PR24 Cost of equity estimation

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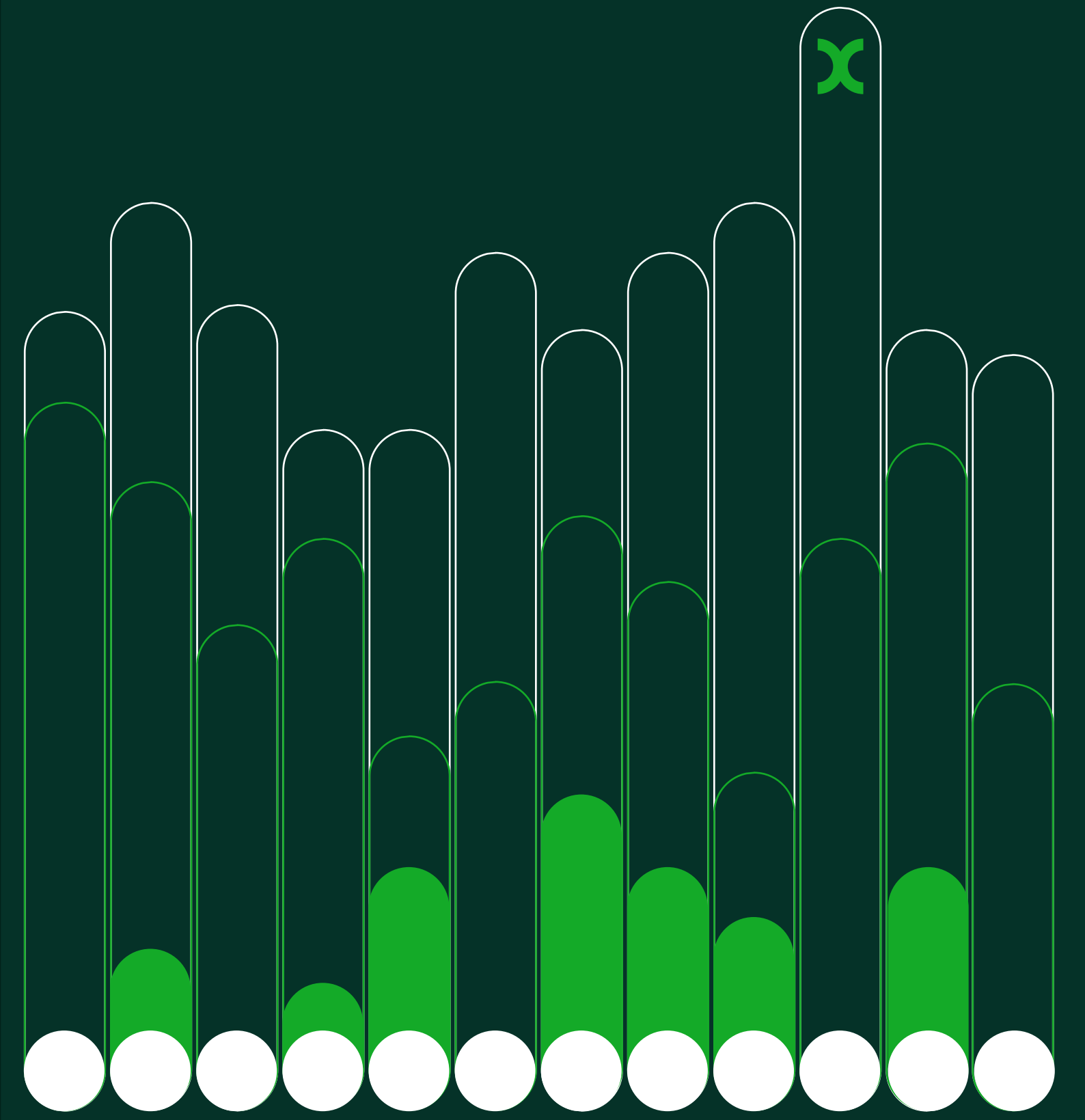

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Executive summary

In its PR24 final determinations (FDs), Ofwat estimated the cost of equity (CoE), a key building block in determining the allowed revenues for the England and Wales water sector, based on the capital asset pricing model (CAPM). Ofwat's choices over input parameters produced a CAPM-implied CoE range of 4.58–5.07% (CPIH-real), implying a midpoint of 4.83% (CPIH-real).[1]

This report is prepared for Anglian Water (ANH) to supplement its referral to the CMA against Ofwat's PR24 FD. We begin by detailing Ofwat's PR24 FD approach, and consider critically the methodology applied. We then provide our analysis of the appropriate cost of equity (CoE) range for the AMP8 price control period. This report also draws on our analysis and research contained in (i) our Investability and Financeability in PR24 report, and (ii) our PR24 Cross-checks to CAPM estimation report.

In implementing the CAPM for the FDs, we consider that there are several key drawbacks to Ofwat's methodology and conclusions. **Chief among these is that Ofwat's estimation fails to adequately reflect current market evidence in arriving at its CAPM parameters.** This is especially notable considering AMP8 is the first of a multi-AMP period of a step change in investment not seen since privatisation. Beyond attenuating Ofwat's parameters, this implies that **Ofwat's CAPM parameters are not reflective of the environment and risks the sector faces now and into the future**—for example, Ofwat's FD estimates an upper bound for the equity beta of 0.65, which is barely higher than the beta adopted by the CMA in PR19 (of 0.64, adjusted for notional gearing of 55%), yet **it cannot be reasonable to conclude that the water sector is no more risky now than in 2021.** We find that this is a recurring theme across Ofwat's CAPM estimation, and we highlight examples of this as we analyse the CAPM parameters in this report.

In its PR24 FDs, Ofwat estimated the risk-free rate (RfR) at 1.52% (CPIH-real), but opted not to allow a convenience premium, citing that evidence for such a premium was insufficient. We view Ofwat's reasoning to be erroneous, arising from its failure to adequately

[1] We note that there are disparities between CAPM parameters reported by Ofwat in the FD appendix and published within models, for example, the allowed return model refers to a risk-free rate of 1.48%. For the purposes of this report, we refer to the estimates referred to by Ofwat in the FD appendices.

duration-match gilts with the reference AAA corporate bond index. We find that once this necessary step is performed, market evidence supports a significant and persistent convenience premium. Upon updating for market data to our cut-off of 31 January 2025, **we determine an estimate of the RfR of 2.31%, including 24bps for the convenience premium.** We note also that this, along with Ofwat's FD estimate, is likely an underestimate of the 'true' RfR—as shown by the cross-check using deflated nominal gilts. The current PR24 FD approach leads to a persistently lower RfR estimate, suggesting Ofwat's estimation approach is downwards-biased.

Next, we consider Ofwat's estimation of the CAPM re-levered equity beta range of 0.59–0.65. In the first instance, it is important to note that **CAPM estimation is subject to measurement error and systematic downward bias**, as shown by academic research.[2] This downward bias is exacerbated by Ofwat's decision to underweight evidence from the last two years, despite the importance of 2-year betas as the most contemporaneous indicator of the forward-looking sector risk profile. This is especially notable considering that in PR19, Ofwat relied on 2-year and 5-year estimation window evidence—**it is not credible that the regulatory approach to beta estimation for PR24 has become less sensitive to recent market evidence than in PR19**. The third source of error is the continued exclusion of PNN from the sample set (comprising the other two listed water companies, UU and SVT), which (i) limits the representativeness of Ofwat's beta estimates for the sector and notional company, and (ii) introduces further downward bias to the beta estimate. Ofwat partially recognises that PNN becomes valid as a 5y comparator from Q2 2026, i.e. only one year after the start of AMP8—yet all evidence from PNN is disregarded for the entire five-year AMP8 period. Indeed, placing evidence on 2-year betas would allow for the inclusion of PNN data without any confounding impact from the divestment of Viridor. Correcting for these views into our estimates, we form a **Low case beta of 0.69**, based on the simple average betas of UU, SVT, and PNN across the 2y, 5y, and 10y estimation windows. For the **High case, we derive a beta estimate of 0.76**, relying on data of UU, SVT, and PNN for the 2y estimation window as the most analogous to the current risks faced by the water sector.

As for the total market return (TMR), Ofwat's PR24 FD position reflected several changes to its approach through the PR24 consultation process,

[2] For example: Black F., Jensen M., Scholes M. (1972), 'The Capital Asset Pricing Model: Some Empirical Tests'; and 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

ultimately arriving at a range of 6.68–6.98% (6.83% midpoint, CPIH-real), reflecting a blend of the ex post and ex ante results. However, a central issue in Ofwat's TMR estimation is its 'fixed TMR' policy, which anchors the TMR to long-term historical data such that it is insensitive to changes in underlying interest rates. It should be clear that strictly adhering to this fixed 'through the cycle' approach at the current time when rates are significantly higher than in PR19 (and indeed, at any other time across the last two decades) is not going to provide adequate incentives to invest. **This is because it implies a return that is lower than required by investors when interest rates have moved materially higher, and under-compensates investors precisely when the sector urgently needs equity capital to finance its investment programme.** Reflecting these considerations, our estimate of the **Low case TMR is set at 7.0% (CPIH-real)**, based on the rounded up one-year arithmetic average of ex post estimates. Simultaneously, our **High case TMR is set to 7.5% (CPIH-real)**, reflecting the potential for required market returns to be currently higher than the long-term average. We note that our High case estimate is lower than the CPIH-real equivalent TMR assumptions made by Ofwat in PR04 (8.3%) and PR09 (7.9%), when rates were last similar to current levels.

Drawing from our parameter estimates above, we then derive our **estimated CAPM-implied CoE range of 5.52–6.25% (CPIH-real)**. As described earlier, and highlighted by the UKRN, because the CAPM is subject to measurement error and parameter uncertainty, it is important to consider evidence from alternative sources as a cross-check in informing the choice of point estimate from the CAPM-implied CoE range.[3] Our analysis of cross-checks for PR24 is contained in our report, PR24 Cross-checks to CAPM estimation—we draw from this report to arrive at our point estimate of the CoE.[4]

In its PR24 FDs, Ofwat 'aimed up' by 27bps above the midpoint of its CAPM-implied CoE range—Ofwat reasoned that this would address low investor sentiment towards the water sector, and would support companies in securing the necessary capital to deliver on the AMP8 investment programme. While this position signals Ofwat's recognition of the change in risks faced by the sector**, it is clear that the degree of aiming up is insufficient, because it results in a CoE point estimate that is insufficient for the sector.** Indeed, Ofwat's aiming up is only 2bps higher than the 25bps aiming up allowed by the CMA in its PR19 re-

[3] UKRN (2023), UKRN guidance for regulators on the methodology for setting the cost of capital, 22 Mar, p. 26, accessed: https://ukrn.org.uk/app/uploads/2023/03/CoC-guidance_22.03.23.pdf.
[4] Refer to Oxera (2025), PR24 Cross-checks to CAPM estimation, 21 March.

determination, despite the significant changes in the environment and outlook for the water sector.

As highlighted in our cross-checks report, Ofwat's PR24 FD CoE allowance is set too low, as indicated by all the cross-checks considered. More specifically, debt-based cross-checks imply a lower bound for the CoE of 6.2% (CPIH-real), well above Ofwat's point estimate of the CoE. We also show that in spite of the 27bps aim up, Ofwat's point estimate of the CoE is, at best, in the lower half of the ranges indicated by its own analysis of cross-check evidence.

We find that cross-check evidence supports the upper bound of our CAPM-implied CoE range—we therefore set 6.25% (CPIH-real) as our point estimate of the CoE for AMP8.

Table 1.1 Summary PR24 CAPM estimates (CPIH-real)

	Ofwat PR24 FD	Oxera estimates
Notional gearing	55%	55%
Risk-free rate	1.52%	2.31%
Notional equity beta	0.59–0.65	0.69–0.76
Total market return	6.68–6.98%	7.0–7.5%
Cost of equity range	**4.58–5.07%**	**5.52–6.25%**
Cost of equity point estimate	**5.10%**	**6.25%**

Note: We use a cut-off data of 31 January 2025.
Source: (1) Ofwat (2024), PR24 final determinations: Allowed return appendix, 19 December, p.6, accessed: https://www.ofwat.gov.uk/wp-content/uploads/2024/12/PR24-final-determinations-Aligning-risk-and-return-Allowed-Return-Appendix.pdf. (2) Oxera analysis.

1 Introduction

The PR24 price review process conducted by Ofwat in consultation with the England and Wales water sector sets the regulatory allowances for the upcoming regulatory period covering 2025–2030 (known as AMP8).

A key building block of the allowed revenues under the regulatory model is the weighted average cost of capital (WACC), which captures the base rate of return to capital investors. The cost of equity (CoE) is a main component of the WACC—as the CoE is not immediately observable from capital markets, the PR24 approach relies on the Capital Asset Pricing Model (CAPM) to derive an estimate of the CoE.

In this report, we assess critically Ofwat's CAPM methodology and parameter estimates for its PR24 final determinations (FDs), and also provide our estimate of the appropriate CoE. Specifically, we examine Ofwat's analysis and propose an alternative CoE estimate that we consider more robust, considering additional evidence and methodologies, as detailed in our report PR24 Cross-checks to CAPM estimation.[5] Our objective is to provide a CoE point estimate that more accurately addresses the challenges faced by the industry, particularly in terms of ensuring investability and supporting the longer-term financial viability of the sector, as discussed further in our report Investability and Financeability in PR24.[6]

1.1 Overview of Ofwat's PR24 FD approach

In its PR24 FDs, Ofwat has maintained the commonly accepted approach of setting the allowed return on equity based on the CAPM. The CAPM essentially estimates the CoE of a particular investment by studying its exposure to 'systematic' or non-diversifiable equity market risk.

The CAPM sets out that the return required by equity investors consists of the risk-free rate (RfR)—which measures the expected return on an asset that is free of risk; the total market return (TMR)—which is used to estimate the equity risk premium, i.e., the premium above the risk-free rate that investors demand for investing in a market equity portfolio, and the equity beta—which represents a company's exposure to systematic risk.

[5] Oxera (2025), PR24 Cross-checks to CAPM estimation, 21 March.
[6] Oxera (2025), Investability and Financeability in PR24, 21 March.

In the FDs, Ofwat's parameter estimates resulted in a CAPM range for the CoE from 4.58–5.07% (CPIH-real).

However, **Ofwat's approach to estimating the CoE contains several shortcomings that leads to a significant understatement of the true return required by investors.** This can be observed in Ofwat's estimate of the equity beta, which is barely higher than in previous regulatory decisions and fails to reflect the heightened risk environment facing the sector, making it unrepresentative of the systematic risk investors actually face. Additionally, the RfR fails to incorporate a convenience premium, exacerbating the underestimation of required returns.

Elsewhere, Ofwat's 'through the cycle' approach to the TMR results in an estimate of market return that is unreasonably insensitive to underlying interest rates—this is depicted by Ofwat's PR24 TMR estimate of 6.83% (CPIH-real) being only c.30bps higher than its PR19 TMR allowance (of 6.50%, CPIH-real), despite underlying interest rates being nearly 350bps higher.[7] This results in Ofwat's CoE estimate of 5.10% (CPIH-real) being (i) only c.90bps higher than its PR19 CoE (of 4.19%, CPIH-real), while the underlying RfR and debt benchmarks have risen by nearly 350bps, and (ii) well below the CoE in PR14 (of 6.38%, CPIH-real) despite the underlying RfR and debt benchmarks now being nearly 20bps higher than in December 2014.

The net impact of the points raised above is that **the CoE is set too low, such that the spread between the CoE and the cost of new debt is now compressed at a time when large amounts of equity capital needs to be attracted into the sector for investment.** Ofwat's aiming-up adjustment, while welcome, is insufficient to result in a CoE that adequately reflects the current sentiment and heightened risks faced by the water sector. This underlines the risk that the FD allowed return will not provide sufficient incentives for new and continued investment into the sector.

In this report, we consider these issues and put forward our view of the methodological changes necessary to lead to parameters estimates which are more reflective of the environment and risks facing the sector, and that lead to an appropriate CoE estimate. This report is structured as follows.

[7] This is approximated using the proxies of the RfR: PR19 RfR allowance of -1.39% compared to our estimate of the RfR as of 31 January 2025 of 2.07%, as contained in this report. Figures in CPIH-real terms. Debt benchmarks refer to the average of the iBoxx A and BBB 10+ non-financials indices.

- Section 2 details Ofwat's estimation of the RfR, and our critique, followed by our proposed methodology.
- Section 3 details Ofwat's estimation methodology of the beta and our proposed methodology.
- Section 4 details Ofwat's estimation methodology of the TMR and our proposed methodology.
- Section 5 covers the various factors informing the choice of the point estimate for the CoE, and concludes.

2 Risk-free rate

The risk-free rate (RfR) measures the expected return on an asset that is considered to be free of risk—where the realised return on an investment will be equal to the expected return. In the CAPM framework, this riskless asset is also referred to as a 'zero-beta asset', i.e. an asset with zero sensitivity to overall market risk. The CAPM assumes that all investors can borrow and lend an unlimited amount of funds at the risk-free rate.

2.1 Overview of Ofwat's PR24 FD approach

In the PR24 Final Determinations, Ofwat has set the allowed RfR by first taking a one-month average of the yields on a 20-year inflation-linked gilt with a cut-off date of 30 September 2024.[8] The resulting RPI-real average yield is then converted to CPIH-real terms through the application of an RPI–CPIH inflation forecast wedge. Ofwat estimated this wedge by taking an average of the 20-year inflation forecasts based on the latest Office of Budget Responsibility (OBR) data and 20-year inflation swaps data.[9]

Table 2.1 summarises the PR24 Final Determinations RfR estimate.

Table 2.1 Ofwat's PR24 FDs RfR estimate

	Point estimate
20y RPI-linked gilt yield (September 2024 average)	1.19%
RPI–CPIH wedge: 'inflation swaps' approach	0.43%
RPI–CPIH wedge: 'official forecasts' approach	0.23%
RPI–CPIH wedge: overall estimate	0.33%
CPIH-real risk-free rate	**1.52%**

Source: Ofwat (2024), 'PR24 Final Determinations: Aligning risk and return – allowed return appendix', December, p. 21.

[8] Ofwat (2024), 'PR24 Final Determinations: Aligning risk and return – allowed return appendix', December, p. 9.
[9] Ibid., pp. 12–15.

2.2 Critique of Ofwat's PR24 FD approach

2.2.1 Convenience premium

The existence of a convenience premium has been documented extensively in academic literature. In particular, numerous publications have explained that government bond rates are not an appropriate benchmark for the 'riskless' rate due to special properties of government bonds, absent which the expected yields on these instruments would be higher.[10] Authors estimate a wide (but consistently positive) range of the implied convenience premium of 30–215bps based on different estimation periods and methodologies for US Treasuries. Research by the Bank of England finds that UK government bonds exhibit similar properties, which suggest the existence of a convenience premium in the UK.[11]

Despite considering CMA precedent,[12] academic research, approaches taken by other regulators[13] and stakeholder submissions however, Ofwat decided not to include any convenience premium in its PR24 FDs, arguing that 'there is insufficiently strong evidence to accurately calibrate an adjustment at our 10–20 year CAPM horizon.'[14] Ofwat further argues that there are 'issues with the reliability of yield data on the AAA-rated bond evidence' and that the estimates up to September 2024 (Ofwat's FDs cut-off) result in a 'slightly negative spread of nominal AAA bonds to nominal gilts [that] may point to a negative convenience yield.'[15]

However, Ofwat's methodology for the convenience premium does not account for differences in bond duration when comparing AAA bonds to gilts. As yield spreads are not uniform across maturities, it is therefore

[10] For example, see Krishnamurthy, A. and Vissing-Jorgensen, A. (2012), 'The Aggregate Demand for Treasury Debt', Journal of Political Economy, 120:2, pp. 233–67; Berk, J. and DeMarzo, P. (2014), *Corporate Finance*, third ed., Pearson, p. 404; Feldhütter, P. and Lando, D. (2008), 'Decomposing swap spreads', Journal of Financial Economics, 88:2, pp. 375–405; Van Binsbergen, J. H., Diamond, W. F. and Grotteria, M. (2022), 'Risk-free interest rates' Journal of Financial Economics, 143:1, pp. 1–29; Koijen, R.S. and Yogo, M. (2020), 'Exchange rates and asset prices in a global demand system', No. w27342, National Bureau of Economic Research.

[11] Bank of England research found that some investor groups in UK government bonds display the behavioural properties consistent with 'preferred habitat' theory, suggesting that some investors in UK government bonds such as life insurers and pension funds are less sensitive to price movements than other investors. Giese, J., Joyce, M., Meaning, J. and Worlidge, J. (2021), 'Preferred habitat investors in the UK government bond market', Bank of England Research Paper Series, 10 September.

[12] CMA (2021), Anglian Water Services Limited, Bristol Water plc, Northumbrian Water Limited and Yorkshire Water Services Limited price determinations: final report, 17 March, para. 9.162.

[13] The CAA in its latest price control settlement for Heathrow airport has allowed for a convenience premium of 32bps over ILG, CAA (2023), 'Economic regulation of Heathrow Airport Limited: H7 Final Decision. Section 3: Financial issues and implementation', March, p.9. The German federal network agency, Bundesnetzagentur (BNetzA), has implicitly allowed for an adjustment for convenience premium since 2005, Bundesnetzagentur (2021), 'Verordnung über die Entgelte für den Zugang zu Elektrizitätsversorgungsnetzen (Stromnetzentgeltverordnung - StromNEV)" , para. 7, https://www.gesetze-im-internet.de/stromnev/BJNR222500005.html.

[14] Ofwat (2024), 'PR24 Final Determinations: Aligning risk and return – allowed return appendix', December, pp. 18–19.

[15] Ibid., pp. 18–19.

important to ensure that the AAA-rated corporate bond index is appropriately duration-matched to the gilts being analysed, to ensure a precise comparison. The omission of duration-matching may lead to conclusions on the size and persistence of the convenience premium that are insufficiently robust.

In essence, the convenience premium is caused by excess demand for highly rated government bonds driven by regulatory requirements for financial institutions to hold gilts in reserve, and the use of government bonds in private institutions' hedging strategies (such as interest rate hedging). To determine if there is a positive and persistent convenience premium, we measure the excess yield on AAA corporate bonds over equivalent gilt yields—as AAA corporate bonds are a close approximation of the market RfR, any excess yield would thus be due to the special characteristics inherent in gilts which increase their demand and consequently leads to lower gilt yields. We begin by considering the Macaulay duration of the iBoxx non-gilt AAA 10+ and the iBoxx non-gilt AAA 10–15 indices. The average Macaulay durations of the benchmark indices are presented in Table 2.2 below.

Table 2.2 Average Macaulay duration of iBoxx indices

	1 month	1 year	5 years
iBoxx AAA 10-15	9.53	9.85	9.63
iBoxx AAA 10+	12.40	13.04	14.33

Note: Arithmetic average calculated for the period up to the cut-off date of 31 January 2025.
Source: Oxera analysis based on Bloomberg data.

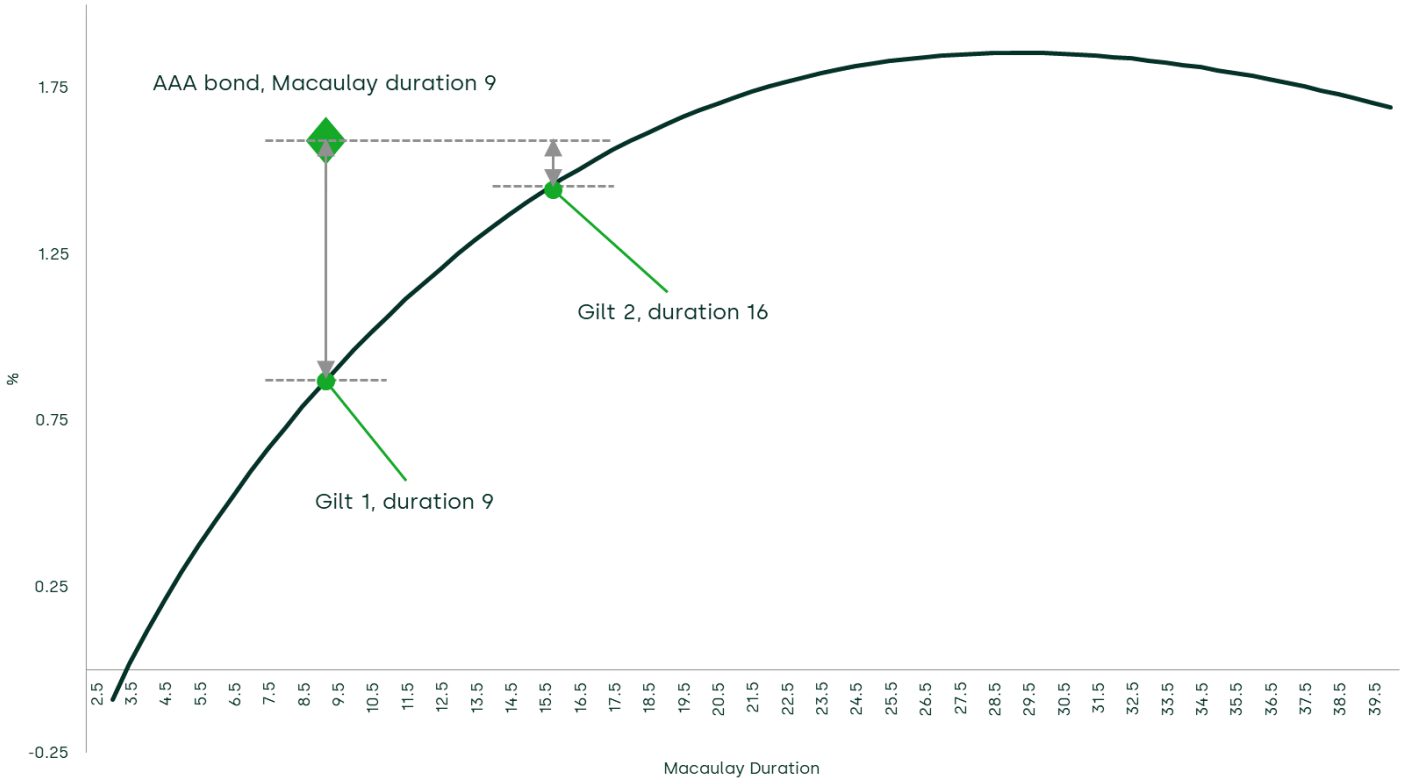
The yields of the benchmark indices should be compared with nominal gilts that are matched with the corresponding duration.[16] For a zero-coupon gilt curve, the duration is equal to the time to maturity of the gilts. Duration represents the weighted average time it takes to receive all interest payments and the principal repayment. As such, comparing the yields on the iBoxx indices with duration-matched gilts limits the

[16] From this point forwards, we use 'duration' to refer to the Macaulay duration, unless otherwise stated.

effect of any time-based premia which may confound estimates of the implied convenience yield.

Figure 2.1 shows the zero coupon ILG yield curve as of 31 January 2025—as this is upward sloping up to maturities (duration) of 27 years, analysis based on a mismatched gilt could lead to a biased estimate of the convenience premium. To illustrate, as the convenience premium is estimated by using the AAA bond yield less gilt yields (as indicated in Figure 2.1, with 'Gilt 1' representing a duration-matched gilt and 'Gilt 2' representing a non-duration-matched gilt), it is intuitive that using the yield at the point of Gilt 2 would lead to an incorrect estimate of the spread, thus underestimating the convenience premium (as denoted by the shorter double-sided arrow). Rather, Gilt 1, as the point on the gilt curve of corresponding duration, should be used instead, thus allowing the estimation of the convenience premium without bias for any tenor/term premia.

Figure 2.1 Illustration of the estimation of the convenience premium, with and without duration-matching of zero-coupon ILG yield curve (nominal)

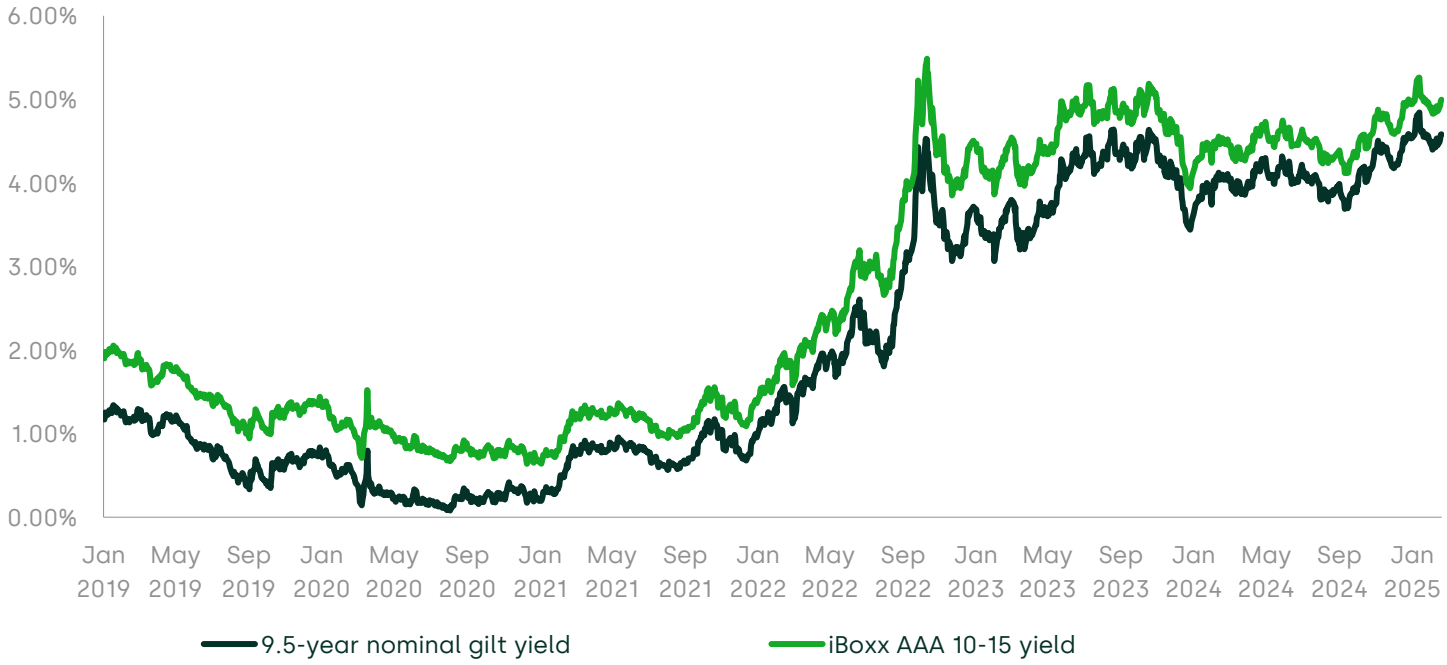


Note: The yield curve shown is drawn from Bank of England data as of 31 January 2025. The point shown for the AAA bond is for illustration purposes only.

Source: Oxera analysis based on Bank of England data.

Based on the estimates in Table 2.2, the five-year average duration of the iBoxx Non-Gilts AAA 10+ and the iBoxx Non-Gilts AAA 10–15 indices rounded to the closest corresponding point on the BoE zero coupon yield curve are 14.5 and 9.5, respectively. Therefore, using a 20-year gilt to calculate the implied convenience premium for this set of benchmark indices, as Ofwat has done, is incompatible as it could incorporate a significant term premium and consequently underestimate the convenience premium.

Figure 2.2 iBoxx Non-Gilts AAA 10-15 (Nominal) vs Gilt yield of corresponding duration



Source: Oxera analysis based on BoE and Bloomberg data

Figure 2.3 iBoxx Non-Gilts AAA 10+ (Nominal) vs Gilt yield of corresponding duration

Source: Oxera analysis based on BoE and Bloomberg data

Figure 2.2 and Figure 2.3 show a comparison of yields between the iBoxx AAA non-gilt indices and gilts of corresponding duration. Specifically, the iBoxx AAA 10+ index has been matched to the 14.5-year gilt, while the iBoxx AAA 10-15 index has been matched to the 9.5-year gilt. Both comparisons demonstrate that the yields of the index of AAA-rated corporate bonds have remained consistently higher than the respective duration-matched gilt yields over time, i.e. there is a consistently positive spread between AAA-rated corporate bond indices and gilts—this supports the existence of a convenience premium, and suggests it is not an isolated phenomenon or even negative, as suggested by Ofwat.

To further evaluate whether the observed results are persistent and robust over time, we test the statistical significance of a positive spread between iBoxx AAA corporate bond yields and gilt yields, both in relation to 20-year gilt yields and duration-matched gilts. We employ a t-test with unequal variances to account for potential differences in yield volatility between corporate bonds and gilts, and perform the test under varying holding periods. We report the results in Table 2.3 below.

Table 2.3 T-test of positive spread

Spread	Sample period	t Statistic	Statistically significant?
iBoxx 10-15 & 9.5y Gilt spread	1m	13.24	Yes
	1y	20.19	Yes
	5y	8.08	Yes
iBoxx 10+ & 14.5y Gilt spread	1m	6.05	Yes
	1y	13.49	Yes
	5y	6.32	Yes

Note: The significance test is performed at a 5% significance level. The null hypothesis associated with the t-test for unequal variances is H_0: The spread is zero and the alternative hypothesis being test is H_1: The spread is greater than zero. Each sample period refers to the time period up to and including 31 January 2025.
Source: Oxera analysis based on Bank of England and Bloomberg data.

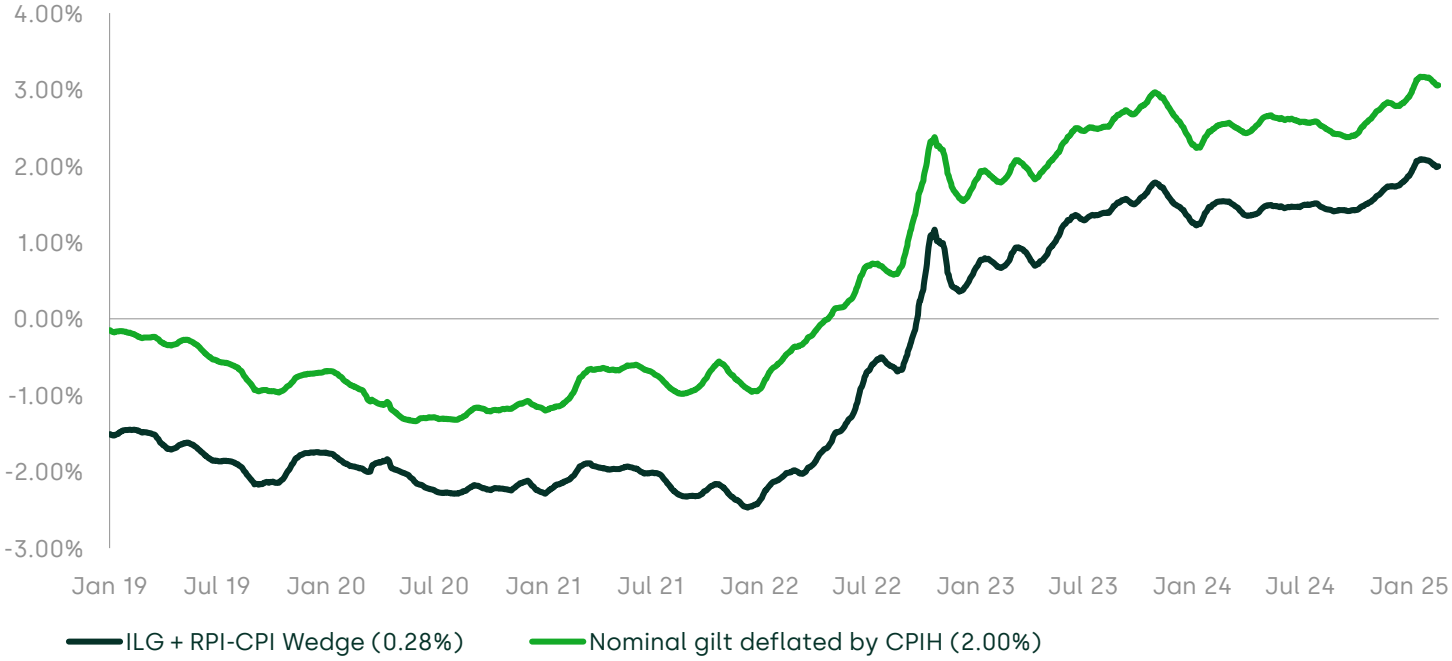
The results show that the positive spreads between the iBoxx 10-15 index and the 9.5-year gilt, and between the iBoxx 10+ index and the 14.5-year gilt, are statistically significant across all sample time periods.[17] This verifies that the convenience premium is positive and persistent over time and cannot be rejected as a temporary or even reductive driver of gilt yields.

2.2.2 Nominal gilts cross-check

To cross-check the estimate of the RfR derived from index-linked gilts, we consider an alternative approach using nominal gilts and the long-run Bank of England (BoE) CPIH inflation target of 2%.[18] Rather than calculating a one-month average of the 20-year ILG yield and adjusting it using an RPI-CPIH inflation forecast wedge, we instead take the one-month average of 20-year nominal gilt yields deflated by the BoE inflation target of 2%. This provides a direct comparison of real yield estimates under different inflation methodologies. Figure 2.4 below illustrates how the RfR has evolved over time under both approaches.

[17] While not presented here, we have also performed significance testing on the spread between (i) iBoxx 10+ against 20y gilts, and (ii) iBoxx 10-15 against 20y gilts. The results are not statistically significant, except in the one and five year average of the iBoxx 10+ against 20y gilt, which support our results shown here. Based on the analysis presented, we surmise that the lack of statistical significance from these specifications is due to the lack of duration-matching, which would explain Ofwat's analysis showing occasional negative spreads, as it fails to correctly adjust for term premia.
[18] Ofwat's approach of deflating by the CPI swap rate is likely to underestimate the CPIH-real RFR, due to the pricing power of the dealer banks that are writing the inflation swaps. More details are provided in Oxera (2025), PR24 Cross-checks to CAPM estimation, 21 March, section 2.1.1.

Figure 2.4 Real RfR calculated based on nominal gilts and ILGs



Source: Oxera analysis based on BoE and OBR data

The figure shows that the monthly yields of the nominal gilt deflated by the 2% CPIH target are consistently higher than those derived using Ofwat's approach, which relies on ILG yields adjusted by an RPI-CPIH wedge. We note that while the wedge over the 20-year gilt may have been higher if estimated at the beginning of this time period, this does not affect the conclusion that the nominal gilt cross-check indicates a higher measure of the RfR than under Ofwat's approach. This suggests that Ofwat's methodology may underestimate the true RfR. In particular, the persistent difference between the two measures raises questions over whether ILGs plus an RPI-CPIH inflation forecast wedge fully reflects market expectations for the long-term CPIH-real risk-free rate. Table 2.4 provides a summary of both approaches.

Table 2.4 Summary of ILG and nominal gilts approaches

	Nominal gilt deflated	ILG + RPI-CPI wedge	Spread
Spot	3.15%	2.07%	1.08%
1 year	2.62%	1.55%	1.07%
5 years	0.78%	-0.41%	1.19%

	Nominal gilt deflated	ILG + RPI-CPI wedge	Spread
Average	2.18%	1.07%	1.11%

Note: Cut-off date of 31 January 2025. [1] RPI-CPIH wedge based on latest Office for Budget Responsibility (OBR) official forecasts and 20-year inflation swaps data.
Source: Oxera analysis based on Bank of England and Bloomberg data.

These results show the gap between the nominal gilts deflated by CPIH and the approach based on ILG yields adjusted by an RPI-CPIH wedge. At the spot level, the nominal gilt-based estimate is 3.15%, compared to 2.07% under Ofwat's approach, resulting in a spread of 1.08%. This difference persists over time, with the one-year and five-year averages also showing higher real yields when using deflated nominal gilts. The five-year spread is particularly notable at 1.19%, suggesting a divergence between the two methodologies over longer periods. On average, the nominal gilt approach suggests yields 1.11% higher than Ofwat's ILG-based estimate, reinforcing concerns that Ofwat's methodology systematically understates the RfR.

2.3 Proposed methodology and estimates

We first use 31 January 2025 as a more recent cut-off date to update Ofwat's one-month average of the yields on a 20-year inflation-linked gilt. The resulting RPI-real average yield is then converted to CPIH-real terms through the application of an RPI–CPIH wedge. Similar to Ofwat's methodology, we estimate the wedge by taking an average of the 20-year inflation forecast based on the latest Office of Budget Responsibility (OBR) data and 20-year inflation swaps data.

We then estimate a convenience premium based on methodological improvements to the CMA PR19 estimation approach. The proposed calculation methodology is implemented through the following steps.

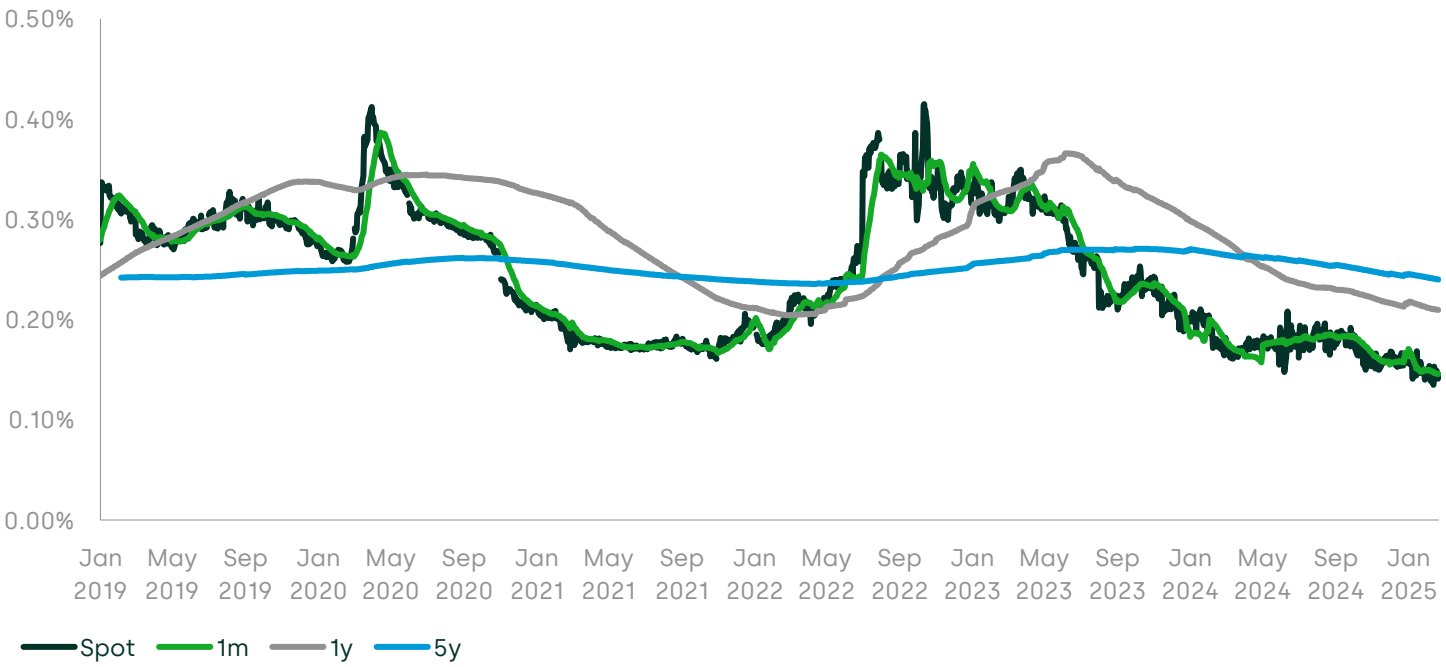
1. Drawing from the CMA PR19 redetermination approach, the IHS iBoxx UK Non-Gilt AAA 10+ and IHS iBoxx UK Non-Gilt AAA 10-15 indices are assessed.
2. All of the calculations are done based on five-year averages to address concerns over the spot volatility of the underlying data, and to align with the length of the price control.
3. The average Macaulay duration by averaging window is determined for each of the assessed indices.
4. The indices are then matched to a point on the BoE nominal zero-coupon curve with maturity corresponding to the Macaulay duration of the index—nominal gilts are used to avoid the need to use an inflation assumption to deflate the iBoxx indices.

5 Average yields by averaging window of the duration-matched gilts are taken away from the corresponding iBoxx index to calculate the implied convenience premium for each of the indices.

6 The resulting premia are then averaged by the respective time windows to give a final convenience premium estimate.

Figure 2.5 below shows the duration-matched convenience premium based on a range of averaging windows. While it is clear that all averaging windows imply a persistent premium over time, some volatility in the estimates can be observed in the shorter estimation windows. The five-year averaging window suggests a relatively stable level of the premium over time, smoothing out any underlying short-term volatility of the estimates. Furthermore, a five-year average aligns with the length of the price control—given the stability of the five-year average across time, we consider that it provides a reasonable expectation of the convenience premium for AMP8.

Figure 2.5 Rolling average estimates of the convenience premium using different averaging periods



Note: Each line shows the rolling average over varying averaging periods.
Source: Oxera analysis based on BoE and Bloomberg Data

2.4 Conclusions

The evidence demonstrates that when estimating the RfR, adjustments are needed to account for the convenience premium. This is consistent with the academic literature and the approaches that are increasingly being used by other regulators, which include an explicit allowance to account for the convenience premium. Our analysis in this section verifies the validity of this—we establish the existence of a positive and persistent convenience premium once the AAA-rated corporate bond index is duration-matched to determine the correct corresponding gilt.

Our methodology results in a **convenience premium estimate of 0.24% based on data up to 31 January 2025.** This is based on applying duration-matching, which is a clear and necessary improvement to Ofwat's PR24 FD methodology, in order to control for the non-uniform term premia across maturities. To ensure an estimate which is stable, we apply the measure of the convenience yield estimated from the five year average, which also aligns to the price control period.

Combining the convenience premium with our underlying RfR results in an estimate of 2.31% (CPIH-real), summarised in Table 2.5 below.

We note that this may be an underestimate of the 'true' RfR. As shown by the evidence from our cross-check approach of deflating nominal gilts by the long-run BoE CPIH target, the RfR that is estimated using index-linked gilts adjusted for the RPI-CPIH wedge is persistently lower than that of the cross-check.

Table 2.5 Risk-free rate estimate

Parameter	Estimate
20-year RPI-linked gilt yield (one-month average, converted to CPI-real)[1]	2.07%
Convenience premium	0.24%
Risk-free rate (CPIH-real)	**2.31%**

Note: Cut-off date of 31 January 2025. [1] RPI-CPIH wedge based on latest Office for Budget Responsibility (OBR) official forecasts and 20-year inflation swaps data.
Source: Oxera analysis based on Bank of England and Bloomberg data.

3 Beta

The equity beta in the CAPM is a measure of how risky an equity investment is compared with the average of the market portfolio. The risk arising because of a company's general exposure to the market is known as 'systematic risk'. Though it is a forward-looking concept, in practice its estimation requires the interpretation of historical market data.

3.1 Overview of Ofwat's PR24 FD approach

In the PR24 Final Determinations, Ofwat calculates the equity beta using the following methodological steps.[19]

1. **Listed comparator set**: Ofwat places weight on Severn Trent and United Utilities betas, but excludes those of Pennon Group[20] based on the view that there has been an insufficient time period for which Pennon Group has been a 'pure-play' comparator, due to distortions from the sale of its unregulated waste management business—leading to both instability of the market perceptions of risk and discontinuity in the group gearing.
2. **Frequency of data**: Ofwat calculates the beta based on daily stock price data.
3. **Estimation window**: In its FDs, Ofwat revised its selection of the estimation window to an average of the 5-year and 10-year betas. Ofwat has excluded shorter periods (e.g. 2-year) from the final estimation, citing concerns over the impact of the pandemic and the war in Ukraine on the beta data.
4. **Gearing and debt beta**: Ofwat re-levers the betas using the Harris–Pringle formula and a notional gearing assumption of 55%. The debt beta is assumed to be within a range of 0.05–0.15.

Table 3.1 summarises Ofwat's PR24 FDs beta estimates on both a levered and unlevered basis.

[19] Ofwat (2024), 'PR24 Final Determinations: Aligning risk and return – allowed return appendix', December, pp. 38–39.
[20] Pennon Group is the holding company of South West Water, Bristol Water, and SES Water.

Table 3.1 PR24 FDs levered and unlevered betas

	Low	High
Raw beta	0.584	0.596
Listed comparator gearing	54.10%	50.48%
Asset beta	0.320	0.349
Debt beta	0.15	0.05
Notional gearing	55.00%	55.00%
Notional equity beta	**0.593**	**0.651**

Source: Ofwat (2024), 'PR24 Final Determinations: Aligning risk and return – allowed return appendix', December, p. 59.

3.2 Critique of Ofwat's PR24 FD approach

3.2.1 CAPM betas are downward-skewed due to the 'low beta anomaly' and regression attenuation bias

There is extensive academic literature suggesting that the CoE implied by the CAPM for low beta, low volatility companies understates the actual observed returns earned by these companies.[21] This is known as the 'low beta anomaly' and is a well-documented bias of the CAPM framework in underestimating required returns for low beta stocks. As covered by the literature, market evidence shows that the security market line (SML, the curve depicting the rate of return as a function of systematic risk), is empirically flatter than predicted by the CAPM-implied beta. This means that by underestimating the beta, the CAPM understates the rate of return required for systematic risk. Given that regulated utility companies typically have equity betas of lower than one, there is risk of this effect leading to a significant underestimation of the required return. As such, there is good reason for choosing a beta point-estimate towards the top-end of the beta estimate rage.

Additionally, beta estimates are likely to be downward-biased due to regression attenuation bias. The academic literature suggests that this effect causes CAPM-based beta estimates to tend toward zero. For example, Jegadeesh, Noh, Pukthuanthong, Roll and Wang simulate various asset pricing models, calibrating the simulation parameters using actual market data. Their findings show that:

[21] For example, Black F., Jensen M., Scholes M. (1972), 'The Capital Asset Pricing Model: Some Empirical Tests'.

'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.' [22]

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).[23] Without any correction for this bias, it ultimately leads to a downward-biased estimation of the CoE. In practice, quantifying the exact impact of the attenuation bias is not possible as it requires replacing an index of equities with the true market portfolio encompassing all assets, including fixed income, property, and unlisted assets. However, knowledge of this downward bias resulting from using an imperfect proxy of market returns in the beta regression equation means that one should exercise caution when selecting the beta point estimate from a range of data to ensure that the resulting CoE estimate does not significantly underestimate the return required by equity investors.

These points altogether mean that with the equity beta at the top of the range of Ofwat's PR24 Final Determinations being 0.65, there is a significant risk that Ofwat's CAPM-implied CoE is underestimated.

3.2.2 Ofwat is wrong to place no weight on 2-year betas

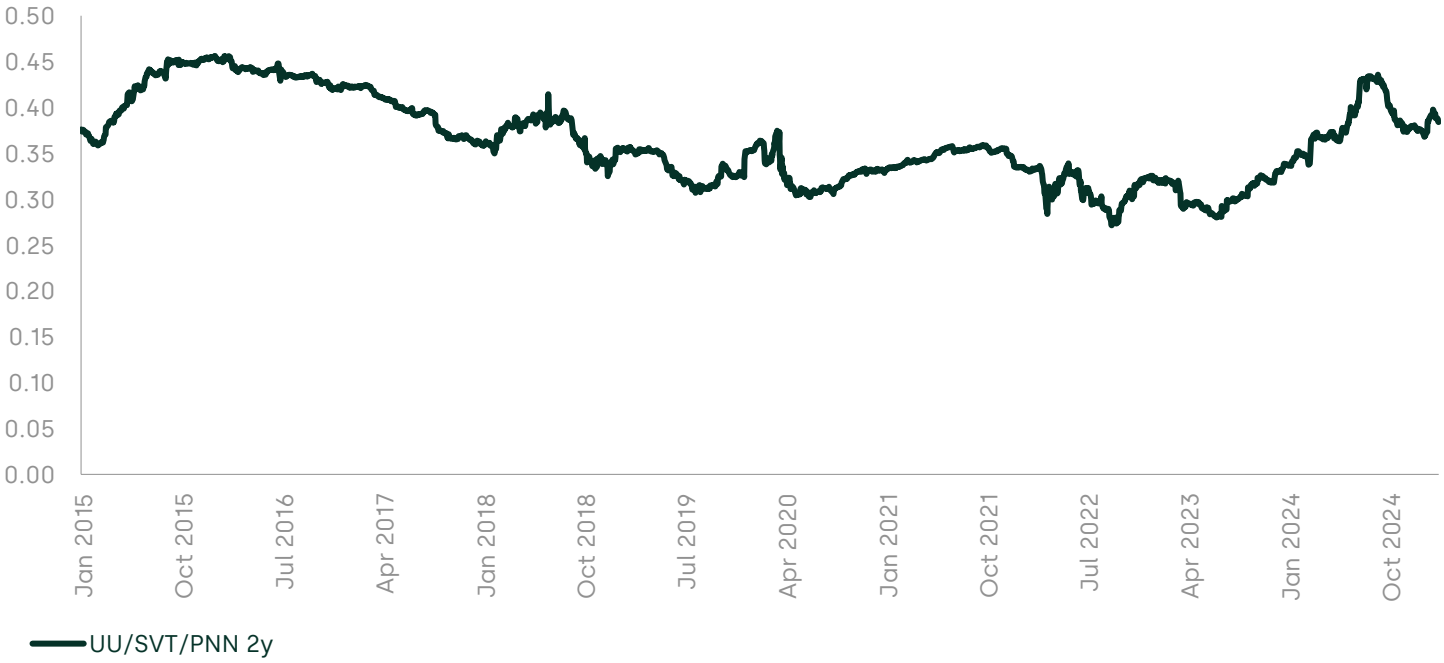
In its PR24 FDs, Ofwat opts not to place weight on evidence from 2-year betas. As the relatively shorter measure, 2-year betas are more responsive to underlying changes in perceived risk.

Table 3.1 illustrates the movement of the asset beta estimates of the three water companies in the comparator sample over the last ten years. We note that there is a clear upward trend in the 2-year beta estimates from 2023, reversing the downward trend over the preceding eight years, coinciding with increased public scrutiny and wider negative sentiment over the perceived increase in risks faced by the sector.

[22] 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

[23] 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.

Figure 3.1 Asset beta movement over time (2y, average of SVT, UU and PNN)



Source: Oxera analysis based on Bloomberg data.

We argue that the 2-year beta provides a more immediate and responsive measure of these changes, capturing the most recent shifts in investor sentiment and reflecting the current environment of increased regulatory pressure, operational challenges, and evolving public expectations. It is not clear that the current increase in 2y betas is noise (as CEPA set out), nor that it would continue to mean revert (as Ofwat set out).[24] Indeed, it is not clear what Ofwat means by 'mean reversion' as should 2y beta levels persist, over time the 5y and 10y betas would be expected to trend towards the current level of the 2y beta. We note also that arguably, the current 5y beta is below the long-run mean (as indicated by 10y betas), owing to the dilutive impact of Covid on water sector betas.

By not incorporating the 2-year estimate, Ofwat's methodology underweights the most recent shifts in market dynamics and the evolving risk profile of the water sector. By relying on only longer-run beta evidence from the 5-year and 10-year estimates, any evidence from higher 2-year betas is arguably suppressed by past periods of stability,

[24] See (1) CEPA (2024), PR24 Cost of equity, 19 December, p. 16, accessed: https://www.ofwat.gov.uk/wp-content/uploads/2024/12/CEPA-PR24-Cost-of-Equity.pdf, and (2) Ofwat (2024), PR24 final determinations: Allowed return appendix, 19 December, p. 42, accessed: https://www.ofwat.gov.uk/wp-content/uploads/2024/12/PR24-final-determinations-Aligning-risk-and-return-Allowed-Return-Appendix.pdf.

before the current change in investor perceptions of sector risk. In particular, this is noticeable from 5-year betas being lower than 10y betas, reflecting the dilutive effect on betas by the lower betas of the water sector during the Covid pandemic. The exclusion of 2-year beta evidence is stark because in its PR19 FD, Ofwat had placed weight on the 2-year alongside 5-year estimates when setting its allowed beta.[25] **It is not credible that the regulatory approach to beta estimation in PR24 becomes less sensitive to recent data than it was in PR19.**

Therefore, we contend that Ofwat's choice to underweight 2-year beta evidence underestimates the immediate and pressing risks currently facing the sector, which are likely to have significant implications for future performance and investor returns. Ultimately, failing to account for them in the cost of capital assessment leads to an outdated view of sector risk. As such, given the significant shift in the risk perceptions of the industry, we consider that the 2-year beta estimates may be the most reflective of the forward looking levels of risk expected for AMP8. Placing direct weight on evidence from the 2-year beta window also allows for the inclusion of PNN into the sample set without its data being influenced by historical impact of Viridor, nor the impact of the divestment transaction.

Ofwat's decision to set an equity beta of 0.622 (midpoint) in its PR24 FD marks a notable reduction from the 0.71 equity beta (equivalent to 0.64 equity beta re-levered at 55% gearing) adopted by the CMA in its PR19 redeterminations. This decline comes despite a fundamental shift in the risk environment facing the water sector. Since PR19, water companies have encountered intensifying scrutiny, rising environmental compliance costs, and increased political and public pressure, all of which contribute to a heightened perception of sector risk. At the same time, the publication of the Long Term Development Strategies (LTDS) by the companies has marked a paradigm shift in the expected level of needed investment across the sector. Increase in the required investments raises the risks both in terms of uncertainty and timing of the return expected by the investors, as well as deliverability risk and potential cost overruns of the extensive enhancement programmes. Another mechanism through which the water sector's large incoming investment programme translates into a higher beta is operational gearing.[26] This reflects the fixed cost of future investments rather than past

[25] Ofwat (2019), 'PR19 Final Determinations: Allowed return on capital technical appendix', December, p.70.
[26] Operational gearing is a measure of a firm's fixed cost relative to its total costs. Operational gearing has a similar effect on the risk of a firm's assets (and thus the corresponding required return) to the effect that financial gearing has on equity risk.

investment—given the material increase in the scale of enhancement programmes in AMP8 onwards, the fixed costs of water companies would rise, thus leading to an increase in operational gearing. This translates directly into a higher asset beta and a corresponding increase in the required return on equity.

On balance, a higher risk profile should be reflected in an increased equity beta. However, Ofwat's determination suggests a contrary view—that the systematic risk of the sector has not increased, or at least not sufficiently to warrant a higher beta. This decision has significant implications for allowed returns and the ability of companies to attract investment in an environment of mounting operational and regulatory challenges.

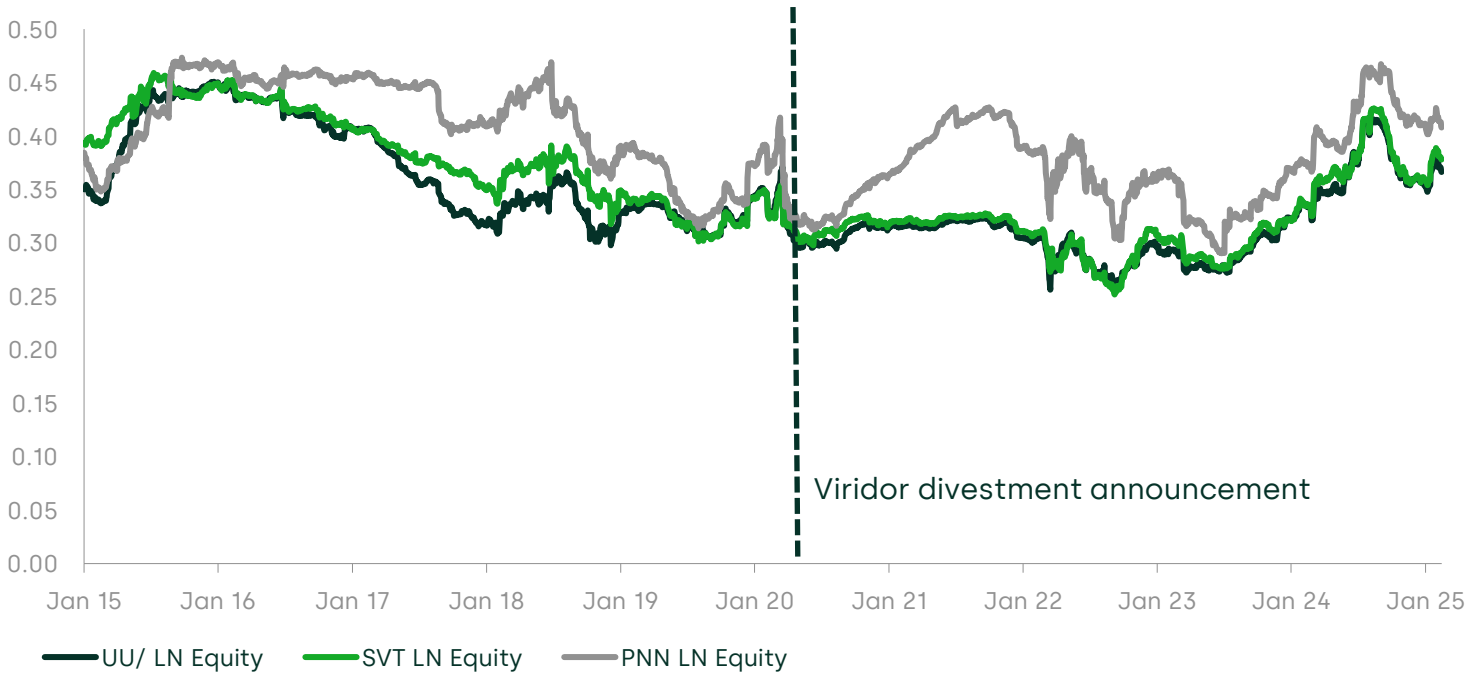
3.2.3 Ofwat is wrong to place no weight on Pennon Group evidence

An additional drawback of Ofwat's approach is its lack of representativeness when compared to the sector, and the notional water company. As its beta analysis is dependent on a small sample of listed water companies—in this case, Severn Trent and United Utilities—Ofwat's results are prone to bias.

Ofwat's exclusion of Pennon Group from the beta sample further undermines the robustness of its methodology, as its sample is thus based on only UU and SVT, which does not offer a representative assessment of systematic risk for the median or notional operator in the water sector. Indeed, in its opinion submitted to the CMA following Pennon's acquisition of SES water, Ofwat stated that the acquisition of SES maintains the focus of Pennon on UK water activities and as such would not reduce its usefulness as a 'pure-play' comparator for the beta estimation.[27] We note that PNN now operates across three water companies (out of the 17 in the sector), and its regulated capital value accounts for 5.2% of the water sector.[28] Given these observations, we consider that there is no clear reason to continue to exclude Pennon's data is estimating the beta. Figure 3.2 below plots PNN's asset beta over time.

[27] CMA (2024), 'Ofwat's Opinion on Pennon's acquisition of SES Water', p. 38.
[28] Data from Ofwat (2024), 'Monitoring Financial Resilience report 2023-24', November.

Figure 3.2 Comparison of 2y asset beta movement (SVT, UU and PNN)



Source: Oxera analysis based on Bloomberg data.

Despite the sale of its Viridor waste management business, Pennon's beta has trended upward, as shown in the chart, suggesting that the market did not consider PNN to be more risky relative to SVT and UU before the divestment. Indeed, after the divestment, Pennon's beta has been persistently higher than SVT and UU. As such, given a lack of full convergence of PNN with the other two listed companies post the divestment, we consider the inclusion of Pennon data from before the divestment to be appropriate and that it does not lead to an overestimation of the levels of systematic risk faced by the water sector. The recent trend reinforces the case for including Pennon in the beta estimation, as its market movements now align more closely with the broader water sector (at least, to a greater degree than either of UU or SVT).

Excluding PNN would disregard a material data point for the industry, leading to a biased estimation of the beta. Ultimately, its inclusion strengthens the robustness of beta estimation, ensuring that the final cost of capital assessment accurately reflects the full spectrum of risks faced by the sector.

Even with the inclusion of PNN however, the approach may be insufficiently representative. This should be uncontroversial—for example, two out of three companies in the beta sample were rated as Outstanding in Ofwat's QAA mechanism (and were the only two

companies in the sector to be rated Outstanding), all three expect to generate returns outperformance over AMP8 (as highlighted above), and all three have a track record of historical outperformance, and being 'best in class'.[29]

Effectively, the sample set is formed of only upper quartile performing water companies. It is therefore unreasonable for Ofwat to conclude that its beta range is the appropriate estimate for the notional company. As a result, the impact of the expected outperformance of the listed companies creates challenges for a direct read-across of the beta analysis for a notional company. Nonetheless, the inclusion of PNN as a valuable datapoint would help to start mitigating the issue of a lack of representativeness..

In the FDs, Ofwat notes that Pennon has had 'clean' raw beta data since Q2 2021[30], yet excludes it on the basis that its longer-term estimation windows—5 and 10 years—would not have a sufficiently long span of clean data. This rationale means that Pennon's 5-year beta would become valid in 2026, just a year into AMP8. By rigidly adhering to its methodology however, Ofwat disregards Pennon entirely, even though its beta is arguably the closest listed proxy to track sector-wide risks.

3.3 Proposed methodology and estimates

We calculate the equity beta using the following methodological steps:

- **Listed comparator set:** Our analysis places weight on the asset betas of Severn Trent, United Utilities, and Pennon Group, ensuring a representative comparator set.
- **Frequency of data:** As Ofwat, we use daily stock price data to estimate beta, capturing market movements with high-frequency observations.
- **Estimation window:** To account for different market conditions over time, we consider the 2-year, 5-year, and 10-year beta estimates.
- **Gearing and debt beta:** We re-lever the betas using the Harris–Pringle formula and apply a notional gearing assumption of 55%, consistent with Ofwat's approach. We adopt Ofwat's debt beta range of 0.05–0.15, using the point estimate of 0.1 in the calculations.

[29] Refer to Section 5.4 of our PR24 Cross-checks to CAPM estimation report.
[30] Ofwat (2024), 'PR24 Final Determinations: Aligning risk and return – allowed return appendix', December, pp. 40 and 51.

Table 3.2 summarises the asset beta estimates with the cut-off date of 31 January 2025.

Table 3.2 Summary asset beta estimates by estimation window

Asset betas	Spot, 2y	Spot, 3y	Spot, 5y	Spot, 10y	Average of 2, 3, 5, and 10y
UU	0.38	0.36	0.32	0.34	0.35
SVT	0.39	0.37	0.33	0.35	0.36
PNN	0.43	0.39	0.37	0.39	0.39
Average	**0.40**	**0.37**	**0.34**	**0.36**	**0.37**
Average (excl. PNN)	**0.38**	**0.36**	**0.32**	**0.34**	**0.35**

Source: Oxera analysis.

To address Ofwat's concern of the 5-year beta estimate for Pennon being inaccurate due to the effects of divesting of Viridor, we also estimate betas based on a 3-year estimation window. A 3-year estimation window removes the impact of the sale of Viridor on the business risk and the cash balances (and by extension) gearing of Pennon. Beta estimates for all three listed water companies increases in the 3-year window relative to the 5-year window. This suggests that the increase in beta in the shorter averaging windows represents a systematic reassessment of the level of risk faced by the industry.

In our approach for the lower bound of the beta range, we maintain a simple average of 2-, 5-, and 10-year beta estimates rather than adopting a rolling average approach, ensuring that all data points within the estimation windows are given equal weight. Ofwat itself acknowledged this issue in its FD, stating that it chose not to place weight on rolling averages as it correctly recognised that rolling averages place less weight on data at the start and end of the averaging period.[31]

Placing weight on 2-year betas allows for a more contemporaneous estimate of the beta, given the steep increase in investments, and therefore delivery risks, anticipated from AMP8 through to AMP9 and

[31] Ofwat (2024), 'PR24 Final Determinations: Aligning risk and return – allowed return appendix', December, p. 57.

onwards. This is as these risks would be more clearly reflected in betas shorter than the 10-year estimation window.

In our high scenario, we base the equity beta on the spot estimate of the 2-year asset betas for UU, SVT and PNN. The focus on the 2-year estimates reflects the heightened risk environment facing the sector, while incorporating PNN provides a more comprehensive view by accounting for its expanded operations across multiple regions and its significant share of the comparator set's regulated capital value. This approach partially mitigates the risk of misestimating systematic risk and ensures that our assessment remains aligned with current market conditions.

3.4 Conclusions

Our analysis results in an equity beta range of 0.69 to 0.76, which sits above Ofwat's FDs estimate. This reflects the recent upward trend in market-perceived risk and ensures alignment with the latest investor expectations. The upper end of our range, based on 2-year asset betas and the inclusion of Pennon, highlights the impact of more contemporaneous market conditions—an aspect overlooked in Ofwat's approach. Considering the balance of evidence, beta estimates towards the upper end of our range are likely to be more representative of the level of systematic risk faced by a notional company going into AMP8, in particular due to the following.

- 2-year beta estimates more fully capture the increase in market perception of risk across the industry;
- The listed companies in the beta sample are insufficiently representative of the average risk faced by a water company—two of the three listed companies' business plans have been rated as 'Outstanding' in Ofwat's QAA mechanism; and all three of the listed companies are widely expected to outperform the baseline allowance based both on the equity analyst assessment and the communication of the companies with their shareholders;[32]
- CAPM beta estimates are likely an underestimate of the required return for regulated utility companies due to (i) the 'low beta anomaly' effect observed for companies with low equity betas and (2) regression attenuation bias, which implies a negative bias in beta estimates more generally; and

[32] Refer to Section 5.4 of our PR24 Cross-checks to CAPM estimation report.

- Large future investment programmes increasing the risk and operational gearing of water companies and as such, increasing equity betas.

Table 3.3 Equity beta estimate

Parameter	Low	High
Equity beta	0.69	0.76

Note: Cut-off date of 31 January 2025. Assuming debt beta of 0.10.
Source: Oxera analysis.

4 Total Market Return

A key input into CAPM estimation is the equity risk premium (ERP), which is the premium above the risk-free rate that investors demand for investing in a market equity portfolio. It is calculated as the difference between the total market return (TMR) and the RfR.

UK regulators have classified methodologies for estimating the TMR as follows.

- **Historical ex post**: based on the average of observable historical returns. This is the most widely used method and the one that produces the most robust results.
- **Historical ex ante**: based on the average of adjusted historical returns, where the adjustment accounts for 'unexpected' events that generated a return lower or higher than the expected return.
- **Forward-looking**: based on investors' expectations of future returns. Various methodologies can be used to estimate this, from survey evidence to dividend discount models.

4.1 Overview of Ofwat's PR24 FD approach

In the PR24 Final Determinations, Ofwat used the following approach to set the TMR.[33]

1. **Approach:** Ofwat derived a range for the TMR using the ex post and ex ante historical approaches, stating that the subjectivity of some forward-looking approaches makes them unsuitable as a primary tool for estimating the TMR.
2. **Averaging technique**: Ofwat derived the ex post TMR range using the arithmetic average of annual returns over overlapping 10–20 holding periods, retaining the approach of converting the geometric average to the arithmetic equivalent adjusted for serial correlation as a cross-check.
3. **Treatment of inflation:** to derive a real equity return series for ex post estimates, Ofwat has placed sole weight on a modelled historical back series of CPIH, compiled from multiple sources.

[33] Ibid., pp. 23–24.

4 **Ex ante approaches** adopted by Ofwat: these include a 'DMS decompositional' approach and a Fama–French dividend growth model approach with a range of input variable assumptions.

After considering the outputs from the various approaches, Ofwat combined them into a single sample and picked the lowest and highest outputs to underpin its estimated TMR range, resulting in an allowed TMR of 6.68–6.98%, with 6.83% as the midpoint (CPIH-real).

4.2 Critique of Ofwat's PR24 FD approach

4.2.1 'Through the cycle' approach to TMR may lead to periods of insufficient returns

Estimating the TMR based on a very long run sample produces results that inherently are not representative of the expected market returns at any one point in time. The long run sample of the data reflects periods of material uncertainty, including wars and financial crises, as well as structural changes to the market and economy as a whole. The application of this long run average depends strongly on the assumption of relative TMR stability through time, referred to by Ofwat as the 'fixed TMR approach'.[34] This approach (also referred to as the 'through the cycle' approach) assumes that the TMR is relatively less volatile than the underlying ERP, in order to allow for greater stability in regulatory determinations of the CoE through time . However, while the TMR may be relatively more stable than the ERP, it is important that it is not then applied as a 'constant' TMR—as highlighted by the UKRN as follows.

"This approach [of assuming a relatively stable TMR] does not imply that regulatory should simply pick the same fixed value for the TMR in each decision for all time, but that the TMR would be relatively less variable than the underlying RfR."[35]

Clearly, assuming a 'fixed' market return cannot mean that it is applicable to every specific period of time. In other words, and as acknowledged by the UKRN, approaches such as Ofwat's 'fixed TMR' may lead to prolonged periods in which the market return is over- or understated, depending on the state of the economic cycle and the underlying interest rates.[36] The argument in favour of this approach is that it would lead to reasonable results over a sufficiently long period of

[34] Ofwat (2024), PR24 final determinations: Allowed return appendix, 19 December, p. 61, accessed: https://www.ofwat.gov.uk/wp-content/uploads/2024/12/PR24-final-determinations-Aligning-risk-and-return-Allowed-Return-Appendix.pdf.
[35] UKRN (2023), UKRN guidance for regulators on the methodology for setting the cost of capital, 22 March, p. 19, accessed: https://ukrn.org.uk/app/uploads/2023/03/CoC-guidance_22.03.23.pdf.
[36] Ibid.

time. However, this makes the **unevidenced assumption that an investor in a water company would be ready to accept periods of insufficient returns as a result of this policy choice, while still being willing to invest significant new equity**—we contend that this assumption is not justified. More importantly, it is undeniable that the 'fixed TMR' policy now results in investors being offered lower returns, at the precise time when the water sector needs to raise large amounts of equity.

In particular, setting the cost of capital based on a fixed through the cycle TMR implicitly assumes that:

- the costs of under- or overestimating the cost of capital are similar; or
- investors will invest even when allowed returns are below the required cost of capital because at other points in time allowed returns may be above the required cost of capital.

The first assumption is unlikely to be correct, because welfare is an asymmetric function—the social and welfare impacts of underestimating the cost of capital such that it leads to delayed or abandoned investment are far greater than the impact of overestimating the cost of capital. This was acknowledged by the CMA in its PR19 re-determination.[37]

Assuming that investors will invest when expected returns are below the required cost of capital, on the basis that returns have exceeded or may exceed the cost of capital at other times, gives rise to three key issues.

- First, it implicitly assumes that any overestimation of the cost of capital in the past is relevant to current investment decisions.
- Second, it assumes that the investor base is unchanged over time—**one cannot credibly expect new shareholders to commit capital at an unsatisfactory rate based on the returns enjoyed by a previous cohort of investors.**
- Third, in price control periods with large requirements for equity injections to fund investment, risks arising from the 'fixed TMR' approach to investability are significantly magnified. Given the need for significant investment in AMP8 and beyond, this consideration is particularly important when compared to previous price controls.

[37] CMA (2021), PR19 Anglian Water Services Limited, Bristol Water plc, Northumbrian Water Limited and Yorkshire Water Services Limited price determinations: Final report, 17 March, para. 9.1276.

Overall, we consider that while the principle that the TMR is relatively more stable than ERP may be a reasonable assumption, in practical applications this cannot lead to an assumption of a 'fixed' TMR without negatively impacting the sufficiency of the allowed returns and investability. This is especially material for the water sector in PR24, given the need to raise equity capital at a scale and pace never tested before in Ofwat's regime. We expand on this below.

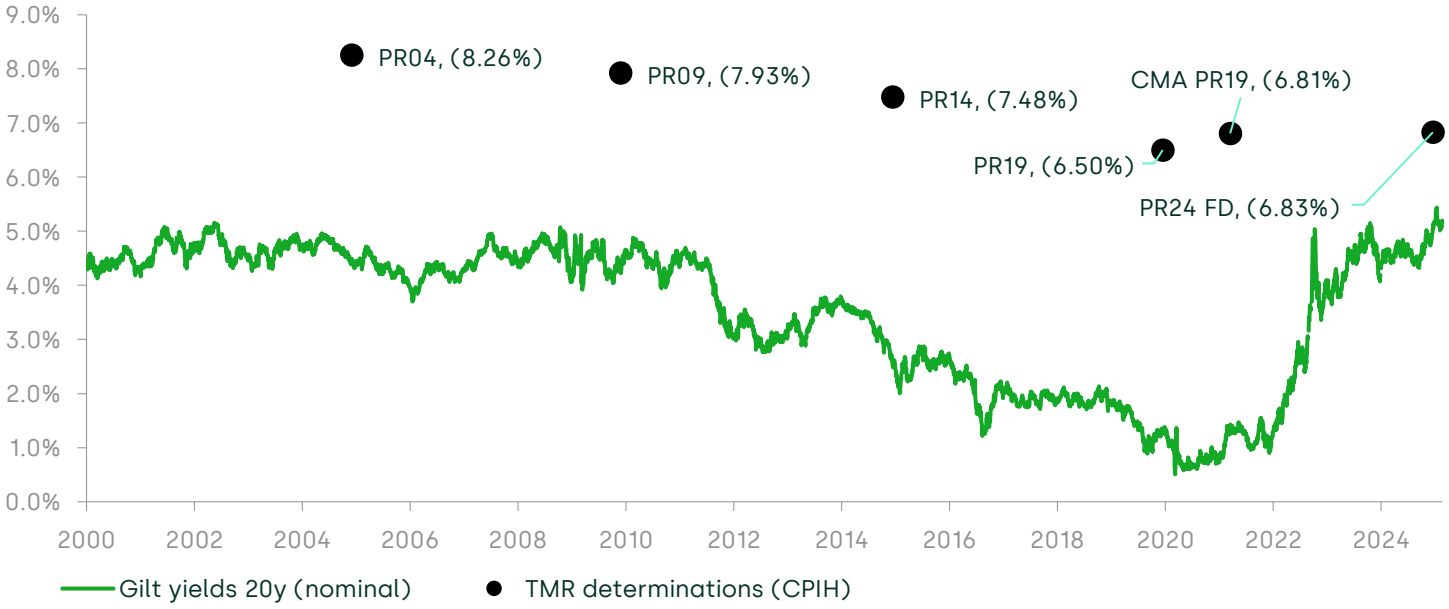
4.2.2 Ofwat's application of its 'fixed TMR' approach exacerbates investability concerns

While Ofwat's application of the 'through the cycle' approach implies a relatively stable TMR over time, the historical TMR allowed by Ofwat across the last two decades has trended downwards in line with underlying interest rates, as shown in Figure 4.1.

Ofwat explains this downward movement of its allowed TMR by setting out that historical determinations were either higher than necessary or reflected one-off circumstances. Accordingly, its downward revisions are claimed to be a reflection of 'methodological improvements' rather than a result of a decrease in the interest rates.[38]

[38] Ofwat (2024), PR24 final determinations: Allowed returns appendix, 19 December, p.27, accessed: https://www.ofwat.gov.uk/wp-content/uploads/2024/12/PR24-final-determinations-Aligning-risk-and-return-Allowed-Return-Appendix.pdf.

Figure 4.1 Historical TMR determinations and underlying gilt yields



Note: Historical RPI-real determinations have been converted to CPIH-real using the long–term wedge as stated by the Office for Budget Responsibility (OBR). We have reflected the changes in the long-term wedges over time. The respective wedges used for PR04, PR09 and PR14 are 0.49%, 0.49%, and 0.69% respectively. For the years before the Bank of England started targeting CPI, we use the 2.5% RPI target.
Source: Oxera analysis

However, it is not clear that Ofwat's 'methodological improvements' are a reflection of a more accurate TMR estimate, as several outstanding issues with the methodology remain outstanding. Namely:

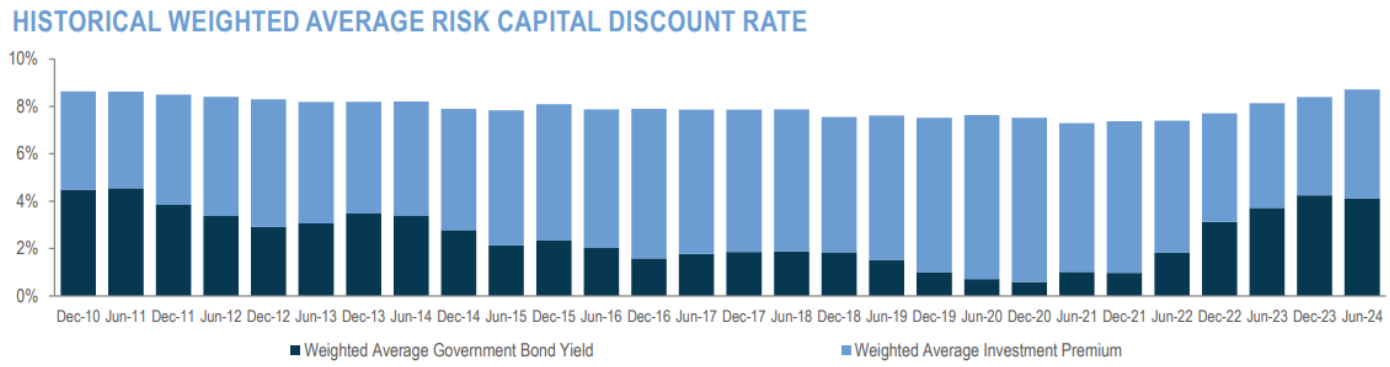
- **Ofwat continues to place equal weight on the ex ante estimation approaches**—the ex ante TMR estimates require a subjective revision adjusting historical periods for 'good' and 'bad' luck and whether those were reflected in the investors' expectations in the past.
- **Ofwat continues to adjust for unevidenced serial correlation in the analysis of historical returns**—work submitted to the CMA by Professor Stephen Schaefer for the NATS (2020) price control redetermination found that the difference between the arithmetic and geometric average returns suggest that the

impact of serial correlation is insignificant, or serial correlation itself is insignificant.[39]

In the past, these 'methodological improvements' have coincided with interest rates decreasing. The position going into AMP8 is markedly different, with interest rates rising in the years preceding the start of the coming price control period. Over-reliance on the 'fixed' TMR policy approach risks being disconnected with the current market environment and as such, resulting in a CoE that is too low to ensure investability in the regime going forwards. This is consistent with the UKRN guidance which highlights that regulators should not take the extreme position to keep TMR constant.[40] Therefore, **it may be reasonable to set the TMR closer to the historical precedents that occurred in an interest rate environment similar to what currently faces the sector.** For example, the allowed TMR in the PR04 and PR09 determinations were 8.3% (CPIH-real) and 7.9% (CPIH-real), respectively.[41]

We observe a similar pattern in the historical discount rates used by infrastructure investment funds, where the total required return on investments increases when interest rates are high. This trend is shown in Figure 4.2.

Figure 4.2 INPP total required return



Source: INPP (2024), 'H1 2024 Results Presentation', September.

[39] Appendix of Schaefer, S. (2020), 'Using Average Historical Rates of Return to set Discount Rates'.
[40] UKRN (2023), UKRN guidance for regulators on the methodology for setting the cost of capital, 22 March, p. 19, accessed: https://ukrn.org.uk/app/uploads/2023/03/CoC-guidance_22.03.23.pdf.
[41] The allowed TMR in PR09 was 7.73% in RPI-real terms, this has been converted assuming a prevailing RPI-CPIH wedge of 0.5%; the allowed TMR in PR09 was 7.40% in RPI-real terms, converted assuming a prevailing RPI-CPIH wedge of 0.5%;

The evolution of historical discount rates used by INPP shows a clear relationship between the total returns required by the infrastructure investors and market interest rates. While total required returns have generally remained stable, they have gradually increased in line with the underlying interest rates, and are now closer to historical levels observed when interest rates were higher (e.g., in 2010). Therefore, it is likely that investors have similar expectations regarding the current TMR, namely a relatively stable TMR that increases to reflect the underlying increase in interest rates.

On balance, the allowed TMR has historically been higher when interest rates were higher, and has decreased in line with falling interest rates, even if an explicit link was not made. It is unclear and unlikely that investors would be willing to accept insufficient returns and commit new equity investments based on a regulatory policy that assumes that returns will be sufficient *on average* across a long time horizon.

4.3 Proposed methodology and estimates

We propose that any 'fixed TMR' estimate should place sole weight on ex post estimates, as these reflect the returns that the market has actually been able to achieve on average, without subjective adjustments to reflect past periods of good or bad 'luck'. To estimate the ex post TMR we use an arithmetic average of annual holding periods over the entire DMS data series.

4.3.1 Averaging historical returns and choice of the holding period

As explained in our previous publication in response to the UKRN consultation,[42] there are two options available when estimating the average TMR: by calculating the geometric mean, and by calculating the arithmetic mean. The geometric mean of any set of numbers is always lower than the arithmetic mean, unless all the numbers are equal (in which case the means are the same). For a series of returns, equality between the geometric and arithmetic means would occur only if there is no volatility at all (i.e. if returns are constant). While there is debate about which is the more appropriate averaging method in any given context, academic literature generally supports the adoption of the

[42] Oxera (2022), 'A review of the methodology used to estimate the allowed cost of equity for regulated companies', November, p. 22, https://www.oxera.com/wp-content/uploads/2023/07/A-review-of-the-methodology-used-to-estimate.pdf.

arithmetic average for estimating the ERP when calculating required equity returns for valuation and capital budgeting purposes.[43]

This conclusion is consistent with the CMA decision in the PR19 redetermination, where the CMA stated that:[44]

> [...] in the absence of clear modelling of the regulator's decision, the most appropriate estimate to use is the arithmetic mean. [...] On balance, we consider that using the arithmetic mean is preferable due to its simplicity and transparency, and also given that at the current time, there is no reason to conclude that one perspective, either that of the capital budgeter or of the portfolio investor, is 'correct'.

We do not adjust the arithmetic averages of the annual returns for serial correlation—using non-overlapping holding periods ensures that there is no serial correlation in the returns. In our previous publication in response to the UKRN consultation,[45] we applied the Ljung-Box test to the DMS series assuming different non-overlapping holding periods.[46] The results show that, for each non-overlapping holding period (i.e. one-year, five-year, ten-year and 20-year), there is no statistically significant serial correlation in the returns.

In respect of the considered holding periods, using non-overlapping holding periods spanning multiple years comes with the disadvantage of significantly reducing the available datapoints, making those estimates more susceptible to outliers.[47] On balance, using a **non-overlapping one-year arithmetic average remains a more robust estimation methodology** than using the geometric average as a basis and adjusting it upwards for the potential impact of serial correlation.[48]

[43] (1) Berk, J. and DeMarzo, P. (2024), *Corporate Finance*, Pearson, Global Edition, 6th edition, January, p. 310. (2) Cooper, I. (1996), Arithmetic versus geometric mean estimators: Setting discount rates for capital budgeting, July, *European Financial Management* **2**:2, pp. 157–167.
[44] CMA PR19 redetermination (2021), paras 9.326–9.328.
[45] Oxera (2022), 'A review of the methodology used to estimate the allowed cost of equity for regulated companies', November, p. 22, https://www.oxera.com/wp-content/uploads/2023/07/A-review-of-the-methodology-used-to-estimate.pdf (last accessed on 5 February 2024).
[46] The Ljung–Box test is a quantitative method that tests for autocorrelation at multiple lags jointly. Ljung, G.M. and Box, G.E.P. (1978), 'On a Measure of a Lack of Fit in Time Series Models', *Biometrika*, **65**:2, pp. 297–303.
[47] CMA PR19 redetermination (2021), para. 9.333.
[48] If the geometric average is used as a starting point, this estimate needs to be uplifted to adjust for the impact of arithmetic averaging. While this impact can be quantified as half the variance of log returns, UK regulators have set this uplift between 1% and 2%, which, in addition to uplifting the geometric average to the arithmetic one, accounts for the assumed impact of serial correlation. We have not assessed the most appropriate way to adjust for serial correlation, given that we do not

4.4 Final TMR range estimate

Our estimate of the ex post arithmetic average TMR with annual holding periods implies a TMR estimate of 6.96% (CPIH-real), based on the latest available DMS data up to 2023. This estimate is based on the entire DMS data series.

In view of the current market environment, we consider that the allowed TMR may need to be set above the long run ex post estimate to more closely reflect the returns required by investors. In particular, we consider that the upper end of the TMR range needs to be increased towards the CPIH-real equivalent TMR assumptions made by Ofwat in PR04 (8.3%) and PR09 (7.9%), when rates were last similar to current levels.

Reflecting all these considerations **our final TMR range for AMP8 is 7.0–7.5% (CPIH-real)**, summarised in Table 4.1 below.

Table 4.1 Total market return estimate

Parameter	Low	High
Total market return	7.00%	7.50%

Source: Oxera analysis.

find it statistically significant in our analysis. See UKRN (2022), 'UKRN guidance for regulators on the methodology for setting the cost of capital', p. 18, https://ukrn.org.uk/app/uploads/2023/03/CoC-guidance_22.03.23.pdf.

5 Cost of equity point estimate

5.1 Overview of Ofwat's PR24 FD approach

Table 5.1 summarises Ofwat's Final Determinations CAPM parameter range and the final allowed return on equity point estimate.

Table 5.1 PR24 Final Determinations cost of equity

	Range	Midpoint estimate
Notional gearing	55%	55%
Total market return	6.68–6.98%	6.83%
Risk-free rate	1.52%	1.52%
Equity risk premium	5.16–5.46%	5.31%
Unlevered beta	0.268–0.295	0.282
Debt beta	0.15–0.05	0.10
Asset beta	0.349–0.320	0.335
Re-levered equity beta	0.593–0.651	0.62
Appointee cost of equity	4.58–5.07%	4.83% (5.10% point estimate post aiming up)

Source: Ofwat (2024), 'PR24 Final Determinations: Aligning risk and return – allowed return appendix', December, p. 60.

In setting the CoE point estimate for PR24, Ofwat stated that it considered cross-check evidence, the welfare impact from underinvestment, asymmetry in incentives and parameter choices, and financeability.[49] Despite commenting on a wide range of cross-checks, Ofwat chose to rely primarily on evidence from the market-to-asset ratio (MAR) cross-check, which, based on Ofwat's calculations, provided support to its CoE range.

Ultimately, Ofwat 'aimed out' to a point estimate CoE of 5.10% (CPIH-real) by rounding up the upper bound of its CAPM range, citing low investor sentiment towards the sector as well as increased risks due to

[49] Ofwat (2024), 'PR24 Final Determinations: Aligning risk and return – allowed return appendix', December, p. 62.

the capital intensity of the AMP8 CAPEX programme.[50] Overall, this effectively represents a 0.27% aim-up over the midpoint of the CAPM-implied CoE range.

5.2 Relevant considerations to derive the point estimate

5.2.1 CAPM parameter uncertainty

With respect to the RfR, we reject Ofwat's claim that its estimate is likely skewed upward, a claim it attributes to the use of 20-year ILGs despite a CAPM horizon of 10 to 20 years.[51] Rather, we consider that **Ofwat's estimate is likely an underestimate of the RfR** as it fails to include any adjustment for the convenience premium, which we estimated to be 24 basis points in Section 2.2.1. Further, Ofwat's estimate of the RfR comes persistently below the RfR estimate derived from deflated nominal gilts, suggesting Ofwat's methodology systematically underestimates the RfR.

Regarding the beta, it should be acknowledged in the first instance that the CAPM beta is subject to estimation bias. Two specific drivers of these are (i) the 'low beta anomaly', effectively projecting lower returns than observed empirically, and (ii) attenuation bias, where the CAPM regression beta is biased towards zero due to imperfect measurement of market returns. Against this backdrop, Ofwat's FD point estimate for the beta is skewed further downwards as it fails to account for evidence from 2-year asset betas. This is notable as 2y betas represent the most contemporaneous indicator of the evolving risk profile of the water sector—Ofwat's choice to rely on only longer-run beta estimates effectively suppresses recent market evidence signalling the shift in the risk profile of the sector. This is further exacerbated by the exclusion of Pennon from the sample set, which biases the beta estimate towards top sector performers, thus limiting the representativeness of Ofwat's beta estimates for the notional company. It is instructive also to observe that Ofwat's upper bound beta estimate for PR24 is 0.65—this is barely higher than the beta adopted by the CMA in PR19 (of 0.64, adjusted for notional gearing of 55%), **yet it cannot be reasonable to conclude that the water sector is no more risky now than in 2021.** This altogether reinforces the view that Ofwat's beta estimate understates the sector's, and notional company's, true systematic risk.

[50] Ofwat (2024), 'PR24 Final Determinations: Aligning risk and return – allowed return appendix', December, p. 84.
[51] Ofwat (2024), 'PR24 Final Determinations: Aligning risk and return – allowed return appendix', December, p. 78.

Lastly, regarding the TMR, with interest rates and return expectations trending materially upwards in the last several years, **rigid adherence to the 'fixed TMR' policy risks misalignment with market conditions and more importantly, with investor expectations.** While the allowed TMR in past determinations has reduced in line with interest rate trends up to 2020, it is unproven that investors in the notional company would now commit new equity based solely on regulatory assumptions of sufficient returns *on average* in the long-term. Therefore, we conclude that Ofwat's FD TMR range fails to account for the significant shift in market conditions. Moreover, despite Ofwat's claimed 'methodological improvements,' several issues with its approach remain unresolved, including its continued weighting of ex ante estimation methods, which rely on subjective adjustments.

While Ofwat's aiming up partially signals its recognition of the change in risk faced by the sector, it is not clear that the degree of aiming up is sufficient, nor that it results in a CoE point estimate that is sufficient for the sector. Indeed, we note that Ofwat's aiming up is only 2bps higher than the 25bps aim up allowed by the CMA in its PR19 re-determination, despite the significant shift in the environment and outlook for the water sector.

The considerations raised above suggest that there remains significant parameter uncertainty within Ofwat's FD CAPM estimation. Supported also by evidence in our cross-checks report summarised below, we conclude that Ofwat's PR24 FD CoE allowance is set too low.

5.2.2 Cross-check evidence

As presented in our report entitled PR24: Cross-checks to CAPM estimation, we consider the following cross-checks.

- Debt-based cross-checks, which describe the use of evidence from debt markets to determine the premia on equity over debt. Taking an iterative approach, we determine incrementally the lower bound for the CoE, arriving at a **strict lower bound CoE of 6.20% (CPIH-real).**
- Market-to-asset ratio (MARs) analysis, which is based on Ofwat's PR24 FD approach of inferring the CoE using stylised in-perpetuity assumptions. We show that this results in disparate estimates of the CoE, which once calibrated to improve representativeness, provides a **CoE range of 6.13–7.34% (CPIH-real).**
- Infrastructure fund's discount rates, which draw on listed funds' share prices, which once adjusted for valuation premia/

discounts and gearing, results in a CoE range of **7.12–7.24% (CPIH-real).**

These results are compared to our CAPM-implied CoE range developed in this report, as summarised in Table 5.2.

Table 5.2 Summary of cross-check ranges against Oxera's estimated CoE range (CPIH-real)

Parameter/ cross-check	Cost of equity
Oxera's estimated CoE range	5.53–6.25%
Oxera debt-based cross-check lower bound	6.14–6.20%
Oxera's MARs-inferred CoE	6.13–7.34%
Oxera's infrastructure fund cross-check	7.12–7.24%

Source: Oxera analysis contained within Oxera (2025), PR24 Cross-checks to CAPM estimation, 21 March.

5.3 Conclusions

Table 5.3 presents our CAPM parameter estimates as determined in this report, resulting in a **CoE range of 5.53–6.25% (CPIH-real).**

Drawing from our cross-checks report (the results of which have been summarised in Section 5.2.2) to inform the selection of a point estimate, we establish that the **cross-check evidence considered supports the top end of our CAPM-implied CoE range.** In particular, evidence from debt-based cross-checks imply a strict lower bound for the CoE of 6.20%. Accordingly, and reflecting the considerations raised in this section, **we select the top end of our CAPM-implied range as our point estimate of the CoE, i.e. 6.25% (CPIH-real).**

Table 5.3 Summary Oxera CAPM estimates (CPIH-real)

	Oxera estimates
Notional gearing	55%
Risk-free rate	2.31%
Notional equity beta	0.69–0.76

	Oxera estimates
Total market return	7.0–7.5%
Cost of equity range	**5.53–6.25%**
Cost of equity point estimate	**6.25%**

Note: Cut-off date of 31 January 2025.
Source: Oxera analysis.

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