longer-term historical averages, and suggests that the RfR would be underestimated if it was set equal to spot or forward yields on government bonds.

Table 3.1 Spot and average yields with maturity of 15+ years

	Spot	Three-month average	Six-month average
20Y ILG average	–2.26%	–2.22%	–2.32%
20Y ILG average, CPIH real	–1.33%	–1.29%	–1.39%
iBoxx £ corp AAA 15+, real	–0.86%	–0.86%	–0.94%
Cross-check: iBoxx £ corp AA 15+, real	–0.73%	–0.69%	–0.79%
	Spread (bp)	**Spread (bp)**	**Spread (bp)**
iBoxx £ corp AAA 15+, real	0.47%	0.43%	0.44%
Cross-check: iBoxx £ corp AA 15+, real	0.60%	0.60%	0.60%

Note: The yields of iBoxx corporate bond indices are deflated using the 20-year ILG-implied inflations from the Bank of England. Based on the OBR's forecast, a CPIH–RPI wedge of 95bp is assumed to derive the CPIH-real values. A cut-off date of 27 May 2021 is assumed.

Source: Oxera analysis based on data from IHS Markit and Bank of England. Office for Budget Responsibility (2021), 'Economic and fiscal outlook', March.

The yield spread on the iBoxx £ corp AAA 15+ index depicted in Figure 3.5 was a cross-check to the convenience premium in our RfR report, dated May 2020.[38] We have observed that IHS Markit subsequently removed three of the six constituents (including two bonds issued by the University of Cambridge and one by the University of Oxford) from that index. The exclusion of half of the bonds in the index negatively affects the quality of this particular index and its robustness as a cross-check of the bottom-up approach.

Notwithstanding the specific features of this particular iBoxx index, in principle using any AAA corporate bond index as the sole method to estimate the RfR requires consideration of factors that may have a differential impact on AAA corporate bond yields as compared with government bond yields, such as liquidity premia and default risk.

3.7.1 Premium on expected loss

Elton, Gruber, Agrawal and Mann (2001) considered actual default rates and bankruptcy recovery rates on corporate debt and showed that a risk-neutral investor will require (at most) a 5bp default premium to invest in a ten-year AA-rated corporate bond.[39]

Berk and DeMarzo (2014) reported data from Moody's that indicates an annual default rate of 0.0% for AAA corporate bonds over 1983–2011 based on a ten-year holding period.[40] The authors also report an average loss rate for unsecured debt of about 60%. This data is consistent with the expected loss component of the AAA corporate yield being close to zero over a ten-year horizon.

Feldhütter and Schaefer (2018) provided estimates of default probabilities using a structural model (Black–Cox) and a new approach for calibrating the

[38] Oxera (2020), 'Are sovereign yields the risk-free rate for the CAPM?', 20 May.
[39] Elton, E., Gruber, M., Agrawal, D., and Mann, C. (2001), 'Explaining the Rate Spread on Corporate Bonds', *The Journal of Finance*, **56**:1, February, Table 6.
[40] Berk, J. and DeMarzo, P. (2014), *Corporate Finance: Third Edition*, Pearson, Table 12.2.

model to historical default rates that leads to more precise estimates of investment-grade default probabilities. The authors presented estimates of default probabilities and premiums up to a 20-year investment horizon.

The authors report actual cumulative default probabilities of 0.87% and 1.71% for AAA-rated corporate bonds over ten- and 20-year horizons.[41] The default probabilities implied by the Black–Cox model are reported as 0.54% and 1.18% for these horizons. The annualised default probabilities are obtained by dividing these figures by the investment horizon. Multiplying by an average loss rate of 60% gives the annualised default premiums, as reported in Table 3.2.

Table 3.2 Estimates of default premiums

Horizon	Ten-year	20-year
Actual	0.03%	0.04%
Black–Cox model	0.05%	0.05%

Source: Oxera analysis based on Feldhütter, P. and Schaefer, S.M. (2018), 'The myth of the credit spread puzzle', *The Review of Financial Studies*, **31**:8, pp. 2897–2942, Table 8.

In addition, Feldhütter and Schaefer (2018) account for the systematic risk premium in AAA corporate yields. Although it is rare for a bond to default when rated AAA, some bonds that default will have originally been rated AAA when they were issued. As the investment horizon increases, the cumulative default probability and the risk premium increase. The uncertainty of the estimate also increases, particularly given that defaults of bonds originally rated AAA at issue are rare.

Table 3.3 summarises the estimated spreads between AAA corporate yields and the underlying RfR, taking into account both default risk and the systematic risk premium. Both the actual and modelled spreads increase with the investment horizon. The divergence between actual and modelled spreads also increases with the investment horizon.

Table 3.3 Estimated spreads of AAA corporate bond yields to risk-free rate

Horizon	7–13-year	13–20-year
Actual	0.06%	0.22%
Black–Cox model	0.01%	0.02%

Source: Oxera analysis based on Feldhütter, P. and Schaefer, S.M. (2018), 'The myth of the credit spread puzzle', *The Review of Financial Studies*, **31**:8, pp. 2897–942, Table 9.

The evidence presented in this section illustrates the following points with respect to estimates of the premium for expected loss on AAA corporate bonds.

- The estimates are based on long time series that average out any volatility in the premium for expected loss over short time horizons.
- There is a wide range of uncertainty around the estimates across the different estimation approaches.

This means that there is a risk of inconsistency when making such adjustments to any particular AAA-rated corporate bond or index. To the extent that such adjustments are appropriate in any specific circumstance, at a ten-year

[41] Feldhütter, P. and Schaefer, S.M. (2018), 'The myth of the credit spread puzzle', *The Review of Financial Studies*, **31**:8, pp. 2897–942, Table 8.

horizon, a downward adjustment of approximately 5bp to the yields on AAA corporate bonds could be considered to control for expected loss. At a 20-year investment horizon, a larger downward adjustment of 5–20bp could be considered.

3.7.2 Premium on liquidity

Liquidity risks may need to be accounted for, when using the yield on AAA corporate bonds to inform the estimate of RfR for the CAPM. This can be done by deducting a liquidity premium from the yield on AAA bonds. Below, we discuss the existing empirical evidence from the academic literature, as well as the findings from our own empirical analysis.

Van Loon (2015) decomposed the credit spreads of the constituents of the iBoxx GBP Investment Grade Index from 2003 to 2014, and found that the median liquidity premium on AAA bonds fluctuated between c. –8bp and +48bp.[42] Excluding the periods of the global financial crisis (2007–08) and the height of the European debt crisis (2011–12), the median liquidity premium largely fluctuates between 0bp and +20bp. While this analysis relied on pre-2014 data, it serves as cross-check on our own empirical analysis, which we present below.

While there are many proxy measures of liquidity, our empirical analysis focuses primarily on the bid–ask spread of the constituents of the iBoxx £ Corp AAA 15+ index.[43]

The bid–ask spreads are expressed in percentage terms, calculated as $\frac{(Ask\ price – Bid\ price)}{Mid\ price}$.[44] We calculate the six-month trailing average of the percentage bid–ask spread preceding 27 May 2021 for each constituent of the iBoxx £ Corp AAA 15+ index.[45]

A liquidity premium of 12bp is calculated by dividing the percentage bid–ask spreads over an assumed holding period of 20 years.[46] This estimate is largely in line with those estimated by Van Loon (2015).

3.8 Oxera’s risk-free rate estimate for RIIO-2

We consider that an appropriate range for the RfR can in principle be informed by both the bottom-up and the top-down RfR estimation approaches.[47] However, as noted in section 3.7, IHS Markit has subsequently removed three of the six constituents from the iBoxx £ corp AAA 15+ index, which reduces the quality of this particular index and its robustness as a cross-check of the bottom-up approach.

The bottom-up approach refers to estimating the RfR by adding a convenience premium to the ILG yields. Previously, we used the spot yield on the 20-year

[42] Inferred from Figure 20 in Van Loon, P.R., Cairns, A.J., McNeil, A.J. and Veys, A. (2015), ‘Modelling the liquidity premium on corporate bonds’, *Annals of Actuarial Science*, **9**:2, pp. 264–89.
[43] Oxera (2020), ‘Adjusting AAA corporate bond yields for expected loss’, 20 July, p. 2.
[44] The percentage bid–ask price may also be calculated using the ask price or the bid price as the denominator. In our analysis, we follow the definition set out in the IMF’s Financial Soundness Indicators Compilation Guide, which uses the mid-price as the denominator. See International Monetary Fund (2006), ‘Financial Soundness Indicators Compilation Guide’, para. 8.44.
[45] The iBoxx £ Corp AAA 15+ index has three constituents as of 27 May 2021.
[46] We note that the CMA used the yields on 20-year ILGs as inputs to its RfR estimation. This implicitly assumes a 20-year holding period.
[47] Oxera (2020), ‘Review of the CMA PR19 provisional findings’, 26 October; and Oxera (2020), ‘Further analysis of the CMA PR19 Provisional Findings on risk-free rate’, 4 December.

ILG for the bottom-up approach.[48] Given the recent volatility in ILGs, we now use the six-month trailing average rather than the spot yield. As noted by the CMA in the PR19 final reports, this will mitigate the impact of any short-term volatility.[49] Specifically, we:

- apply the **lower bound** of our estimates of the convenience premium contained in our RfR report submitted to the CMA (+50bp) to the six-month trailing average yield on the 20-year ILG as at 27 May 2021 (–2.32% RPI-real, or –1.39% CPIH-real, deflated using the breakeven inflation);[50]

- apply a forward rate adjustment of +11bp, estimated using Ofgem's methodology set out in the Final Determinations WACC allowance model and assuming a cut-off date of 27 May 2021.[51]

This leads to an estimate of **–0.77%**.

The top-down approach refers to estimating the RfR using AAA corporate bond yields. This approach has the benefit of starting with a rate unaffected by the convenience yield. Adjustments can then be considered to control for factors that may have a differential impact on AAA corporate bond yields as compared with government bond yields, such as liquidity premia and default risk. Specifically, we:

- deflate the nominal yields on iBoxx £ Corp AAA 15+ index using the breakeven RPI inflation rates, and apply a 0.95% RPI–CPIH wedge (based on the OBR's March forecast) to derive the CPIH-real values. This modification removes any premium for inflation risk that is embedded in nominal yields;

- take the six-month trailing average of the CPIH-deflated yield on the AAA bond index, and make downward adjustments of 13bp for expected loss[52] and 12bp for the liquidity premium, as explained in sections 3.7.1 and 3.7.2 respectively.

Table 3.4 presents the RfR estimated using the top-down approach. By applying the adjustments for forward premium, expected loss and liquidity premium to the CPIH-real six-month trailing average yield of the iBoxx £ corp AAA 15+ index, we arrive at an estimate of **–1.08%**.

[48] Oxera (2020), 'The cost of equity for RIIO-2 – Q3 2020 update', 4 September, p. 14, Table 2.5.
[49] Competition and Markets Authority (2021), 'Anglian Water Services Limited, Bristol Water plc, Northumbrian Water Limited and Yorkshire Water Services Limited price determinations – Final Report', 17 March, para. 9.208.
[50] Ofgem used the spot yield on the 20-year ILG to inform its RfR determination.
[51] Ofgem's RIIO-T2 and GD2 Final Determinations found a forward rate adjustment of +16bp, assuming a cut-off date of 30 October 2020. See Ofgem (2020), 'RIIO-2 Final Determinations – Finance Annex', December, p. 26.
[52] We apply a downward adjustment of 13bp, which is the midpoint of our recommended range for a 20-year investment horizon (i.e. the midpoint of 5–20bp, rounded up to the nearest bp), as set out in our note to the CMA.

Table 3.4 Risk-free rate estimation (CPIH-real)

	Value
iBoxx £ corp AAA 15+, six-month trailing average, CPIH-real[1]	–0.94%
+ forward premium[2]	+0.11%
– adjustment for expected loss[3]	–0.13%
– adjustment for liquidity premium[4]	–0.12%
RfR with adjustments	–1.08%

Note: [1] The yields of the iBoxx £ corp AAA 15+ index are deflated using 20-year ILG-implied inflations from the Bank of England. An RPI–CPIH wedge of 95bp is assumed to derive the CPIH real values. A cut-off date of 27 May 2021 is assumed. [2] Oxera estimate using Ofgem methodology, assuming a cut-off date of 27 May 2021. [3] We apply a downward adjustment of 13bp, which is the midpoint of our recommended range for a 20-year investment horizon (i.e. the midpoint of 5–20bp, rounded up to the nearest bp), as set out in our note to the CMA. [4] We assume a holding period of 20 years.

Source: Oxera analysis based on data from IHS Markit and Bank of England.

We recommend placing more weight on the bottom-up approach, which produces an estimate of **–0.77%** for two reasons.

First, the bottom-up approach takes a medium- to long-term view on the evidence on convenience yields, while the top-down approach as currently implemented combines a short-term measure of AAA yields with adjustments that include a long-term estimate of the premium for expected loss. This horizon mismatch will understate the RfR when AAA yield spreads narrow if the premium for expected loss is positively correlated with AAA yield spreads. The medium- to long-term estimates used in the bottom-up approach are more appropriate for a five-year price control period.

Second, when applying the top-down approach there is a high degree of estimation uncertainty around any adjustments (e.g. the premium for expected loss), and a risk of inconsistency when making such adjustments to any particular AAA-rated corporate bond or index.

In sum, our estimate of the CPIH-real RfR for RIIO-2 lies between **–1.08% and –0.77%** (with a mid-point of **–0.93%**) as at 27 May 2021. We recommend placing more weight on the upper end of this range for the reasons set out above.

4 TMR and ERP

This section sets out the updated evidence on the TMR. As in the 2019 and 2020 Oxera reports, we rely on historical evidence from DMS as the primary source of input, together with the forward-looking evidence derived from the Oxera implementation of the Bank of England DDM as a cross-check.[53] We also present evidence from academic surveys by Fernandez et al.

4.1 Historical evidence and inflation

The 2020 Oxera report presented the long-run average UK equity market returns based on the 2020 edition of the DMS book, which covered data from 1899 to 2019. At that time, the long-run geometric and arithmetic averages of the real UK equity market returns were 5.5% and 7.3% respectively. Based on the 2021 edition of DMS, which covers data from 1899 to 2020, the long-run geometric and arithmetic averages of the real UK equity market returns have decreased by 0.1%, to 5.4% and 7.2% respectively.

In the 2019 Oxera report, we mentioned that academic studies have shown that averaging equity returns for the period 1899–2018 produces the lowest average relative to any other averaging period, either shorter or longer. This suggests that estimates of the long-term equity market return based on the period covered by the DMS dataset may be downward-biased.[54]

In addition, as noted in the 2019 Oxera report, since the 2019 edition of DMS, the book has deflated the nominal returns with an inflation series that is a hybrid of RPI and CPI inflation.[55] For comparability, one must obtain real returns that are consistent with RPI or CPI inflation over time. Therefore, we cannot directly rely on the DMS real estimates. Rather, the nominal returns shown in the DMS book need to be deflated by a different inflation series from the one presented therein. In the 2019 Oxera report, we outlined two possible methods for achieving this, namely:

1. adding the forecast RPI–CPIH wedge to RPI-real historical returns restated using today's RPI methodology (which is Oxera's preferred approach);
2. deflating nominal returns by CPI inflation, adjusted for bias in the historical estimates of CPI.

To implement the first approach, we created an adjusted RPI series as part of our work for Heathrow Airport. The intention was to build a hypothetical historical RPI series as if it were restated using today's RPI methodology. As noted in the 2019 Oxera report, if the historical (1899–2019) RPI series was restated using today's RPI calculation methodology, the series could be up 30bp higher than if based on the official RPI series published by the ONS.[56]

[53] See Oxera (2019), 'The cost of equity for RIIO-2: Q4 2019 update', pp. 12–27; and Oxera (2020), 'The cost of equity for RIIO-2 – Q3 2020 update', 4 September, pp. 15–26.
[54] Oxera (2019), 'The cost of equity for RIIO-2: Q4 2019 update', p. 13. See, for instance, Grossman, R.S. (2014), 'Bloody Foreigners! Overseas Equity on the London Stock Exchange, 1869 to 1928', January, Wesleyan University, Connecticut; Turner, J., Acheson, G., Hickson, C. and Ye, Q. (2008), 'Has equity always earned a premium? Evidence from nineteenth-century Britain', 10 May, available at: https://voxeu.org/article/has-equity-always-earned-premium-evidence-nineteenth-century-britain (last accessed 3 October 2019); and NGET (2019), 'National Grid's response to Ofgem's RIIO-2 sector-specific methodology consultation – Finance', pp. 24–25.
[55] Dimson, E., Marsh, P. and Staunton, M. (2019), 'Credit Suisse Global Investment Returns Yearbook 2018', February.
[56] Oxera (2019), 'Estimating RPI-adjusted equity market returns', 2 August.

We subsequently undertook further research on the historical RPI series, and in an updated report concluded that there are likely to have been significant methodological changes in the RPI series other than just the 2010 change related to the way the ONS collects clothing prices. Making a selective upward adjustment to the long-run average of RPI inflation based on just the 2010 change ignores these other changes and is therefore not robust and is likely to bias the estimate of long-run RPI inflation upwards. If, for example, the changes in the early 1990s are also accounted for, it would be appropriate to deflate the long-run average equity return using the published RPI data without making any further adjustments for the forecast wedge between RPI and CPI inflation.[57]

The second approach of adjusting the historical estimates of CPI to identify and remove biases is subject to a much higher degree of uncertainty because the CPI series prior to 1997 has been estimated ex post. We consider that it is more robust to start with the official RPI historical series and then to consider any adjustments to the RPI series, such as the analysis we described above.

The historical estimates of the CPI are essentially based on estimates of what the wedge between RPI and CPI inflation would have been in the past, in particular the 'formula effect'. The empirical challenges of estimating the formula effect back to 1950 are underlined by the downward revision made by the OBR in December 2019 to estimates of how much the formula effect contributes to the wedge between RPI and CPI inflation. This revision suggests that the effect of the 2010 change to the way inflation data was collected had a lower impact on RPI inflation than we previously thought. This illustrates the risk that making adjustments to the historical RPI data could increase rather than decrease the accuracy of the real expected equity return.

We requested the data and code underlying the CPI backcast undertaken by the ONS. The ONS was unable to locate the information used to construct the historical CPI estimates, and has been unable to replicate them. The ONS is currently revising the backcast of historical CPI and there continues to be an active debate among members of the Advisory Panel on Consumer Prices – Technical regarding the methodology for correcting the backcast series of CPI.[58] We consider that it would be inappropriate to switch to this estimated historical inflation series for setting a price control when the series is under revision and may be subject to error, given that the results cannot be reproduced.

In addition to concerns about the robustness of the historical estimates of CPI, we consider that the CED/CPI estimates are likely to be materially upward-biased estimates of inflation and, therefore, to yield downward-biased estimates of real return for the following periods.[59]

- **1900–50**: this period uses Consumption Expenditure Deflator (CED) data, which is theoretically and empirically a closer proxy for RPI than CPI. Combining CED with RPI is likely to slightly understate the long-run average

[57] Oxera (2020), 'Response to the CMA on estimating RPI-adjusted equity market returns', prepared for Heathrow Airport, 15 April.
[58] Minutes of the 9 October 2020 meeting of the Advisory Panel on Consumer Prices—technical, available at: https://uksa.statisticsauthority.gov.uk/wp-content/uploads/2020/12/APCP-T2015-Minutes-October-2020_v3.pdf (last accessed 24 February 2021), section 4.
[59] As noted in National Grid (2020), 'Total Market Return: The consistency of long-run CPI and RPI inflation series in the UK, and their relative suitability for use in calculating the actual historic long-run average equity market return in the UK on a "real" basis', 23 January.

of RPI inflation, while overstating to a larger extent the long-run average of CPI inflation. See Appendix A3 for more detail.

- **1950–88**: this period uses the O'Neill and Ralph econometric backcast, which yields estimates of the RPI–CPI 'wedge' that are surprisingly small and tend to zero as the backcast is extended further back in time.[60] The modelling work reported by O'Neil and Ralph (2013), which provided the basis of the backcast CPI series, estimated that the formula effect between RPI and CPI averaged 0.7% a year over the period 1989–2011, and projected back an average of 0.29% a year over the period 1950–88.[61] However, the latter average figure masks a wide difference within the period, with levels back to 1974 being comparable to the period after 1989, but close to zero or negative before then. Given abnormally high inflation rates after the 1973 oil shock, during which the model was likely to have projected higher-than-average effects, but a tendency for the backcast methodology to understate the effect progressively the longer the back projection, the estimated average for the pre-1989 period is subject to considerable doubt.
- Additionally, the analysis was calibrated using estimates for the CPI for the 1988–96 period, which have since been revised.[62] The CMA acknowledges that these corrections had not yet been incorporated into the 1950–88 portion of the backcast.[63] There is no basis for assuming that errors in the 1988–96 portion of the backcast would not have an appreciable impact on the nearly 40 years of data prior to 1988 that was calibrated on the previously erroneous data for the 1988–96 period.

The historical RPI series is not subject to the estimation error created by using a backcast of CPI and is therefore a more reliable basis for the purpose of calculating historical real returns to inform the estimate of future returns.

As such, the rest of this section will focus on the issue of converting the average returns obtained using the first method (adjusted RPI plus the forecast RPI-CPIH wedge) to an unbiased market discount rate that can be used to set the allowed TMR.

4.1.1 Converting from a historical average to an unbiased market discount rate

The regulated allowed rate of return determines annual cash flows, which are not compounded over time in the regulatory model. Regulators have at times considered various ways of combining different estimators developed for other purposes based on geometric and arithmetic averages when determining the market parameters of the CoE. For example, regulators sometimes place weight on the estimators developed by Blume[64] and Jacquier, Kane and Marcus (JKM)[65] for the purpose of estimating the future value of an investment

[60] Oxera (2019), 'The cost of equity for RIIO-2: Q4 2019 update', p. 16.
[61] O'Neill, R. and Ralph, J. (2013), 'Modelling a Back Series for the Consumer Price Index', Office for National Statistics, p. 9.
[62] Minutes of the 7 April 2020 meeting of the Advisory Panel on Consumer Prices—technical, available at: https://uksa.statisticsauthority.gov.uk/wp-content/uploads/2020/07/APCP-T-Minutes-April_meeting_v4.pdf (last accessed 20 October 2020).
[63] Competition and Markets Authority (2020), 'Provisional findings', 29 September, para. 9.165.
[64] Blume, M.E. (1974), 'Unbiased Estimators of Long-Run Expected Rates of Return', *Journal of the American Statistical Association*, **69**:347.
[65] Jacquier, E., Kane, A. and Marcus, A. (2005), 'Optimal Estimation of the Risk Premium for the Long Run and Asset Allocation: A Case of Compounded Estimation Risk', *Journal of Financial Econometrics*, **3**:1, pp. 37–55

based on compounding of equity returns. Estimators have also been developed by Cooper for the purpose of valuation and capital budgeting.[66] However, the relationship between the estimators listed above and the unbiased estimate of the regulated allowed rate of return is a complex problem that has not been solved. Therefore, to avoid introducing downward bias into the estimate, there are two options: adopt an arithmetic average, or include the Cooper estimators alongside those of Blume and JKM.

Based on the UKRN Cost of Capital report,[67] Ofgem uses geometric averaging with a subjective uplift to estimate the arithmetic average TMR. The following text summarises the position on averaging adopted in the UKRN Cost of Capital report:[68]

> This issue was also discussed at some length in both MMW and in Smithers and Wright (2013). In that discussion we concluded, again, that rather than calculate arithmetic averages directly (which can generate spurious differences, especially when returns are affected by exchange rate fluctuations), it is more appropriate to work from geometric (compound) average returns and add an adjustment of 1 to 2 percentage points, depending on the extent to which regulators wish to take account of serial correlation of returns.
>
> […] [W]e suggest a modest downward adjustment of the original range proposed by MMW, to a range of 6-7%, primarily reflecting a smaller adjustment from geometric to arithmetic returns.

In doing so, it is proposing to set a return lower than the actual arithmetic average observed in the data, which has the result of embedding a downward bias to the value of the regulated business and undercompensating investors. This is due to the concern of Wright and Mason that returns are predictable to some degree and negatively serially correlated.[69]

However, as highlighted by the submission made by Professor Stephen Schaefer to the CMA for the NATS (2020) price control redetermination, the observed relationship between the arithmetic and geometric averages suggests that any serial correlation is insignificant, or that the impact of serial correlation on the relationship between arithmetic and geometric average returns is insignificant. Professor Schaefer states that:[70]

> [T]he difference between the arithmetic and geometric mean return is given by one half of the variance. Bound up in the assumption of normality are further assumptions that both the expected return and the variance of returns are constant over time and that returns are not serially correlated.

Professor Schaefer further shows, based on analysis of the DMS data, that:[71]

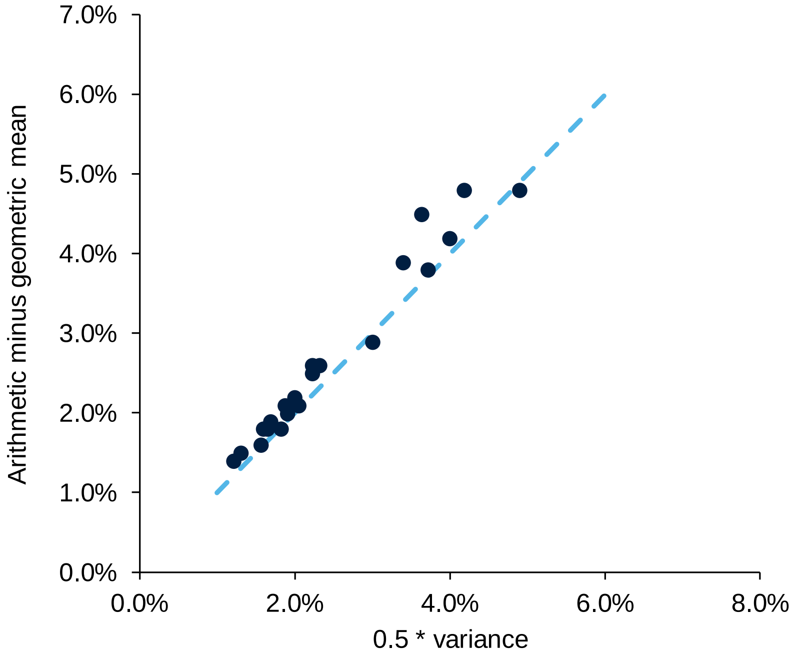
> despite this, the difference between the arithmetic and geometric means is indeed well approximated in the data by one half the variance.

Figure 4.1 below reproduces Professor Schaefer's analysis, which plots the difference between the arithmetic and geometric mean returns against the

[66] Cooper, I. (1996), 'Arithmetic versus geometric mean estimators: Setting discount rates for capital budgeting', *European Financial Management*, **2**:2, pp. 156–67.
[67] UK Regulators Network (2018), 'Estimating the cost of capital for implementation of price controls by UK Regulators'.
[68] Ibid., Appendix E.
[69] Serial correlation is the statistical term used to describe the relationship of the same variable across specific periods. If a variable is serially correlated, future observations are affected by past observations and therefore, to some degree, predictable.
[70] Appendix of Schaefer, S. (2020), 'Using Average Historical Rates of Return to set Discount Rates', contained within Oxera (2020), 'Deriving unbiased discount rates from historical returns', 14 February.
[71] Ibid.

variance of the annual returns divided by two. This exercise was conducted using 119 years of returns across 21 countries using DMS data from 1899–2019. The figure shows that, irrespective of whether variance and expected returns vary over time, the difference between the arithmetic and the geometric mean is closely approximated by half of the realised variance. The implication is that applying the appropriate upward adjustment to the geometric mean of half the variance of annualised returns would result in an estimate close to the arithmetic average.

Figure 4.1 Difference in mean returns plotted against variance



Source: Reproduced from Schaefer, S. (2020), 'Using Average Historical Rates of Return to set Discount Rates', contained within Oxera (2020), 'Deriving unbiased discount rates from historical returns', 14 February.

Notwithstanding the above, we note that even if serial correlation were to have a material impact on returns over holding periods longer than one year, this can be addressed by averaging returns over ten- and 20-year holding periods, using non-overlapping returns. The results of the TMR estimated using arithmetic averages over annual, ten-year and 20-year holding periods (non-overlapping) are summarised in Table 4.1.

Table 4.1 TMR estimation—non-overlapping returns

Holding period	RPI	CPIH
One year	6.6%	7.6%
Ten years	6.2%	7.3%
20 years	6.5%	7.5%

Note: Oxera analysis based on DMS data from 1899 to 2020. CPIH numbers are estimated using an inflation wedge of 0.954%.

The UKRN report suggests a lower uplift to the geometric average based on the predictability of stock returns.[72] However, the academic literature on return

[72] Wright, S., Burns, P., Mason, R. and Pickford, D. (2018), 'Estimating the cost of capital for implementation of price controls by UK Regulators', pp. 8 and 39.

predictability is controversial. For example, the well-known Stambaugh (1999)[73] article identifies a bias in the time-series models typically used in papers that find evidence of returns predictability. The main papers citing evidence in support of returns predictability pre-date Stambaugh (1999) and their results have not been revised to take the latter findings into account. Hjalmarsson (2007)[74] tested the Stambaugh bias on panel data. The main theme of the paper is that these biases can lead to false inferences and the appearance of correlations that are in fact random noise. Hjalmarsson notes that:[75]

> Based on the results from the standard fixed effects estimator, the evidence in favour of return predictability is very strong, using either of the three predictor variables. However, when using the robust methods developed here, the evidence disappears almost completely […].

In sum, the empirical evidence does not justify deviating from the arithmetic mean based on arguments concerning serial correlation. The UKRN report itself notes that it is difficult to quantify any effect:[76]

> While the qualitative evidence for return predictability (and for this predictability being embodied in market expectations—which is not necessarily the same thing) is quite strong, it is much harder to point to an agreed quantitative methodology that could be employed to capture this feature in a methodology that is both implementable and defensible.

We conclude that there is not strong evidence of serial correlation or predictability in returns. Our recommendation is to use direct arithmetic averages of annual returns.

4.1.2 Dividend discount models

As part of the analysis conducted for our earlier RIIO-2 reports, we constructed a DDM following the Bank of England's methodology. As a sensitivity, the DDM presented in this report reflects the assumptions stated by the CMA in the PR19 provisional findings, as well as the Bank of England methodology.[77]

DDMs are used to infer the discount rate applied to future equity cash flows. According to the DDM theory, the expected market return is the discount rate at which the present value of future equity cash flows is equal to the current market price. The DDM used in this report is composed of three parameters:

- a dividend yield, which is observed in the market;
- share buybacks, which are also observed in the market;
- the growth rate of dividends and buybacks, which needs to be assumed.

The result of the DDM is the expected market return (or TMR), which is equal to the sum of the three components above.

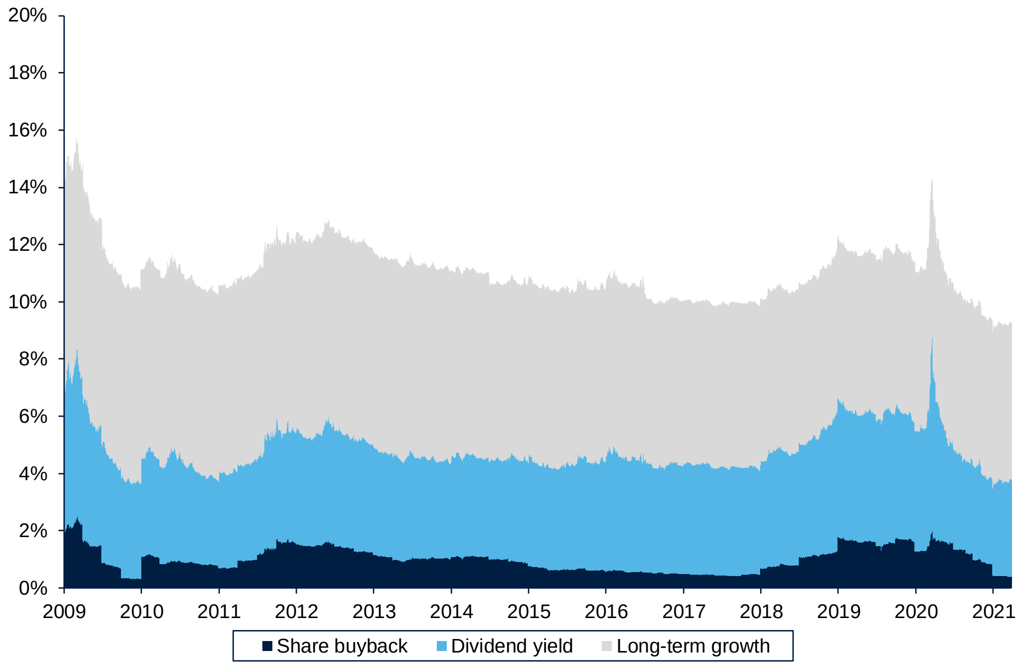
DDMs are typically highly sensitive to the growth rate assumptions, in particular to the long-term growth rate. The Bank of England model links the long-term dividend growth rate to forecasts of the long-term growth rates of

[73] Stambaugh, R. (1999), 'Predictive Regressions', *Journal of Financial Economics*, **54**, pp. 375–421.
[74] Hjalmarsson, E. (2007), 'The Stambaugh Bias in Panel Predictive Regressions', The Board of Governors of the Federal Reserve System.
[75] Ibid., p. 2.
[76] Mason, Wright, Burns and Pickford (2018), op. cit., p. 41.
[77] Competition and Markets Authority (2020), 'Anglian Water Services Limited, Bristol Water plc, Northumbrian Water Limited and Yorkshire Water Services Limited price determinations—Provisional findings', September, para. 208-9.212.

gross domestic product (GDP) for a weighted sample of countries. Its rationale is that the UK-listed companies in the index used in the DDM operate internationally and derive a significant proportion of their revenues from outside the UK. As such, the growth and risk of their dividends will be affected not only by the UK economy, but also by international economic developments.

We present below the results of a DDM that considers the historical dividend yield and share buybacks of the FTSE All-Share Index, and different growth rate forecasts.[78] Due to short-term volatility in share prices and buybacks, we adopt a five-year average of the DDM estimates. The result of using the weighted GDP growth forecast is an average expected market return equal to 10.6% in nominal terms and 8.4% in CPI-real terms. Figure 4.2 summarises the results.

Figure 4.2 Nominal TMR: weighted GDP growth rate



Source: Oxera analysis based on Bloomberg, Refinitiv Datastream, and the IMF World Economic Outlook. The cut-off date is 31 March 2021.

We acknowledge that the DDM is sensitive to the growth rate assumptions described above. To illustrate this sensitivity, we also present the results based on forecast GDP growth for the UK as opposed to a weighted sample of countries. The two approaches are summarised in Table 4.2 below.

[78] Our approach is consistent with the analysis presented by Europe Economics and PwC in their advice to Ofwat. Specifically, we use the same data on dividend and share buyback yields, and use a range of growth rates to infer the total equity return. See PwC (2019), 'Updated Dividend Discount Model analysis for PR19', July; and Europe Economics (2017), 'Initial Assessment of the Cost of Capital', December; Europe Economics (2019), 'The Allowed Return on Capital for the Water Sector at PR19 – Final Advice', December.

Table 4.2 DDM results

	Five-year average
Nominal	
Weighted GDP growth forecast	10.6%
UK GDP growth forecast	8.8%
Real (CPIH)	
Weighted GDP growth forecast	8.4%
UK GDP growth forecast	6.6%

Source: Oxera analysis based on Bloomberg, Refinitiv Datastream, and the IMF World Economic Outlook. The cut-off date is 31 March 2021.

This approach is conservative in comparison to the weighted GDP growth forecast, as companies listed on the London Stock Exchange are generally exposed to international markets,[79] which on average have higher GDP growth rates than the UK.

Nonetheless, our estimated TMR range between 7.0% and 7.5% appears aligned with the overall DDM analysis above. The estimate based on UK GDP growth is 6.6% CPIH-real, whereas a weighted international return that accounts for the international exposure of UK firms is higher, at 8.4%.

4.1.3 Survey evidence

As described in our previous reports, survey results need to be interpreted with a degree of caution when used as another source of evidence for the ERP and TMR. Issues with survey evidence include:

- respondents' answers possibly being influenced by the way questions are phrased—for example, whether the question asks about required returns to equity or expected returns on a specified stock market index (the '**framing effect**');
- there is a tendency for respondents to extrapolate from recent realised returns, making the estimates less forward-looking and prone to be anchored on recent short-term market performance ('**recency bias**');
- the results are based purely on judgement, which may also be influenced by a respondent's own position or biases, and are less reliable than estimates based more on market evidence on pricing.

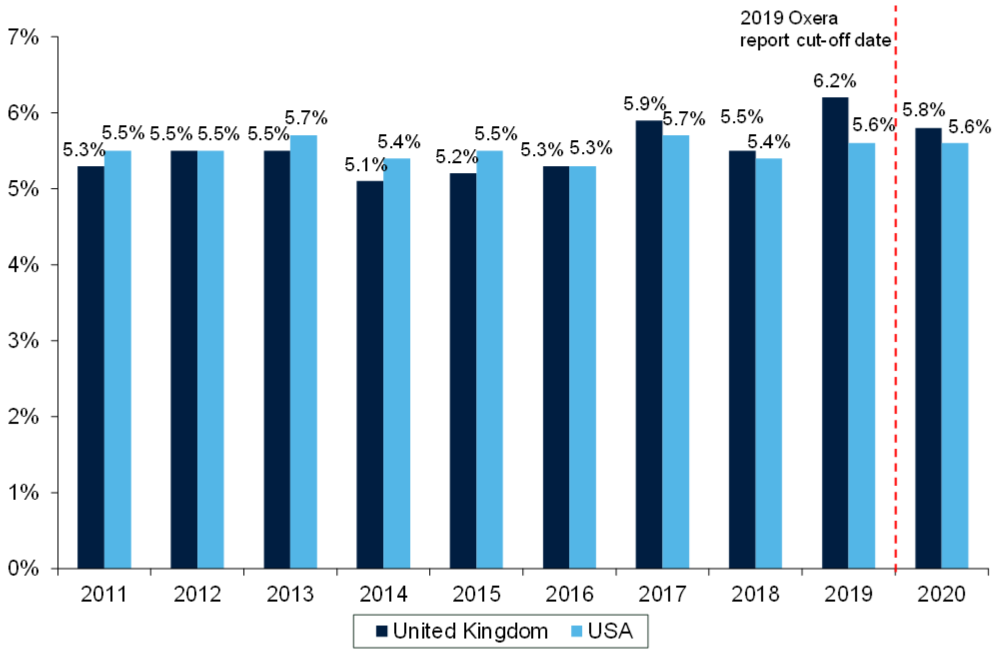
Notwithstanding the need to interpret the survey evidence with caution, this sub-section presents up-to-date evidence in relation to respondents' expectations about ERP and TMR.[80]

Survey evidence from Fernandez et al. for the UK suggests some year-to-year variation in responses.[81] This is presented in Figure 4.3 below, which shows the evolution for the average ERP from annual surveys of finance and economics professors, analysts and company managers in the UK and the

[79] In 2020, companies in the FTSE All-Share Index generated only 23% of revenues in the UK, with the rest coming from international activities. Oxera analysis based on Bloomberg data.
[80] Updated survey results had not been published as at the cut-off date for this report of 31 March 2021.
[81] Fernandez, P., Pershin, V. and Acín, J.F. (2017), 'Discount Rate (Risk-Free Rate and Market Risk Premium) used for 41 countries: a survey', 17 April; Fernandez, P., Pershin, V. and Acín, J.F. (2016), 'Market Risk Premium used in 71 countries in 2016: a survey with 6,932 answers', 9 May; Fernandez, P., Pershin, V. and Acín, J.F. (2019), 'Market Risk Premium Used in 69 Countries in 2019: A Survey', 26 May; Fernandez, P., Apellaniz, E. and Acín, J.F. (2020), 'Survey: Market Risk Premium and Risk-Free Rate used for 81 countries in 2020', 25 March.

USA over time. In both countries, the expected ERP has stayed within a range of around 5–6%.

Figure 4.3 ERP survey data from Fernandez et al. for the UK and the USA



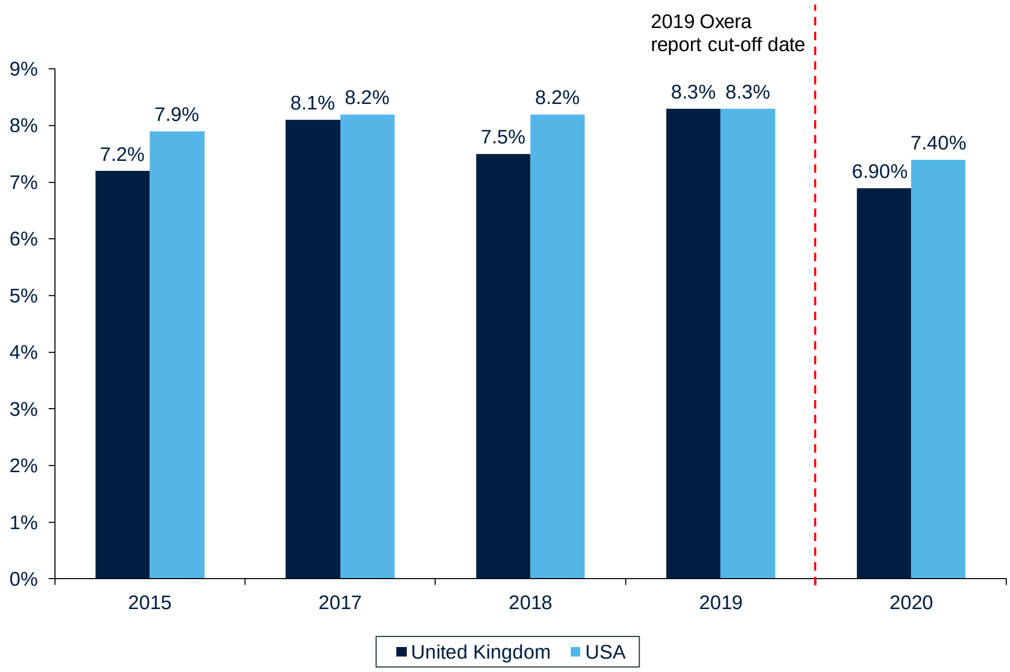
Note: The red dotted line represents the cut-off date from our first report.

Source: Oxera analysis based on Fernandez, P., Pershin, V. and Acín, J.F. (2016), 'Market Risk Premium used in 71 countries in 2016: a survey with 6,932 answers', 9 May; Fernandez, P., Pershin, V. and Acín, J.F. (2017), 'Discount Rate (Risk-Free Rate and Market Risk Premium) used for 41 countries: a survey', 17 April; Fernandez, P., Pershin, V. and Acín, J.F. (2019), 'Market Risk Premium Used in 69 Countries in 2019: A Survey', 26 May; Fernandez, P., Apellaniz, E. and Acín, J.F. (2020), 'Survey: Market Risk Premium and Risk-Free Rate used for 81 countries in 2020', 25 March.

In the 2020 version of Fernandez et al., the authors also presented estimates of the nominal TMR for 2015, 2017, 2018, 2019 and 2020.[82] We present this information in Figure 4.4 below.

[82] We note that Fernandez et al. do not provide TMR estimates for 2016, which supports our view that survey results should be interpreted with a degree of caution due to a lack of consistency over time.

Figure 4.4 TMR survey data from Fernandez et al. for the UK and the USA



Note: The red dotted line represents the cut-off date from our first report. We note that Fernandez et al. do not provide TMR estimates for 2016.

Source: Fernandez, P., Apellaniz, E. and Acín, J. F. (2020), 'Survey: Market Risk Premium and Risk-Free Rate used for 81 countries in 2020', 25 March.

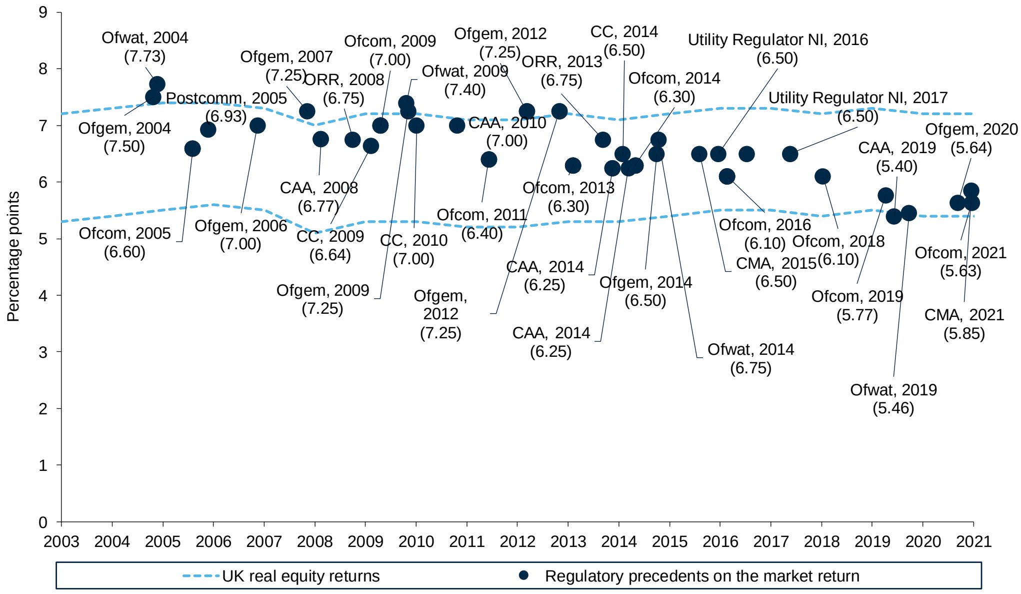
As shown in Figure 4.4, the expected nominal TMR has historically been in the range of 7–8%.

Despite the attempt by Fernandez et al. to poll academics globally, the respondents are not necessarily the same academics each year and it is not clear how this affects trends. As such, we do not place weight on year-to-year changes in this survey, and we did not adjust our TMR estimate upward in 2019 despite the upward movement in the survey data. We also note that the upward adjustment to generate an estimate of the arithmetic average annual return should imply a similar TMR range to Oxera, as these represent expected returns and not a discount rate.

4.1.4 Regulatory announcements on TMR

UK regulatory precedent and recent announcements on the TMR are shown in Figure 4.5 below, together with the evolution of the long-run average real equity returns for the UK since 2003. This includes the most recent announcements in the UK. These announcements feature an RPI-real allowed TMR of 5.40 to 5.85, which is materially lower than the TMR precedents observed historically.

Figure 4.5 Historical averages and UK regulatory precedent on the RPI-real TMR



Note: The top UK line represents arithmetic averages; the bottom UK line represents geometric averages. DMS calculation methodology is not constant over time. The cut-off date is 31 March 2021.

Source: Oxera analysis based on Dimson, E., Marsh, P., and Staunton, M. (2021), 'Credit Suisse Global Investment Returns Yearbook', p. 195; Dimson, E., Marsh, P., and Staunton, M. (2020), 'Summary Edition Credit Suisse Global', p. 23; and regulatory decisions.

It is important to note several characteristics of the latest regulatory announcements. First, in contrast to Ofgem, Ofcom does not have a financing duty.[83] This allows Ofcom to attribute less weight to financeability constraints, thus allowing, all else being equal, a lower CoE to be assumed. Second, multiple transmission and GD companies have appealed to the CMA, with the allowed equity return being a common ground of appeal across all appellants. Finally, in the NATS appeal, the CMA did not take into consideration the responses to its provisional findings.

The recent UK regulatory announcements also rely heavily on a number of recommendations made in the UKRN study.[84] The similarity of approach and assumptions across different regulators means that these cannot be regarded as independent data points, which undermines their value as cross-checks.

In sum, while the most recent regulatory publications have used a TMR below the historically observed level, these cannot be relied on for determining the TMR assumption for RIIO-ED2. The CMA has undertaken a more detailed review of the issues when making the Final Determinations on the water PR19 appeals. This detailed analysis by the CMA represents the most recent UK regulatory decision on the TMR.

[83] Ofgem (2013), 'Joint Regulators Group (JRG) Cost of Capital and Financeability', March, available at: https://www.ofgem.gov.uk/ofgem-publications/37070/jrg-report-cost-capital-and-financeability-final-march-2013-pdf (last accessed 4 June 2021).
[84] UK Regulators Network (2018), 'Estimating the cost of capital for implementation of price controls by UK Regulators'.

4.2 Conclusion

The updated historical data on average equity market returns yields an estimate of the market discount rate of 7–7.5% (CPIH-real). This is based on the arithmetic average and checked against the average of non-overlapping ten- and 20-year holding periods, deflated by the long-run average of RPI inflation (as published by the ONS) and converted into CPIH terms by applying the RPI–CPIH inflation forecast wedge.

Evidence from our primary cross-check, the DDM, varies depending on the assumed growth rate, but points towards a higher TMR estimate than the historical average equity market returns. The survey evidence points to a nominal TMR in the range of 7.0–8.0%. The downward inflation adjustment combined with the upward adjustment to convert this into the arithmetic average annual return should result in a TMR consistent with our range. We further note that the detailed analysis by the CMA for the Final Determinations of the PR19 water appeals represents the most recent UK regulatory decision on the TMR.

On balance, we maintain our position that the evidence supports the assumption that the TMR is more stable over time than the ERP. As such, we consider that the updated historical data remains supportive of the 7.0–7.5% CPIH-real (6.0–6.5%, RPI-real) TMR range presented in the 2020 Oxera report.

5 Risk and beta

The CAPM is a one-factor model that assumes risk is measured by the scaled covariance of an asset's returns with the returns of the market as a whole. The equity beta in the CAPM is a measure of how risky an equity investment is compared with a diversified market portfolio.[85]

The CAPM therefore does not consider any company-specific risks, nor does it incorporate other potential sources of systematic risk. For regulated firms, it ignores any priced risk exposure to regulatory and/or political decisions. Relatedly, recent academic research finds that for low-beta firms, the CAPM systematically generates a required return on equity that is 'too low'.[86]

The equity beta is also affected by the level of gearing. As a result, the equity beta captures both financial risk (which depends on the company's capital structure) and business risk. The calculation of an asset beta removes the financial risk component embedded in the equity beta. Since it represents the hypothetical risk of the firm with zero debt, the asset beta is independent of the choice of capital structure. It is therefore a more relevant measure for assessing business risk and comparing it across companies.

For a company listed on the stock market, estimating the equity beta using regression analysis is straightforward because all required market data is publicly available. For companies that are not listed, listed comparator companies need to be identified that can be used as a proxy. Observable equity betas for these companies need to be adjusted to the level of gearing in the company in question in order to be comparable.

Similarly, when assessing the riskiness of an industry, a sample of companies present in that sector should be used and the asset betas of those companies should indicate the overall risk of the business. Ideally, the sample would be formed by pure-play comparators—i.e. companies that operate exclusively in the sector of interest. However, depending on the industry, there may be few pure-play comparators; in this case, the sample of comparators would include companies that have a significant part of their operations in the industry of interest.

This section looks at:

- choice of comparators (section 5.1);
- technical estimation issues for equity beta (section 5.2);
- gearing and the relationship between equity beta and asset beta (section 5.2.1)
- debt beta (section 5.2.2);
- asset beta estimation results (section 5.3);
- the impact of political and regulatory risk (section 5.4).

[85] An equity beta of 1 means that the stock return perfectly covaries with the market return. An equity beta of less than 1 means that it tends to move in the same direction as the market return, but to a lesser magnitude (and vice versa for an equity beta of more than 1).
[86] Dessaint, O., Olivier, J., Otto, C. and Thesmar, D. (2021), 'CAPM-Based Company (Mis)valuations', *The Review of Financial Studies*, **34**:1, January, pp. 1–36.

5.1 Choice of comparators

To enable a robust estimation of the beta, it is important to ensure that reliable data is available and that the stocks being analysed are sufficiently liquid. In particular, when estimating the beta for a given economic activity, the main challenge is finding publicly-listed companies that are largely involved in the specific activity of interest. For example, in a regulatory context, the majority of profits or revenues should come from the regulated part of the business operating in the sector under consideration.

For the estimation of the asset beta range, this report considers two comparator samples: a UK sample, comprising listed UK energy and water companies, and a European sample of comparable energy networks. We conclude that water companies and energy companies present different risk profiles, which is reflected in the historical series of the betas. Therefore, our final sample of comparators consists solely of energy networks in the UK and Europe. The choice of comparators for each sample is described in turn below.

5.1.1 UK comparators

When selecting comparators, the goal is to find firms with a similar asset risk to UK energy networks. It is therefore important to choose companies that are similar in their exposure to systematic risk. The most important characteristics are the type of assets (sector), the company's business mix and the regulatory framework under which it operates.

In its Sector Specific Methodology Decision, Ofgem states that 'estimates of the beta for ED2 are made by starting with our estimates for the beta of the GD&T sectors'.[87] In its Final Determinations for GD and GT, Ofgem relied on a comparator sample with two energy network companies (National Grid and Scottish & Southern Energy) and three water companies (Pennon, Severn Trent and United Utilities).[88] This approach raises a number of issues.

In our 2018 report, we had originally excluded SSE from our sample that determined the asset beta range because 'a significant portion of its business stems from generation and supply, which is not directly comparable to the business profile of an energy network'.[89] Similarly, we showed that:[90]

> […] the divergence of SSE's beta from the rest of the UK utilities in the last two years suggests that its sharp increase in beta may not be wholly attributable to the perceived risk of its network business.

Following the publication of the 2018 Oxera report, SSE took a series of steps to dispose of its energy supply and services business, which would make its revenue mix more similar to that of the UK regulated energy networks. Therefore, we included SSE in our sample of UK energy firms in the 2019 Oxera report and SSE's two-year beta converged with those of the other networks. However, we noted in our 2020 report that, since the beginning of 2020, SSE's beta had diverged from the other networks, suggesting that part of the risk profile was not yet aligned with that of the other networks.[91] Due to this, we again exclude SSE from the sample of UK energy companies.

[87] Ofgem (2021), 'RIIO-ED2 Sector Specific Methodology Decision: Annex 3 Finance', 11 March, para. 3.41.
[88] Ofgem (2020), 'RIIO-2 Final Determinations – Finance Annex', December, Table 10.
[89] Oxera (2018), 'The cost of equity for RIIO-2', 28 February, section 3.
[90] Ibid.
[91] Oxera (2020), 'The cost of equity for RIIO-2, Q3 2020 update', 4 September, section 3.1.1.

Second, as explained in the 2020 Oxera report,[92] the rapid technological change and the investment uncertainties created by an increased focus on decarbonisation suggest that the fundamental risk of energy networks is greater than that faced by water networks. For example, Investec has stated that:[93]

> We maintain our belief that energy should attract a higher return than water given the risks and uncertainties, and given the multi-period investment needs of energy, this is not just about RIIO-2, and settling a number of issues via a CMA referral might well be the best course of action for both Net Zero and shareholders, despite the disruption it would undoubtedly cause in the short-term.

The resulting UK sample of energy networks (National Grid) is too small to be considered a representative sample that accurately captures all of the systematic risks faced by UK energy networks. In line with Ofgem's approach, we also present pure-play water networks (Severn Trent and United Utilities) as possible comparator companies because they are utilities and subject to a similar regulatory regime, although they face a different set of business risks than energy networks. It is for these reasons that we recommend broadening the sample to consider European energy networks.

5.1.2 European comparators

Given the lack of listed energy network comparators in the UK, it is necessary to include European comparators to generate an adequately sized representative sample. We further note that the goal of an asset beta is to capture *asset* risk. We argue that the asset risk between UK and European energy networks should be more similar than two different industries inside the same country.

As explained in our previous reports, we use four listed energy networks comparators in our sample: Enagas, Red Eléctrica, Snam and Terna. This sample is the result of a filtering process that excludes companies based on a range of factors, such as percentage of regulated activities, data availability and liquidity. The sample used by Ofgem/CEPA[94] includes these comparators, in addition to REN and Elia.

In the 2020 Oxera report,[95] we explained that our methodology was specifically designed to screen out illiquid firms because illiquidity creates estimation problems when calculating beta. Furthermore, we explained that CEPA failed to exclude those comparators because its analysis compares a broad sample of European energy companies, of which most appear to be illiquid; hence, CEPA's benchmark for the liquidity filters is affected by the sample choice.

The results from applying these liquidity filters to the set of potential comparators are summarised in Table 5.1.

Table 5.1 Liquidity measures for European comparators

	BICS sub-industry	Average bid–ask spread (% of closing price)	Average share turnover (%)
Elia	Electricity Networks	**0.22%**	**0.06%**
Enagas	Gas Utilities	0.07%	0.56%

[92] Ibid., section 3.3.
[93] Investec (2021), 'SSE Net Zero a considerable opportunity', 26 January, p. 7.
[94] CEPA (2020), 'RIIO-2: Beta estimation issues', 9 July.
[95] Oxera (2020), 'The cost of equity for RIIO-2', 4 September, p. 29.

Red Eléctrica	Electricity Networks	0.05%	0.38%
REN	Electricity Networks	0.21%	0.08%
Snam	Gas Utilities	0.05%	0.28%
Terna	Electricity Networks	0.05%	0.31%
Average		**0.09%**	**0.27%**

Note: Liquidity filters relate to 2019 data. The values highlighted in red fail the respective liquidity filters. These cases are considered individually, but companies that do not pass most of the filters shown in this table are generally excluded.

Source: Oxera analysis based on Bloomberg data.

We observe that REN and Elia are clear outliers based on low share turnover at 0.06–0.08% and high average bid–ask spreads at 0.21–0.22% of closing price. Therefore, based on the liquidity filters, we consider that REN and Elia are not appropriate to include in the sample of European energy networks.

5.2 Technical estimation issues for equity beta

In our previous reports, we measured comparators' equity betas using daily data over two- and five-year periods. Since the publication of these reports, a range of different evidence has been considered for the data frequency, estimation windows and averaging procedure used to measure equity betas. On balance, none of the new evidence has convinced us to deviate from our previous methodology. However, as discussed later, we consider a cut-off date of 31 December 2019 to be appropriate in order to avoid the impact of the COVID-19 pandemic on beta estimation.

The rest of this section considers the main technical estimation issues, namely gearing and debt betas.

5.2.1 Gearing

For a fully equity-financed firm, the asset beta is the same as the equity beta. However, for a firm with significant amounts of debt financing, the asset beta and the equity beta may be very different. Assuming a combination of debt and equity financing, the asset beta is a weighted average of the equity beta and the debt beta, as described by the 'Harris–Pringle formula':[96]

$$\beta_a = \beta_e \cdot (1 - g) + \beta_d \cdot g$$

where g = the gearing ratio, defined as $\frac{net\ debt}{debt+equity}$.

As explained in previous reports, there are two options that avoid creating an inconsistency between the definition of debt used in de-gearing comparator asset betas and the definition of debt used to re-gear for the purpose of setting revenue allowances. The choice is between using market values or book values of debt in both steps of the calculation. Using book values for debt is the standard approach followed in regulatory price controls, and for the purpose of this report we calculate the level of historical gearing using the book value of net debt, consistent with the 2019 and 2020 Oxera reports.

[96] The Harris–Pringle formula assumes that the firm maintains a constant level of gearing, and therefore that the same WACC can be used to discount the cash flows in each period. The appeal of the Harris–Pringle formula in a regulatory context is that it is consistent with the notion of a regulator assuming a constant gearing ratio throughout the price control period.

5.2.2 Debt beta

In its Sector Specific Methodology Decision, Ofgem considered that 'the same debt beta as derived for GD&T can also be applied to the notional ED company.'[97] For context, in its RIIO-2 Final Determinations for GD&T, Ofgem adopted a debt beta range of 0.0–0.15 and a point estimate of 0.075.[98] In setting its range, Ofgem relied on the evidence presented by CEPA in a report for the UKRN[99] and the CMA's provisional range from its PR19 provisional findings.[100]

In June 2020, we prepared a report[101] that addressed the report on debt beta authored by CEPA for the UKRN.[102] In that report, we showed that methods based on regressions (the direct and indirect methods) and structural models have the advantage of measuring the systematic exposure of debt to market risk. In contrast, the spread decomposition method lacks robust theoretical support and relies on multiple uncertain parameters. The degree of uncertainty over the assumptions required by the spread decomposition approach suggests that it provides little or no incremental evidential value relative to the other approaches. Therefore, regulators should rely on regression-based and structural methods when setting debt beta for a price control. We discuss each method in more detail in Appendix A4.

Further, controlling for interest rate risk is important when estimating debt beta using a regression-based method. Otherwise, the resulting debt beta estimate will capture risks over and above credit risk, resulting in a biased estimate. This was not reflected by CEPA when it compared the methodology used by Schaefer and Strebulaev (2008) (i.e. the indirect regression-based approach) with the direct regression-based methodology used by PwC and Europe Economics.[103]

Estimates of debt beta using the direct and indirect regression-based methods, as well as the structural method, are summarised in Figure 5.1.[104]

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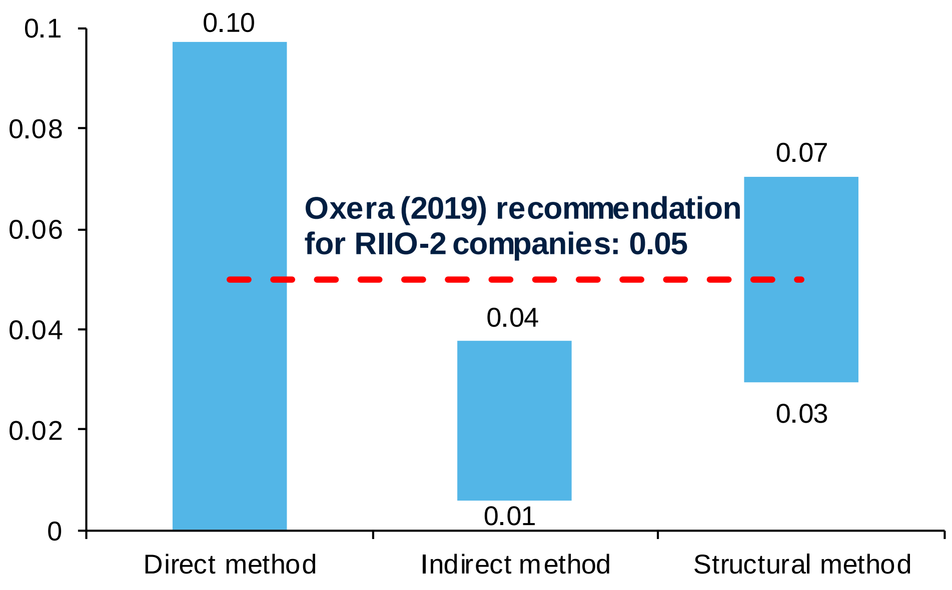
[97] Ofgem (2021), 'RIIO-ED2 Sector Specific Methodology Decision: Annex 3 Finance', 11 March.
[98] Ofgem (2020), 'RIIO-2 Final Determinations – Finance Annex', 8 December, para. 3.67.
[99] UK Regulators Network (2019), 'Considerations for UK regulators setting the value of debt beta', December.
[100] Competition and Markets Authority (2020), 'Anglian Water Services Limited, Bristol Water plc, Northumbrian Water Limited and Yorkshire Water Services Limited price determinations: Provisional findings', 29 September, para. 9.315 and Table 9-17.
[101] Oxera (2020), 'Estimating debt beta for regulated utilities', 4 June.
[102] CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', report for the UK Regulators Network, 2 December, available at: https://www.ukrn.org.uk/wp-content/uploads/2019/12/CEPAReport_UKRN_DebtBeta_Final.pdf (last accessed 4 June 2021).
[103] CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, pp. 7–10.
[104] The direct method involves regressing bond returns on market returns, but this can be extended to include government bond returns. The indirect method involves regressing an issuer's bond returns on (i) the respective issuer's equity returns and (ii) the returns on government bonds. The coefficient on equity returns is subsequently multiplied by the issuer's equity beta to obtain the debt beta estimate. The structural method involves using option-pricing models to estimate a debt beta consistent with the market data.

Figure 5.1 Evidence on debt beta



Note: The ranges of estimates for the direct method and the indirect method are set out in Figure A4.1 and Figure A4.2. Those for the structural method are set out in Figure A4.3. The range is derived using a sensitivity analysis on the key parameter. The red dashed line represents our estimate of the appropriate debt beta assumption for RIIO-2 (0.05), which was set out in our 2019 reports on (i) asset risk premium, debt risk premium and debt betas dated 23 January 2019, and (ii) beta and gearing dated 20 March 2019. The lower bound of the direct method is set to 0, excluding one marginally negative estimate from United Utilities.

Source: Oxera analysis.

In sum, we continue to see no evidence that supports a debt beta estimate greater than 0.05 and therefore consider that Ofgem would be incorrect to assume a debt beta of 0.075 for an electricity distribution (ED) notional company.

5.3 Asset beta

In the following sub-section, we present our beta estimates for the comparator sample and subsequently provide our assessment of the appropriate asset beta range for UK energy networks. We then convert this into an equity beta range based on a notional gearing assumption of 60%.

Our estimations are based on a cut-off date of 31 December 2019 to prevent the impact of the COVID-19 pandemic from being included. As noted in the 2020 Oxera report, we observe that energy betas have increased significantly since the start of the pandemic.[105] Our estimates are therefore conservative.

First, we present the asset betas of the UK comparator sample in Table 5.2. For illustrative purposes, we use two-, five- and ten-year estimation windows.

[105] Oxera (2020), 'The cost of equity for RIIO-2, Q3 2020 update', 4 September, section 3.3.

Table 5.2 Asset beta UK sample

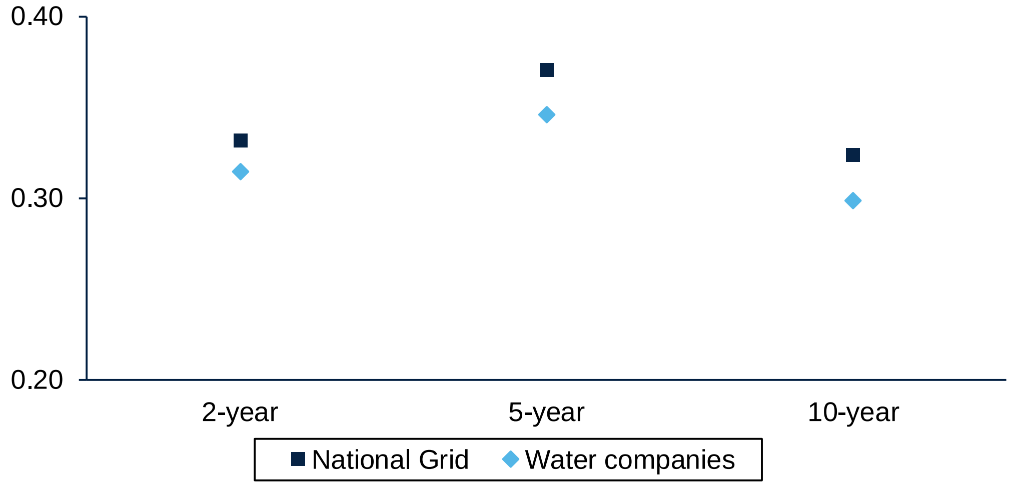
Estimation window	Averaging period	NG	UU	SVT	Average water companies
Two-year	Spot	0.33	0.31	0.32	0.31
Five-year	Spot	0.37	0.34	0.35	0.35
Ten-year	Spot	0.32	0.29	0.31	0.30

Note: 'Water companies' includes United Utilities and Severn Trent. We present the spot averaging period for all estimation windows. The cut-off date is 31 December 2019. Asset betas are calculated using daily data and a debt beta of 0.05.

Source: Oxera analysis based on Bloomberg data.

Our analysis shows that National Grid's asset beta is significantly higher than the average asset beta of UK water companies for all estimation windows. This is further demonstrated in Figure 5.2.

Figure 5.2 Comparison of asset betas for National Grid and UK water companies



Note: 'Water companies' includes United Utilities and Severn Trent. We present the spot averaging period for all estimation windows. The cut-off date is 31 December 2019. Asset betas are calculated using daily data and a debt beta of 0.05 is used.

Source: Oxera analysis based on Bloomberg data.

Furthermore, we consider that National Grid's asset beta is likely to be an underestimate of the true asset beta of National Grid's UK regulated business due to its Group asset beta reflecting elements of lower risk faced by its US business. Indeed, Mayer, Alexander and Weeds (1996) present evidence that US asset betas for electricity and gas companies are on average 0.30 and 0.64 lower than their UK counterparts, stating that there is 'a clear disparity between the beta values of utility companies in the United States and the UK, which is usually attributed to the relatively lower powered regulatory incentives in the United States'.[106] On taking this into consideration, the disparity between the asset betas of UK water companies and National Grid's UK-regulated business would be even more significant.

[106] See Mayer, C., Alexander, I. and Weeds, H. (1996), 'Regulatory Structure and Risk and Infrastructure Firms: An International Comparison', pp. 27 and 30.

Second, we present the asset betas of the EU energy networks comparator sample in Table 5.3. For illustrative purposes, we present asset betas calculated using two-, five- and ten-year estimation windows.

Table 5.3 Asset beta EU energy networks

Estimation window	Averaging period	ENG	REE	SRG	TRN	Average EU
Two-year	Spot	0.33	0.26	0.43	0.39	**0.36**
Five-year	Spot	0.36	0.37	0.44	0.43	**0.40**
Ten-year	Spot	0.43	0.44	0.40	0.39	**0.41**

Note: Equity betas are estimated relative to the Eurostoxx TMI index, using daily data. A debt beta of 0.05 is used. The cut-off date is 31 December 2019.

Source: Oxera analysis based on Bloomberg data.

The market data points to a range of 0.36–0.41 depending on the estimation window considered, which is higher than the range of 0.31–0.35 for UK water companies. This demonstrates that energy companies display higher levels of systematic risk than water companies.

Our assessment of the sample of asset betas is summarised in Table 5.4. This is based on a five-year estimation window prior to the increase in betas that is attributable to the market disruption created by COVID-19.

Table 5.4 Asset betas

	Five-year
National Grid	**0.37**
Average water UK	**0.35**
Enagas	0.36
Red Eléctrica	0.37
Snam	0.44
Terna	0.43
Average energy EU	**0.40**

Note: UK water companies include Severn Trent and United Utilities. National Grid and UK water company equity betas are estimated relative to the FTSE All-share index, using daily data. European energy company equity betas are estimated relative to the Eurostoxx TMI index, using daily data. A debt beta of 0.05 is assumed. We present the spot averaging period for all estimation windows. The cut-off date is 31 December 2019.

Source: Oxera analysis based on Bloomberg data.

As discussed previously, the goal of an asset beta is to capture asset risk, which should be more similar for UK and EU energy networks relative to two different industries within the same country. The difference in asset risk between the energy and water sectors is highlighted by an average asset beta of 0.40 for EU energy networks, compared with 0.35 for UK water companies, based on five-year betas prior to the market disruption created by COVID-19. This demonstrates that energy companies display higher levels of systematic risk than water companies, showing that water companies are inappropriate comparators and should therefore be excluded.

To conclude, we propose an asset beta range that uses National Grid's five-year asset beta as the low end and the EU energy networks average five-year asset beta as the high end, giving an asset beta range of 0.37–0.40. This results in an equity beta range of 0.85—0.93 at 60% notional gearing.

Table 5.5 Equity beta results

	Equity beta range
Equity beta	0.85–0.93

Note: The unadjusted equity beta range is based on re-levering our estimated asset beta range of 0.37–0.40 assuming a debt beta of 0.05 and 60% notional gearing.

Source: Oxera analysis based on Bloomberg, Bank of England and iBoxx data.

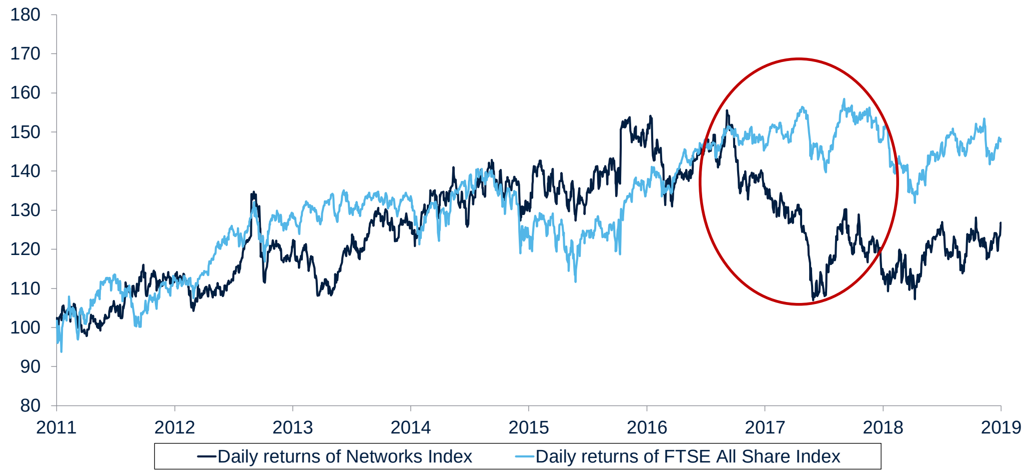
5.4 The impact of political and regulatory risk

In our March 2019 report, we noted that recent evidence demonstrated the increase in political and regulatory risk for UK energy networks, which meant that the beta in the CAPM equation would be unlikely to reflect the full level of risk faced by UK energy networks. This evidence included:

- more frequent political and regulatory news triggering share price falls (i.e. sharp declines in reaction to news);
- an increase in share price volatility since 2016—a period during which the UK Labour Party asserted its policy of renationalising utilities if it were to come to power;
- a decline in the status of National Grid and other regulated utilities as 'defensive stocks';
- an increased focus on regulatory and political risk as a valuation driver in analyst assessments.

Figure 5.3 below presents the value of the value of the networks' equity at the time of a growing/stable wider equity market. As noted above, 2016 represents the time when the UK Labour party asserted its policy of renationalising utilities if it were to come to power. As such, we consider that the fall in the networks' value, relative to the FTSE All-Share Index over the same period, is a further demonstration that in recent times, UK network companies have been exposed to heightened regulatory and political uncertainty.

Figure 5.3 Total equity returns of the UK networks and the FTSE All-Share indices (2011=100)



Source: Oxera analysis based on Datastream data.

In principle, the premium that investors require for exposure to political and regulatory risk factors would be best estimated using multifactor models.

However, given the preference of UK regulators to use the CAPM, we instead compare the CAPM beta for the entire sample period with the CAPM beta that excludes major political and regulatory announcements two days before and after. Table 5.6 compares the two-year equity betas for regulated utilities in the UK.

Table 5.6 Equity betas and political/regulatory risk

	Two-year betas	Two-year betas controlling for political and regulatory announcements	Difference
National Grid	0.74	0.72	–0.01
Pennon Group	0.75	0.69	–0.06
United Utilities	0.67	0.64	–0.02
Severn Trent	0.63	0.61	–0.02

Note: We have excluded observations dating two days pre- and post-announcement. The cut-off date is March 2019.

Source: Oxera analysis based on Bloomberg data.

The beta of regulated utilities eliminating regulatory and political announcements is, on average, 0.03 lower. This suggests that there is a higher risk associated with the dates where political and regulatory announcements were made. As a cross-check, and to confirm the hypothesis that those dates present a higher risk, we have estimated the beta of National Grid using the returns of the five days before and after major political and regulatory announcements.[107] In other words, we quantify the beta only for the dates around the political and regulatory announcements. Table 5.7 shows the results.

Table 5.7 National Grid equity beta and political/regulatory risk

	2Y betas full sample	Betas –5/+5 window around the announcement day	Difference
National Grid	0.74	0.79	+0.05

Source: Oxera analysis based on Bloomberg data. The cut-off date is March 2019.

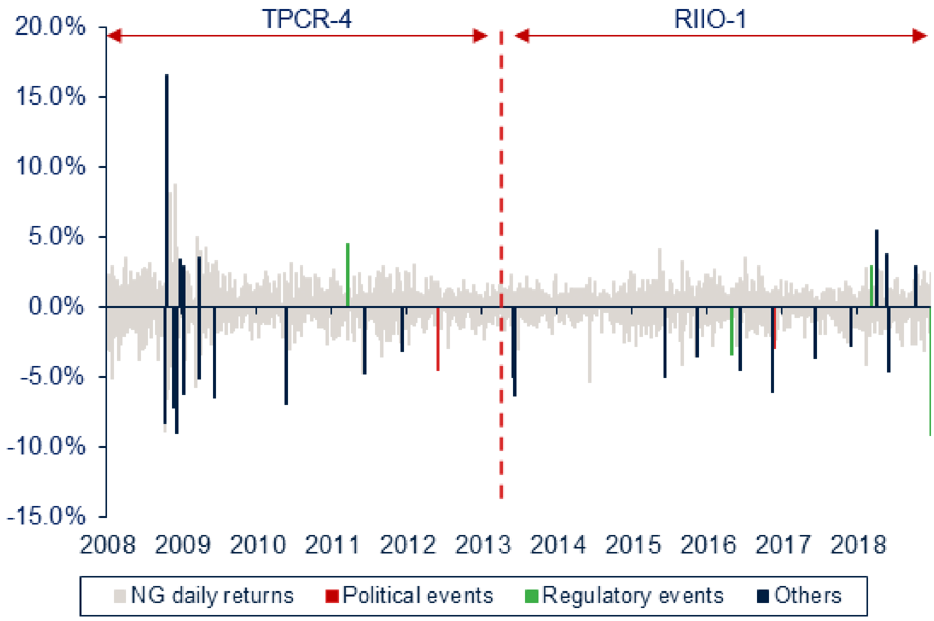
Consistent with our previous findings, the beta of National Grid is 0.05 higher on the dates where political and regulatory announcements were made. These results indicate lower levels of undiversifiable risk in periods free of regulatory announcements. Such time-series variation suggests that risk increases during periods of political and regulatory uncertainty. We acknowledge that the evidence above does not quantify the potential risk premium over and above the CAPM beta.[108] We consider this question next.

5.4.1 Negative co-skewness and political and regulatory risk

As discussed in our 2020 report, a striking feature of political and regulatory announcements is their impact on the stock prices of regulated energy companies. From Figure 5.4, it is clear that the majority of regulatory announcements caused sharp declines in National Grid's share price relative to the market as a whole.

[107] In order to render calculations possible, we use a five-day window around the announcement day. This ensures that the sample is sufficiently large to run a regression.
[108] A reader may wonder whether our evidence implies that the CAPM captures political and regulatory risk. As shown in the following section on skewness, it does not, because the CAPM is capturing longer-term averages and not sudden negative shocks.

Figure 5.4 National Grid's share price reaction (a sharp increase or decrease in price relative to the FTSE All-Share), 2008–18

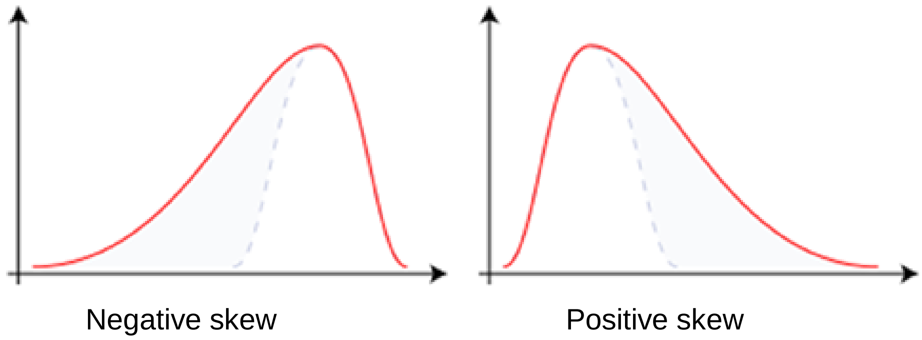


Note: The highlighted statistically significant observations (two standard deviations away from the long-run historical average) represent extreme movements in National Grid's share price, where its share price deviated substantially from that of the FTSE All-Share. Events are categorised based on a qualitative assessment of the news content. 'Others' includes systematic, company-specific and safe haven events.

Source: Oxera analysis based on Thomson Reuters data.

Such rapid declines in share prices is a concept known as negative skew. Skewness measures the potential upside or downside of an investment, and examples of negative and positive skewness can be seen in Figure 5.5.

Figure 5.5 Positive and negative skewness



Source: Hermans, R. (2008), 'Diagrams illustrating negative and positive skew', 16 August, open source.

Stocks that have a positively skewed distribution of past returns are characterised by a low probability of high future payoffs. Multiple studies find that investors find these stocks appealing and take a large, undiversified position in these stocks in order to make their overall wealth more lottery-like.[109] In contrast, stocks with a negatively skewed distribution of past returns

[109] Barberis, N. and Huang, M. (2008), 'Stocks as Lotteries: The Implications of Probability Weighting for Security Prices', *American Economic Review*, **98**:5, pp. 2066–2100; Conrad, J., Dittmar, R.F. and Ghysels,

are associated with limited upside and some probability of a large downside. Investors are averse to these negatively skewed stocks and require a premium for holding such stocks. The academic literature demonstrates that investors require a premium potentially exceeding 3% for holding stocks with negative co-skewness with the market index, holding beta constant.[110]

In the UK, regulated energy companies are intuitive candidates for negatively skewed investments, in the sense that they present limited upside but some probability of a significant downside. As noted collectively in the Ofgem and CEPA reports, regulated energy companies bear a number of potential serious downside risks, such as nationalisation, cybersecurity risk, and technological changes. Conversely, any outperformance has the potential to be capped by regulators, seemingly removing any offsetting upside for a rational investor.

We further note that Ofgem may believe that its Return Adjustment Mechanisms (RAMs) protect consumers from overperformance and companies from underperformance. We agree with Ofgem that upside performance is limited. Although a separate issue may be that the RAM adjustment punishes efficiency and innovation and rewards poor performance, we want to distinguish between skewness driven by political risk versus simple financial underperformance. Left co-skewness is a sudden and dramatic downside event, such a nationalisation or a punitive regulatory decision, not an unfavourable financial result.

Based on the above, we conclude that the higher volatility around political and regulatory announcements, in combination with negative skewness and co-skewness, shows that investors' risk expectations are not fully captured using a one-factor CAPM model. Therefore, an appropriate risk-return remuneration should consider the downward bias implied by the simplified CAPM framework when determining the point estimate.

E. (2013), 'Ex Ante Skewness and Expected Stock Returns', *Journal of Finance*, **68**:1, pp. 85–124; and Mitton, T. and Vorkink, K. (2007), 'Equilibrium Underdiversification and the Preference for Skewness', *Review of Financial Studies*, **20**:4, pp. 1255–88.

[110] Harvey, C. and Siddique, A. (2000), 'Conditional Skewness in Asset Pricing Tests', *Journal of Finance*, **55**, pp. 1263–96.

6 CAPM-based required equity returns for RIIO-2

Table 6.1 summarises the updated CoE parameters for the CAPM. In light of the updated evidence presented in sections 3, 4 and 5, the updated CoE range is 5.81–6.87% (CPIH-real at 60% notional gearing).

Table 6.1 Summary of RIIO-2 cost of equity estimates

	Oxera 2020		Current evidence		Change	
	Low	High	Low	High	Low	High
Real TMR (%)	7.00	7.50	7.00	7.50	-	-
Real RfR (%)	–1.00	–1.00	–0.93	–0.93	0.07	0.07
ERP (%)	8.00	8.50	7.93	8.43	–0.07	–0.07
Asset beta	0.38	0.41	0.37	0.40	–0.01	–0.01
Debt beta	0.05	0.05	0.05	0.05	-	-
Equity beta at 60% gearing	0.88	0.95	0.85	0.93	–0.03	–0.02
Real CoE at 60% gearing (%)	**6.00**	**7.08**	**5.81**	**6.87**	**–0.19**	**–0.21**

Note: All figures are presented in CPIH-real terms and do not include a 25bp downward adjustment for expected outperformance as advocated by Ofgem. The real CoE at 60% gearing may not equal the sum of its components due to rounding.

Source: Oxera analysis.

As shown in Table 6.1, the net impact of changes in the capital market evidence and changes in methodology (i.e. the approach to the RfR)[111] is that the CoE range is lower than the 2020 Oxera report.

We note that Ofgem's T2 and GD2 Final Determinations contain a large number of cross-checks meant to support a lower CoE. Notwithstanding our concerns with the robustness of these cross-checks, which we set out in Appendix A1, none of them is directly comparable with Ofgem's CAPM analysis. In contrast, the comparison we have undertaken between the allowed return on assets and the pricing of risk within the debt market is a test of internal consistency between different elements of the capital structure for the same company. A cross-check that is directly comparable to the CoE for companies regulated under RIIO-2 should be given more weight. The details of this work are presented in two reports undertaken by Oxera and previously submitted to Ofgem.[112,113]

Appendix A1F summarises the findings of the two above reports, setting out the ARP–DRP differential implied by the Ofgem RIIO-2 Final Determinations. We show the following:

- that the benchmarks for ARP–DRP can be employed not only as a cross-check to CoE, but also to obtain conservative estimates of the allowed WACC, because of the downward bias in asset beta estimation;
- that the ARP–DRP framework assesses financeability with a neutral treatment of inflation. The ARP–DRP 'delta' is designed in a similar fashion

[111] We discuss these changes in more detail in sections 3 and 5.
[112] Oxera (2019), 'Risk premium on assets relative to debt', 25 March.
[113] Oxera (2020), 'Asset risk premium relative to debt risk premium', 4 September.

to the nominal PMICR, which is used by Fitch Ratings to assess the companies' debt financeability;

- how our ARP–DRP differential has been used to cross-check the CoE of the T2 and GD2 Final Determinations, which shows that Ofgem's allowed return is significantly below contemporaneous market evidence.

We consider that this cross-check is superior to the other cross-checks proposed by Ofgem when benchmarking the CoE.

7 Conclusions

As presented in section 6, the CAPM evidence suggests a 5.81–6.87% (CPIH-real at 60% notional gearing) range for CoE. We consider that the inputs used to calculate this range better represent the returns on a zero beta asset, as required by the CAPM, provide a balanced assessment of the evidence on TMR, and better capture the economic intuition behind asset risk and asset beta. The CoE presented in this report is consistent with the networks remaining financeable from the perspective of equity investors.

Oxera has carefully balanced and included multiple sources of market information. We consider that our estimate is conservative, particularly given that:

- we omit SSE from our analysis of beta;
- we are currently ignoring two-year estimates and are using a cut-off date of 31 December 2019 for our beta estimation due to the market volatility driven by the economic conditions created by the COVID-19 pandemic;
- our recommended range does not include any adjustments to reflect the evidence that returns of regulated networks are subject to political and regulatory risk, and exhibit negative co-skewness.

If we had more heavily weighted these characteristics, our CoE range would have been higher.

In contrast, the cumulative impact of Ofgem's changes in assumptions and methodologies since RIIO-1 is to lower the CoE. As shown in Appendix A1, Ofgem's cross-checks cited in support of a lower CoE are often revised higher when using updated data or correcting outliers/errors. Its inputs to the CoE appear to fail the MM test, while parameters adopted by Oxera conform more closely to the MM proposition that the weighted average cost of capital should not change with gearing. Many of its cross-checks use firms that are not true comparators based on risk and liquidity. This implies that Ofgem's risk premium allowance for equity relative to debt is relatively low, and raises questions about whether the networks would be financeable from the perspective of equity investors. In terms of asset beta, Ofgem's emphasis on including water companies as appropriate comparators is inconsistent with the market evidence on the beta of National Grid and the wider sample of liquid EU energy network comparators compared with pure-play water companies.

As explained in the 2018 and 2019 Oxera reports, selecting the point estimate within the range requires striking the balance between the risk of setting consumer bills unnecessarily high in the short term and the risk of setting the allowed return below the cost of capital and undermining incentives to invest to deliver the consumer benefits of network resilience and enhancement. This trade-off is particularly important over the long term, as the rational response to an allowed return lower than the cost of capital would be to develop business plans that minimise investment, posing a risk to reliability and innovation in the sector.

The risk of underinvestment is closely connected to the issue of regulatory stability. Given that regulated networks make investment decisions that span multiple price control periods, limiting volatility in allowed returns from one price control period to the next facilitates the securing of long-term investment. To summarise this point, we note that the following changes from RIIO-1 have all had the effect of reducing the CoE:

- restating the 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 arithmetic average, resulting in a lower TMR;
- moving to spot yields on government bonds, which lowers the estimated RfR;
- using a debt beta of 0.075 where previously Ofgem used zero, which artificially deflates the notional equity beta;
- using UK water companies as part of the comparators sample and excluding SSE from the comparators sample, which reduces the observed betas;
- reducing the allowed return below the estimate of the CoE.

We restate our consideration that these changes in combination significantly increase the uncertainty of the CoE estimates and the risk of underestimating the CoE. Moderating the reduction in the allowed return on equity for the RIIO-2 controls compared with the RIIO-1 controls would support long-term investment.

A1 Ofgem cross-checks

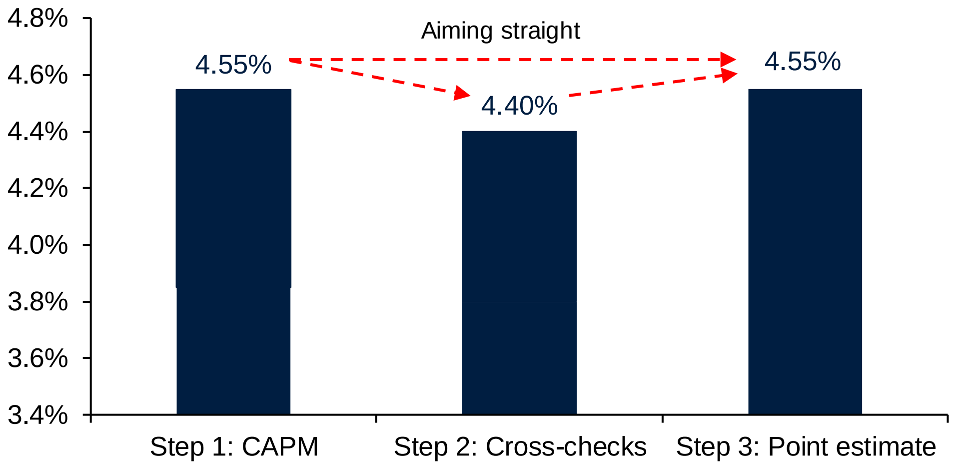
Summary of cross-checks

- Ofgem has used six cross-checks to support its proposed CoE range in the Final Determinations for ET/GT/GD2, and has proposed to support its decision in the ED2 SSMD with the use of the same cross-checks.
- Detailed analysis of these cross-checks suggests that there are estimation issues and problems with reliability as valid cross-checks on returns for energy networks. We therefore cannot recommend placing weight on these cross-checks.
- We recommend placing weight on an alternative cross-check, the asset risk premium (ARP) – debt risk premium (DRP) differential. We consider that this cross-check is superior to the other cross-checks proposed by Ofgem.

This section looks at the cross-checks evidence provided by Ofgem at ET/GT/GD2. Ofgem has confirmed that it considers these cross-checks are relevant for ED2. We therefore discuss the cross-checks in detail.

Ofgem considered six cross-checks of the CoE.[114] At the Final Determinations, and as illustrated in Figure A1.1 below, Ofgem concluded that the cross-checks would support a reduction to the CAPM-estimated CoE range (step 2). However, Ofgem did not reduce the CoE estimate relative to the CAPM-estimated range. Instead it used the cross-checks to describe its final CoE point estimate of 4.55% as including ‘aiming up’. However, without the cross-checks, Ofgem is ‘aiming straight’ from its CAPM analysis.

Figure A1.1 Ofgem’s use of CAPM and cross-checks in deriving a point estimate



Source: Oxera analysis based on Ofgem (2020), ‘RIIO-2 Final Determinations – Finance Annex, 8 December, Table 12.

We therefore re-examine the evidence on Ofgem’s cross-checks below. We begin with the six cross-checks Ofgem has used to present the step 1 range as

[114] Ofgem’s sixth cross-check is a ‘hybrid’ cross-check that relies on the TMR point estimate implied by investment manager forecasts. See all of the cross-checks in Ofgem (2020), ‘RIIO-2 Draft Determinations – Finance Annex’, 9 July, Table 24.

an 'aimed-up' range in the Final Determinations. We then discuss the ARP–DRP, an additional cross-check for which Oxera has previously submitted two reports to Ofgem.[115]

Altogether, the following cross-checks are examined in this section:

- Ofgem: MM theorem;
- Ofgem: MARs;
- Ofgem: infrastructure funds;
- Ofgem: OFTO returns;
- Ofgem: investment managers and the 'hybrid' cross-check;
- Oxera: ARP and DRP.

A1A Modigliani–Miller theorem

In the RIIO-T2 and GD2 Draft Determinations, Ofgem investigated the CoE implied from the MM model as part of the cross-checks to the CoE. Ofgem followed a two-step procedure to cross-check the CoE estimated at the notional gearing level. It concluded that, for companies with a gearing level close to 60% (United Utilities and Pennon), the CoE is similar to the observed CoE.

In our response to the Draft Determinations,[116] we showed that the parameter estimates result in a CoE that is inconsistent with the MM theorem. In particular, we found the following inaccuracies.

- The cost of debt is calculated by relying on historical evidence instead of a forward-looking cost of debt that is assumed by MM. A more appropriate figure would be the spot iBoxx AAA/B or the Utilities index.
- The RfR is found by relying on spot yields on UK gilts as a benchmark. We submitted a report in May 2020,[117] explaining that the violation of the MM model is considerably mitigated if the RfR is set at more plausible levels than the underestimates assumed in recent regulatory decisions. Specifically, we show that, all else equal, the further the RfR is below plausible levels, the more the WACC exhibits instability with reference to the level of gearing.
- The incorrect TMR and debt beta are used for the reasons stated in section 4 and section 5.2.2.

We consider the MM theorem to be an important cross-check for setting the allowed return of a regulated business. Therefore, in this subsection, we present an updated analysis based on the MM theorem using Ofgem's Final Determinations and our approach.[118]

Table A1.1 presents our replication of Ofgem's analysis. Specifically, we use Ofgem's CAPM parameters and observed betas/gearing to generate WACC

[115] Oxera (2019), 'Risk premium on assets relative to debt', 25 March; and Oxera (2020), 'Asset risk premium relative to debt risk premium', 4 September.
[116] Oxera (2020), 'The cost of equity for RIIO-2, Q3 2020 update', 4 September, p. 73.
[117] Oxera (2020), 'Are sovereign yields the risk-free rate for the CAPM?', prepared for the Energy Networks Association, 20 May.
[118] We note that Ofgem heavily relies on its Final Determinations for GD2 and T2 throughout its SSMD for ED2 and therefore consider this updated analysis to be relevant.

estimates. We then compare this with Ofgem's actual WACC. Our results show that the MM propositions do not hold using Ofgem's parameters, and the 're-geared' estimations yield a higher WACC. The difference in WACC is considerably greater than zero, which implies a violation of the MM propositions.

Table A1.1 Ofgem parameters

	SSE	NG	PNN	SVT	UU
Observed gearing					
Equity beta (five-year)	0.81	0.61	0.67	0.66	0.69
Equity beta (ten-year)	0.65	0.55	0.59	0.59	0.58
WACC (five-year)	3.81%	2.71%	2.95%	2.76%	2.83%
WACC (ten-year)	2.98%	2.39%	2.59%	2.47%	2.39%
Notional gearing (60%)					
Equity beta (five-year)[1]	1.29	0.84	0.90	0.79	0.78
Equity beta (ten-year)[1]	1.04	0.73	0.79	0.69	0.64
WACC (five-year)	4.48%	3.18%	3.38%	3.02%	2.99%
WACC (ten-year)	3.70%	2.80%	3.01%	2.70%	2.54%
Difference WACC					
Five-year	0.67%	0.47%	0.44%	0.26%	0.16%
Ten-year	0.72%	0.42%	0.43%	0.24%	0.15%

Note: [1] Assuming a 0.075 debt beta. The cost of debt is set at 1.82% for NG, PNN, SVT and UU, and at 1.59% for SSE. CPIH-real.

Source: Oxera analysis based on Ofgem and Thomson Reuters data.

Correcting for the appropriate cost of debt, RfR, debt beta, and TMR estimated by Oxera results in a reduction of the WACC difference across the companies in the sample.

Table A1.2 Corrected parameters

	SSE	NG	PNN	SVT	UU
Observed gearing					
Equity beta (five-year)	0.81	0.61	0.67	0.66	0.69
Equity beta (ten-year)	0.65	0.55	0.59	0.59	0.58
WACC (five-year)	3.65%	2.20%	2.41%	2.04%	2.01%
WACC (ten-year)	2.86%	1.82%	2.03%	1.72%	1.56%
Notional gearing (60%)					
Equity beta (five-year)[1]	1.30	0.85	0.91	0.80	0.79
Equity beta (ten-year)[1]	1.06	0.73	0.80	0.70	0.65
WACC (five-year)	3.71%	2.24%	2.44%	2.06%	2.02%
WACC (ten-year)	2.93%	1.85%	2.07%	1.74%	1.57%
Difference WACC					
Five-year	0.06%	0.04%	0.04%	0.02%	0.01%
Ten-year	0.06%	0.03%	0.03%	0.02%	0.01%

Note: [1] Assuming a 0.05 debt beta. The cost of debt is set at –0.29% for all the companies. The RfR is set at –0.93%. The TMR is set based on the midpoint of our range at 7.25% for all companies. Values are in CPIH-real terms.

Source: Oxera analysis based on Ofgem and Thomson Reuters data.

In sum, the CoE parameters presented by Ofgem violate the theoretical relationship between the WACC and gearing. Given these results, we consider that Ofgem's MM cross-checks cannot support the CoE proposed in its SSMD for ED2.

A1B Market-to-asset ratios

Ofgem's second cross-check on the allowed return is evidence from MARs. This section undertakes an analysis that highlights the problems of using MAR analysis as a possible cross-check for the CoE.

Ofgem's MAR analysis does not capture all factors relevant to market valuations

In our September 2020 report submitted to Ofgem, we showed how the average equity valuations of listed UK water companies may be explained by company-specific expected outperformance on TOTEX, ODIs and debt financing, as well as plausible assumptions on the value of non-regulated business activities; PR14 reconciliations; accrued dividends; and an expected takeover premium. Our analysis indicates that the observed MARs could be driven by factors not related to Ofwat's allowed return, which Ofgem agreed with in principle in the Sector Specific Methodology Decision.[119]

> We do exercise some caution when considering market-to-asset ratios. Firstly, there may be limited information in listed share prices as these stocks could, particularly in the short-run, be influenced heavily by wider market "noise". Second, as noted in the UKRN Study by Burns, any premium on corporate transactions could, at least in part, reflect (i) a control premium; or (ii) a winner's curse.

More generally, the use of MARs to suggest that the CAPM-estimated CoE is 'aimed up' is not in line with recommendations from the UKRN cost of capital study. While the authors—who were commissioned jointly by the Civil Aviation Authority, Ofcom, Ofgem and the Utility Regulator—did recognise the impact of returns on market valuations, they cautioned against and highlighted the challenges in using MARs to make inferences about investors' required returns:[120]

> Different drivers of outperformance are at play and multiple combinations of various drivers can explain observed premia. In addition, the role of expected outperformance means that the premia may result from unobserved investor assumptions that may be considered unrealistic or optimistic but are nevertheless the reality behind the premia. For these reasons we consider that evidence from transaction premia is less reliable and much harder to interpret than other sources of evidence on the CoE.

and:[121]

> However, we would caution the direct jump into conclusion that the existence of large premia must have been caused by the allowed equity return being set too high. There are a large number of different potential drivers of these premia, of which a divergence between the allowed and actual cost of equity is only one.

Based on the evidence above, we consider the MARs analysis not to be a sufficiently reliable approach to place weight on for the estimate of the RIIO-2 CoE.

[119] Ofgem (2012), 'RIIO-2 Sector Specific Methodology Annex: Finance', 18 December, para. 3.127.
[120] UK Regulators Network (2018), 'Estimating the cost of capital for implementation of price controls by UK Regulators', 6 March, p. 68.
[121] Ibid., p. 66.

A higher expected return in future price controls can help to explain the currently observed market premia

Our September 2020 report also highlighted two other issues. First, we found that market valuations of the listed water companies might be explained by expectations of a higher return in the future. In particular, taking Ofwat's allowed return of 4.19% CPIH for AMP7 and adding 50bp for subsequent price controls helps to explain the premia we currently observe. That is, investor expectations of 50bp higher returns in the future would increase the valuation of regulated water companies today. Our assumption for the allowed return after AMP7 (4.19% + 50bp = 4.69%) is conservative—it is approximately 40bp lower than the CMA's provisional finding of 5.08%.

The MAR analysis for the listed energy companies has estimation issues

Second, our report highlighted the estimation issues related to undertaking MAR analysis for non-pure-play comparators such as National Grid and SSE. These companies have sizeable business activities that are not regulated or are not in Great Britain and these assets need to be removed from market valuations in order to compare to the regulatory asset value. Ofgem's advisers, CEPA, recognise this issue as the 'decomposition problem' and indicate that incorrect estimates of the non-GB regulated business activities could bias the observed premia in its analysis:[122]

> Where the value of the non 'GB regulated' business is incorrectly estimated, this will bias the MAR premia for the 'GB regulated' business, potentially leading to incorrect inferences being drawn from the analysis.

Finally, the MARs analysis in the Final Determinations includes the share price reactions of National Grid and SSE in the three-week period following the CMA's provisional findings. Ofgem proposes that 'investors in SSE and NG interpreted CMA's PFs as a positive, and unexpected, signal for higher returns'.[123] We caution against drawing inferences for an entire industry based on the short-term 'noise' of selected companies, in particular given the volatility in market valuations during the COVID-19 pandemic. We reiterate Ofgem's earlier position that market 'noise', particularly in the short term, requires caution in interpreting market values:[124]

> We do exercise some caution when considering market-to-asset ratios. Firstly, there may be limited information in listed share prices as these stocks could, particularly in the short-run, be influenced heavily by wider market "noise".

The CMA's position in the PR19 water redeterminations is also cautious:[125]

> There are a wide range of reasons why prices may rise and fall over time, and the companies in question are fast track companies with low debt costs. Interpreting from one equity price to a particular cost of capital assumption is therefore difficult.

In light of these estimation issues, as well as our findings for the listed water companies and the caution advised by the UKRN and the CMA, we cannot recommend placing weight on this evidence as a cross-check for the CoE.

[122] CEPA (2020), 'RIIO-2: Use of Market Evidence', 9 July, p. 14.
[123] Ofgem (2020, 'RIIO-2 Final Determinations – Finance Annex', 8 December, p. 53.
[124] Ofgem (2012), 'RIIO-2 Sector Specific Methodology Annex: Finance', 18 December, para. 3.127.
[125] Competition and Markets Authority (2021), 'Water Redeterminations 2020: Choosing a point estimate for the Cost of Capital – Working Paper', January, p. 27.

Recent transactions of regulated utilities are not representative

The announced acquisitions of Western Power Distribution (WPD) by National Grid, and Bristol Water by Pennon Group are not representative of the market value of other regulated assets. In both cases, these are effectively mergers of companies operating in the same industry. The merging parties also operate in the same regions of the UK. It is likely that significant cost savings and performance synergies are anticipated as a result of these mergers.

Furthermore, the WPD acquisition is linked to the sale of electricity distribution assets owned by National Grid in the USA. This linkage further complicates the analysis of this transaction and reduces its representative value.

Overall, these recent transactions do not enable generalised inferences to be made about the level of the cost of equity or expected outperformance.

A1C Infrastructure fund discount rates

Ofgem considers infrastructure fund discount rates as a cross-check on the CoE.

Our March 2019 report on the subject looked at the funds' asset compositions, which we found to have lower risk than energy networks.[126] Moreover, where funds' portfolio investments face greater revenue or volume risks than energy networks, these are generally hedged by long-term or availability-based contracts and/or government subsidies—e.g. renewable obligation certificates (ROCs). We therefore concluded that these infrastructure funds have a lower risk–return profile and are not a suitable cross-check on the RIIO-2 CoE.

At the Sector Specific Methodology Decision, Ofgem agreed with us in principle that infrastructure funds might have lower risk and provided some more information on fund riskiness.[127] Then, at the Draft Determinations, it increased the sample of funds from six to 13 (excluding the outlier fund 3i).[128] We have reviewed the portfolios of assets in these funds and provide a brief overview below.

[126] Oxera (2019), 'Infrastructure Funds Discount Rates', March, Tab 88.
[127] Ofgem (2012), 'RIIO-2 Sector Specific Methodology Annex: Finance', 18 December, p. 150/Appendix 3.
[128] Ofgem (2020), 'RIIO-2 Draft Determinations – Finance Annex', para. 3.94.

Table A1.3 Portfolios of infrastructure funds

Company	Portfolio
BBGI	100% long-term availability-based public–private partnership[1]
JLIF	Inactive since 25 May 2018. Before that 100% in infrastructure projects
JLG	57.3% availability-based investment and 42.7% demand-based investments
HICL	72% in public–private partnership, 20% in demand-based assets and 8% in regulated assets
GCP	60% in renewable energy, 25% in Private Finance Initiative and 15% in social housing
INPP	Schools, energy transmission, gas distribution, health facilities, judicial facilities, military housing, transport and waste water
GRP	100% in operational renewable electricity generation assets within the eurozone
UKW	100% in operating UK wind farms
FSFL	Equities, bonds, gold miners, properties, emerging markets, cash, absolute funds and infrastructure
TRIG	55% in onshore wind, 35% in offshore wind, 9% in solar and 1% in batteries
BSIF	100% in UK solar energy
NESF	100% in solar photovoltaic assets
JLEN	Wind, anaerobic digestion, solar, waste and wastewater

Note: [1] We note that COVID-19 is expected to have limited impact on BBGI's future cash flows as these come exclusively from long-term availability-based government or government-backed contracts. This reduces the risk to investors of BBGI. See Inframation News (2021), 'BBGI UPBEAT ON DEAL PIPELINE AFTER REBOUND', 25 March.

Source: Oxera analysis based on each fund's website.

We observe that the asset classes and the risk of the diversified portfolios differ significantly from those of a pure-play energy network business. For example, the BBGI portfolio is invested entirely in long-term, availability-based public–private partnerships. Therefore, we continue to consider that the infrastructure funds' discount rates are not an appropriate benchmark for the CoE in RIIO-2 due to the fundamental differences in the risk profile.

In addition, we note Ofgem's 'three further analytical improvements' at the Draft Determinations.[129] In short, Ofgem uses each fund's discount rate and then deflates it using the market premium to the latest reported net asset value. This 'implied IRR' was then used as a cross-check to support Ofgem's CoE. The intuition provided by Ofgem is the same as for the MAR arguments (discussed in section A1B)—specifically, Ofgem assumes that any premium above the net asset value (NAV) means that the fund is overestimating its own cost of capital. As noted above in section A1B, there are multiple explanations for a market premium that do not rely on the overestimation of cost of capital. For example, the NAV reported by each fund may take a more prudent view of future cash flows relative to market expectations. We further investigate the infrastructure funds' discount rates and whether they represent an appropriate cross-check for the CoE.

Each fund uses these discount rates as its CoE measure. As they are publicly traded, each fund has an observable beta. Since we can observe each fund's CoE, beta, and RfR, we can estimate the implied TMR for each fund as a cross-check on the reasonableness of this data.

[129] Ofgem (2020), 'RIIO-2 Draft Determinations – Finance Annex', para. 3.94.

First, we note that these funds in general have very low or non-existent gearing.[130] Assuming that the discount rate is equivalent to the fund's WACC/CoE, we can estimate the implied TMR using each fund's equity beta and CoE. As most of the funds report extremely low gearing, we have assumed gearing to be zero for all the funds. Consistent with our analysis, we have assumed a –1.0% real RfR. We come up with an implied TMR range to account for the fact that two- and five-year betas differ. The results are summarised below.

Table A1.4 TMR implied from funds' discount rates

	Discount rate	Two-year equity beta	Five-year equity beta	Implied TMR range	Real TMR range
JLG LN Equity	9.10%	0.58	0.56	14–15	11–12
HICL LN Equity	7.00%	0.36	0.33	16–18	13–14
INPP LN Equity	6.97%	0.39	0.33	15–18	12–14
GCP LN Equity	8.50%	0.38	0.31	20–24	17–21
BBGI LN Equity	6.77%	0.25	0.22	22–24	19–21
UKW LN Equity	6.90%	0.41	0.33	14–17	12–14
FSFL LN Equity	6.50%	0.39	0.30	14–17	11–14
TRIG LN Equity	6.70%	0.46	0.40	13–14	10–11
BSIF LN Equity	6.00%	0.20	0.16	23–28	20–24
NESF LN Equity	6.25%	0.38	0.32	14–16	11–13
JLEN LN Equity	7.30%	0.33	0.29	18–21	15–19

Note: Calculations in nominal terms. Gearing assumed to be equal to zero. RfR is –0.93% in real terms.

Source: Oxera analysis based on the funds' annual reports and Bloomberg data.

We first note that the funds' five-year equity betas range from 0.16 to 0.56. Furthermore, the betas do not correlate well with the stated discount rates; for example, BSIF has a beta of 0.16–0.20 and a CoE of 6.0%, whereas NESF reports a beta of 0.32–0.38 and a CoE of 6.25%. This could be because the funds have a variety of different risk exposures, including to different countries.

Next, we note an average implied real TMR of 18.0%, with high variation. This is so high as to be unreasonable. Although infrastructure funds may relay useful data in some cases, they are clearly inappropriate for a CoE cross-check for regulated UK energy firms. The implied TMR and lack of consistency between their own betas/CoE suggest that this data is unreliable for the type of cross-check attempted by Ofgem, and that infrastructure funds' discount rates are not an appropriate benchmark for the CoE in RIIO-2.

[130] Relaxing this assumption does not significantly change the analysis below.

A1D OFTO returns

In its Draft Determinations, Ofgem considered the implied equity IRRs from winning OFTO bids as a cross-check to its CoE estimate. Using the most recent OFTO tender rounds, Ofgem arrived at an equity IRR of 7.0–10.2% (nominal), with a point estimate of 7% (4.9% CPIH-real).[131]

First, it is important to notice how, in the Draft Determinations, Ofgem is using OFTO required equity returns as an upper bound comparator for setting the CoE, as outlined above. However, this decision contrasts with the view expressed by the UKRN, which stated:[132]

> Whilst the required returns from OFTO and PFI projects is informative, given the risk characteristics of these projects, they represent the low end of the range of comparable values for network utilities.

Moreover, the UKRN makes clear that the OFTO equity returns should be used as a lower bound comparator rather than an upper bound comparator for the CoE, for the following reasons.[133]

- For OFTO there is no price control, so no regulatory reset risk (although some residual political/regulatory risk may remain should the OFTO model be revised retrospectively).
- No construction risk (at least all existing OFTOs for which evidence is available have been delivered under the 'generator build' model under which the OFTO faces no construction risk).
- Financing can be largely completed upfront, implying very limited refinancing risk (but with some scope for refinancing upside).

We have also explained in our response to the Draft Determinations that OFTO projects are operational assets with a very different risk profile compared to the onshore energy networks regulated by RIIO-2. In particular, the net cash flows are largely fixed in real terms over the duration of the OFTO tender revenue stream. As such, we consider that any comparison of asset risk is likely to significantly underestimate the cost of capital for a network that undertakes capital and replacement expenditure in addition to operational expenditure.[134]

Furthermore, in the OFTO regulatory regime, different OFTO developers bid their desired return into the market and the winning bid is selected as a competitive outcome. For onshore transmission networks, on the other hand, Ofgem uses regulatory judgement in setting returns for companies in the sector. There is therefore a relative financeability risk for onshore networks if the return is set too low by Ofgem. This is discussed in a CEPA-authored report submitted to Ofgem.[135]

Additionally, Ofgem assumes a terminal value of zero at the end of the expected project life. However, it is implausible to assume that investors expect zero terminal value for OFTO assets beyond the end of the tender revenue stream, as it assumes that the assets are worthless. In a more realistic scenario where the successful bidders assumed positive net cash flows after the end of the contracted revenue period when placing bids, the

[131] Ofgem (2020), 'RIIO-2 Draft Determinations – Finance Annex', 9 July, paras 3.86–3.89 and Figure 12.
[132] UK Regulators Network (2018), 'Estimating the cost of capital for implementation of price controls by UK Regulators', 6 March, p. 172.
[133] Ibid.
[134] Oxera (2020), 'The cost of equity for RIIO-2 – Q3 2020 update', 4 September
[135] CEPA (2016), 'EVALUATION OF OFTO TENDER ROUND 2 AND 3 BENEFITS', March, p. 16.

implied IRR would be higher. Moreover, they also may have different tax structures and their bids may factor in expected outperformance, further underestimating the anticipated IRR.

Due to significant differences in asset risk and based on the UKRN evidence, we consider that OFTOs constitute an inappropriate cross-check to use in the RIIO-2 process. Therefore, we remain of the position that inferences made from OFTO bids should not be used to benchmark the CoE for onshore energy networks.

A1E Investment managers

In this subsection, we provide more detailed commentary on Ofgem's analysis of the investment managers cross-check.

At the Sector Specific Methodology Decision, Ofgem provided analysis that it argued supported an average TMR of 7.65% (nominal).[136] This analysis excluded two outliers from its sample: the forecasts by Vanguard and Willis Tower Watson. One year later, at the Draft Determinations, Ofgem found that the average observed TMR had decreased to 7.10% for the same sample of forecasts (excluding the same outliers).[137] Ofgem has not updated its analysis at the Final Determinations.

First, we note that there is a large variance in the forecasts, both across different investment managers and over time. This instability of estimates does not provide a reliable average return. Second, we observe that nearly the entirety of the decline in Ofgem's estimated TMR between the Sector Specific Methodology Decision and the Draft Determinations was due to a decrease in the investment horizon for Schroders, from 30 to ten years.[138] If the original horizon had been used, Schroders would have estimated a TMR of 7.90% rather than 4.90%.[139] We understand that Ofgem has made this change to align the Schroders estimate with the investment horizon of the other forecasts.

In addition to changing the investment horizon from 30 years to ten years, Ofgem's new estimates from Schroders were based on US rather than UK data.[140] This is inconsistent with the remainder of the sample, which is all based on UK data. Due to the bias introduced by this outlier, we therefore consider it unreasonable to include the Schroders data point in the analysis.

We note that by excluding the Schroders outlier, the average TMR estimated by investment manager reports would have been 7.49% at the Sector Specific Methodology Decision (rather than 7.65%) and 7.38% at the Draft Determinations (rather than 7.10%).

The sample of forecasts is quite small, containing only 11 forecasts (including the outliers).

More generally, we discussed in our 2019 report that TMR estimates produced by investment managers have the primary purpose of providing prudent

[136] Ofgem (2019), 'RIIO-2 Sector Specific Methodology Decision – Finance', 24 May, Figure 6.
[137] Ofgem (2020), 'RIIO-2 Draft Determinations – Finance Annex', 9 July, Table 23.
[138] Ibid.
[139] Schroders (2019), '30-year return forecasts (2019–48)', January, p. 8, available at: https://www.schroders.com/en/sysglobalassets/digital/insights/2019/pdfs/2019_jan_long-run-return-forecasts-2019-2048-final.pdf (last accessed 4 June 2021).
[140] Schroders' forecasts are achieved by estimating the returns to all other countries/regions based on the US estimates. Specifically, it takes the current US ERP estimate (relative to US bonds) and multiplies it by the country/region's historical ERP beta to US ERP. The beta-adjusted country/region ERP estimate is then added to its nominal bond return estimate to get to the equity return forecast.

estimates of future returns to their clients.[141] This is mainly a function of the regulatory framework, namely the FCA Conduct of Business Sourcebook, which states the maximum rates of return that financial services companies must use in their calculations when providing retail customers with projections of future benefits (it creates a ceiling):[142]

> Firms are required to use rates of return in their projections that reflect the performance of the underlying investments, but the ceilings imposed by the FCA aim to prevent consumers being misled by inappropriately high rates.

We also note that the CMA, during the water redeterminations, exercised caution in interpreting forecasts made by market analysts:[143]

> These estimates may also prove to be no more accurate than our own assessment, or may be specifically tailored to particular investors or house views rather than representing the cost of capital demanded by the average or marginal investor in the sector.

This suggests that, at best, this evidence should be regarded as providing a lower bound on the CoE. If any weight is to be placed on this evidence in deriving the discount rate appropriate for setting the CoE allowance, an upward adjustment needs to be made to correct for the downward bias arising due to geometric averaging. As explained by Cooper (1996), both the geometric and arithmetic averages are likely to be downward-biased estimators of the discount rate. Therefore, one must upwardly adjust these to generate a true market discount rate.

Ofgem agrees with this correction in principle, but not on the magnitude of the adjustment. It uses an uplift of 1% in line with a JP Morgan publication, which we note is inconsistent with the estimate implied by the DMS (2020) data of 1.87%.[144]

> We contacted the investment managers and received confirmation that their published values are in geometric terms. We therefore agree with Oxera that geometric averages may need upward adjustment. Oxera suggested an uplift of 2% but it is much less clear to us that this quantum is appropriate. As shown at Figure 6 below, in the absence of arithmetic values from the publishers, we assume an uplift of 1%, which we believe is appropriate based on the JP Morgan publication (which implies a differential between arithmetic and geometric forecasts of 0.82%).

Given the conceptual and estimation issues, we consider it prudent not to place weight on this evidence.

A1F Asset risk premium and debt risk premium

As part of the Energy Networks Association's response to Ofgem's RIIO-2 Sector Specific Methodology Decision, in March 2019 Oxera submitted evidence to Ofgem on how the regulator's proposed allowance on the CoE compared with the pricing of risk for these companies in the debt markets ('the first Oxera ARP–DRP report').[145] We explained that the ARP–DRP

[141] Oxera (2019), 'Review of RIIO-2 finance issues: rates of return used by investment managers', p. 2.
[142] Financial Conduct Authority (2017), 'Rates of return for FCA prescribed projections', p. 5.
[143] Competition and Markets Authority (2021), 'Water Redeterminations 2020: Choosing a point estimate for the Cost of Capital – Working Paper', January, p. 22.
[144] Ofgem (2019), 'RIIO-2 Sector Specific Methodology Decision – Finance Annex', 24 May, para. 3.90. See also Competition and Markets Authority (2020, 'Anglian Water Services Limited, Bristol Water plc, Northumbrian Water Limited and Yorkshire Water Services Limited price determinations - Provisional Findings', 29 September, Table 9-3.
[145] Oxera (2019), 'Risk premium on assets relative to debt', 25 March.

differential could be used as a cross-check on the appropriate level of the allowed CoE.

On 4 September 2020, Oxera submitted to Ofgem an updated ARP–DRP report ('the second Oxera ARP–DRP report').[146] This report (i) included the newly available data from the bond markets; (ii) adopted a revised approach to the RfR set out in a recent Oxera submission to the CMA;[147] and (iii) improved the methodologies used for our analysis in response to Ofgem's concerns set out in the RIIO-2 Sector Specific Methodology Decision.

In this section, we set out the ARP–DRP implied in Ofgem's RIIO-2 Final Determinations, and compare them to those implied by: (i) contemporaneous market evidence for the cost of debt and the RfR; and (ii) a mixture of contemporaneous market evidence and regulatory precedent on the asset beta and the TMR.[148] We show that Ofgem's RIIO-2 allowances for the CoE set out in the Final Determinations are low relative to that implied by contemporaneous market evidence.

Overview of the ARP–DRP framework

The ARP reflects the excess return required by investors in return for providing capital to risky assets. It is calculated using the following formula:

$$Asset\ risk\ premium = asset\ beta \cdot equity\ risk\ premium$$

The DRP reflects the excess return required by investors in return for acquiring risky debt, and can be calculated using one of two approaches:[149]

Approach 1

$$DRP\ =\ yield\ to\ maturity -\ expected\ loss - RfR$$

Approach 2

$$DRP =\ debt\ beta \cdot equity\ risk\ premium$$

As explained in the second Oxera ARP–DRP report, we consider that the appropriate benchmark for the ARP–DRP differential should be derived from contemporaneous market evidence.[150] Therefore, we recommend placing more weight on Approach 1, which uses traded yields on utilities' bonds in the DRP estimation.

In the second Oxera ARP–DRP report, we show that the ARP–DRP differential can be employed to: (i) obtain conservative estimates of the allowed WACC, because of the downward bias in asset beta estimation; and (ii) assess financeability in a way that is neutral with respect to the treatment of inflation. Below, we present a short summary of our conclusions from that report.[151]

The ARP–DRP framework implies conservative estimates of the WACC

The academic literature and econometrics textbooks explain that attenuation bias, a form of regression bias, would have biased the regression coefficients

[146] Oxera (2020), 'Asset risk premium relative to debt risk premium', 4 September.
[147] 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.
[148] For a detailed methodology, see Oxera (2020), 'Asset risk premium relative to debt risk premium', 4 September.
[149] 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.
[150] Oxera (2020), 'Asset risk premium relative to debt risk premium', 4 September, p. 15.
[151] Oxera (2020), 'Asset risk premium relative to debt risk premium', 4 September.

of CAPM-based models (i.e. the equity beta and debt beta) towards zero.[152] For example, Jegadeesh, Noh, Pukthuanthong, Roll and Wang (2019) simulate various asset pricing models, calibrating the simulation parameters using actual market data. Their findings show that:[153]

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

The downward attenuation bias in the estimated asset beta ($\widehat{\beta_a}$) is caused by the presence of measurement errors in the independent variable (i.e. market returns as proxied by returns on an index of equities).[154,155] Without any correction to this bias, 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. As a result, the ARP–DRP differentials implied by the RIIO-2 Final Determinations fall at higher percentiles within the empirical distribution of market evidence, making the benchmarking more conservative. The ARP–DRP analysis can also be used to obtain conservative estimates of the WACC, by deriving the ARP and the CoE from the median ARP–DRP differential.

The ARP–DRP framework assesses financeability with a neutral treatment of inflation

The ARP–DRP framework also provides important additional information for the assessment of financeability.

The ARP–DRP 'delta' is designed in a similar fashion to the nominal PMICR, which is used by Fitch Ratings to assess companies' debt financeability. The ARP–DRP delta achieves this through the measurement of the companies' return on assets relative to debt. It is a useful addition to the PMICR, as it assesses 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 regulatory package 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 different indices.

The ARP–DRP differential implied by the RIIO-2 Final Determinations

Table A1.5 presents the detailed calculations of the ARP–DRP differential implied by the Final Determinations, which is at 2.19%.

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[152] Oxera's debt beta of 0.05 is an unbiased estimate, based on the methodology set out in 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.
[153] 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*, pp. 273–98.
[154] 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 $\boldsymbol{E}$ is the market value of equity; and $\boldsymbol{D}$ is the market value of debt.
[155] To the extent that the RAB is based on coefficients deriving from regression models, the attenuation bias in the estimated asset beta would be present across our sample of comparators.

Table A1.5 The ARP–DRP differential implied by the RIIO-2 Final Determinations

	Calculation	RIIO-2 FD
Publication date		08/12/2020
Three-month trailing average yield on 20-year nominal gilts[1]	[A]	0.80%
Convenience premium[2]	[B]	0.50%
Risk-free rate (nominal)	[C] = [A] + [B]	1.30%
Total market return (nominal)[3]	[D]	8.65%
Equity risk premium	[E] = [D] – [C]	7.36%
Asset beta[4]	[F]	0.33
ARP	**[G] = [E] x [F]**	**2.45%**
Yield to maturity (nominal)[5]	[H]	1.85%
Expected loss[6]	[I]	0.30%
DRP	**[J] = [H] – [C] – [I]**	**0.26%**
ARP–DRP differential	**[K] = [G] – [J]**	**2.19%**

Note: The calculations have minor discrepancies due to rounding errors. The DRPs presented are calculated under Approach 1. To standardise the various regulatory approaches to estimating RfR and debt beta across sectors and over time, we adopt Oxera's methodology for RfR and debt beta. This approach is consistent with our ARP calculations for the comparators and Ofgem's Draft Determinations in the second Oxera ARP–DRP report.

[1] As at the publication date. [2] The bottom end of the range recommended in the Oxera RfR report. [3] Restated in nominal terms using Ofgem's CPIH-real TMR of 6.50%, and an assumed CPIH inflation of 2.02% (the OBR's CPIH forecast for 2024).[4] Re-levered and de-levered assuming a debt beta of 0.05 and notional gearing of 60%, as recommended by Oxera. The unadjusted asset beta is 0.349 for the Final Determinations. [5] Spot yield of the iBoxx £ non-financials A and BBB 10+ indices as at the publication date. [6] We assumed an expected loss of 30bp for senior unsecured debt. See Oxera (2019), 'Risk premium on assets relative to debt', 25 March.

Source: Data from Thomson Reuters Datastream and Bank of England yield curve; and Ofgem (2020), 'RIIO-2 Final Determinations – Finance Annex', 8 December.

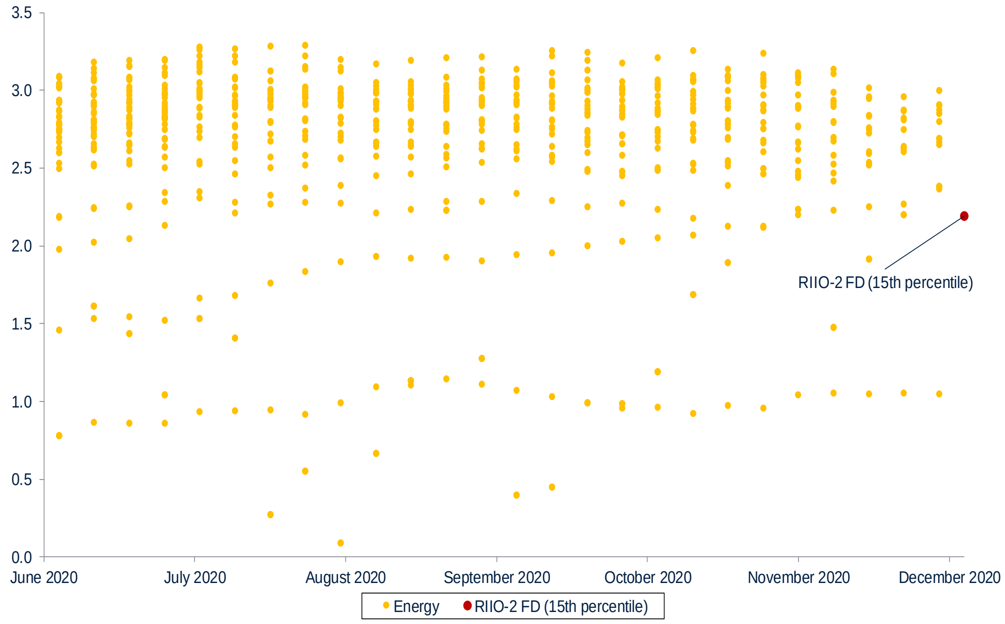
ARP–DRP differentials implied by contemporaneous market evidence

In this section, we compare the ARP–DRP differentials implied by the RIIO-2 Final Determinations to those implied by: (i) contemporaneous market evidence for the cost of debt and the RfR; and (ii) a mixture of contemporaneous market evidence and regulatory precedent on the asset beta and the TMR.[156] Our methodology is consistent with that set out in the second Oxera ARP–DRP report.

Figure A1.2 illustrates that the ARP–DRP differential implied by Ofgem's RIIO-2 Final Determinations allowed return on equity falls significantly below contemporaneous market evidence over the six-month period prior to the publication date. Specifically, Ofgem's midpoint allowance for the Final Determinations falls at the 15th percentile of the empirical distribution of market evidence for the six months preceding the publication date of the Final Determinations.

[156] For detailed methodology, see Oxera (2020), 'Asset risk premium relative to debt risk premium', 4 September.

Figure A1.2 Comparison of ARP–DRP differentials implied the RIIO-2 Final Determinations to those implied by contemporaneous evidence on UK energy bonds



Note: The ARP–DRP differentials are calculated under Approach 1, based on weekly averages of daily traded yields of UK energy bonds. The ARP–DRP differentials implied by the comparators are calculated under Approach 1, and represent the difference between ARP and DRP. Specifically, ARP is the product of the asset beta (estimated using a debt beta of 0.05) and ERP (calculated from linearly interpolated TMR from regulatory precedents, nominal gilts with a maturity matching those of the corresponding energy bonds, and an upward RfR adjustment of 50bp). For bonds issued by non-publicly traded energy companies, we use the asset beta adopted in Northern Ireland Electricity's RP6 (0.36, after using a debt beta of 0.05). For bonds issued by publicly traded energy companies (i.e. National Grid), we estimate the corresponding two-year asset beta using data on share price, gearing, and return on market index (the FTSE All-share index). Of the 57 energy bonds in our sample, 18 were issued by National Grid (including by NGGT and NGET).

The comparators' DRPs are estimated by subtracting the yield on maturity-matched nominal gilts, adjusted upwards by 50bp, and the expected loss of 30bp, from the traded yields of the energy bonds.

We adjust the yield on RPI-linked bonds by 3% and CPIH-linked bonds by 2%, using the Fisher equation.

Source: Oxera analysis using data from Bloomberg, Thomson Reuters Datastream and Bank of England.

A1G Conclusion

Ofgem has used six cross-checks to compare the CAPM-implied CoE. We find that there are estimation issues with all of the cross-checks, and that they are individually and collectively unreliable.

We recommend placing weight on an alternative cross-check, the ARP–DRP differential, which shows that Ofgem's allowed return is significantly below contemporaneous market evidence. We consider this cross-check to be superior to the other cross-checks proposed by Ofgem.

A2 Cross-checks on the TMR

This entire section looks at the cross-checks evidence provided by Ofgem at ET/GT/GD2. Although Ofgem has not repeated this procedure at this stage of the ED2 process, it has confirmed its position that the cross-checks are relevant for ED2.

A2A Investment manager forecasts

At the Sector Specific Methodology Consultation (SSMC), Ofgem used estimates published by investment managers as cross-checks in two ways: of its TMR range, and of the CAPM-implied CoE.[157] We note that Ofgem does not present new analysis for this cross-check in the Final Determinations, instead referencing its earlier work at the Draft Determinations. Nonetheless, for the reasons described in section A1E, we recommend placing no weight on this cross-check when setting the TMR and CoE ranges.

A2B Total market return in USD

In its Sector Specific Methodology Consultation (SSMC), Ofgem proposes cross-checking its TMR range with long-run outturn averages measured in USD terms.[158] In its Final Determinations, Ofgem justifies this cross-check by stating that 'the marginal investor can move capital internationally', and that this cross-check also supports the use of CPI as an inflation measure.[159] Its specific reasoning is as follows:[160]

> 1) US CPI over the period was a more accurate estimate of inflation over the entire period than the UK inflation indices; and 2) Purchasing Power Parity theorem holds, in the very long run, in which case the exchange rate reflects the difference in inflation between two currencies. Both propositions seem reasonable to us.

We address both points in turn below. First, while it is empirically correct for Ofgem to state that CPI inflation brings UK real market returns for the period 1899–2016 more into line with USD-based returns, our analysis indicates that the comparability of real returns appears to be driven more by the choice of the averaging period than by the inflation index. For example, Table A2.1 shows that returns deflated using the DMS inflation index are identical to the USD-based returns for the 1899–2012 period, at 5.23%. However, the 2012 DMS data used *RPI* to calculate real market returns from 1947 onwards, and a narrowly defined index of retail prices before that. There is no use of CPI at all in this series, lending no support to the use of CPI over RPI.

[157] Ofgem (2019), 'RIIO-2 Sector Specific Methodology Decision – Finance,' 24 May, Table 10.
[158] Ofgem (2018), 'RIIO-2 Sector Specific Methodology Consultation – Finance Annex', 18 December, paras 3.67–3.70.
[159] Ofgem (2020), 'RIIO-2 Final Determinations – Finance Annex', December, para. 3.91.
[160] Ibid.

Table A2.1 Average real UK market returns measured in GBP and USD, based on DMS (2012)

Period	DMS real returns (£)	DMS real returns ($)
1899–2012	5.23%	5.23%
1899–2000	5.78%	5.61%
2000–2012	0.67%	2.08%
1955–2012	6.58%	7.32%

Note: Historical geometric average of real UK market returns in GBP and USD, deflated using the DMS (2012) inflation series and nominal market returns dataset.

Source: Oxera analysis based on DMS data from 1899 to 2011.

In the table, we also note very different returns expressed in GBP and USD in the 2000–12 period, as well as differences in the 1955–2012 and 1899–2000 periods. We conclude that the only inflation series resulting in parity between real UK returns expressed in USD is the series that uses RPI. Due to the instability of this relationship over different time periods, we do not view this as a useful cross-check.

Second, we find that PPP between USD and GBP does not hold with regularity. We consider this result to be not surprising as the academic literature disagrees with the practical applications.

Specifically, there are many other factors in addition to the change in relative prices that could affect PPP, including differences in the cost of labour, market conditions, trade policies, and differences in the baskets of consumer goods. The most well-known empirical violation of PPP is the Balassa–Samuelson effect, which predicts that the PPP will not hold in reality.[161,162] This can be driven by differences in prices of local services and transportation costs. A survey by Tica and Druzic (2006) notes at least 60 academic articles empirically documenting this violation of PPP in various countries.[163]

As one can see, the concept of a pure PPP is not generally accepted in academia. In fact, a hypothetical ‘international dollar’ has been created by academics in order to describe a world where PPP would hold. The exchange rates vary significantly from the true USD and are used to translate true exchange rates into a fictional world of PPP.[164]

Given the observed empirical and academic evidence, we recommend placing no weight on the USD/GBP cross check.

[161] Balassa, B. (1964), ‘The Purchasing Power Parity Doctrine: A Reappraisal’, *Journal of Political Economy*, pp. 584–96.
[162] Samuelson, P.A. (1964), ‘Theoretical Notes on Trade Problems’, *Review of Economics and Statistics*, 46:**2**.
[163] Tica, J. and Druzic, I. (2006), ‘The Harrod–Balassa–Samuelson Effect: A Survey of Empirical Evidence’, *EFZG Working Paper* Series 0607.
[164] World Bank Data Help Desk, ‘What is an “international dollar”?’, retrieved 13 April 2019.

A3 Deflation of historical equity market returns

A3A Consumption Expenditure Deflator is a closer proxy for RPI than CPI

For the period 1900–50, for which there is no RPI or CPI data, the CMA considered whether the CED was more like RPI or CPI. Plotting the CED against both the RPI and CPI from 1950 to 2016, the CMA reached the following conclusion:[165]

> CED cannot be said to be more like RPI or more like CPI. Therefore, we find that it is reasonable to combine CED data with both CPI and RPI, respectively, when deflating historic returns, on the basis that CED represents the most reliable measure of inflation available for the first half of the twentieth century.

It also calculated that:[166]

> That analysis suggested that RPI exceeded CED by around 0.4% over the 1950 to 2016 period, while CPI was around 0.1% lower than CED over that same period.

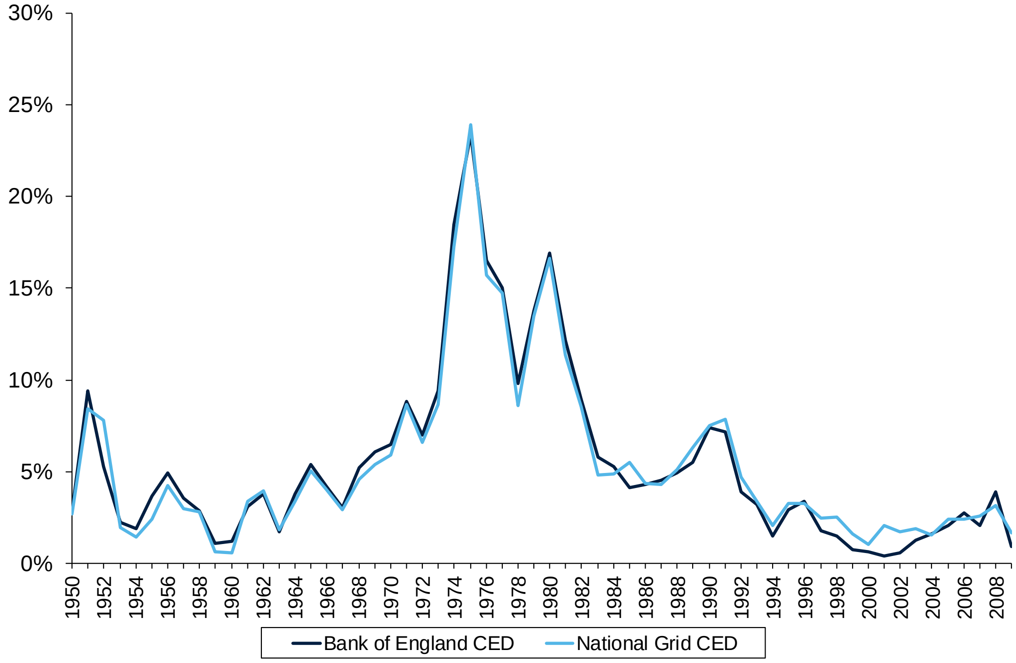
To draw this conclusion, the CED deflators after 1950 must be calculated in a manner consistent with the pre-1950 CED deflators. This is not what the CMA did. Rather, it used a post-1950 CED series, which is based on deflators from recent editions of the National Accounts. The ONS changed the calculations that lie behind the deflators in the National Accounts for the 2011 Blue Book. The deflators were then retrospectively changed back to 1997. They were subsequently extended back to 1948 in the 2012 Blue Book. Further changes have continued to be made to the CED series in subsequent editions of the National Accounts, and as a result the deflators in more recent National Accounts have become ever less consistent with the original formulation of CED deflators as used for Blue Books prior to 2009. These changes would not have been obvious to the CMA, as they can only be detected by inspecting the historical National Accounts.

The pre-1950 CED series constructed by Feinstein (1972)[167] was extended forward by Sefton and Weale (1995),[168] who used data published in the National Accounts up to the 1993 edition. National Grid subsequently extended this series to 2009 using National Accounts published between 2000 and 2009 (i.e. before the major methodology change in 2010 and the subsequent revision of the back series).[169]

The inflation series based on the deflators calculated by National Grid from Sefton and Weale (1995) and the 2000–10 Blue Book National Accounts does not match the historical CED series that is in the Millennium Data Set. We report the time series of the two below.

[165] Competition and Markets Authority (2021), 'Anglian Water Services Limited, Bristol Water plc, Northumbrian Water Limited and Yorkshire Water Services Limited price determinations – Final Report', 17 March, para. 9.310.
[166] Ibid., para. 9.308.
[167] Feinstein, C.H. (1972), National Income, Expenditure and Output of the United Kingdom 1855-1965, *Cambridge University* Press, as referenced in National Grid (2020), 'Total Market Return: The consistency of long-run CPI and RPI inflation series in the UK, and their relative suitability for use in calculating the actual historic long-run average equity market return in the UK on a "real" basis', 23 January.
[168] Sefton, J. and Weale, M. (1995), 'The Reconciliation of National Income and Expenditure Balanced Estimates of National Income for the United Kingdom, 1920-1990', *Cambridge University Press*.
[169] National Grid (2020), 'Total Market Return: The consistency of long-run CPI and RPI inflation series in the UK, and their relative suitability for use in calculating the actual historic long-run average equity market return in the UK on a "real" basis', 23 January, pp. 38–43.

Figure A3.1 Comparison of Millennium Data Set CED and the deflators from Sefton and Weale (1995) and the 2000–10 Blue Book National Accounts produced by National Grid



Note: CMA data corresponds to its 2020 Provisional findings.

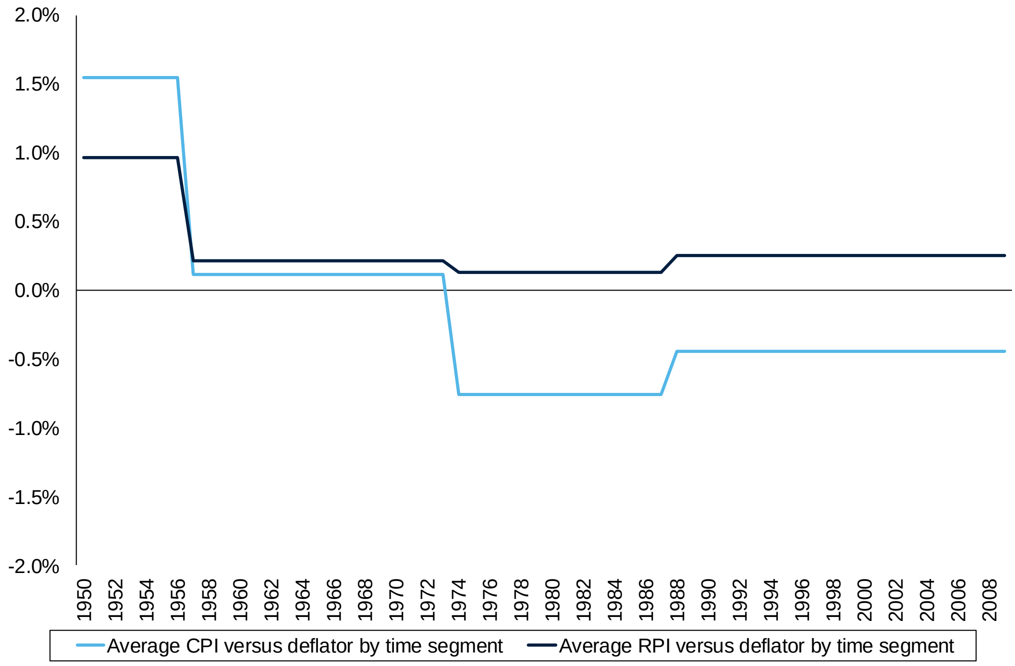
Source: Bank of England; National Grid.

Figure A3.2 below compares the CED series from the historical Blue Book National Accounts against the published RPI as well as against the estimates and published data for the CPI. It shows that before 1956, the backcast CPI inflation is significantly higher than RPI inflation, which seems implausible given the known methodological differences between these series and also their empirical relationship after 1956. This change in relationship coincides with the birth of the modern RPI (then called the Index of Retail Prices). This new index included a range of important methodological improvements—in particular, all wage-earning households were included, not only the working class.[170] The index took its weights from the more recent 1953 expenditure survey, rather than the pre-war late-1930s survey.[171] Owner-occupier housing costs were also included for the first time.[172]

Between 1956 and 2009 (the last year for which comparable CED data is available), the average differential between RPI and the CED is relatively stable and averages 21bp. In comparison, the average differential between the CED and the backcast of CPI has changed significantly over time and averages minus 32bp.

[170] Johnson, P. (2015), 'UK Consumer Price Statistics: A Review', study prepared for the UK Statistics Authority, January, p. 118.
[171] Expenditure weights calculated from the Family Expenditure Survey (FES) were monitored for 'significant changes'. The FES was about a quarter of the sample size of the 1953 Budget inquiry.
[172] Using the concept of equivalent rents. See O'Neill, R., Ralph, J. and Smith, P.A. (2013), 'Modelling a Back Series for the Consumer Price Index', pp. 141–3.

Figure A3.2 Average differential in each of several time segments between each of CPI and RPI and the deflators from Sefton and Weale (1995) and the 2000–10 Blue Book National Accounts



Source: National Grid (2020), 'Total Market Return: The consistency of long-run CPI and RPI inflation series in the UK, and their relative suitability for use in calculating the actual historic long-run average equity market return in the UK on a 'real' basis', 23 January, p. 11.

This suggests that, prior to 1950, where the CPI backcast uses CED, this series is both theoretically and empirically closer to RPI than CPI. Combining CED with RPI is likely to slightly understate the long-run average of RPI inflation, while overstating to a larger extent the long-run average of CPI inflation. This finding is opposite to that of the CMA, because the CMA has inadvertently performed the comparison using a CED series that is inconsistent over time and included the 1950–56 period, which contains an implausible reversal of the relationship between RPI and the CPI backcast.

A3B Oxera analysis of changes to RPI

The CMA notes the work that Oxera undertook for Heathrow, which sought to identify structural breaks in the RPI series and adjust for these breaks to create a long-term RPI series consistent with how RPI is defined today. This work concluded that if the historical (1899–2019) RPI series were restated using today's RPI calculation methodology, the series would be at most 30bp higher than if based on the official RPI series published by the ONS.[173]

The two grounds provided by CMA for rejecting the findings of this analysis were:[174]

> Oxera's analysis has not been applied comprehensively across the whole of the relevant period (1950 onwards). Therefore, we do not believe it is appropriate to

[173] Oxera (2019), 'Estimating RPI-adjusted equity market returns', 2 August.
[174] Competition and Markets Authority (2021), 'Anglian Water Services Limited, Bristol Water plc, Northumbrian Water Limited and Yorkshire Water Services Limited price determinations - Final Report', 17 March, para. 9.298(a).

> place weight on Oxera's analysis in identifying the impact of changes in the formula effect over time.

and that:[175]

> during the early 1990s period when Oxera's analysis suggests that the size of the formula effect would have reduced due to various methodological changes, there is some other evidence from the ONS suggesting that the opposite effect may have been taking place.

The first ground for rejecting the conclusions of this analysis is unjustified because the Oxera analysis does cover the full period from 1950 onwards. The first Oxera report for Heathrow examined methodological and statistical breaks in the CED/RPI series since 1900, finding a series of breaks from 1971 to 2011.[176] The second Oxera report for Heathrow updated the analysis to explicitly control for known macroeconomic shocks, such as GDP, oil price, mortgage interest payments, and exchange rate movements.[177] As data on mortgage interest payments only extends back to 1987, this more refined approach was only able to identify breaks that appear in the period 1988–2018. The more refined approach builds on the earlier analysis and does not replace it.

The second ground relies on an interpretation of the ONS paper where the first backcast of the CPI (for the period 1988–96) was published. Oxera has already responded to this interpretation, by providing the CMA with analysis suggesting that the upward trend in the formula effect over the period 1989–97 cannot be relied on and that estimates of the formula effect are likely to be underestimated for the period prior to 1997.[178]

In summary, the CMA has provided insufficient justification for rejecting the finding that if the historical (1899–2019) RPI series were restated using today's RPI calculation methodology, the long-run average of RPI inflation would be at most 30bp higher than if based on the official RPI series published by the ONS. In light of this, it is inappropriate for the CMA to place more, or even equal weight, on the historical CED/CPI series than on the CED/RPI series when deflating historical equity returns.

[175] Competition and Markets Authority (2021), 'Anglian Water Services Limited, Bristol Water plc, Northumbrian Water Limited and Yorkshire Water Services Limited price determinations - Final Report', 17 March, para. 9.298(b).
[176] Oxera (2019), 'Estimating RPI-adjusted equity market returns', 2 August, Table 3.1.
[177] Oxera (2020), 'Response to the CMA on estimating RPI-adjusted equity market returns', 15 April.
[178] Oxera (2020), 'Estimating CPI: the 1988–96 ONS estimates', 28 July.

A4 Debt beta

As discussed in section 5.2.2, Ofgem adopts a debt beta range of 0.0–0.15 and a point estimate of 0.075 in its Final Determinations for GD and GT.[179] In setting this range, Ofgem relied on the evidence presented by CEPA in a report for the UKRN[180] and the CMA's provisional range from its PR19 provisional findings.[181] In its report for the UKRN, CEPA outlined four methods for estimating debt beta:

- the direct method;
- the indirect method;
- structural methods;
- decomposition methods.

In our response to the CMA's PR19 provisional findings, we explained that the high end (0.15) of the CMA's range reflects evidence that Europe Economics (EE) provided to Ofwat.[182] In recommending a 0.15 debt beta assumption to Ofwat, EE used the decomposition approach as the primary source of evidence.

In this appendix, we discuss each method in turn and summarise the methodological findings of the 2020 Oxera report on debt betas.[183]

A4A Direct method

The direct method, as described by CEPA, involves regressing bond returns directly on equity market returns to obtain the debt beta estimate. This method has been mentioned in the determination of allowed debt beta for H7 and RP3 by the Civil Aviation Authority and for PR19 by Ofwat.[184]

CEPA claims that debt beta estimates obtained from the direct method have poor statistical properties, which include low statistical significance, volatility over time, implausible values, and/or low explanatory power of the underlying regression model.[185]

Low statistical significance and/or low explanatory power of the underlying model, as we found in some observations within our sample under the direct method, implies that the standard errors of the estimates are so high that the estimates are not statistically distinguishable from zero. While there is a risk that the regression model has been incorrectly specified or that the underlying data contains some noise, this lack of statistical significance could also result from true debt betas of zero. In other words, a lack of statistical significance means that one cannot reject the null hypothesis that the debt beta is zero, not that the estimation method is flawed because it does not generate a

[179] Ofgem (2020), 'RIIO-2 Final Determinations – Finance Annex', 8 December, para. 3.67.
[180] UK Regulators Network (2019), 'Considerations for UK regulators setting the value of debt beta', December.
[181] Competition and Markets Authority (2020), 'Anglian Water Services Limited, Bristol Water plc, Northumbrian Water Limited and Yorkshire Water Services Limited price determinations: Provisional findings', 29 September, para. 9.315 and Table 9-17.
[182] See Oxera (2020), 'Review of the CMA PR19 provisional findings', 26 October, section 3.2.1.
[183] Oxera (2020), 'Estimating debt beta for regulated utilities' 4 June.
[184] Europe Economics (2019), 'The Cost of Capital for the Water Sector at PR19', 17 July; and PwC (2019), 'Estimating the cost of capital for H7 and RP3 – Response to stakeholder views on total market return and debt beta', August.
[185] CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, p. 7.

statistically significant result. Indeed, the direct method could be used productively in combination with the other estimation approaches.

Moreover, volatility by itself is not a reason for discarding an estimation method, as the true values of debt betas may be volatile over time. It is unclear if CEPA is of the view that the firm-level debt beta should be stable over time, which is inconsistent with the way that Ofgem/CEPA estimate other time-varying betas.

Finally, with respect to the allegedly 'implausible' estimates produced by the direct method, it is unclear which criteria were used to reach such conclusions. If the criteria were dictated by past regulatory decisions, it is important to examine the robustness of the underlying methods and evidence base.

A4B Indirect method

The indirect method described by CEPA is the two-step approach derived from Schaefer and Strebulaev (2008).[186] This is the same method as the one adopted in Oxera's earlier report for the ENA on estimating the appropriate equity and debt betas for the forthcoming RIIO-2 price control.[187]

The first step in this approach is to regress the returns of a company's bond (or portfolio of bonds) against the returns on an index of government bonds (a duration similar to the bond or the portfolio of bonds should be chosen) and the returns on the shares of the same company.[188] The second step is to multiply the coefficient on the company's equity returns (this is the elasticity of debt with respect to equity) obtained from the regression in the first step by the company's equity beta. This provides an estimate of the debt beta for the company in question.[189]

CEPA appears to have misunderstood the Schaefer and Strebulaev (2008) paper, as illustrated by two inaccurate statements. First, CEPA claims that the authors used simulations of structural models,[190] while in fact the authors calculated the theoretical sensitivities directly using structural methods. Second, CEPA claims that the authors used bond indices in their regressions.[191] This is incorrect. The authors used a large sample of bonds, and reported the average level of the estimated debt betas grouped by credit rating.

The second statement conceals an important difference between the indirect and direct methods. The regressors used in the indirect method include the equity returns and equity beta of the bond issuer, which will differ across issuers. The indirect method therefore always controls for differences in systematic risk across issuers. In contrast, the direct method, when using the returns on bond indices as the dependent variable, implicitly assumes that all issuers have the same systematic risk. The CEPA report in effect claims that there is no benefit to applying the indirect method instead of the simpler direct method. This is not necessarily correct, as the simpler direct method that uses

[186] CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, p. 10; and 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.
[187] Oxera (2019), 'Review of RIIO-2 finance issues: The estimation of beta and gearing', 20 March.
[188] Note that if a company is privately held i.e. it does not have listed shares, then the indirect method cannot be used.
[189] The coefficient on equity returns obtained in the first regression is the elasticity of debt with respect to equity. This is not a debt beta and has to be scaled by the equity beta in order to obtain the debt beta.
[190] CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, p. 8.
[191] Ibid., p. 10.

returns on bond indices (instead of individual bonds) as the dependent variable makes more restrictive assumptions relative to the indirect method, where the debt beta can vary across issuers. This claim belies a fundamental misunderstanding of the indirect method.

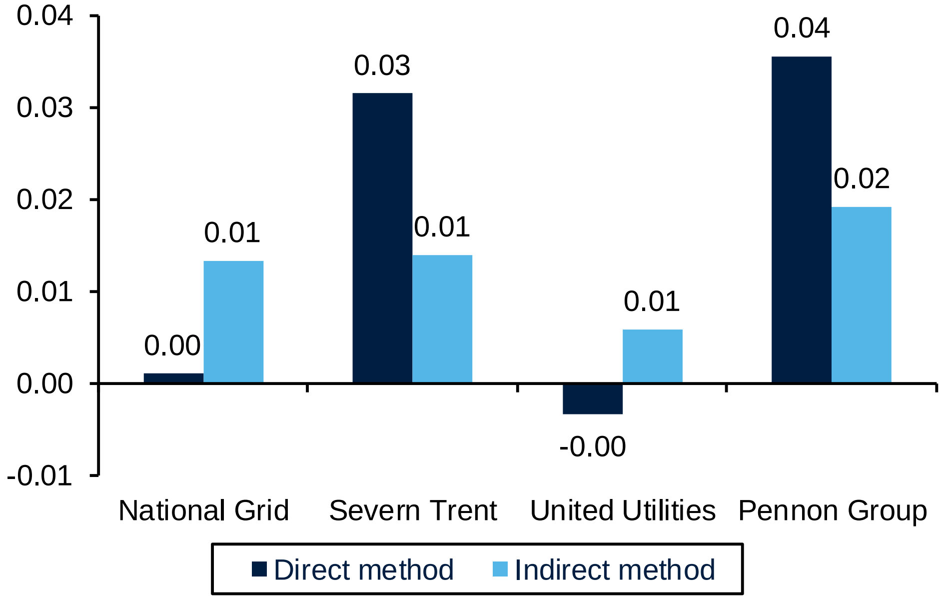
A further difference between the indirect and direct method is controlling for interest rate risk in the estimation of debt beta.[192] The absence of control for interest rate risk is an important limitation of the single variable regression specification assumed by CEPA. Failing to control for interest rate risk in the context of debt beta estimation can lead to omitted variable bias. However, this does not have to be a fundamental difference between the two methods, since the direct method can be modified to include government bond returns as an additional regressor.

With the assistance of Professor Stephen Schaefer, we used the indirect method (replicating the approach from Schaefer and Strebulaev (2008)) when estimating the debt beta for the upcoming RIIO-2 price controls.[193] We estimated the debt beta using bonds from National Grid, United Utilities, Severn Trent and Pennon Group.[194] We concluded that the evidence supported a debt beta assumption no higher than 0.05 for RIIO-2.

We have expanded our original analysis for the Energy Networks Association by presenting a sensitivity using the direct method, where we do not control for interest rate risk. We have compared this new sensitivity against the results that we presented previously using the indirect method, which controls for interest rate risk.[195] We present the results of our analysis in Figure A4.1.

[192] When estimating debt beta, one is looking to isolate the credit risk of the debt instrument from the interest rate risk.
[193] Oxera (2019), 'Review of RIIO-2 finance issues: The estimation of beta and gearing', March.
[194] Ibid.
[195] We analysed the returns on 38 corporate bonds issued by National Grid (22), Severn Trent (9), United Utilities (6) and Pennon Group (1), from 1998 to 2018. For more details, see Oxera (2019), 'Review of RIIO-2 finance issues: Asset risk premium, debt risk premium and debt betas', 23 January.

Figure A4.1 Comparison of direct and indirect methods for debt beta estimates



Note: The estimates presented above correspond to averages of debt betas for individual bonds. The analysis is based on 38 bonds, namely 22 for National Grid, nine for Severn Trent, six for United Utilities, and one for Pennon Group. Refer to section 4.2 of the Oxera report dated 23 January 2019 for detailed results.

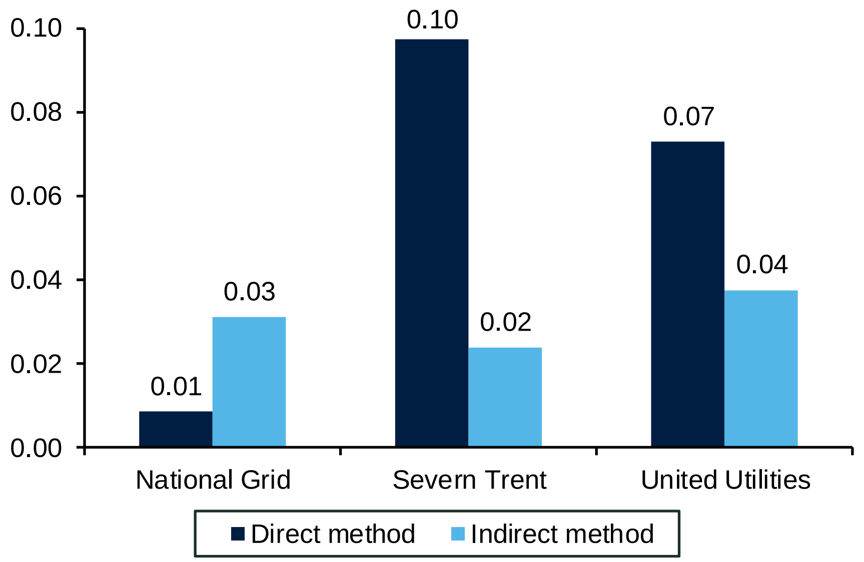
Source: Oxera analysis, based on Oxera (2019), 'Review of RIIO-2 finance issues: Asset risk premium, debt risk premium and debt betas', 23 January.

It can be seen that the estimates obtained under the direct method can be either higher or lower than those obtained under the indirect method, depending on the underlying company. However, in all cases, the average debt beta estimate across different bonds remains below 0.05, i.e. Oxera's recommended estimate.

Further, as highlighted in our previous analysis, a material number of debt beta estimates are statistically indistinguishable from zero.[196] In order to understand the magnitude of debt betas in cases where they are statistically different from zero, we also present the results exclusively for the bonds that exhibit positive and statistically significant debt betas. This is illustrated in Figure A4.2.

[196] In particular, out of a total sample size of 38, 14 bonds exhibit a statistically insignificant debt beta.

Figure A4.2 Comparison of direct and indirect methods for debt beta estimates, statistically significant observations only



Note: The estimates presented above correspond to averages of debt betas for individual bonds. The analysis is based on 24 bonds with statistically significant debt betas, namely 13 for National Grid, nine for Severn Trent, and two for United Utilities. Refer to section 4.2 of Oxera's report on debt beta dated 23 January 2019 for detailed results.

Source: Oxera analysis, based on Oxera (2019), 'Review of RIIO-2 finance issues: Asset risk premium, debt risk premium and debt betas', 23 January.

It can be seen that even within the sample of statistically significant debt betas, the average beta remains below 0.05. Similarly, just as for the whole sample, controlling for interest rate risk makes a non-negligible impact on the debt beta estimates. This implies that regardless of whether a debt beta appears to be statistically significant or not, it is prudent to control for interest rate risk in the regression. Therefore, as discussed above, the direct method should be modified to include government bond returns as an additional regressor.

A4C Structural methods

CEPA also discusses structural methods.[197] The structural methods rely on the theoretical option pricing models derived by Merton (1974) and Black and Cox (1976). These models can be used to calculate a debt beta based on assumptions about parameters such as gearing, equity volatility and equity beta.

As described by CEPA, there are two advantages of using structural methods to estimate the debt beta. First, the model has strong theoretical foundations.[198] Second, the model allows for the consistent de-levering and re-levering of debt beta as it specifies the relationship between gearing and debt beta.[199]

[197] CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, section 2.1.3.
[198] CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, p. 11.
[199] Debt beta and equity beta are both positively correlated with gearing. However, when de-levering and re-levering equity beta for differences in gearing between the target company and comparators used to estimate asset beta, debt beta is typically held constant. This can result in the use of the incorrect debt beta when undertaking this process. CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, p. 11.

CEPA cites three disadvantages of using structural methods. First, CEPA states that regulators are unfamiliar with using the method.[200] However, regulators have not been averse to introducing new methods and data, and through their actions they have demonstrated that unfamiliarity is not a barrier in practice.

Second, according to CEPA, structural methods do not offer a complete account of credit spreads.[201] However, a complete account of credit spreads is not directly relevant to the evaluation of structural methods for the purpose of estimating debt betas. Instead, CEPA should be assessing whether structural methods capture debt betas well. This was the purpose of the paper by Schaefer and Strebulaev (2008), cited by CEPA.[202] Schaefer and Strebulaev (2008) found that structural models, on average, capture debt betas well.[203] Therefore, this criticism from CEPA is not directed at the issue at hand (i.e. the estimation of debt beta).

The final disadvantage cited by CEPA is that structural methods require several assumptions. This is true; however, one can measure directly most of the parameters required to estimate debt beta using structural methods. Additionally, another method cited by CEPA, the decomposition approach, requires just as many assumptions as the structural method but has weaker theoretical underpinnings, for the reasons set out below. Therefore, it would appear that the structural method is a more robust approach to estimating debt beta than the decomposition approach.

With regard to CEPA's application of the structural method, we have identified two errors in its calculation.

First, as a proxy for the volatility parameter, CEPA has used the volatility of equity returns, not that of asset returns. However, since the model proxies equity as a call on the company's assets, the volatility parameter needs to be set to that of asset returns. Correcting this error decreases CEPA's estimate of debt beta from 0.16 to 0.11.

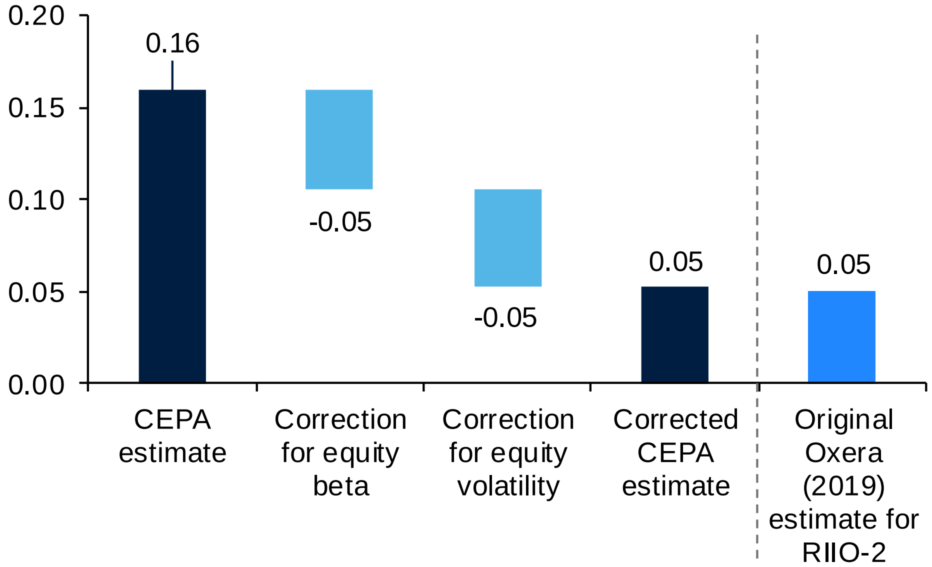
Second, CEPA has not applied the conversion from asset beta to debt beta correctly. According to Berk and DeMarzo (2014), the asset beta is converted to debt beta using the following equation:[204]

$$\beta_d = \frac{(1 - N(d_1))}{g} \beta_a$$

However, as can be seen from Appendix A of the CEPA report, instead of using the asset beta in the last term, CEPA has used an equity beta estimate.[205] Correcting this mistake further reduces CEPA's debt beta estimate from 0.11 to 0.05, which is in line with Oxera's recommendation for RIIO-2. This is illustrated in Figure A4.3.

[200] CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, p. 11.
[201] Ibid.
[202] 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.
[203] Schaefer and Strebulaev (2008) analysed the precision of structural methods by comparing the debt beta obtained by structural methods for various credit ratings and maturities to those obtained using empirical methods. They found that, on average, structural methods did approximate the debt beta obtained empirically through regressions.
[204] Berk, J. and DeMarzo, P. (2014), *Corporate finance. Third edition*, p. 768, equation 21.20.
[205] Oxera analysis based on CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, Appendix A, p. 26.

Figure A4.3 Correcting CEPA's structural debt beta estimate



Note: CEPA's original and corrected estimate both assume a gearing of 40%, yield spread of 1%, a time horizon of ten years, equity volatility of 30% and equity beta of 0.7. We note that CEPA does not disclose how it arrived at the yield spread of 1%.

Source: Oxera analysis based on CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, Appendix A, p. 26.

In sum, the corrected estimates of the structural method point to a 0.05 debt beta.

A4D Decomposition method

CEPA's final approach is the decomposition approach. This method was used in the Competition Commission's review of the Heathrow Q5 price control in 2007.[206] The method involves decomposing the debt spread (i.e. the spread between yields on corporate and government bonds) into three components: default premium, default risk premium, and liquidity premium. The decomposition method was the main method relied on to derive the debt beta for the recent price controls for PR19 and RP3.[207]

CEPA quotes several advantages of the decomposition method. First, CEPA notes that when the Competition Commission introduced the debt beta to UK regulation in 2007, the Competition Commission observed that the decomposition approach was used by leading academic researchers and recommended by Berk and DeMarzo (2007).[208] However, Berk and DeMarzo have since updated their textbook and no longer recommend this method for estimating debt beta. Instead, the authors refer to structural method for estimating company-specific betas and to a mapping between a credit rating and debt beta,[209] as estimated by Schaefer and Strebulaev (2009).[210]

[206] Competition Commission (2007), 'Reference of Heathrow Airport to the Competition Commission', 3 October, Appendix F, p. 24.
[207] Ofwat (2019), 'PR19 final determinations: Allow return on capital appendix', 16 December, p. 55; and Europe Economics (2019), 'Comments on NERA/NERL critiques of Europe Economics' WACC analysis', 6 June, pp. 16–20.
[208] Competition Commission (2007), 'Reference of Heathrow Airport to the Competition Commission', 3 October, Appendix F, p. 24.
[209] Berk, J. and DeMarzo, P. (2014), 'Corporate finance. Third edition', p. 413 and p. 765, example 21.10.
[210] Schaefer, S.M. and Strebulaev, I.A. (2009), 'Risk in capital structure arbitrage. Stanford GSB working paper', as referenced by Berk and DeMarzo.

The second advantage cited by CEPA is that the estimates produced by the decomposition approach are less volatile.[211] However, having less volatile estimates is not necessarily an advantage. First, the reduced volatility could be driven by the mis-specification of inputs when decomposing the credit spreads. Second, less volatility does not necessarily imply a better estimate, as the underlying debt beta may be changing over time. Therefore, whether stability is a sign of a good approach should be considered when evaluating the merits of the decomposition approach.

CEPA cites three disadvantages with the decomposition approach.

First, CEPA acknowledges that it can be hard to calibrate the parameters.[212] This is not surprising given the number of parameters that need to be estimated, and particularly given the uncertainty associated with measuring these parameters.[213]

The uncertainty associated with the decomposition approach was noted by the CMA in its preliminary decision in the NATS appeal:[214]

> We [CMA] considered that the evidence to support the debt beta was largely speculative. The CAA's analysis was based on regulatory precedent, and an attempt to deconstruct the debt premium [i.e. the decomposition approach]. The reasons for [the] current level of the debt premium, in particular why it is much higher than the premia implied by the debt beta and risk of default, are largely unexplained. NERL's evidence, in our view, illustrated that there was **significant uncertainty over the ability to measure debt betas using the CAA's approach**. [Emphasis added]

This led to the CMA putting more weight on the regression estimates provided by NATS's advisers in reaching its draft decision.[215]

The second disadvantage noted by CEPA is that there are conceptual challenges associated with the decomposition approach.[216] This relates to the fact that some of the components used in the decomposition approach may be both systematic and idiosyncratic in nature and the components may be correlated with each other.[217]

The third disadvantage noted by CEPA is that the decomposition approach does not allow one to assess the statistical significance of the debt betas obtained.[218] This criticism applies to any approach that does not use statistical methods (i.e. regression analysis) for estimating the debt beta.

Another disadvantage that could be added to those noted by CEPA is that there is no agreement between market practitioners on how to implement the decomposition approach. For example, the formula cited by CEPA that is used by EE differs from the formula used by the Competition Commission in 2007 and again in 2010.[219]

[211] CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, p. 12.
[212] Ibid., pp. 12–13.
[213] For example, the liquidity premium estimates reported by CEPA ranges from 0.01bps to 250bps. CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, p. 13.
[214] Competition and Markets Authority (2020), NATS (En Route) Plc/CAA Regulatory Appeal: Provisional findings report, para. 12.115.
[215] Ibid., para. 12.116.
[216] CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, p. 13.
[217] Ibid.
[218] Ibid.
[219] The two approaches differ with how one treats the liquidity premium. See CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, p. 1 and CC F24.

As a result of these disadvantages, the decomposition approach could be viewed as an inferior version of the structural methods cited by CEPA. This is because, unlike the decomposition method, structural methods have strong theoretical foundations, have been shown to approximate the regression estimates correctly, and can account for the relationship between gearing and debt beta. Additionally, both approaches require a similar number of parameters to be specified. Therefore, we would recommend that regulators place more weight on the structural method and the regression-based methods than the decomposition approach.

Flaws in the Europe Economics decomposition methodology

Moreover, our review of the EE decomposition approach (i.e. the approach that EE primarily relied on to produce a debt beta estimate of 0.15) finds that EE makes a number of material errors, as follows.

- EE decomposed the credit spread for the iBoxx A/BBB 10-year+ non-financial indices to derive its debt beta assumption, using the yield on 15-year nominal gilts as the RfR assumption. EE is incorrect to use government bonds as a proxy for the RfR, as explained in section 5. This causes the DRP, and hence the debt beta estimate from the decomposition approach, to be overstated.
- The expected loss assumption is an underestimate. Expected loss reflects what an investor would expect to lose over the life of the debt instrument (i.e. it is the probability-weighted loss from default). EE estimated the annualised expected loss for a water company to be 4bp, comprising a 20bp probability of default and 20% loss given default. This is inconsistent with academic evidence and previous estimates of the expected loss used by regulators.
- Feldhütter and Schaefer (2018) found that the ex ante annual probability of default from structural methods for A- and BBB-rated companies is c. 0.3% and 0.8% respectively for a 20-year bond.[220] Given that Ofgem assumes a notional credit rating of A/BBB, the midpoint of this range of 50bp would be an appropriate assumption for the expected probability of default. This is substantially higher than EE's estimate.
- Empirical evidence on loss given default suggests that a loss given default assumption of around 60% is more appropriate for A- and BBB-rated debt (the credit rating assumed by Ofgem).[221] Indeed, EE attempts to justify a 20% loss given default as a 'typical estimate of 'costs of bankruptcy' across many sectors'[222] without providing a source or reference.

[220] In Table 8 of Feldhütter and Schaefer (2018), op. cit., the cumulative default rates for various maturities and credit ratings are presented. This can be converted into an annual figure using the following formula:

$$Annualised\ default\ rate = 1 - (1 - cumulative\ default\ rate)^{(1 \div length\ of\ bond)}$$

The cumulative default rate for 20-year A- and BBB-rated bonds is 6.37% and 14.24% respectively. We convert this into an annual default rate, i.e. for 20-year A-rated bonds: $1 - (1 - 0.0637)^{(1 \div 20)} = 0.3\%$; and for 20-year BBB-rated bonds: $1 - (1 - 0.1424)^{(1 \div 20)} = 0.8\%$.

[221] See Moody's (2019), 'Annual default study: Defaults will rise modestly in 2019 amid higher volatility', 1 February, Exhibit 28. Moody's report the recovery rates—i.e. the amount recovered by investors as a percentage of face value in the event of a default. Therefore, to obtain the loss given default, one has to subtract the recovery rate from 1 to obtain the loss given default—i.e.

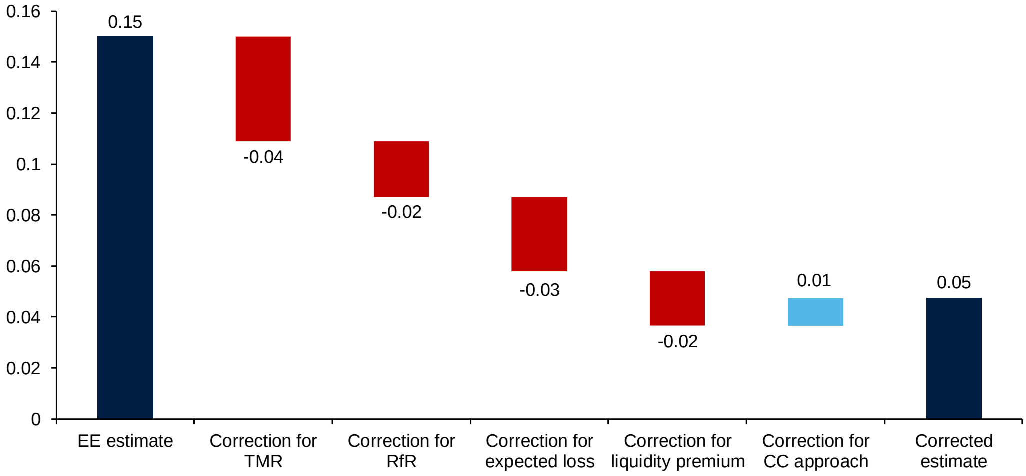
$$Loss\ given\ default\ (\%) = 1 - recovery\ rate\ (\%).$$

[222] Europe Economics (2019), 'The Allowed Return on Capital for the Water Sector at PR19 – Final Advice', December, p. 39.

- In line with our 2020 report, which analysed the risk premium on assets relative to debt,[223] correcting EE's estimate would result in an expected loss assumption of 0.30%.[224] This assumption is also in line with previous Competition Commission determinations. For example, for the expected loss assumption in its determination for BAA in 2007, the Competition Commission assumed a range of 14–38bp;[225] whereas, for its 2010 Bristol Water determination, it assumed that around 50% of the credit spread was explained by expected loss.[226]
- The liquidity premium is not in line with the Competition Commission's precedent.[227] The Competition Commission last assumed a liquidity of premium of 0.5%, compared to Europe Economics' liquidity premium assumption of 0.3%. While some judgement is involved in estimating the liquidity premium, it would be prudent to reflect this uncertainty by using a range. As a result, we present a sensitivity on the corrected decomposition approach assuming a liquidity premium of 0.5%.
- The formula used by EE for attributing the observed credit spreads to systematic and idiosyncratic components is not consistent with the formula used by the Competition Commission when it adopted the same approach to set the debt beta for BAA.[228]

Correcting the various errors in EE's decomposition approach significantly reduces the debt beta from 0.15 to 0.05—see Figure A4.4 below.

Figure A4.4 Impact on debt beta of correcting errors in EE's decomposition approach



Note: Average debt beta estimates since 2010. For the Competition Commission's approach, a 33% expected loss was assumed. The cut-off date for our analysis is 31 December 2019.

Source: Oxera analysis.

A4E Debt beta and gearing

CEPA notes that the debt beta may not be stable through time and may change with gearing. We consider both of these arguments. First, CEPA's

[223] Oxera (2020), 'Asset risk premium relative to debt risk premium', 4 September.
[224] 50% × 60% = 30%.
[225] Competition Commission (2007), 'Reference of Heathrow Airport to the Competition Commission', 3 October, Appendix F, para. 102.
[226] Competition Commission (2010), 'Bristol Water plc price determination', Appendix N, Table 1.
[227] Ibid, Appendix N, p. 54.
[228] Competition Commission (2007), op. cit., Appendix F, p. 24.

report on debt beta cites (via a NERA report) empirical evidence in Fama and French (1993) as support for a debt beta as high as 0.22.[229,230] However, Fama and French made no such claim. The text referred to in the CEPA report was an example showing how one can estimate erroneously high debt betas if one omits important factors. Fama and French actually concluded that the debt beta is negative or zero for all but the lowest-grade bonds. Our upper bound of 0.05 is therefore conservative, based on academic evidence introduced as supporting evidence by CEPA.

We further note that the incorrectly cited Fama and French evidence is the clear outlier in Table 4.2 of the aforementioned NERA report, where it also cites support for debt betas of 0.05 for AAA to A- bonds by the Brattle Group, and 0.04 for Schaefer and Strebulaev (2008). In contrast, Ofgem cites studies that selectively choose data points from NERA's report supporting a much higher debt beta, some of which appears to be based on a misrepresentation of the academic evidence as discussed above.

Second, CEPA mentions that debt beta may change with gearing, stating: 'The evidence we have seen indicates that a ten percentage point change in gearing might be expected to result in a 0.06 change in debt beta (at least over some range)'.[231] Although we agree that there is a theoretical relationship between debt beta and gearing, depending on the theoretical assumptions, one cannot solve for the debt beta and simultaneously for either the asset beta and equity beta. For example, without tax effects, Modigliani and Miller (1963) implies the following relationship:[232]

$$\beta_e = \beta_a + \frac{D}{E}\,(\beta_a - \beta_d)$$

Without the use of structural methods, one can solve for a relationship between the debt beta and gearing *only* if one already knows *both* the asset beta and the equity beta. Further, any effect is likely to be minor, given the low levels for debt beta estimated in our 2019 study.

A4F Misrepresentation of Oxera's previous evidence

CEPA claims that Oxera's evidence supports a National Grid debt beta of 0.20.[233] This is a misrepresentation based on one regression model, similar to the earlier-discussed misrepresentation of Fama and French (1993). In our earlier report, we made the point that:[234]

> If […] we simply regress returns on a portfolio of National Grid debt against the FTSE we obtain a coefficient of 0.20 (t = 2.48) while a regression of returns on riskless debt (the Barclays 7-10 year gilt index) against the FTSE gives a coefficient of 0.13. Including the Barclays gilt index in the regression along with NG equity reduces the coefficient on NG equity to 0.08 (t=2.23) and it is this figure, multiplied by the equity beta of NG, that reflects the credit risk of NG rather than the estimate of 0.20 that we obtain by regressing simply on the FTSE.

229 Fama, E.F. and French, K.R. (1993) 'Common risk factors in the returns on stocks and bonds.' *Journal of Financial Economics*, **33**:1, pp. 3–56.
230 CEPA (2019), 'Consideration for UK regulators setting the value of debt beta', report for UK Regulators Networks, 2 December.
231 CEPA(2020), 'RIIO-2: Beta estimation issues', 9 July, p. 53.
232 Modigliani, F. and Miller, M. (1963), 'Corporate income taxes and the cost of capital: a correction', *American Economic Review*.
233 CEPA (2020), 'Considerations for UK regulators setting the value of debt beta', report for the UK Regulators Network, 2 December.
234 Oxera (2019), 'Review of RIIO-2 finance issues: The estimation of beta and gearing', 20 March.

> […] many of the estimates of debt beta are not statistically significantly different from zero, and the average estimate across the full sample is 0.01. If the sample is censored by removing estimates that are not statistically significantly different from zero, then the average estimate increases to 0.03, and the estimate for National Grid is also 0.03.

In summary, our evidence supports that of Fama and French, who found a low or non-existent debt beta after controlling for debt characteristics.

A4G Conclusion

As described in the Oxera report published in June 2020,[235] based on the estimates from the direct and indirect regressions with the corrected version of CEPA's structural method, a debt beta assumption of 0.05 for regulated industries would be appropriate.

Further, we recommend that regulators focus on using regression-based methods and structural methods for estimating the debt beta for regulated entities, and that it is important to control for interest rate risk when applying regression-based methods. Otherwise, the resulting debt beta estimate would capture risks over and above credit risk, resulting in a biased estimate.

[235] Oxera (2020), 'Estimating debt beta for regulated utilities', 4 June.

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