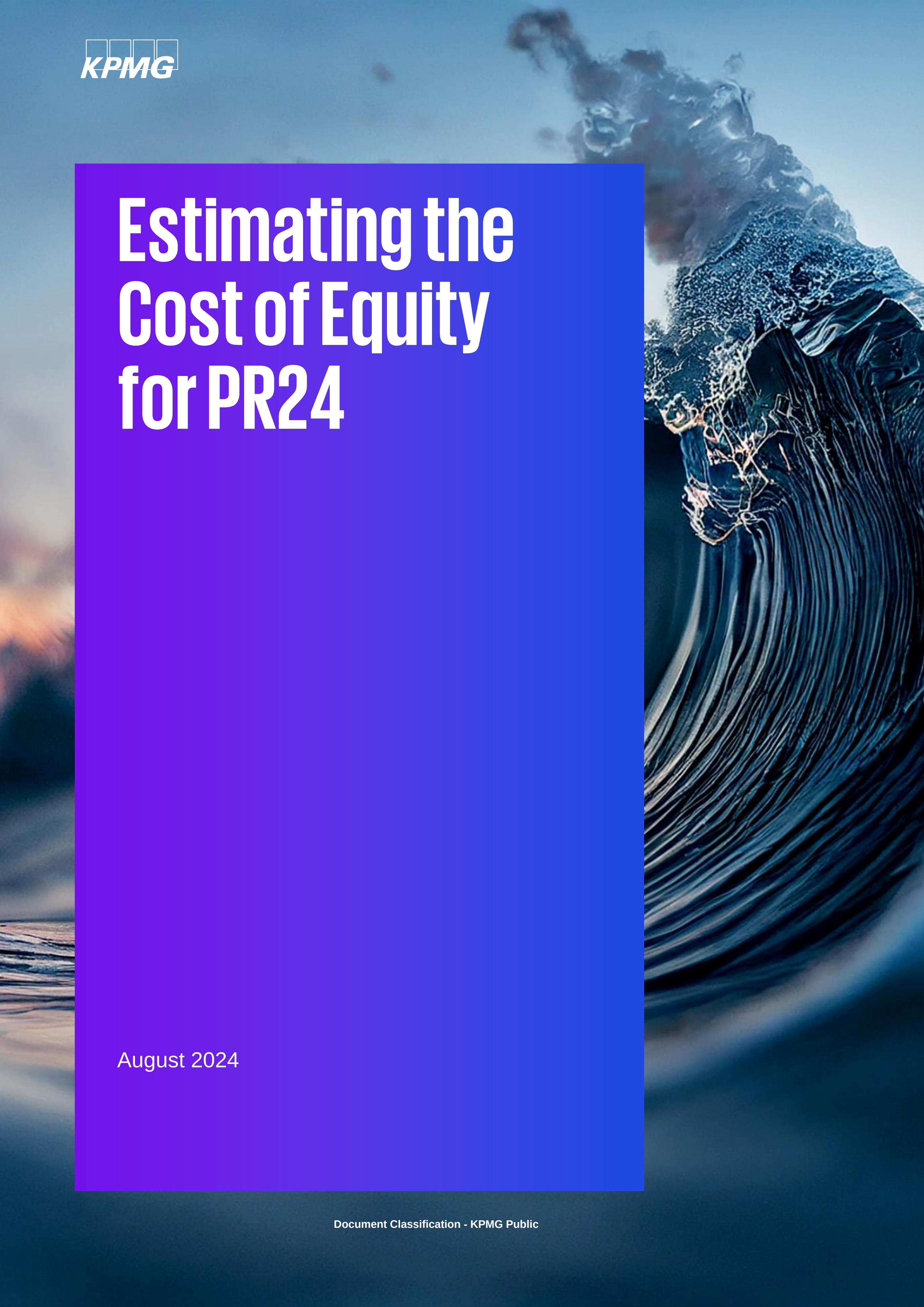

Estimating the Cost of Equity for PR24

August 2024

Contents

1. Important notice

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The group of companies commissioned this work to assist in their considerations regarding the Water Services Regulation Authority (Ofwat)’s PR24 Draft Determination (DD) on the cost of equity. Ofwat published the DD on 11th July 2024.

The agreed scope of work is included in section 3.2 of this Report. The group of companies should note that our findings do not constitute recommendations as to whether or not the group of companies should proceed with any particular course of action.

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2. Executive summary

On July 11th, 2024, Ofwat published the Draft Determination (DD) for the PR24 price control which covers the period from April 2025 to March 2030.

PR24 poses significant new challenges for the sector, with unprecedented levels of mandated investment, increasing delivery and performance risk, higher borrowing costs than experienced over the past decade and strong competition for investor capital across infrastructure asset classes. These factors underscore the importance of the PR24 cost of equity (CoE) as a mechanism to attract and retain equity capital within the sector.

The DD CoE has increased by 66bps relative to the Final Methodology (FM). Approximately half of this movement is driven by methodological changes to the TMR and an aiming up adjustment to support investability, given the market perception of higher risk for the sector[1].

Market commentary from rating agencies and equity analysts has highlighted a mismatch between risk and return based on the PR24 DD. While the DD includes a higher CoE and new regulatory mechanisms designed to mitigate risk, it also introduces a significant challenge on Totex, more demanding operational performance targets and stronger incentive rates.

At the same time, water companies based on the DD will have a lower CoE compared to the provisional CoE for RIIO-3. The lower CoE estimate for water juxtaposes with the market perception of risk for this sector. Barclays for example notes that "*Ofwat sees water as a lower-risk asset than other regulated assets. We do not see evidence of this, nor do investors*"[2]. An additional consideration for the relative attractiveness of equity investment in the sector continues to be the proximity to the return available on debt, which carries significantly lower risk.

These factors, if not addressed, could deter equity investors from the water sector. In this context, it is important to consider the appropriate principles for setting an evidence-based, balanced and risk-reflective allowance for the CoE to attract and retain equity investment in the sector in a highly competitive environment.

2.1. Risk-free rate

The starting point for the risk-free rate is 1m trailing average of 20Y RPI index-linked gilt (ILG) yields.

The risk-free rate for the CAPM is likely to lie above the ILG yield because (1) investors cannot borrow at the ILG yield; and (2) ILGs benefit from the convenience yield (CY).

In relation to (1):

The standard CAPM assumes that investors can borrow and save at the same risk-free rate. However, in the real world, the risk-free borrowing rate (r_b) is higher than the risk-free saving rate (r_s). In this case, the risk-free rate for the CAPM lies between the two rates as per Brennan (1971).

The CMA viewed its PR19 FD as an application of Brennan (1971). In particular, the CMA used the ILG yield as an estimate for r_s and the AAA corporate bond yield as an estimate for r_b.

Ofwat has not recognised (1) in the DD although this was the key rationale for the CMA's PR19 FD.

In relation to (2):

CY is explored across two steps.

First, assume as a simple benchmark that investors can borrow and save at the same risk-free rate.

ILGs like other government bonds provide additional benefits to investors (such as their superior collateral value vs other safe assets) which push their yield below the risk-free rate. The difference is CY. In consequence, CY(ILG) must be added to the ILG yield to obtain the risk-free rate.

[1] The remainder of the upwards change relates to movements in market data.
[2] Barclays (2024), Breaking the water cycle – no longer, so positive, p.64.

Second, now consider the more realistic case that investors' r_b exceeds their r_s. Specifically, r_s is equal to the common risk-free rate in the previous world but r_b increases. In this case:

- r_s remains ILG yield *plus* CY(ILG)
- r_b now becomes ILG yield *plus* CY(ILG) *plus* borrowing costs

This estimate for r_s more directly takes account of CY than the CMA's estimate. The CMA's estimate for r_b is the best possible estimate that exists but is conservative. The CMA's estimate of r_b can be expressed as ILG yield *plus* difference in yield between AAA bonds and ILGs (AAA-ILG difference).

Quantification of CY(ILG) and AAA-ILG difference:

The lower bound adjustment required to ILGs is based on CY(ILG) and the upper bound adjustment is based on the AAA-ILG difference.

The AAA-ILG difference is estimated directly based on the difference in yield between RPI AAA bonds and ILGs. This produces an estimate of 67bps.

2Y CY(ILG) is based on (1) estimate of CY for 2Y nominal gilts (NGs) in academic literature; and (2) analysis aiming to estimate the equivalent 2Y CY(ILG) from the academic literature estimate of 2Y CY(NG). The result is a range of 2-29bps. The midpoint of 15.5bps is selected as the point estimate. This recognises that the drivers of CY apply similarly to NG/ILGs but NGs may be more liquid.

Ofwat challenged in the DD whether estimates of CY at shorter tenors could hold at longer tenors. The empirical and qualitative evidence suggests this is reasonable. Further, the cross-check for CY(ILG) based on >10Y RPI AAA bonds implies a significantly higher value than 15.5bps.

Range and point estimate for the risk-free rate:

A range of 0-67bps is adopted for the adjustment required to ILGs. The upper bound position of 67bps is based on the AAA-ILG difference. The lower bound position of 0bps assumes no CY(ILG) is required, but this is not used to inform the point estimate for the adjustment to ILGs.

The point estimate of 41bps is below the midpoint of 15.5bps (point estimate for CY(ILG)) and 67bps.

The 1m trailing average of 20Y ILG yields over June 2024 is 1.21%. This implies a range for the risk-free rate of 1.21%-1.88% with a point estimate of 1.62% in RPI terms.

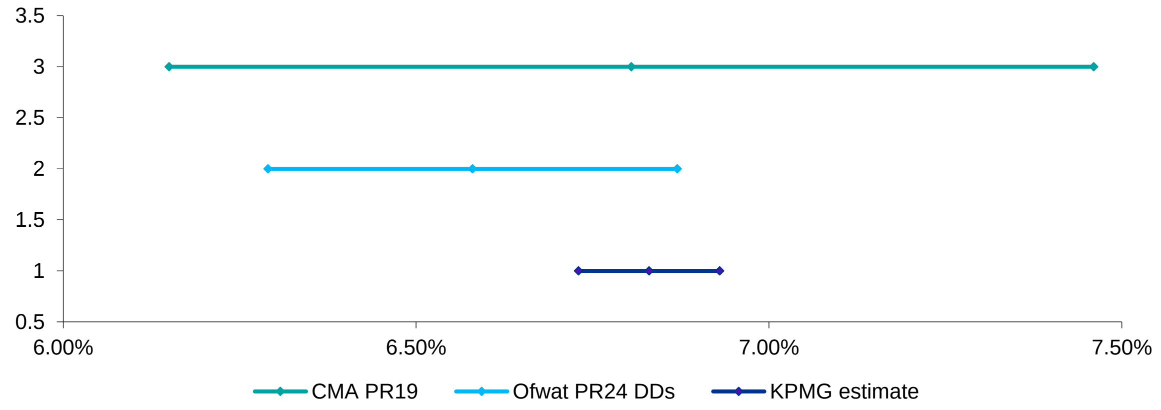
Adopting Ofwat's RPI-CPIH wedge of 0.34% results in an overall range for the risk-free rate of 1.55%-2.22% with a point estimate of 1.96% in CPIH terms.

2.2. TMR

The TMR range in this Report is based on historical ex post and ex ante approaches. The historical ex post estimate informs the upper end of the range (6.93%) and the ex ante estimate the lower end of range (6.75%). The resulting midpoint of 6.84% closely aligns with the CMA's PR19 estimate of 6.81%[3], reflecting the standard regulatory assumption that the TMR is relatively stable, and estimates developed in quick succession should be consistent. By contrast, the PR24 DD estimate is 23bps lower than the CMA's.

3 CMA (2021), PR19 Final Determination, Table 7.

Figure 1: The KPMG TMR Range compared to CMA PR19 and PR24 DDs



Source: KPMG analysis

The KPMG estimate is fully encompassed within the CMA's PR19 range. The significant narrowing of the range is driven primarily by (1) the use of new data from DMS 2024 for ex ante approaches, which was not available to the CMA and (2) the movement in market data since the CMA's final decision.

The difference between TMR estimates in this Report and PR24 DD is mainly attributable to the ex ante estimate. In this Report it is derived as the midpoint of the range based on (1) the DMS decompositional approach (6.82%) and (2) the Fama-French dividend discount model (6.68%). The use of these approaches aligns with the PR24 DD and the CMA's PR19 methodology, though analytical improvements have been made to enhance the robustness of the estimates, as summarised in the table below.

Table 1: Ex ante estimates

Approach	Analytical Improvements	Impact versus the DD
DMS Decompositional	The Report calculates the estimate directly in CPIH terms using the new date from DMS 2024. This is a more precise approach that eliminates the need for judgmental adjustments to account for the differences in the inflation measures used by DMS and Ofwat[4].	An increase of 24bps.
Fama-French DGM	This Report substitutes the Barclays Equity and Gilt Study (BEGS) data with the new data from DMS 2024. The BEGS data has widely recognised shortcomings and is not appropriate for use in a regulatory setting. DMS 2024 is a clearly superior dataset which now includes previously unavailable information.	An increase of 68bps.

Source: KPMG analysis

The historical ex post estimate is derived as the simple 1-year arithmetic average as (1) there is no statistically significant evidence of serial correlation and (2) both investor and capital budgeter perspectives are relevant which requires the estimation of a neutral TMR in the form of the long-run arithmetic average. The resulting estimate of 6.93% is slightly higher than the PR24 DD point estimate of 6.87%.

[4] The published Decompositional approach values in Table 12 of DMS 2024 are in CPI-real terms based on the DMS' own series, which uses COLI in earlier years. COLI is a lower quality data series that overstates real values. Regulators historically applied a downwards COLI-CED adjustment to account for the lower quality of the COLI series. Expressing returns directly in CPIH terms eliminates the need for this adjustment and also suggests that the 35bps DD adjustment is likely overstated by 25bps.

2.3. Beta

An overall unlevered beta range of 0.28 to 0.35 is adopted in this Report. This estimate is underpinned by the principles that (1) the purpose of beta assessment is to appropriately capture the systematic risks expected by investors in the long-run, and (2) in a dynamic risk environment, betas based on historical data will not necessarily be the most appropriate guide to the assessment of forward-looking risk.

Treatment of distortive events

The impact of distortions from Covid-19 and the Russia-Ukraine war on estimates that inform the DD range is material.

Ofwat considers that Covid19 is an "*uninfluential factor*", however the table below indicates that this position is not consistent with the empirical data. The use of rolling averages in the DD amplifies the weight assigned to the data from this period and understates long-run systematic risk.

Table 2: Impact of distortions due to Covid19 and Russia-Ukraine war

Timeframe	Spot	1-year average	2-year average	5-year average
2-year	-0.02 (-7%)	-0.03 (-10%)	-0.04 (-16%)	-0.07 (-22%)
5-year	-0.06 (-19%)	-0.07 (-21%)	-0.08 (-23%)	-0.03 (-10%)
10-year[5]	0.01 (+3%)	0.03 (+10%)	0.02 (+7%)	-0.00 (-2%)

Source: KPMG analysis using Refinitiv Eikon and Refinitiv Datastream data.

The reduction in water company betas was driven by a decrease in the volatility ratio between SVT/UUW and FTSE All Share returns due to the flight-to-safety effect. This reflects the defensive nature of water company stocks whose returns fluctuate less than the overall market during periods of stress. The sustained increase of 2-year betas – which are now above 5-year and 10-year estimates – suggests that at a minimum there has been a reversal of these distortions ahead of AMP8.

Methods designed to address the impact of such distortive events indicate that unlevered beta estimates below 0.28, based on SVT/UUW data, would not be appropriate. By contrast, Ofwat has adopted 0.26 as the lower bound of the PR24 DD range.

Treatment of forward-looking risk

PR24 capital programmes continue to imply increasing risk exposure for companies even after accounting for new risk mitigations introduced in the PR24 DD. This increase is not yet reflected in beta estimates, which lag in capturing the impact on share prices and total returns due to their reliance on historical data.

Analysis of non-financial UK stocks within the FTSE 350 reveals a positive and statistically significant relationship between capital intensity and beta. The analysis of the risk exposure implied by the PR24 DD Totex using KPMG's stochastic risk model also finds that there is a material increase in Totex risk relative to PR19 after accounting for new risk mitigations. Consequently, beta estimates based on historical data for listed water companies are unlikely to fully account for forward-looking risks. Additional comparators and cross-checks are necessary to accurately capture and price these forward-looking systematic risks.

Selection of comparators

Additional data from PNN is both valuable and relevant for estimating the PR24 beta, as SVT and UUW represent only a subset of the industry whose betas embed historical outperformance that is not representative of the notional company. To account for the limitations inherent in the PNN data, PNN has been excluded from determining the lower bound of the beta range in this Report.

Incorporating NG at the higher end of the beta range could better capture the forward-looking risk exposure for the water sector because (1) the regulatory frameworks for the two sectors are relatively

[5] The observed increase in 10-year betas is likely driven by the relatively lower betas before the regime change at PR14 being assigned less weight relative to 2020. Refer to section 8 of the September 2023 report.

similar, (2) NG's historical RCV growth aligns more closely with the growth anticipated for water, and (3) empirical evidence indicates that the market is pricing higher risk for water relative to energy.

The estimate adopted in this Report and the basis of its derivation are set out in the table below.

Table 3: Overall unlevered beta range for PR24

		Lower bound	Upper bound
Business-as-usual (BAU) beta	Basis of estimation	• SVT/UUW betas estimated based on a replication of the CMA PR19 approach for mitigating the impact of distortive events[6]. • This is cross-checked against a re-weighting approach that assumes that a distortive event which is similar in impact to the pandemic and war, would affect 1, 2 or 3 out of 20 years[7].	• The upper bound adjusted to include the impact of PNN based on the difference between 2-year betas for SVT/UUW/PNN and SVT/UUW.
	Estimate	0.28	0.33
Forward-looking beta	Basis of estimation		• NG beta estimated based on a replication of the CMA PR19 approach for mitigating the impact of distortive events. • Cross-checked against evidence from: (1) the relationship between capital intensity and beta based on FTSE 350 excluding financials, and (2) translating the impact of the increasing capex intensity on RoRE range to equity beta.
	Estimate		0.35
Overall range		0.28	0.35

Source: KPMG analysis

The overall beta range of 0.28 to 0.35 adopted in this Report (1) substantially mitigates the impact of transient distortive factors and (2) takes into account – at the upper end of the range – the likely increase in systematic risk going forwards.

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6 At PR19, the CMA limited the weight assigned to estimates affected by distortions (i.e. December 2020 cut-off) by setting a range that encompassed the upper end of the estimates (spot, 1-, 2- and 5-year averages of 2-, 5- and 10-year betas) to December 2020 and the full range of that to February 2020. This approach is replicated in this Report using daily beta estimates for the same estimation and averaging windows and based on cut-offs of February 2020 and June 2024.

7 This analysis differs from that included in the September 2023 report. That report effectively assumed that a distortive event would affect 2 years out of 20; this Report assumes that 1, 2, or 3 years would be affected. The September 2023 report also did not take into account data after the start of Russia-Ukraine war in February 2022. This Report calculates distorted betas as of mid-December 2023.

2.5. Notional gearing

The assumed reduction in notional gearing from 60% to 55% at PR24 is not supported by robust market evidence and corporate or regulatory finance principles. In consequence, this Report adopts notional gearing of 60%.

- Notional gearing of 55% sits materially below the average for the water sector. All else equal, this suggests that 55% gearing is below efficient market levels.
- A lower level of notional gearing has been assumed to support financial resilience. However, assuming a lower notional gearing cannot improve the notional company's overall financial position if business risk has increased – assuming lower gearing in practice reallocates risk from debt to equity. Where there is a marked increase in business risk on a forward-looking basis, the efficient market outcome would be a higher return to price in changes in risk (as reflected in the beta estimates in this Report).
- The DD assessment of issues affecting gearing during AMP7 omits relevant factors that exert upwards pressure on gearing, such as AMP7 operational performance across the sector. Observed gearing in the sector has not reduced from the beginning of AMP7.

2.6. Retail margin adjustment

The DD incorporates a 6bps deduction to the appointee WACC in the form of a retail margin adjustment (RMA) to prevent double counting of compensation for the systematic risk of the retail business, given the provision of a separate retail margin.

The calculation of the RMA is underpinned by several flawed assumptions.

First, it assumes that the risk of the retail business exceeds that of the wholesale business and that the retail margin adequately compensates for these additional risks. However, the validity of this assumption is not substantiated by the DD, which does not benchmark the retail margin against a holistic analysis of retail risks.

Second, the assumption that retail creditor balance is entirely comprised of trade creditors drives half of the DD adjustment but does not hold in practice as c.90% of the creditor balance is intercompany based on DD financial models.

Third, the adjustment relies on a working capital financing rate below the appointee cost of new debt. There is a high degree of variation in working capital rates among different companies, suggesting different derivation bases. Moreover, for integrated wholesale-retail businesses, financing for retail working capital is often indistinguishable from the overall debt portfolio. As such the use of the notional cost of new debt is appropriate.

Using the appropriate working capital balance and financing rate reduces the adjustment to less than 1bp. In consequence, this Report does not apply an RMA.

2.7. Cross-checks

The purpose of cross-checks is to increase the reliability and robustness of the CoE estimate derived based on the CAPM. Cross-checks are inherently subject to limitations and require careful and systematic selection to ensure effectiveness.

Criteria for evaluation of cross-checks

The primary criteria used to assess cross-checks in this Report are whether they are transparent, targeted, objective, and unbiased and consistent with established academic research. The assessment against these criteria indicates that multi-factor models (MFMs) and inference analysis represent balanced cross-checks, as they are targeted, unbiased, and grounded in academic research. In contrast, the DD's sole cross-check, MAR, is not targeted, heavily reliant on assumptions and can result in a wide range of outcomes.

The MAR cross-check did not receive systematic evaluation in the DD. In contrast, the MFM evidence has been evaluated based on stringent criteria that are inconsistent with its intended role as a cross-check rather than a primary model for estimation of returns. Applying different criteria and hurdles to different cross-checks risks introducing bias and omission of relevant evidence for cross-checking returns. To ensure a comprehensive and objective assessment, criteria should be applied consistently to all cross-checks.

Ofwat commentary on MFMs

The commentary from Ofwat's advisers does not provide sufficient and robust grounds for the exclusion of MFMs from the suite of cross-checks at PR24 FD. The evaluation has significant shortcomings, including mischaracterisations of the analysis, flawed statistical testing methods that deviate from established academic approaches, and the dismissal of robust statistical testing evidence included in the original MFM report.

Established statistical tests confirm the q-factor model's superior performance relative to the CAPM. Enhancements to the MFM analysis have increased the sample size and improved statistical test results, with two out of three additional factors now individually statistically significant.

Based on June 2024 cut-off, the q-factor model yields a CoE 0.71 – 2.21% higher than the CAPM.

Ofwat commentary on inference analysis

The evaluation of inference analysis by Ofwat's advisers has significant shortcomings and does not provide sufficient and robust grounds for its exclusion from the suite of cross-checks in the FD. These include mischaracterisation of the conceptual and analytical foundations of inference analysis, as well as flawed statistical testing methods.

Inference analysis is an asset pricing model that estimates the expected return on equity based on a relative pricing approach. This method derives asset returns based on the prices of other assets, specifically the cost of debt and the ratio of return on equity to the return on debt (i.e. elasticity).

Following the analytical approach developed by Campello, Chen, and Zhang (CCZ), inference analysis uses elasticity to estimate expected equity returns for water stocks. This estimate is then used as a cross-check for the regulatory CoE.

Inference analysis indicates that the CAPM-derived CoE based on the PR24 DD methodology as of June 2024 is c.153bps below the lower bound of the inferred CoE range.

Market-based cross-checks

The Report also considers market-based cross-checks typically used by regulators like Ofwat and Ofgem indicate that the expected market return has significantly increased by 115 – 282bps relative to equivalent figures in 2019. These approaches, although reliant on and sensitive to assumptions, can provide a directional signal on the evolution of expected market return.

2.8. Selection of a point estimate

This Report adopts a range of 15 – 75bps as the required adjustment to the midpoint of the CAPM-CoE range to address parameter uncertainty and to support investability in current market conditions.

- The lower bound represents the minimum required to avoid disincentivising high levels of investment projected for AMP8 and beyond in the context of parameter uncertainty, in line with the CMA's decision at PR19.
- The upper bound reflects (1) the *de minimis* adjustment required to address the underestimation of systematic risk in water stocks by the CAPM, as evidenced by multi-factor model analysis (70bps) and (2) other contemporaneous cross-checks.

Table : Implications of cross-check evidence for the selection of a point estimate

Approach	Implications of the cross-check evidence
Multi-factor models	The point estimate for the allowed CoE for PR24 should be 0.71 – 2.21% higher than the midpoint of the CAPM-derived CoE range to address the structural underestimation of systematic risk for water companies by the CAPM. MFM evidence is assigned the most weight in the calibration of the aiming up adjustment as the q-factor model has stronger explanatory power than the CAPM.
Inference analysis	The CAPM-derived CoE in this Report (midpoint, pre-aiming up) is at least 66bps lower than would be expected relative to the current market pricing of debt in the sector and the relationship between debt and equity pricing. As equity is riskier than debt, the expected return on equity needs to be substantively above the expected return on debt of the same company, as otherwise an investor is unlikely to be incentivised to invest in equity.
Market-based cross-checks	A range of market-based cross-checks, which consider contemporaneous market evidence, indicates that expected market return has significantly increased relative to PR19. This includes a DDM, equity analyst reports, survey evidence and infrastructure fund discount rates. When combined with midpoint CAPM parameters in this Report, the observed evolution of expected market return relative to 2019 suggests upward pressure on CAPM-derived CoE, ranging from 56 to 170bps.

Source: KPMG analysis

The Report adopts the midpoint of the implied aiming up range of 45bps but notes that it may be necessary to increase the point estimate to at least the upper end of the aiming up range to support investability.

This Report does not aim up to reflect asymmetric risk exposure. Where companies identify the presence of expected loss or negative skewness, they should apply an adjustment when selecting a point estimate from the CoE range implied by the analysis in this Report.

2.9. CoE estimate for PR24

The table below summarises the estimated range for the required CoE at PR24. This range reflects:

- An estimate of the market-based CoE based on a balanced evaluation of current market data, academic literature, and relevant regulatory precedent; and
- The uplift required to reflect cross-check evidence and attract and retain equity capital, given high levels of investment projected for AMP8 and beyond.

The CoE range below is presented pre and post aiming up. On a 60% gearing basis – i.e. reflecting the notional gearing assumption adopted in this Report – the CoE range is 5.16 – 6.11% pre aiming up, and 5.31 – 6.86% post aiming up.

The CoE estimate is also presented on a 55% notional gearing basis to enable like-for-like comparison with the DD estimate. This implies a CoE range of 4.82 – 5.73% pre aiming up and 4.97 – 6.48% post aiming up.

Table 4: PR24 CoE range based on parameter-level estimates, with aiming up included

Parameter (CPIH)	KPMG (Jun 2024) 55% gearing Lower bound	KPMG (Jun 2024) 55% gearing Upper bound	KPMG (Jun 2024) 60% gearing Lower bound	KPMG (Jun 2024) 60% gearing Upper bound
Notional gearing	55%	55%	60%	60%
TMR	6.75%	6.93%	6.75%	6.93%
RFR	1.55%	2.22%	1.55%	2.22%
Unlevered beta	0.28	0.35	0.28	0.35
Debt beta	0.10	0.10	0.10	0.10
Observed gearing	53.74%	43.72%	53.74%	43.72%
Asset beta	0.34	0.39	0.34	0.39
Notional equity beta	0.63	0.74	0.70	0.83
Coe before aiming up, appointee	4.82%	5.73%	5.16%	6.11%
Aiming up	0.15%	0.75%	0.15%	0.75%
CoE, appointee	4.97%	6.48%	5.31%	6.86%
RMA	0.00%	0.00%	0.00%	0.00%
CoE, wholesale	4.97%	6.48%	5.31%	6.86%

Source: KPMG analysis

The point estimate for CoE is 6.12% on a 60% notional gearing basis, incorporating aiming up of 45bps relative to the midpoint. The point estimate on a 55% notional gearing basis is 5.76% which compares to the DD estimate of 4.71% (updated for June 2024 cut-off).

Table 5: Point estimates of PR24 CoE

Parameter (CPIH)	KPMG (Jun 2024) 55% gearing	KPMG (Jun 2024) 60% gearing	Ofwat DD (Jun 2024) Point estimate
Notional gearing	55%	60%	55%
TMR	6.84%	6.84%	6.58%
RFR	1.96%	1.96%	1.55%
Unlevered beta	0.32	0.32	0.27
Debt beta	0.10	0.10	0.10
Observed gearing	48.73%	48.73%	52.91%
Asset beta	0.36	0.36	0.33
Notional equity beta	0.69	0.76	0.60
Coe before aiming up, appointee	5.31%	5.67%	4.57%
Aiming up	0.45%	0.45%	0.28%
CoE, appointee	5.76%	6.12%	4.85%
RMA	0.00%	0.00%	0.13%
CoE, wholesale	5.76%	6.12%	4.71%

Source: KPMG analysis

The CoE estimate derived in this Report is consistent with several principles implied by the CMA's determination of the allowed CoE at PR19, supporting consistency with the outcomes of previous price control whilst recognising the new challenges faced by the sector.

3. Context and scope

3.1. Context

On July 11th, 2024, Ofwat published the Draft Determination (DD) for the PR24 price control which covers the period from April 2025 to March 2030. Ofwat has set an allowed appointee cost of equity (CoE) of 4.80% CPIH-real, based on a March 2024 cut-off and 55% notional gearing. This represents a 66bps increase from the Final Methodology (FM), with approximately half of the movement driven by methodological changes to the TMR and an aiming up adjustment to support investment in the sector[8].

For the PR24 price control, two key themes will shape the context in which water companies must deliver their plans.

First, the upcoming price control will represent a material shift in the operating and financing environment for water companies, leading to a significant increase the risk borne by companies and their investors. AMP8 will see all water companies experience a step-change in risk exposure, driven by a significant ramp-up in capital programmes which are increasing in scale and complexity. Capital programmes also entail significant deliverability pressures, many of which are beyond the direct control of companies, coupled with challenging efficiency targets.

At the same time, the design of the regulatory framework for AMP8 will make PR24 the most challenging price control to date, with companies facing more stringent incentives, stricter ODIs and tougher targets. Moreover, the increased risk exposure that companies will bear is expected to be enduring, extending beyond AMP8, and impacting multiple future price controls.

Market commentators have highlighted a mismatch between risk and return based on the PR24 DD:

- Moody's notes that the risk of cost overruns, future underperformance and the risk of incurring penalties have increased and that "*the draft [determination] also increases the risk that sector returns may not be enough to attract the equity funding the companies need to support increasing investment*"[9].
- JPM suggests that "*in PR24, Ofwat must balance its conservative approach to setting returns with evidence of rising UK water sector risks* ***and the need to sustainably attract debt & equity capital to the sector***"[10] and that "*Ofwat recognises the financial challenges that the sector faces in AMP8 but believes balance sheets can be stabilised by raising equity and/or limiting dividends****. We are less optimistic and expect low equity investor appetite for UK water companies post the DDs***"[11].

Second, for the first time since privatisation water companies will need to attract significant amounts of new equity capital to finance critical investments and to be financeable throughout AMP8. The regulatory CoE needs to be sufficient to provide incentives for firms and their investors to meet investment requirements, as recognised by the CMA at PR19[12]. Attracting new equity will require investment appraisals to yield positive results and for the investment proposition to be sufficiently competitive relative to both other forms of capital investment and other equity investment opportunities. In other words, the cost of capital (and the price control as a whole) must represent an investable proposition.

In the PR24 DD, Ofwat notes that investor sentiment for the sector is currently low and acknowledges that it is important that "*determinations are seen to support investment and investor confidence at a time when all companies (whether good or poor performers) are expected to continue to raise record levels of debt and equity finance, while competing with other sectors and internationally for the*

8 The remainder of the upwards change relates to movements in market data.
9 Moody's (2024), Ofwat's draft determination increases sector risk, p.8.
10 J.P.Morgan (2024), What a Week for UK Water!, p.2.
11 Ibid., p.1.
12 CMA (2021), PR19 Final Determination, para. 9.1236.

allocation of that capital"[13]. At this stage, Ofwat has not carried an assessment of investability which would considers whether the water sector can successfully compete for investment in a highly competitive market based on the DD.

Ofgem meanwhile, in its recent Ofgem's Sector Specific Methodology Decision (SSMD), characterises the allowed return on equity as "*[the] return required to attract and retain sufficient equity capital"*[14]. The SSMD sets out initial commentary on the importance of assessing investability of the RIIO-3 price controls and how attractive the investment opportunity in energy networks is relative to other options.

The PR24 CoE estimate is lower than the equivalent figure in the SSMD[15] by 34 bps (based on 60% gearing), with the difference primarily driven by the TMR estimate and Ofgem's provisional[16] inclusion of European comparators, which significantly increases the upper end of the range. This is partially offset by Ofwat aiming up in the selection of the point estimate.

The lower CoE estimate for water juxtaposes with the market perception of risk for this sector.

- Barclays notes that "*Ofwat sees water as a lower-risk asset than other regulated assets. We do not see evidence of this, nor do investors*"[17].
- Moody's meanwhile notes that "*the lower cost of equity allowance for water companies* [relative to energy networks] *implies that the overall risk should be lower in the water sector. However, the water companies in England and Wales face heightened public and political attention, and tougher performance incentives may prevent them from achieving the allowed returns*"[18].

As a result, investors looking to deploy capital in regulated utilities may elect to pivot towards energy rather than water.

A key consideration for the relative attractiveness of equity investment in the sector continues to be the proximity to the return available on debt, which carries significantly lower risk. Market commentary from both debt and equity perspectives has highlighted the convergence between debt and equity pricing and its misalignment with market expectations:

- "*Based on the proposed parameters, the cost of equity allowance provides a slightly better buffer to the cost of new debt allowance than the early view estimate. However it still indicates **a rather low equity premium to attract new funding in a higher interest rate [environment]**"*[19]**.**
- "[The] C*ost of equity allowed by Ofwat looks low vs. debt – currently debt returns are c.6.0% nominal. We would note that recent debt issuances from Severn Trent and Pennon were at 155bps (29 July) and 185bps (29 July) over risk-free. Risk-free is 4.3-4.5% leading to a return on debt of 5.875% in Severn Trent (14 years tenor) and 6.375% in Pennon (17 years). With a CPIH of c.2% this is a real cost of debt of c.4% real, only 80bps less than the proposed discount rate of equity. **We see this spread as too thin**"*[20].

The current debt-to-equity spread is unlikely to reflect the additional risks borne by equity holders, and all else equal could discourage equity investors from committing capital to the sector.

These factors, combined with the significant increase in market rates, would be expected to exert upwards pressure on allowed CoE relative to the CMA's estimate for PR19. In this context, it is important to consider the appropriate principles for setting an evidence-based, balanced and risk-reflective allowance for the CoE to attract and retain equity investment in the sector.

[13] Ofwat (2024), PR24 Draft Determination, Aligning risk and return – Allowed return appendix, p. 74.
[14] Ofgem (2024), RIIO-3 Sector Specific Methodology Decision – Finance Annex, para. 3.1.
[15] Ofgem (2024), RIIO-3 Sector Specific Methodology Decision – Finance Annex, Table 12, para. 3.227.
[16] Ofgem "*retain the flexibility to weight comparator data in the way that* [it] *think*[s] *is appropriate, and may not pick the midpoint of the range".*
[17] Barclays (2024), Breaking the water cycle – no longer, so positive, p.64.
[18] Moody's (2024), Ofwat's draft determination increases sector risk, p.8.
[19] Moody's (2024), Ofwat's draft determination increases sector risk, p.7.
[20] Barclays (2024), Breaking the water cycle – no longer so positive. P.61.

This Report therefore explores academic literature, relevant regulatory precedent, and market evidence to estimate returns required to attract and retain the required equity investment in the context of a significant increase in capital programmes and overall risk in the sector.

3.2. Scope and structure of the Report

KPMG has been engaged by a group of water companies to develop a risk-reflective estimate of the regulatory CoE for PR24. This estimate is based on relevant financial literature, regulatory principles, and the latest market data, and considers the implications of the evidence and estimates presented in the PR24 DD.

The Report derives the CoE estimate for PR24 based on following steps:

- First, it develops an estimated range for each CoE parameter using methodologies that are well-supported by financial literature, regulatory precedent, and current market evidence. It considers the implications of the evidence and estimates for each parameter provided in the DD. Where the Report identifies that the DD approach has been unbalanced or inconsistent with relevant and robust evidence, it includes commentary to shed light on the reasons behind these findings (sections 4, 5, 6).
- Second, it considers the appropriate assumptions for notional gearing (section 7) and the retail margin adjustment (section 8).
- Third, it considers the implications of the evidence from cross-checks that can increase the accuracy of the CoE assessment (section 9).
- Fourth, it sets out the framework for the selection of the point estimate of CoE (section 10) and comments on the appropriate risk-reflective point estimate for the allowed return on equity for PR24.
- Fifth, it analyses the technical findings and commentary from Ofwat and its advisors in relation to the muti-factor model (MFM) and inference analysis cross-check evidence submitted over the course of the PR24 price review process (section 11).

3.3. Authors

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Professor Gregory was a member of the CC’s cost of capital panel from 2009 to 2017 and continues to provide advice to the Competition and Markets Authority (CMA). In addition to more than thirty papers in peer-reviewed academic journals, he has contributed to an OECD Roundtable publication on Excessive Prices and is the author of the Financial Times book ‘Strategic Valuation of Companies’.

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Professor Edmans' book, Grow the Pie: How Great Companies Deliver Both Purpose and Profit, was featured in the Financial Times Best Business Books of 2020 and won the Financial Times award for Excellence in Sustainable Finance Education. He is a co-author of the 14th edition of Principles of Corporate Finance (with Brealey, Myers, and Allen). The UK government appointed him to conduct one study on the alleged misuse of share buybacks and a second one the link between executive pay and investment.

4. Risk-free rate

The risk-free rate in the CAPM represents the rate of return expected by investors for holding a risk-free asset, i.e. an asset with zero risk. This section is structured as follows:

1 It sets out Ofwat's approach to and estimate of the risk-free rate.

2 It evaluates Ofwat's starting point for the risk-free rate based on gilt yields.

3 It considers the impact of differing risk-free borrowing and saving rates.

4 It considers the impact of the convenience yield.

5 It considers whether an adjustment to gilt yields is required and different approaches for quantifying the adjustment.

6 It evaluates Ofwat's estimate of the RPI-CPIH wedge.

7 It sets out the overall estimate for the risk-free rate.

4.1. Ofwat's approach to and estimate of the risk-free rate

Ofwat set a point estimate for the risk-free rate in the PR24 DD of 1.43% CPIH-real. This point estimate is based on the approach set out in the table below.

Table 6: Ofwat's approach to risk-free rate

Component	Approach
Risk-free rate proxy	Yields on RPI index-linked gilts (ILGs)
Tenor	20Y
Cross-checks	Ofwat considers yields on 20Y ILGs, 20Y nominal gilts (NGs), 20Y SONIA swaps and the CMA PR19 AAA index, but observes only SONIA swaps point to a significantly different (lower) estimate. Ofwat does not rely on SONIA swaps as (1) swap rate is less intuitively interpreted than other risk-free rate proxies as an investment return; and (2) large negative swap spreads at 20Y tenor may be due to pension funds buying swaps to increase portfolio duration rather than to increase their weighting of risk-free assets
Averaging period	1m average of 20Y ILG yields using data over March 2024
Adjustments	No adjustments have been applied to 20Y ILG yields
RPI-CPIH wedge	0.34% based on the 20Y RPI-CPI wedge implied by inflation swaps and OBR forecasts. This wedge is applied to 20Y ILG yields to convert from an RPI to a CPIH basis

Source: KPMG analysis and PR24 DD

4.2. ILG yields as a starting point for the risk-free rate

Ofwat's starting point for the risk-free rate is the 1m average of 20Y ILG yields. Ofwat considers the use of 20Y ILG yields may be conservative as (1) 20Y ILGs are not truly risk-free; and (2) Ofwat has solely used 20Y ILGs instead of placing weight on 10Y and 20Y ILGs. On (1), investors generally perceive gilts as risk-free and this was reaffirmed by the CMA at PR19. On (2), the CMA at PR19 used 20Y ILGs as this matched the long asset lives in the sector which holds true at AMP8 based on Ofwat's DD average run-off rate (4% which implies 25Y remaining asset life). The use of a 1m average should be revisited at FD based on prevailing and expected market conditions at that time.

This section considers whether Ofwat's starting point for the risk-free rate is appropriate.

4.2.1. Risk-free rate proxy and tenor

Ofwat's starting point for the risk-free rate is the yield on 20Y ILGs. Ofwat identifies two reasons for why this may be a conservative starting point.

First, 20Y ILGs are not truly risk-free. They embed a degree of default, illiquidity and term risk which increase their yield above that of a truly risk-free asset, based on analysis from CEPA.

Second, Ofwat has solely used 20Y ILGs instead of placing equal weight on 10Y and 20Y ILGs which it considers is consistent with its PR19 FD. 20Y ILG yields are higher than an average of 10Y and 20Y ILG yields based on data over September 2022 and March 2024.

20Y ILGs are not truly risk-free

In the CAPM, an investor can invest their wealth in the market portfolio and the risk-free asset. In practice, no asset is entirely risk-free as is assumed in the CAPM. However, government bonds are investors' safest alternative to investing in the market portfolio and investors generally perceive these as risk-free. It follows that the real world equivalent of the CAPM risk-free asset is government bonds.

In consequence, to the extent that there is any small risk premium present in government bonds, this does not alter the investor choice of using government bonds like the CAPM risk-free asset. Accordingly, CEPA's points on a risk premium in government bonds are not relevant for the real world application of the CAPM as long as government bonds are the safest alternative to investing in the market portfolio. Notwithstanding this, CEPA's points are discussed below.

Default risk

CEPA suggests that UK government bonds are not completely immune to default risk because (1) the UK government does not have unlimited power to print money to cover GBP liabilities; (2) the UK government was downgraded in 2016 and 2017 to AA/Aa2 credit rating; and (3) 5Y UK credit default swaps imply a low default probability.

In theory, the UK government *does* have unlimited power to print money and there has not been a situation in the past which has called into question its power to do so. As such, it is expected that the UK government can always print money to honour its GBP liabilities and thus avoid default.

It may be possible that there is a small risk of default under extreme conditions, but this is not reflective of normal or plausible market conditions. Indeed, CEPA recognises that *"it is true that the UK government has effective recourse in the event of nearly any default…"*[21]. It appears appropriate to focus on plausible rather than non-plausible scenarios with remote likelihoods of occurring.

Importantly, the CMA at PR19 appeared to share the same view. The CMA acknowledged the UK government's credit rating downgrades, but still concluded that "*it appears clear to us* [the CMA] *that ILGs closely match part of our key requirement of the RFR, that the bonds are risk free"*[22].

This would imply that CEPA's point on default risk is not material and reaffirm that UK government bonds are an appropriate starting point for the risk-free rate.

Illiquidity risk

CEPA suggests there are plausible arguments for why government bonds may carry illiquidity risk.

The first reason outlined below shows why liquidity is not a relevant consideration in the CAPM. The last two reasons show that even if liquidity is assumed to be a relevant consideration, government bonds do not carry illiquidity risk.

First, in the CAPM investors choose stocks based only on their risk and return. As liquidity is not a factor in the investor's asset allocation decision, it is not a property of the CAPM risk-free asset.

Relatedly, Ofwat in the PR24 FM recognised estimates of the convenience yield (CY) for government bonds[23]. CY is driven by the additional benefits of government bonds beyond their risk/return trade-off i.e. beyond the properties of the CAPM risk-free asset. Liquidity is a driver of CY.

The presence of CY for government bonds means that they are more liquid than other safe assets. Put differently, they may be too liquid compared to the CAPM risk-free asset. Ofwat has implicitly agreed with this by recognising estimates of CY for government bonds.

Second, CEPA has not provided any specific arguments or evidence on illiquidity risk which means it is not possible to evaluate the reasonableness of its point.

[21] CEPA (2024), PR24 Cost of Equity, p. 50.
[22] CMA (2021), PR19 Final Determination, para. 9.103.
[23] Ofwat (2022), PR24 Final Methodology, Appendix 11 – Allowed return on capital, p. 93.

In any case, government bonds are widely considered to be the most liquid asset in the market. CEPA appears to agree with this, noting that *"gilts are likely to have higher liquidity than a comparable corporate bond"*[24]. Thus government bonds cannot be illiquid since all other assets are relatively less liquid. The implication is that government bonds cannot carry illiquidity risk.

Third, Ofwat agrees with CEPA's view of illiquidity risk but this appears to be inconsistent with its own position on CY and the view of its previous adviser. Ofwat's advisers at PR19 indicated that the bid-ask spreads on government bonds are the benchmark from which the liquidity of other assets should be measured[25]. It follows that government bonds cannot be illiquid if they represent the benchmark.

Term risk

CEPA suggests that longer-dated government bonds feature term risk. It cites two potential drivers for the term risk: (1) there is higher sensitivity to interest rate risk at longer tenors i.e. the market value of longer-dated bonds is more sensitive to changes in interest rates; and (2) this is compensation for investors who are locking up their funds for a longer horizon.

First, the CAPM assumes that investors hold the risk-free asset until its maturity. In this case, the risk-free asset is proxied by government bonds.

Government bonds provide a risk-free return over their maturity i.e. these are only risk-free when held to maturity, not when used for short-run trading. In consequence, term risk is only relevant for an investor if they sell the government bonds before maturity. This is not the case in the CAPM.

For example, interest rate risk is irrelevant for the investor as they would not be seeking to sell the government bond for its market value at any point in time. The investor has knowingly bought the (zero-coupon) bond purely for the risk-free cashflow they receive at maturity of the bond.

Second, the allowed return has been calibrated using long-dated government bonds because investors in the sector have long holding periods. This calibration assumes that investors invest in long-dated government bonds that match the duration of their long holding period.

CEPA's point around term risk implies that it would be appropriate to calibrate the return for investors with long holding periods using short-dated government bonds. This calibration, in contrast, assumes that investors continually reinvest in short-dated government bonds over their long holding period.

The latter is not convenient or efficient for investors. As a result, it is not relevant to compare the yield on longer- and shorter-dated government bonds.

Return on zero-beta asset in place of a risk-free rate

The discussion above indicates that 20Y ILGs can be used as the risk-free asset in the CAPM.

Ofwat may still consider that government bonds are not risk-free and therefore the risk-free rate cannot be identified. In this case, Ofwat should use the return on a zero-beta asset in place of the risk-free rate in the CAPM. Black (1972)[26] shows the CAPM holds with the zero-beta return. Ofwat in the PR24 FM acknowledged the possibility of using the zero-beta return in the CAPM[27].

The zero-beta asset bears no systematic risk whereas the risk-free asset bears no risk. Hence, the return on the zero-beta will be higher than the risk-free asset as the former bears idiosyncratic risk.

Di Tella et al. (2023) finds that in the US the real zero-beta return[28] is 7.6% higher than the real 1m Treasury bill return per year on average over 1973-2020[29]. It comments that *"the average level of the zero-beta rate may seem surprising. But it reflects a well-known fact, going back to Black et al. [1972], who pointed out, in the context of CAPM, that the expected return of an equity portfolio with zero covariance to the market was well in excess of Treasury bill yields"*.

[24] CEPA (2024), PR24 Cost of Equity, p. 51.
[25] CMA (2021), PR19 Final Determination, para. 9.224.
[26] Black, F. (1972), 'Capital Market Equilibrium with Restricted Borrowing'.
[27] Ofwat (2022), PR24 Final Methodology, Appendix 11 – Allowed return on capital, p. 13 and 93.
[28] The zero-beta return is not tenor-specific because equities are assumed to have a flat term structure. The implication is that the zero-beta return can be used to set the allowed return at both short and long investment horizons.
[29] Di Tella, S., Hebert, B., Kurlat, P., and Wang, Q. (2023), 'The Zero-Beta Interest Rate'.

20Y ILGs have been used instead of an average of 10Y and 20Y ILGs

Ofwat at PR19 DD used the average yield on 10Y and 20Y ILGs as a starting point for the risk-free rate at an investment horizon of 15Y. At PR19 FD, it moved to directly use the yield on 15Y ILGs[30].

The CMA at PR19 ultimately decided to use 20Y rather than 15Y ILGs as adopted by Ofwat: *"…we note the very long-life assets and long-horizon investment decisions that are likely to be based on our cost of capital estimates. As a result, we suggest that a 20-year investment horizon would closely match the reality of decision-making within the sector and so use gilt and other market data at or close to 20-year maturities. We note this horizon is longer than the 15 years used by Ofwat"*[31].

Ofwat does not provide rationale for why it could in principle be appropriate to deviate from the CMA PR19 FD and revert to its PR19 DD position. Further, the sole use of 20Y ILGs is supported by:

- Ofwat in the PR24 DD has used a run-off (depreciation) rate of 4% on average for the sector[32]. This corresponds to an average remaining asset life of 25Y for AMP8. 20Y ILGs would broadly match the duration of cashflows implied by this average remaining asset life. Indeed, they can be seen as conservative as their maturity is only 20Y rather than 25Y.
- Ofwat requires companies to plan their capex over the next 25Y through its new Long Term Delivery Strategy framework for AMP8[33]. This suggests that 20Y ILGs should be used to broadly match the reality of decision-making that Ofwat requires for the sector.
- The risk-free rate and the cost of new debt in the allowed return both provide forward-looking expectations of rates. Ofwat has used the iBoxx non-financial A/BBB 10+ index as the benchmark index for the cost of new debt. This index has a tenor close to 20Y[34]. The risk-free rate should therefore be based on 20Y ILGs to maintain consistency across the allowed return.
- Ofgem in the RIIO-3 SSMD bases its estimate of the risk-free rate on 20Y ILGs. It comments that this is in line with RIIO-2 and consistent with UKRN guidance that the maturity of the risk-free rate proxy matches the investment horizon for the sector[35].
- CEPA considers the yields on 20Y ILGs are more stable than on 10Y ILGs[36]. Thus sole use of 20Y ILGs is preferable because investors in utilities target stable returns over a long time horizon.

Notwithstanding that conceptually it appears appropriate to rely only on 20Y ILGs, there are two points on Ofwat's empirical analysis that should be highlighted:

- Ofwat reports the difference in yield on 20Y ILGs and the average of 10Y and 20Y ILGs in RPI terms. This difference would be smaller in CPIH terms given the RPI-CPIH wedge for a 15Y bond would be higher than for a 20Y bond under Ofwat's DD approach. CEPA recognises the same[37].
- The difference in yield between 20Y ILGs and 15Y ILGs is smaller than that between 20Y ILGs and the average of 10Y and 20Y ILGs. The use of 15Y ILGs represents Ofwat's PR19 FD position. Further, the differences are significantly smaller over a long-term window e.g. 20Y.

4.2.2. Averaging period

Ofwat has used a 1m trailing average. It considers that this length of trailing average balances the benefits of (1) more recent data which may be more reflective of market conditions over AMP8; and (2) averaging over a longer historical period to protect against unusual daily volatility in yields.

[30] This move was for two reasons: (1) depending on the shape of the yield curve between 10-20Y, the direct yield for 15Y may be different to an average of 10Y and 20Y; and (2) direct yields are generated using a more sophisticated line of best fit.
[31] CMA (2020), PR19 Provisional Findings, para. 9.128.
[32] Ofwat (2024), PR24 Draft Determination, Aligning risk and return appendix, p. 44.
[33] Ofwat (2022), PR24 and beyond: Final guidance on long-term delivery strategies, p. 13.
[34] The tenor of the iBoxx non-financials A/BBB 10+ index has been 19.8Y on average over the >26Y period from 01/01/1998 (date on which iBoxx begins) to 30/06/2024.
[35] Ofgem (2024), RIIO-3 Sector Specific Methodology Decision – Finance Annex, paras. 3.37-3.38.
[36] CEPA (2024), PR24 Cost of Equity, p. 49.
[37] Ibid., p. 49, footnote 19.

Ofwat revisited whether the risk-free rate should be indexed but has ultimately decided to retain an ex-ante trailing average. This is because 20Y gilt yields have stayed broadly flat since the start of the year which makes the rationale for indexing less persuasive. It also noted that its PR24 FM assessment that the benefits of indexation do not clearly outweigh the costs, remains relevant.

Trailing average length

The choice of trailing average should reflect prevailing and expected market conditions.

Ofgem in the RIIO-3 SSMD has indexed the risk-free rate using a 1m trailing average in line with RIIO-2. However, Ofgem comments that *"…if we* [Ofgem] *were setting an RFR for the entire control period, there may have been a benefit from basing our estimate of the RFR on a longer-average of ILG yield data to avoid potentially 'locking in' short-term volatility for the whole length of the control"*[38].

CEPA also considers that *"…a slightly longer trailing average of 3-6 months would also be acceptable, as it could capture trends and provide more stability*"[39].

Ofgem's RIIO-3 SSMD and Ofwat's PR24 DD both used a data cut-off of March 2024. Based on this cut-off, the 3m and 6m trailing average of 20Y ILG rates were 10bps and 14bps higher than the 1m.

Based on a June 2024 cut-off, all three trailing averages imply broadly the same value. The 12m trailing average is also aligned with these which suggests that 20Y ILG rates have stabilised. Hence, the choice of trailing average length does not appear material based on the latest outturn rates.

However, forward rates for 20Y ILGs (and NGs) at present suggest the market expectation is for the spot rates on these instruments to increase over AMP8. Assuming Ofwat will not index the risk-free rate, it should retain a 1m trailing average if this market expectation holds at FD. The 1m trailing average would minimise the loss to investors if the market expectation was to materialise in practice as it would exclude lower rates from earlier months.

Ofwat should continue to monitor how spot and forward rates on 20Y ILGs evolve and consider what length of trailing average is merited at FD. Ofwat in the PR24 FM indicated that it would revisit the trailing average length, for example, if the 1m trailing average was unusually high or low due to temporary factors[40].

Indexation

Ofwat has decided against indexation which increases the importance of setting the ex-ante trailing average appropriately based on prevailing and expected market conditions.

4.3. Differing risk-free borrowing and saving rates

The risk-free rate for the CAPM is likely to lie above the ILG yield because (1) investors cannot borrow at the ILG yield; and (2) ILGs benefit from the convenience yield. Ofwat appears to conflate both into (2) but these are conceptually separate and necessary adjustments. The CMA's rationale for its PR19 FD was (1) whereas it did not directly account for (2). Taking (1) and (2) in combination implies the risk-free rate for the CAPM lies between the risk-free borrowing rate and the risk-free saving rate; the latter of which is proxied by the ILG yield *plus* convenience yield. The CMA's proxy for the risk-free borrowing rate was the AAA corporate borrowing rate. This rate is very close to but is not completely risk-free. However, it represents the lowest possible (and likely understated) cost at which investors can borrow in practice and is therefore the best estimate for the risk-free borrowing rate.

This section considers (1) how the adjustment for differing risk-free borrowing and saving rates is distinct to that for CY; (2) how the Brennan (1971) variant of the CAPM should be applied in practice to adjust for these; and (3) Ofwat's and CEPA's points on the analysis that quantified the adjustment for the former in the September 2023 CoE report.

38 Ofgem (2024), RIIO-3 Sector Specific Methodology Decision – Finance Annex, para. 3.38.
39 CEPA (2024), PR24 Cost of Equity, p. 48.
40 Ofwat (2022), PR24 Final Methodology, Appendix 11 – Allowed return on capital, p. 17.

4.3.1. Conceptual distinction from CY

The September 2023 CoE report indicated that the appropriate risk-free rate for the CAPM is likely to lie above the ILG yield because (1) investors cannot borrow at the ILG yield; and (2) ILGs benefit from CY. Ofwat appears to conflate both into CY[41].

These are two conceptually separate and necessary adjustments. The first applies where the risk-free borrowing rate exceeds the risk-free saving rate. The second applies even where these are the same.

Investors cannot borrow at the ILG yield

The standard CAPM assumes that investors can borrow and save at the same risk-free rate. However, in the real world, the risk-free borrowing rate is higher than the risk-free saving rate. In this case, the appropriate risk-free rate for the CAPM lies between the two rates as shown by Brennan (1971)[42]. The intuition behind Brennan (1971) is explained in the September 2023 CoE report[43].

The CMA viewed its PR19 FD to base the risk-free rate on both ILGs and AAA corporate bonds as an application of Brennan (1971): "*We consider that our interpretation of the CAPM in a situation of different borrowing and lending rates…is in principle in line with Brennan's (1971) often quoted finding that the market equivalent RFR is a weighted average of the RFR of all individual investors*"[44]. In particular, the CMA used ILGs as a proxy for the risk-free saving rate and AAA corporate bonds as a proxy for the risk-free borrowing rate.

Brennan (1971) does not explore CY. Given the CMA's PR19 FD was primarily based on Brennan (1971), its decision cannot directly relate to CY[45].

ILGs benefit from CY

CY is explored across two steps.

a. Assume, as a simple benchmark, that investors can borrow and save at the same risk-free rate as in the standard CAPM.

The risk-free rate is used as a measure of an investor's time value of money: the required return for receiving a riskless payoff in the future instead of today[46].

Ofwat has used the ILG yield for this benchmark. However, government bonds provide additional benefits to investors such as the ease with which they can perform money-like roles. These benefits create additional investor demand for government bonds and push their return below that implied by the investor's time value alone. The difference is CY.

It is not only government bonds that bear CY; take physical cash as another example. Physical cash (notes and coins) and cash held in a bank account are both risk-free. However, physical cash earns no return whereas cash held in a bank account earns the deposit rate i.e. physical cash bears CY. This is because physical cash has a superior ability to perform money-like roles as it can be spent immediately. Rational investors are willing to pay for this convenience of physical cash.

It follows that for ILGs, CY(ILG) must be added to their return to obtain the risk-free rate.

b. Now consider the more realistic case that investors' risk-free borrowing rate exceeds their saving rate.

Specifically, the saving rate is equal to the common risk-free rate in the previous world but the borrowing rate increases.

41 Ofwat (2024), PR24 Draft Determination, Aligning risk and return – Allowed return appendix, p. 13.
42 Brennan, M. (1971), 'Capital Market Equilibrium with Divergent Borrowing and Lending Rates'.
43 KPMG (2023), Estimating the Cost of Equity for PR24, sections 6.5.1-6.5.2.
44 CMA (2021), PR19 Final Determination, para. 9.263.
45 Further, the CMA does not characterise its decision as directly for CY. For example, it comments *"what is also clear is that ILGs do not completely meet our* [the CMA] *requirement of the RFR as applied in the CAPM, that all market participants can borrow at the same rate"* in para. 9.104.
46 Van Binsbergen, J., Diamond, W., and Grotteria, M. (2022), 'Risk-free interest rates'.

The saving rate remains ILG yield *plus* CY(ILG). The borrowing rate now becomes ILG yield *plus* CY(ILG) *plus* borrowing costs. These borrowing costs relate to e.g. the transaction costs and collateral requirements associated with borrowing.

The CMA's estimate of the risk-free borrowing rate is discussed in section 4.3.2. The CMA's estimate of the risk-free saving rate is the ILG yield. However, a more complete estimate would be the ILG yield *plus* CY(ILG) as this explicitly takes into account the presence of CY.

Conclusion

It is not appropriate to conflate the adjustments for differing risk-free borrowing and saving rates and CY wholly into CY. These are two conceptually separate adjustments.

The first adjustment is as important as the CY adjustment, not least since it was the key rationale for the CMA's PR19 FD. CY is in effect an additional layer on top of the CMA's PR19 FD.

4.3.2. AAA corporate bond yields as the risk-free borrowing rate

The CMA used AAA corporate bond yields as the risk-free borrowing rate because: *"…the risk of loss resulting from default on these bonds is exceptionally low…"*[47] and *"…non-government bonds with the highest possible credit rating provide an input that is both very close to risk free (issuers with a higher credit rating than the UK government, but with some inflation and default risk) and is at least closer to representing a rate that is available to all (relevant) market participants*"[48].

The September 2023 CoE report explained that what matters is the rate at which investors, not corporates, borrow since it is investors who provide capital to corporates. Investors are backed by securities whose prices can significantly fluctuate whereas, corporates are backed by hard assets and thus can achieve lower borrowing costs. It follows that the AAA corporate borrowing rate is a conservative and likely understated estimate of the investor borrowing rate[49].

The AAA corporate borrowing rate is used as the risk-free borrowing rate even though it is (almost but) not perfectly risk-free as specified by Brennan (1971). This is because the AAA corporate borrowing rate represents the lowest possible rate at which investors (or indeed corporates) can borrow in the real world. In this context, the AAA corporate borrowing rate is the best possible estimate of the risk-free investor borrowing rate for the practical application of Brennan (1971).

The CMA shared this view, noting that it *"…consider*[s] *that the yield on these* [AAA] *indices provides information on the lowest risk borrowing costs available to nongovernment market participants…"*[50].

Ofwat appears to deduct default and illiquidity premia from the AAA corporate borrowing rate to derive the risk-free borrowing rate[51]. This is not appropriate for three reasons.

First, it is not appropriate to adjust for illiquidity premia because perfect liquidity is not a property of the CAPM risk-free asset as explained in section 4.2.1.

Second, it is not appropriate to adjust for default premia because investors have default risk which is reflected in their borrowing rate. In consequence, investors will not be able to borrow at the default-free AAA corporate borrowing rate. Even without an adjustment for default risk, the AAA corporate borrowing rate is a conservative estimate of the investor borrowing rate.

Third, investors factor their default risk into their asset allocation decision so it is not appropriate to adjust for this. For example, an aggressive investor can achieve a high risk position by either (1) investing their initial wealth in high beta stocks such as tech; or (2) borrowing and investing more than their initial wealth in the market portfolio. The aggressive investor will take account of the default premium within their borrowing rate in making this asset allocation decision.

47 CMA (2021), PR19 Final Determination, para. 9.146.
48 Ibid., para. 9.149.
49 KPMG (2023), Estimating the Cost of Equity for PR24, section 6.5.4.
50 CMA (2021), PR19 Final Determination, para. 9.150.
51 Ofwat (2024), PR24 Draft Determination, Aligning risk and return – Allowed return appendix, p. 13.

Further, Ofwat adopts estimates of default and illiquidity premia cited in the CMA PR19 FD. However, it has not engaged with the risk premia estimates provided in the September 2023 CoE report which are based on more recent data[52].

For clarity, the risk premia estimates in the previous report are used to derive CY from AAA corporate bonds, not to derive the risk-free borrowing rate. Ofwat in the PR24 FM endorsed this approach to deriving CY but did not suggest this was required to derive the risk-free borrowing rate[53].

Ofwat may still consider it is not possible to identify the risk-free borrowing rate. In this case, Ofwat should use the zero-beta return *plus* shorting costs in place of the risk-free borrowing rate in the Brennan (1971) framework. This is explained in the September 2023 CoE report[54].

4.3.3. Application of Brennan (1971) and the standard CAPM

Ofwat considers that *"…a proper calibration of the Brennan (1971) concept…would involve consideration of borrowing and lending restrictions affecting market participants, as well as how to average the participant-specific risk-free lending and borrowing rates, which are likely to be more numerous than the two rates featured in the CMA's analysis*"[55].

The CMA was clear on the rationale for its application of Brennan (1971) in the PR19 FD: "*We* [the CMA] *acknowledge that we have not tried to undertake the exercise of assessing all investor borrowing and lending rates, or the precise balance of current and potential borrowers and lenders, in our target market. We consider that such an exercise would be impractical within a redetermination process. Rather, we have applied a highly-simplified but, in our opinion, reasonable assumption that we can gain sufficient insight into the market RFR…*"[56].

The CMA's application of Brennan (1971) appears reasonable. It balances the desirability for an accurate estimate of the risk-free rate that reflects the real world with the need to avoid undue complexity. Hence the approach in the September 2023 CoE report built on the CMA's PR19 FD.

Ofwat's position appears to be that since it is challenging to apply Brennan (1971) in full form, the right alternative is to do nothing. However, the CMA's application of Brennan (1971) is clearly an improvement on doing nothing. Further, Ofwat indicates that it is not aware of another regulatory jurisdiction that uses the full Brennan (1971) framework[57]. This should not be a reason for dismissing the CMA's application of Brennan (1971) which represents an improvement on Ofwat's DD approach. A regulator should seek to be a thought leader and implement best practice.

CEPA considers that in Brennan (1971) the marginal investor in utilities is likely to be a net lender (e.g. pension fund) for whom the risk-free saving rate would be appropriate[58]. This argument was made by Ofwat and its advisers at the PR19 appeal.

CEPA has not engaged with the rationale in the September 2023 CoE report which shows this argument is flawed based on the intuition behind Brennan (1971)[59]. The report explained that the higher cost of capital for pension funds is not due to facing the risk-free borrowing rate themselves. It is to compensate them for being overweight on utilities compared to the market portfolio and therefore not being fully diversified. Indeed, the CMA ultimately decided that it is was not necessary to define the exact nature of the marginal investor and the rate at which they borrow[60].

Ofwat appears to advocate the standard CAPM on the basis of its simplicity[61]. CEPA indicates that adopting a more sophisticated model that relaxes the standard CAPM assumptions would require significant care and effort as well as depart from regulatory precedent[62].

52 KPMG (2023), Estimating the Cost of Equity for PR24, section 6.6.5.
53 Ofwat (2022), PR24 Final Methodology, Appendix 11 – Allowed return on capital, p. 15.
54 KPMG (2023), Estimating the Cost of Equity for PR24, section 6.5.6.
55 Ofwat (2024), PR24 Draft Determination, Aligning risk and return – Allowed return appendix, p. 17.
56 CMA (2021), PR19 Final Determination, para. 9.263.
57 Ofwat (2024), PR24 Draft Determination, Aligning risk and return – Allowed return appendix, p. 17.
58 CEPA (2024), PR24 Cost of Equity, p. 46.
59 KPMG (2023), Estimating the Cost of Equity for PR24, section 6.5.2.
60 CMA (2021), PR19 Final Determination, paras. 9.159 and 9.265.
61 Ofwat (2024), PR24 Draft Determination, Aligning risk and return – Allowed return appendix, p. 17.
62 CEPA (2024), PR24 Cost of Equity, p. 46.

The Brennan (1971) framework as applied in the September 2023 CoE report is relatively simple to implement and is not a significant departure from the standard CAPM. Further, the Brennan (1971) framework is theoretically justified, long established and is covered in standard corporate finance textbooks for practitioners which suggests it is well accepted[63]. Whilst it is not possible to correct all the imperfections of the standard CAPM, moving to the Brennan (1971) variant of the CAPM would be an improvement and is relatively straightforward to implement.

The CMA at PR19 recognised that prior to the publication of the 2018 UKRN report there was a consistent precedent of setting the risk-free rate above spot 20Y ILG yields[64]. The purpose of this gap was not explicitly to compensate CY or differing risk-free borrowing and saving rates. Nevertheless, the CMA considered that the gap *"…may have removed an inadvertent mitigation to problems associated with the standard regulatory approach of sole reliance on the potentially imperfect RFR proxy of government bond yields"*[65].

In more recent price controls UK regulators have broadly followed the CMA PR19 FD approach to setting the risk-free rate. This includes CAA H7 FD[66], CAA NR23 FD[67] and UREGNI GD23 FD[68].

4.3.4. Ofwat's and CEPA's points on the analysis of RPI AAA bonds vs ILGs

The September 2023 CoE report estimated an upper bound adjustment to the 20Y ILG yield based on the difference between the risk-free borrowing rate proxied by RPI AAA bond yields and maturity-matched ILG yields[69]. Ofwat and CEPA have reviewed this analysis and raised a number of points.

High-level response

Before discussing each point, there is merit in first providing a high-level response. In principle, it does not appear reasonable to dismiss the analysis entirely on the basis of data limitations. The analysis was based on the complete population of RPI AAA bonds that have been rated as such since their issuance. Thus the analysis simply reflects the extent of the best available data.

The limitations of the data have been recognised in the way the analysis was treated. The analysis used a c.5Y horizon given the yields on the bonds may be unstable over a short time horizon. Further, the analysis informed the upper bound adjustment to 20Y ILG yields but the midpoint of the range was selected as the point estimate. This avoided attaching excessive weight to the upper bound.

Importantly, the AAA corporate borrowing rate is a conservative and likely under-estimate of the investor borrowing rate. Hence, the analysis may be pointing to an adjustment that is already too low.

Detailed response

The individual points that Ofwat and CEPA raise are discussed in turn below.

The bonds in the analysis were chosen by KPMG

CEPA suggests that the bonds in the analysis were chosen by KPMG.

This appears to mischaracterise the approach taken to the analysis. The bonds in the analysis were not chosen, they represent those which met a range of relevant criteria. These criteria are:

- Bond is linked to RPI
- Bond has been rated AAA throughout its life
- Bond is GBP denominated
- Bond is not an asset-backed security

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63 Such as Berk and DeMarzo (2014), 'Corporate Finance' as highlighted in the September 2023 CoE report, and Brealey, Myers, Allen and Edmans (forthcoming 2025), 'Principles of Corporate Finance'.
64 CMA (2021), PR19 Final Determination, para. 9.99.
65 Ibid., para. 9.107.
66 CAA (2022), H7 Final Proposals, Section 3: Financial issues and implementation, paras. 9.247-9.248.
67 CAA (2023), NR23 Final Decision, paras. 5.64 and 5.91-5.93.
68 UREGNI (2022), GD23 Final Determination, para. 10.17.
69 KPMG (2023), Estimating the Cost of Equity for PR24, section 6.6.6.

- Refinitiv has data for the bond
- Bond is active at some point during the window 02/07/2018 to 30/06/2023

The estimation window for the analysis was selected to optimise for data availability in Refinitiv. This is line with Ofwat's approach to CY analysis in the PR24 FM[70]. Ofwat adopted an estimation window that was not entirely consistent with Diamond and Van Tassel (2021) due to data availability issues.

Most of the bonds are issued by the EIB and the EIB is not completely risk-free

CEPA comments that most of the bonds have been issued by the EIB and supranational organisations like the EIB are not completely risk-free.

The CMA recognised that supranational organisations like the EIB are common issuers of AAA rated bonds in its decision to base the risk-free borrowing rate on nominal AAA indices[71]. Supranational bonds are backed by multiple sovereign sponsors which means they are effectively sub-sovereign. As a result, they are very low risk and less risky than bonds issued by private institutions.

These bonds are very but not completely risk-free. Despite this, they represent the best possible estimate of the risk-free borrowing rate as explained in section 4.3.2. An investor wanting to invest in safe assets would likely choose supranational bonds.

CEPA comments that the sample of bonds in the analysis is limited (12 bonds of which 8 are issued by the EIB). This could mean the analysis will not lead to a more widely accessible borrowing rate.

The nominal AAA indices used by the CMA had similar characteristics but the CMA decided that these indices were still able to provide useful information. In any case, the yields on AAA rated bonds are a conservative estimate of the investor borrowing rate as explained in section 4.3.2. Thus it would be expected that most investors in practice could only borrow above this rate.

Berk and DeMarzo (2020) notes that: *"In practice, investors receive a lower rate when they save than they must pay when they borrow. For example, short-term margin loans from a broker are often 1% to 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, but there is still a difference"*[72]. This suggests that even collateral-rich investors have to borrow at a premium over government rates that is above that implied by the AAA corporate borrowing rate (66bps based on September 2023 CoE report).

The bonds are subject to thin-trading and wider bid-ask spreads than gilts

CEPA comments that the bonds in the analysis are thinly-traded and less liquid than gilts.

It is plausible that investors hold RPI-linked AAA bonds until maturity i.e. investors use them like the risk-free asset. This would explain why the bonds are not actively traded. The result of this thin-trading would be wider bid-ask spreads on the bonds relative to gilts.

Perfect liquidity is not a property of the CAPM risk-free asset as explained in section 4.2.1. As such, the liquidity of the bonds in the analysis is not a relevant consideration for assessing whether they can be used as a proxy for the risk-free borrowing rate.

If liquidity was assumed to be a relevant consideration, CEPA shows that the nominal AAA bonds in its own analysis are broadly as liquid as the RPI-linked AAA bonds in the KPMG analysis[73]. This implies that liquidity would not be a differentiator between the two analyses.

Ofwat indicates that the data for the RPI-linked AAA bonds in the KPMG analysis is 'Refinitiv evaluated' which is due to the thinly-traded nature of the bonds.

CEPA implies that nominal AAA bonds are also likely to be thinly-traded by showing these bonds have similar bid-ask spreads as the RPI-linked AAA bonds. However, nominal AAA bonds still served as the basis for CEPA's analysis, which Ofwat quotes in the DD, and for the CMA's PR19 FD. This

[70] Ofwat (2022), PR24 Final Methodology, Appendix 11 – Allowed return on capital, p. 97.
[71] CMA (2021), PR19 Final Determination, paras. 9.111 and 9.150.
[72] Berk, J. and DeMarzo, P. (2020), 'Corporate Finance', p. 440.
[73] CEPA (2024), PR24 Cost of Equity, p. 98.

suggests that CEPA and the CMA, like KPMG, rely on AAA bonds with the understanding that the data available for these bonds is not perfect but reflects the best that exists.

The weighted-average years to maturity of the analysis does not reach >10Y

Ofwat considers that the weighted-average years to maturity of the analysis does not reach >10Y over the estimation window of 02/07/2018 to 30/07/2023.

The September 2023 CoE report noted that the market value weighted-average years to maturity was 10.3Y over the estimation window. It is not clear how Ofwat carried out its weighting.

There are discontinuities in the time series of the analysis

Ofwat comments that there are discontinuities in the time series of the analysis.

The analysis has been updated to incorporate the short-end of the ILG yield curve. The long-end of the yield curve starts at a maturity of 2.5Y but the short-end starts at 2Y[74]. This lengthening of the ILG yield curve for the analysis by 0.5Y has helped to reduce discontinuities.

The analysis has also been updated to use data from Bloomberg instead of Refinitiv. This has two key benefits for the analysis. First, Bloomberg's data availability allowed for a longer estimation window which begins from 01/01/2007. Second, Bloomberg's data availability allowed for 6 new bonds to be added to the analysis. These are issued by the EIB, EBRD, NWB Bank and KBN.

The updates to the analysis have enhanced its robustness and reliability. The updated analysis still has a market value weighted-average years to maturity of >10Y based on the long-term average.

The results of the updated analysis are discussed in section 4.5.2.

4.4. Convenience yield

The academic literature on the convenience yield is limited to shorter-dated safe assets. Ofwat has challenged whether these estimates of the convenience yield for shorter-dated safe assets can be extrapolated to longer-dated safe assets. The evidence suggests this is reasonable: (1) the term structure of the convenience yield in academic literature is mostly upwards sloping; and (2) the collateral value component of the convenience yield for longer-dated safe assets is at least the same as that for shorter-dated safe assets. Ofwat also notes the academic literature uses a data cut-off in 2020 but the estimates of the convenience yield are likely to be higher based on a more recent cut-off.

This section (1) provides a recap of CY; (2) considers the term structure of CY; and (3) considers whether Diamond and Van Tassel's analysis of CY(NG) can inform the allowed return for AMP8.

4.4.1. Recap of CY

The concept of CY is explained in section 4.3.1 and further in the September 2023 CoE report[75]. CY exists in the real world and thus should be adjusted for in the practical application of the CAPM.

The academic literature on CY is largely focused on the US. Diamond and Van Tassel (2021) is the only academic paper that provides UK-specific estimates of CY, which were for NGs. As the paper only considered NGs, it was important to assess whether its findings would extend to ILGs.

The September 2023 CoE report analysed whether the CY factors cited in academic literature apply to ILGs to the same extent as NGs[76]. The analysis implied that the vast majority of factors apply similarly to NGs/ILGs but NGs may be more liquid than ILGs. This suggested that there was CY in ILGs and CY(NG) may be a good benchmark for CY(ILG).

Whilst the September 2023 CoE report acknowledged that NGs may be more liquid than ILGs, CEPA shows for a sample of NGs/ILGs that ILGs have lower bid-ask spreads than NGs[77].

[74] The short-end of the ILG yield curve starts at a maturity of 25m but this is used as a close proxy for 2Y ILGs.
[75] KPMG (2023), Estimating the Cost of Equity for PR24, section 6.4.1.
[76] Ibid., sections 6.4.2-6.4.3.
[77] CEPA (2024), PR24 Cost of Equity, p. 98.

Ofwat may consider that it is not possible to estimate CY(ILG) and therefore identify the risk-free saving rate. In this case, Ofwat should use the zero-beta return in place of the risk-free saving rate in the Brennan (1971) framework. This is explained in the September 2023 CoE report[78].

4.4.2. Term structure of CY

Diamond and Van Tassel estimate CY for NGs with tenors of 3m to 2Y. Ofwat has challenged whether these estimates of CY for shorter-dated safe assets can be extrapolated to longer-dated safe assets[79]. The evidence on this issue is set out below.

Empirical analysis of CY term structure

The September 2023 CoE report relied on Diamond and Van Tassel (2021) to derive CY(ILG). The paper was most recently updated in April 2024. The updated version of the paper presents a 2Y CY(NG) of 29bps which is smaller than the 38bps shown in previous versions. CY for shorter tenor NGs have not moved. The data cut-off nor the approach for the paper have changed.

The CY term structure in the previous version of the paper was clearly upward sloping between tenors of 3m and 2Y. This suggested that CY could be higher than 2Y NGs for the long tenors on which the risk-free rate is based. The CY term structure in the updated paper is less definitive.

However, the term structure remains mostly upwards sloping (2Y is the exception but may be an outlier) and there is not enough of a time series to conclude that CY declines at longer tenors. As such, it appears reasonable to assume that the 2Y CY could hold at longer tenors, all else equal.

Qualitative analysis of CY term structure

Ofwat indicates there are two reasons for why CY may be less relevant for longer-dated safe assets relative to shorter-dated safe assets. First, accounting definitions of cash and cash equivalents tend to include only highly liquid short-term instruments. Second, the market value of longer-dated assets is more sensitive to interest rate expectations, which could undermine their usefulness as collateral.

Accounting definitions

Ofwat does not explain conceptually why accounting definitions are a relevant driver of CY. Accounting definitions are focused on a company's solvency whereas CY is focused on an investor's asset allocation decisions. These seem completely unrelated. Accordingly, accounting definitions do not appear to be referenced in the academic literature on CY.

It could be the case that Ofwat is applying a very literal definition of 'money-like' and so is assuming that only shorter-dated safe assets can bear CY. This interpretation is more narrow and prescriptive than the conceptual use of 'money-like' in the academic literature on CY. Many non-cash equivalents are also 'money-like' as they are still safe, liquid and collateralisable.

In any event, IAS 7 requires that only investments with a maturity of 3m or less from the date of acquisition are reported as cash equivalents[80]. Diamond and Van Tassel (2024) show that CY(NG) for 6m, 1Y and 2Y tenors are markedly above that for 3m. This suggests that empirically accounting definitions are not relevant for CY.

Collateral value

The most robust way to assess whether there is a difference in CY between shorter- and longer-dated safe assets due to collateral value is to review the applicable legislation.

Counterparties need to pledge collateral to banks in order to engage in a range of transactions such as borrowing money, trading derivatives, entering into security financing transactions with banks. Banks require collateral to mitigate the credit risk generated by undertaking these transactions.

[78] KPMG (2023), Estimating the Cost of Equity for PR24, section 6.5.6.
[79] Ofwat (2024), PR24 Draft Determination, Aligning risk and return – Allowed return appendix, p. 16.
[80] IAS 7 Statement of Cash Flows, para. 7. Standard can be found here.

The collateral value of an asset is derived by applying a haircut to its current market value to account for valuation uncertainty[81]. The haircuts for gilts and AAA corporate bonds required by the applicable legislation are set out in the table below[82].

Table 7: Haircuts for gilts and AAA corporate bonds

Remaining maturity	Gilts			AAA corporate bonds		
	20-day liquidation period	10-day liquidation period	5-day liquidation period	20-day liquidation period	10-day liquidation period	5-day liquidation period
≤1Y	0.707%	0.5%	0.354%	1.414%	1%	0.707%
>1 and ≤5Y	2.828%	2%	1.414%	5.657%	4%	2.828%
>5Y	5.657%	4%	2.828%	11.314%	8%	5.657%

Source: KPMG analysis and data from Articles 197 and 224 and EBA mapping table

Reading the table vertically indicates that the haircuts on (1) gilts with tenors of 1-5Y are 4x that of gilts with tenors of ≤1Y; and (2) gilts with tenors of >5Y are 2x that of gilts with tenors of 1-5Y. This is irrespective of the liquidation period of the transaction for which the gilt is used as collateral[83].

However, the difference in collateral value between shorter- and longer-dated gilts is not relevant for the term structure of CY as Ofwat suggests. This is because CY for gilts is the difference in yield between gilts and other safe assets, such as AAA corporate bonds, *of the same maturity*. It is necessary to hold constant the maturity as CY is the difference in yield between two assets with the same cash flow profile that differ only in terms of their convenience. As such, the table should only be read horizontally, not vertically, to evaluate the term structure of CY.

Reading the table horizontally indicates that the haircuts on gilts are half that for AAA corporate bonds at the same maturity (and liquidation period). The difference between the two in absolute terms becomes larger at higher maturities (and liquidation periods). This means that the collateral value component of CY does not decline at longer tenors.

In addition, the haircuts on gilts of 3m, 6m and 1Y tenor are the same under equivalent liquidation periods. However, CY(NG) for 1Y tenor is markedly above that for 3m and 6m based on Diamond and Van Tassel (2024). This clearly demonstrates that collateral value is not the sole driver of CY[84] and so CY cannot be assumed to move one-for-one with collateral value.

On balance, it appears reasonable to assume that CY holds for longer-dated safe assets.

4.4.3. Relevance of Diamond and Van Tassel analysis

Ofwat argues that the relevance of the Diamond and Van Tassel analysis of CY(NG) for setting the allowed return for AMP8 may be limited by a data cut-off of 27/07/2020[85].

First, Ofwat relied on the Diamond and Van Tassel analysis of CY(NG) as a starting point for its analysis of CY(ILG) in the PR24 FM[86]. It follows that Ofwat has previously considered that the Diamond and Van Tassel analysis is relevant for setting the allowed return at AMP8.

Second, the Diamond and Van Tassel analysis is based on a very long-run of data so should be reflective of long-term conditions.

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81 The value of the non-cash asset may not be fixed. It may differ over time as a result of changes in market conditions or the perceived credit quality of the issuer of the bond/equity.

82 Article 224 illustrates the haircuts that have to be applied to the current market value of assets to derive their collateral value. Gilts fall in the category Article 197(1)(b) whereas AAA corporate bonds fall in the category Article 197(1)(c) and (d) based on Article 197. Gilts and AAA corporate bonds are both of credit quality step 1 based on the EBA mapping table. Articles can be found here and the EBA mapping table can be found here.

83 The liquidation periods that apply for different types of transactions are explained in Article 224(2).

84 CY is driven by *inter alia* the liquidity of government bonds and the ease at which they can be traded by uninformed agents, posted as collateral, satisfy regulatory capital requirements, or perform other roles similar to that of money. This is explained in section 6.4.1 of the September 2023 CoE report.

85 Ofwat (2024), PR24 Draft Determination, Aligning risk and return – Allowed return appendix, p. 16.

86 Ofwat (2022), PR24 Final Methodology, Appendix 11 – Allowed return on capital, p. 96-97.

Third, Diamond and Van Tassel observe that CY(NG) appears to have a positive relationship with interest rates. Given that interest rates in the UK have risen significantly over 2020-2024, it may be likely that CY(NG) is higher based on a more recent data cut-off.

Fourth, the September 2023 CoE report estimated CY(NG) *less* CY(ILG) of 27bps for the quantitative analysis of CY(ILG)[87]. This was over Ofwat's FM estimation window which had a data cut-off in line with Diamond and Van Tassel. Updating the data cut-off to 30/06/2024 implies a slightly smaller value of 24bps. This would result in a higher estimate of CY(ILG), all else equal.

This suggests that Ofwat's argument may not be material.

4.5. Quantitative analysis of adjustments to ILG yields

The lower bound adjustment to ILGs is based on the convenience yield (CY) and the upper bound adjustment is based on the difference in yield between AAA corporate bonds and ILGs (AAA-ILG).

AAA-ILG: The difference in yield between RPI AAA bonds and ILGs provides the most direct estimate of the AAA-ILG difference. This produces an estimate of 67bps.

CY(ILG): 2Y CY(ILG) is based on (1) estimate of 2Y CY(NG) in academic literature; and (2) analysis aiming to estimate the equivalent 2Y CY(ILG) from the academic literature estimate of 2Y CY(NG). The result is a range of 2-29bps. The midpoint of 15.5bps is selected as the point estimate for 2Y CY(ILG). It is reasonable to assume this holds for longer-dated ILGs. The cross-check for CY(ILG) based on >10Y RPI AAA bonds implies a significantly higher value than 15.5bps.

Overall range and point estimate for the adjustment to ILGs: A range of 0-67bps is adopted for the adjustment required to ILGs. The upper bound position of 67bps is based on the AAA-ILG difference. The lower bound position of 0bps assumes no CY(ILG) is required, but this is not used to inform the point estimate for the adjustment to ILGs. The point estimate of 41bps is slightly below the midpoint of 15.5bps (point estimate for CY(ILG)) and 67bps.

This section estimates the adjustment required to the ILG yield to arrive at the appropriate risk-free rate for the CAPM in RPI terms.

4.5.1. Bounds for the appropriate risk-free rate in the CAPM

The sections above discuss the bounds for the appropriate risk-free rate in the CAPM. These bounds are summarised in the table below. In the table, r* is the appropriate risk-free rate, r_s is the risk-free saving rate and r_b is the risk-free borrowing rate.

Table 8: Bounds for the appropriate risk-free rate in the CAPM

Bounds for r*	r_s can be identified	r_s cannot be identified
Lower bound for r* (r_s)	ILG yield + CY(ILG)	Zero-beta return
Upper bound for r* (r_b)	AAA corporate bond yield	Zero-beta return + shorting costs

Source: KPMG analysis

The table indicates that r* lies between r_s and r_b in line with Brennan (1971). It shows that r_s is derived by adding CY(ILG) to the ILG yield and r_b is derived by adding the difference in yield between ILGs and AAA corporate bonds to the ILG yield. In other words, the lower bound adjustment to the ILG yield is CY(ILG) and the upper bound adjustment is the AAA-ILG difference.

The AAA-ILG difference and CY(ILG) are estimated in sections 4.5.2 and 4.5.3 respectively.

4.5.2. Adjustment for risk-free borrowing rate (AAA-ILG difference)

CMA PR19, CEPA and the September 2023 CoE report all estimated the AAA-ILG difference using distinct approaches. These approaches are discussed in turn.

87 KPMG (2023), Estimating the Cost of Equity for PR24, section 6.6.1.

CMA PR19 and CEPA analysis of nominal AAA bonds

Both the CMA and CEPA inferred the AAA-ILG difference from nominal AAA bonds.

The CMA at PR19 compared the yield on ILGs to the yield on its nominal AAA index[88]. The CMA inflated the yield on ILGs by the long-term RPI-CPIH wedge assumption and deflated the yield on its nominal AAA index by the long-term CPIH assumption. This enables a like-for-like comparison between the two yields in CPIH terms, but the resulting difference between the two yields is highly sensitive to the inflation assumptions adopted. CEPA recognises the same[89].

CEPA considers that comparing the yield on NGs to the yield on the CMA's nominal AAA index represents a more robust approach as it avoids the need for inflation adjustments.

iBoxx indices start on 01/01/1998 which means the longest averaging window that can be taken for the AAA-NG difference is from this date until 30/06/2024 (>26Y). The yield on the CMA's AAA index has been 48bps above that of maturity-matched NGs in RPI terms over this averaging window[90].

As the CMA's AAA index comprises only a small sample size of instruments, the yield on the index may be unstable over short averaging windows. Thus it is preferable to use the longest possible averaging window to ensure the estimate of the AAA-NG difference is not distorted by temporary factors. The implication is that the long-term average provides the most reliable estimate.

It may be relevant to consider short term averages of the AAA-NG difference solely because Ofwat uses a 1m trailing average of 20Y ILG yields as the starting point for the risk-free rate. The yield on the CMA's AAA index has been 3bps below that of maturity-matched NGs over June 2024.

This negative AAA-NG difference over the 1m average is out of line with expectations (e.g. AAA bonds have a small, but non-zero, risk of default unlike gilts) and the long-term average. This suggests it may be reflective of temporary factors and is therefore not a reliable estimate.

In any case, it appears more appropriate to estimate the AAA-ILG difference directly from RPI-linked AAA bonds rather than to infer this nominal AAA bonds. This was the premise behind KPMG's analysis of RPI-linked AAA bonds and ILGs in the September 2023 CoE report.

This is fully consistent with Ofwat's PR24 FM position on CY that CY for NGs cannot be assumed to apply directly to ILGs without justification[91]. For clarity, CY is the not the same as AAA-ILG difference.

For completeness, CEPA considers a second approach for estimating the AAA-NG difference. This second approach is based on comparing the yield on each individual constituent bond in the CMA's AAA index to the yield on maturity-matched NGs over March 2024. CEPA describes this approach as the same as that adopted by the CAA at H7[92].

For accuracy, the CAA did not carry out bond-by-bond analysis like CEPA which was explained in the September 2023 CoE report[93]. More importantly, CEPA's second approach, like its first, suffers from the same underlying issue in that it assumes the AAA-NG difference applies directly to ILGs.

KPMG analysis of RPI AAA bonds

The September 2023 CoE report estimated the AAA-ILG difference directly by comparing the yield on RPI-linked AAA bonds to the yield on maturity-matched ILGs[94].

The analysis has been updated to incorporate the short-end of the ILG yield curve and use data from Bloomberg instead of Refinitiv as discussed in section 4.3.4.

The updated analysis is carried out as follows:

- Download the daily yield, daily price and daily amount outstanding as well as the issue and maturity dates for the RPI-linked AAA bonds.

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88 Simple average of the iBoxx non-gilts AAA 10Y+ and 10-15Y indices.
89 CEPA (2024), PR24 Cost of Equity, p. 96.
90 Based on daily maturity-matching.
91 Ofwat (2022), PR24 Final Methodology, Appendix 11 – Allowed return on capital, p. 15-16 and 97.
92 CEPA (2024), PR24 Cost of Equity, p. 97.
93 KPMG (2023), Estimating the Cost of Equity for PR24, section 6.6.3.
94 Ibid., section 6.6.4.

- Calculate the daily AAA-ILG difference for each RPI-linked AAA bond based on its yield *less* the yield on a maturity-matched ILG where data for both is available.
- Calculate the daily market value for each RPI-linked AAA bond based on its price *multiplied* by its amount outstanding.
- Calculate the daily market value weighted-average of the AAA-ILG difference across the group of RPI-linked AAA bonds.
- Average the daily market value weighted-average over the estimation window.

The updated analysis comprises of 18 bonds which represent those that meet the criteria outlined in section 4.3.4, apart from two differences which arise due to the move to Bloomberg. First, Bloomberg must have data for the bond. Second, the bond must have been active at some point since 01/01/2007. This is the earliest date for which Bloomberg has amount outstanding data.

The longest averaging window is therefore 01/01/2007 until 30/06/2024 (>17Y). The AAA-ILG difference is 69bps in RPI terms over this averaging window. There are on average 10 active bonds with a market value weighted-average years to maturity of 10.4Y across the window.

The 1m average over June 2024 is also considered given Ofwat's use of a 1m trailing average. The long-term average is still preferred on the basis that it produces a more reliable estimate. The AAA-ILG difference is 65bps over June 2024. There are on average 8 active bonds with a market value weighted-average years to maturity of close to 10Y across the window.

In this case, the 1m average is broadly aligned with the long-term average which suggests it is not affected by temporary factors and so is a reliable estimator. On this basis, the midpoint of the 1m and the long-term averages is selected as the point estimate for the AAA-ILG difference (67bps).

As noted in section 4.3.2, the AAA corporate borrowing rate is a conservative estimate of r_b.

This means that at least 67bps needs to be added to the ILG yield to derive r_b.

4.5.3. Adjustment for risk-free saving rate (CY)

CY(ILG) can be estimated based on approaches using Diamond and Van Tassel (2024) and RPI AAA bonds. These approaches are discussed in turn.

Reworking of Ofwat's analysis based on Diamond and Van Tassel (2024)

Diamond and Van Tassel (2024) estimates CY(NG) using the put-call parity relationship on European FTSE100 options. It finds 2Y CY(NG) of 29bps.

In the PR24 FM, Ofwat inferred 2Y CY(ILG) from the 2Y CY(NG) in Diamond and Van Tassel by applying the following formula from Liu et al. (2015)[95]:

CY(NG) – CY(ILG) = Gilt BEI – Swap BEI (breakeven inflation)

The September 2023 CoE report indicated that this formula assumes the entire gap between gilt BEI and swap BEI is due to higher CY for 2Y NGs relative to 2Y ILGs. However, it should reflect that the gap could also be due to the illiquidity of inflation swaps[96]. The modified formula becomes:

CY(NG) – CY(ILG) = Gilt BEI – Swap BEI + inflation swap illiquidity premium

Ofwat highlighted the inflation swap illiquidity issue in the DD and did not disagree with it[97]. Moreover, Ofwat recognises in the DD that inflation swap rates incorporate an illiquidity premium[98].

In the PR24 FM, Ofwat used an estimation window for CY of 18/06/2007 to 27/07/2020 which broadly aligns with that in Diamond and Van Tassel. 2Y CY(NG) *less* 2Y CY(ILG) is 27bps over Ofwat's estimation window based on the modified formula above. This implies a 2Y CY(ILG) of 2bps.

95 Liu, Z., Vangelista, E., Kaminska, I. and Relleen, J. (2015), 'The informational content of market-based measures of inflation expectations derived from government bonds and inflation swaps in the United Kingdom'.
96 KPMG (2023), Estimating the Cost of Equity for PR24, section 6.6.1.
97 Ofwat (2024), PR24 Draft Determination, Aligning risk and return – Allowed return appendix, p. 16.
98 Ibid., p. 123.

The September 2023 CoE report considered that 2Y CY(ILG) is likely to lie between the estimate from the modified Ofwat analysis and the 2Y CY(NG) estimate from Diamond and Van Tassel. This approach reflects a key finding from the report that the majority of CY factors cited in academic literature appear to apply similarly to NGs/ILGs but NGs may be more liquid than ILGs.

The result of the approach is a range for 2Y CY(ILG) of 2-29bps. The bounds of 2bps and 29bps are both likely to be higher based on a more recent data cut-off as explained in section 4.4.3.

As such, it does not appear appropriate to place excessive weight on the lower bound. The midpoint of the range of 15.5bps is selected as the point estimate for 2Y CY(ILG).

It is reasonable to assume this 15.5bps holds for longer-dated ILGs based on section 4.4.2.

This means that CY(ILG) of 15.5bps needs to be added to the 20Y ILG yield to derive r_S.

Cross-check based on RPI AAA bonds

CY(ILG) can be estimated by comparing the yield on RPI AAA bonds after adjusting for default risk to the yield on maturity-matched ILGs. In this context, ILGs are the risk-free asset with CY and RPI bonds after adjusting for default risk are the risk-free asset without CY.

This approach was adopted by academic literature on CY prior to the publication of van Binsbergen et al. (2022)[99], which was basis of Diamond and Van Tassel (2024). For example, Krishnamurthy and Vissing-Jorgensen (2012) compare the yield on AAA corporate bonds controlling for default risk to US Treasuries to estimate CY for US Treasuries[100]. Importantly, the paper only adjusts for default risk and is clear that the superior liquidity of US Treasures relative to other safe assets is part of its CY.

In the PR24 FM, Ofwat endorses this approach for estimating CY: *"The CAA's 32bp estimate of the convenience yield is derived by comparing the yield of the nominal gilt closest in tenor to the CMA's AAA-rated corporate bond index with that index. It has the advantage of being derived via a simple and easily-reproducible approach, but the estimate is likely to capture other risk premia (eg default and complexity risk) in AAA rated gilts alongside the convenience yield"*[101].

The RPI AAA bonds are not asset-backed (senior unsecured) so complexity risk is not relevant. Moreover, there do not appear to be established asset pricing models that feature complexity risk and this seems to have been developed with limited theoretical or empirical justifications. For clarity, liquidity should not be adjusted for as it is not a property of the risk-free asset, it is a driver of CY as explained in section 4.2.1. This is affirmed by the academic literature on CY including Krishnamurthy and Vissing-Jorgensen (2012) and van Binsbergen et al. (2022).

Relatedly, van Binsbergen et al. (2022) comments that the approach above could underestimate CY for US Treasuries. This is because a AAA corporate bond is sufficiently safe, liquid, and collateralisable to be somewhat money-like and therefore may itself bear CY. In this case, the yield on AAA corporate bonds controlling for default risk may be lower than the CY-free risk-free rate.

The estimate of CY(ILG) based on Diamond and Van Tassel (2024) should serve as the primary approach as this is at present the leading academic study on CY. However, estimates of CY(ILG) based on the approach above can serve as a cross-check as it originates from earlier academic literature on CY and has been endorsed by Ofwat in the PR24 FM.

The September 2023 report estimated that the default risk embedded in AAA corporate bonds yields was 0-9bps with a point estimate of 5bps, which is slightly above the midpoint of the range. This point estimate recognised that AAA corporate bonds are not risk-free but are very low risk.

This suggests that estimates of CY(ILG) can be obtained by reducing the point estimate of the AAA-ILG difference by 0-9bps. The result is an estimate for CY(ILG) of at least 58bps. This cross-check provides a quantitative indication of what CY may look like at longer tenors and could exert upwards pressure on the estimate of CY based on Diamond and Van Tassel (2024).

This cross-check supports a CY(ILG) adjustment of at least 15.5bps to the 20 ILG yield to derive r_S.

[99] Van Binsbergen, J., Diamond, W., and Grotteria, M. (2022), 'Risk-free interest rates'.
[100] Krishnamurthy, A. and Vissing-Jørgensen, A. (2012), 'The Aggregate Demand for Treasury Debt'.
[101] Ofwat (2022), PR24 Final Methodology, Appendix 11 – Allowed return on capital, p. 15.

4.5.4. Conclusion

This section sets out the range and point estimate for the adjustment required to the ILG yield to arrive at the risk-free rate in RPI terms.

Range

The range adopted for the adjustment required to the ILG yield is 0-67bps.

The upper bound position of 67bps is based on the minimum adjustment required to the ILG yield to derive r_b. At this position it would be assumed that r* is equal to r_b. In principle, r* could be equal to r_b as the estimate adopted for r_b is below the true investor borrowing rate.

The lower bound position of 0bps is based on assuming that r* is equal to r_s and there is no CY(ILG) adjustment required to derive r_s.

This position is not used to inform the point estimate for the adjustment required to the ILG yield. This is because 0bps is below the absolute lower bound for CY(ILG) of 2bps (albeit close to it) and the point estimate for CY(ILG) of 15.5bps which are both conservative.

Point estimate

The ILG yield requires an adjustment of at least 15.5bps to derive r_s and 67bps to derive r_b. Accordingly, a truncated range of 15.5-67bps is used to inform the point estimate.

Brennan (1971) states that r* is a weighted average of r_b and r_s; however the theoretical weights cannot be translated into empirical measures. The CMA in its application of Brennan (1971) at PR19 decided it was not necessary to assess the precise balance of borrowers and savers[102]. The CMA ultimately determined r* to be the midpoint of its estimates of r_b and r_s[103].

In this context, it appears reasonable to select a point estimate of 41bps for the adjustment to the ILG yield which is slightly below the midpoint of 15.5bps and 67bps. This is conservative as the estimates adopted for r_b and r_s are themselves conservative.

Separately, Ofwat may consider it is not possible to identify r_s because it considers either there is no risk-free asset or the risk-free asset bears CY which cannot be estimated. If this is the case, Ofwat should follow the zero-beta return option in Table 8. This will imply a significantly higher adjustment to the ILG yield than 41bps based on the evidence presented in section 4.2.1.

4.6. RPI-CPIH wedge

Ofwat estimates a 20Y RPI-CPIH wedge of 0.34% by placing equal weight on 20Y forecasts for the RPI-CPI wedge from inflation swaps and official forecasters (OBR for DD). Ofwat uses CPI as a proxy for CPIH as it considers that the CPI-CPIH wedge is generally small. Ofwat's estimate appears reasonable in principle. Ofwat should continue to monitor evidence and revisit its estimate at FD.

This section evaluates Ofwat's estimate of the RPI-CPIH wedge.

Ofwat comments that regulators have typically used the OBR's long-run RPI-CPI wedge of 0.9-1% to convert ILG yields into CPIH terms. However, the UKSA RPI reform should mean that there is no RPI-CPIH wedge after 2030. In this context, Ofwat has estimated the RPI-CPIH wedge in the PR24 DD using a different approach to that in previous price reviews[104].

In the PR24 DD, Ofwat estimated an RPI-CPIH wedge of 0.34%.

Ofwat has estimated this RPI-CPIH wedge by placing equal weight on forecasts for the RPI-CPI wedge from inflation swaps and official forecasters (OBR for DD). These forecasts are at the 20Y horizon reflecting that Ofwat's starting point for the risk-free rate is 20Y ILGs.

[102] CMA (2021), PR19 Final Determination, para. 9.263.
[103] Ibid., para. 9.265.
[104] Ofwat (2024), PR24 Draft Determination, Aligning risk and return – Allowed return appendix, p. 123.

These two approaches are briefly described below:

- Inflation swaps – uses 20Y zero-coupon RPI and CPI swap rates to directly estimate the 20Y wedge priced in financial markets. These swap rates do not include a forward rate adjustment.
- Official forecasts – uses OBR forecasts of the annual wedge and assumes the annual wedge is zero post-2030 due to the UKSA RPI reform. This is a more fundamentals-based approach.

Ofwat does not place sole weight on swap-implied forecasts because swap rates contain illiquidity and inflation risk premia that may distort the swap-implied wedge as a measure of the true wedge expected by investors. It places equal weight on swap-implied forecasts and official forecasts because it considers the current macroeconomic environment could widen the gap between the inflation expectation priced-in financial markets and in official forecasts[105].

Ofwat assumes CPI can proxy CPIH because it considers the CPI-CPIH wedge is generally small and not persistently negative or positive over time. In the PR24 FM, Ofwat commented that CPIH was 6bps higher than CPI on average over the longest run of data available until September 2022[106].

Ofwat's estimate for the RPI-CPIH wedge of 0.34% appears reasonable in principle. Ofwat should continue to monitor evidence and revisit its estimate at FD, particularly as it is not making a forward rate adjustment on its inflation swap approach. Ofwat should reassess at FD whether it is appropriate to assume a CPI-CPIH wedge of zero over the period until the 2030 UKSA RPI reform[107].

4.7. Derivation of the risk-free rate range for PR24

The table below summarises the overall range for the risk-free rate.

Table 9: Overall range for the risk-free rate

Component	Index	Formula	Ofwat DD	KPMG	
				Lower	Upper
1m average of 20Y ILG yields	RPI	A	1.21%	1.21%	1.21%
Adjustments	RPI	B	0%	0%	0.67%
Risk-free rate	RPI	C = A+B	1.21%	1.21%	1.88%
RPI-CPIH wedge	n/a	D	0.34%	0.34%	0.34%
Risk-free rate	CPIH	E = (1+C)*(1+D)-1	1.55%	1.55%	2.22%

Notes: Based on a cut-off date of 30 June 2024
Source: KPMG analysis and data from Refinitiv

The table below summarises the truncated range and point estimate for the risk-free rate.

Table 10: Truncated range and point estimate for the risk-free rate

Component	Index	Formula	Ofwat DD	KPMG		
				Lower	Upper	Point
1m average of 20Y ILG yields	RPI	A	1.21%	1.21%	1.21%	1.21%
Adjustments	RPI	B	0%	0.155%	0.67%	0.41%
Risk-free rate	RPI	C = A+B	1.21%	1.36%	1.88%	1.62%
RPI-CPIH wedge	n/a	D	0.34%	0.34%	0.34%	0.34%
Risk-free rate	CPIH	E = (1+C)*(1+D)-1	1.55%	1.71%	2.22%	1.96%

Notes: Based on a cut-off date of 30 June 2024
Source: KPMG analysis and data from Refinitiv

105 Ofwat (2022), PR24 Final Methodology, Appendix 11 – Allowed return on capital, p. 22.
106 Ibid., p. 22.
107 The RPI-CPIH wedge is expected to become zero after 2030 which will make the CPI-CPIH wedge irrelevant from that point. This means the CPI-CPIH wedge is only relevant for 5Y out of the 20Y horizon of Ofwat's RPI-CPIH wedge estimate.

5. Total Market Return

The total market return (TMR) is the expected return on a market portfolio that represents the investment opportunity set of a well-diversified investor considering adding the asset in question to her portfolio. The asset's return is defined in relation to the relative risk that this asset contributes to the well-diversified market portfolio. TMR is not directly observable, as it is a forward-looking estimate of investors' expectations of return for taking on equity market risk. As a result, it requires estimation.

This section is structured as follows:

1 It sets out a summary of the methodology and the estimate adopted in the PR24 DD.

2 It considers the methodology for the estimation of the ex post TMR and presents the resulting estimate.

3 It considers the methodology for the estimation of the ex ante TMR and presents the resulting estimate.

4 It derives an overall TMR range based on the estimates implied by ex post and ex ante approaches.

5.1. Ofwat's approach to estimate TMR

Ofwat estimated a TMR range of 6.29% to 6.87% CPIH-real in the PR24 DD. This range is based on the approach set out in the table below.

Table 11: Ofwat's approach for TMR estimation

Component	Approach
Historical ex post	Range formed based on 10- and 20-year overlapping averages of returns, estimated directly on a CPIH-real basis.
Historical ex ante	Range formed based on the (1) DMS decompositional approach and (2) implementation of the Fama-French Dividend growth model using the Barclays Equity and Gilt Study (BEGS) data.
Overall TMR range	Lower bound based on the midpoint of the ex ante range and the upper bound on the midpoint of the ex post range.

Source: KPMG analysis and PR24 DD

5.2. Estimation of TMR using the historical ex post approach

This Report adopts a historical ex post TMR estimate of 6.93% CPIH-real, calculated as the simple 1-year arithmetic average. This figure is slightly above the DD point estimate of 6.87%.

The use of the simple 1-year average is appropriate unless there are compelling reasons to justify an alternative approach. Departure from the simple 1-year average is not justified in this case as:

(1) there is no statistically significant evidence of serial correlation[108] based on the empirical analysis undertaken in this Report. Ofwat contends that statistical tests are of limited use for detecting serial correlation and presumes it presence by default, requiring proof to the contrary. Serial correlation is not a default feature of data, and the burden of proof lies in demonstrating its presence through empirical analysis. Consistent with this, the absence of serial correlation is considered the null hypothesis in conventional statistical testing.

(2) both investor (providers of capital)) and capital budgeter (users of capital) perspectives are relevant for the estimation of TMR[109], as recognised by the CMA at PR19[110]. In consequence. TMR should be estimated such that it is a 'neutral' rate in the form of the long-run arithmetic average, not assuming a specific holding period[111]. In contrast, Ofwat consider that the investor perspective is the relevant one, resulting in a TMR that is unsuitable for capital budgeters.

These two factors indicate that a divergence from the 1-year simple arithmetic average is not justified.

5.2.1. Ofwat's approach in the PR24 DD

The PR24 DD ex post TMR range is 6.81 – 6.93%, with a midpoint of 6.87%. This midpoint is 5bps lower than the FM estimate (6.92%), due to the inclusion of an additional year of returns data. The table below summaries the PR24 DD approach, which remains unchanged from the FM.

Table 12: Ofwat's methodology for estimating ex post TMR

Parameter	Approach
Data source	Global Investment Returns Yearbook 2024 (DMS 2024)[112].
Averaging technique	10- and 20-year overlapping averages only.
Inflation	Derived in CPIH-real terms using a synthetic CPIH series, constructed based on (1) BoE 'Original' Millenium dataset (1899-1949); (2) ONS CPIH backcast (1950-1988); (3) ONS outturn CPIH data (1988+)[113].
Cross-checks	Geometric-plus-conversion-factor approach, which adds half the variance of log returns to the geometric mean return, with a 9bps deduction for serial correlation.

Source: KPMG analysis and PR24 DD

[108] Serial correlation (or autocorrelation) refers to the degree of correlation of variables between two (or more) different observations. The presence of serial correlation would indicate variables are not random and hence would need to be adjusted to reflect the 'true' market return.

[109] This is because the regulatory WACC serves a dual purpose: it facilitates investors in calculating the expected future value of their investments in regulated companies, and it assists regulated companies in determining present values for capital budgeting decisions.

[110] CMA (2021), PR19 Final Determination, para. 9.328.

[111] A neutral TMR allows capital budgeters and investors to make adjustments to obtain unbiased figures for their specific requirements. If the rate provided is not neutral, there is a risk of rate distortion when applied from the opposite perspective.

[112] Dimson, Marsh, and Staunton (2023), Global Investment Returns Yearbook and associated data. This publication is referred to hereafter as 'DMS 2024'.

[113] Ofwat do not rebase the BoE dataset which results in a minor discrepancy due to a mismatch between financial data year end (December) and Inflation year end (June) for the 1899-1949 period. The impact is not material.

Ofwat has continued to reject the use of the simple arithmetic 1-year average as it considers that:

- there is serial correlation present in the UK returns data.
- the investor perspective, which would imply an average holding period of 10-20 years, is the relevant one for the estimation of TMR as (1) Ofwat's primary objective is to secure investment and (2) capital budgeters would use company-specific WACC for discounting, rather than the allowed return.

The application of these criteria is consistent with the September 2023 report, which considered that the simple 1-year arithmetic average should be used unless compelling reasons – i.e. the presence of serial correlation or either perspective being more relevant – justify deviation from this approach. However, the application of the criteria to determine the appropriate approach to TMR estimation in the PR24 DD is flawed as discussed below.

5.2.2. Consideration of serial correlation

Ofwat assumes that returns are serially correlated, citing the serial correlation coefficient value for UK equity returns from DMS 2024 (-0.08). However, it does not address the statistical significance of this value. Ofwat also disregards evidence from the September 2023 report, which found no statistically significant evidence of serial correlation within UK historical equity returns series.

Ofwat contends that statistical tests are of limited use for detecting serial correlation and that such correlation should be *expected* in the returns data. It notes that:

- If returns were truly uncorrelated, the variance ratio would be higher than observed; however, Ofwat acknowledges that the observed variance ratio falls within the 95% confidence interval for a series without serial correlation.
- "*A degree of serial correlation in returns is a key premise underpinning the use of long-run average historical returns to identify the TMR*"[114].
- At the RIIO-2 CMA appeals, the CMA accepted Ofgem's arguments that statistical significance was "*extremely hard to find*"[115] in this area and that a lack of serial correlation "*would imply that commonly used valuation criteria (such as price-earnings ratios) were spurious information in terms of predicting whether returns were likely to be high or low in the future*"[116].

First, it is not appropriate to assume that serial correlation is present by default and must be *disproven*. Instead, the burden of proof lies in demonstrating its presence, as serial correlation is not a default feature of data but rather a condition that must be established through empirical analysis. Consistent with this, the absence of serial correlation is considered the null hypothesis in conventional statistical testing.

There is no statistically significant evidence of serial correlation based on the empirical analysis undertaken in this Report. The serial correlation coefficient value cited by Ofwat from DMS 2024 is not statistically significant[117] and should not be relied upon to inform the approach for the estimation of ex post TMR. Furthermore, it appears to be inconsistent for Ofwat to dismiss the value of statistical testing while also citing a serial correlation figure from DMS 2024 which itself appears to have been derived through statistical analysis.

Second, while the variance of the series may be lower than what would be observed if returns were uncorrelated, as acknowledged by Ofwat, this variance falls within the confidence interval of the theoretical variance ratio for a series without serial correlation. Consequently, this observation does not provide sufficient evidence to conclude that serial correlation is present.

Third, a degree of serial correlation in returns is not a necessary premise for using long-run average historical returns to estimate the TMR. Instead, the use of historical returns to estimate TMR is

[114] Ofwat (2024), PR24 Draft Determination, Aligning risk and return appendix, p. 30.
[115] CMA (2021), RIIO-2 Final Determination Volume 2A: Cost of equity, para. 5.250.
[116] Ibid.
[117] DMS 2024 does not comment on the statistical significance of this value, However, the value can be replicated by applying the Cumby-Huizinga statistical test to the UK return series which allows for the examination of statistical significance.

grounded in the principle that these returns represent a reasonable expectation of future performance based on historical data.

Fourth, although the detailed submissions by Ofgem to the CMA at RIIO-2 regarding the implications from valuation criteria are not publicly available for scrutiny, the commentary in the final determination suggests that this argument may not meet the required evidential standard. Specifically, the hypothesis that valuation models are reliant on serially correlated returns is not well substantiated and likely to be flawed. This is because:

- Adjusting historical returns based on a supposition from forward-looking valuation models would be fundamentally inconsistent with the historical ex post approach, which is intended to represent actual past performance.
- The predictive power of P/E ratios is fundamentally a function of the relationship between CoE, earnings, re-investment ratios and return on equity[118]. These relationships – and hence the effectiveness of P/E ratios in forecasting returns – are dependent on the quality of the underlying inputs and assumptions, particularly those concerning short- and long-term return on equity, as well as payout policies and retention ratios. This has no implications for serial correlation, nor does it imply any assumption of serial correlation.

Notably, Ofgem itself appears to have changed its view as it is proposing to estimate the ex post TMR for RIIO-3 based on the 1-year simple arithmetic average without any adjustments for serial correlation[119].

Overall, a departure from the 1-year simple arithmetic average on the grounds of serial correlation is not required or justified. This is driven by the fact that if real returns follow a random walk with stationary mean and standard deviation, the best estimate of future returns is the long run historical average.

5.2.3. Consideration of the appropriate perspective for estimating the TMR

TMR estimates will differ depending on whether one or both of investors' (the provider of capital) and capital budgeters' (the users of capital) perspectives are deemed to be relevant.

Ofwat contends that the investor perspective is the more relevant one as its primary objective is to secure investment. However, this position does not take into account that the regulatory WACC serves a dual purpose: it facilitates investors in calculating the expected future value of their investments in regulated companies, and it assists regulated companies in determining present values for capital budgeting decisions. This regulatory WACC is essential for both parties and plays a significant role in guiding investment and financial planning within the regulated environment. Given that both perspectives are equally relevant, the regulator's determination of the TMR should give equal consideration to both. The CMA recognised this point at PR19, noting that "*there is no reason to conclude that one perspective, either that of the capital budgeter or of the portfolio investor, is 'correct'*"[120].

Ofwat additionally considers that capital budgeters would use a company-specific WACC for discounting, rather than the allowed return, suggesting that the regulatory WACC need not accommodate the requirements of capital budgeters. This assumption is flawed.

First, the regulatory WACC is estimated for a notionally structured company, based on an assumption in the DD of no out- or under-performance at the P50 level. In this context, the allowed return and the company-specific WACC are conceptually indistinguishable[121]; assuming otherwise would invalidate the notional construct. Therefore, a distinction between the allowed return and the company-specific WACC does not apply in this notional framework.

[118] This is shown mathematically in Appendix D.
[119] Ofgem (2024), RIIO-3 Sector Specific Methodology Decision – Finance Annex, para. 3.120, 3.123.
[120] CMA (2021), PR19 Final Determination, para. 9.328.
[121] If the two concepts were not indistinguishable, the notional company would require some form of adjustment (in either direction) to ensure it represented a 'fair bet' for investors, as the asymmetry would need to be priced to ensure cashflows equate to the notional allowed return.

Second, from an actual company perspective, while the capital budgeter would use a company-specific WACC for discounting, the allowed return remains a critical factor for investors. The comparison between the allowed return and the required return is integral to investor decision-making. Thus, both the allowed return and the company-specific WACC are relevant in this context.

Overall, as both perspectives are equally valid, the correct approach in a regulatory setting – as noted by Schaefer (2020)[122] – is to provide a 'neutral' estimator of market return in the form of the long-run arithmetic average. Capital budgeters will then make positive adjustments, while compounders will make negative adjustments, to obtain unbiased figures for their specific requirements. If the rate provided is not neutral, there is a risk of rate distortion when applied from the opposite perspective.

5.2.4. TMR estimate from the historical ex post approach

The evidence presented in this section implies that there are no compelling reasons to depart from the simple 1-year arithmetic average in the estimation of the ex post TMR for PR24. This is because (1) there is no statistically significant evidence of serial correlation and (2) both investor and capital budgeter perspectives are relevant which requires the estimation of a neutral TMR in the form of the long-run arithmetic average.

The table below sets out the results from the primary approach and the cross-check using the geometric-plus-conversion-factor approach. Both the primary approach and the cross-check imply a TMR of 6.93 CPIH-real. This estimate is slightly higher than the PR24 DD point estimate of 6.87% and slightly lower than the midpoint of the CMA's range of 6.55 – 7.46%[123] at PR19, reflecting the influence of the most recent returns data.

Table 13: Ex post TMR estimates

CPIH-real	Assumption
Primary approach	6.93%
Cross-check based on geometric-plus-conversion-factor approach	6.87%

Source: KPMG Analysis

5.3. Estimation of TMR using the historical ex ante approach

This Report adopts a historical ex ante TMR estimate of 6.75% CPIH-real, derived as the midpoint of the range based on (1) the DMS decompositional approach and (2) the implementation of the Fama-French dividend discount model. Both approaches utilise data directly from DMS 2024. This figure compares to a midpoint estimate of 6.29% CPIH-real in the PR24 DD.

The overall approach adopted in this Report aligns with the PR24 DD and the CMA's methodology at PR19. However, it uses the newly extended DMS dataset for both approaches, substituting the BEGS[124] data due to known shortcomings. Estimates are derived directly on a CPIH-real basis, thereby obviating the need for a -35bps COLI-CED adjustment.

[122] Steven Schaefer (2020), Comments on CMA views on Estimating Expected Returns.
[123] CMA (2021), PR19 Final Determination, para. 9.334. 5.6 – 6.5% RPI-real, translated into CPIH using the CMA's wedge of 0.9%.
[124] The Barclays' Study calculates equity returns between 1899 and 1935 based on an index constructed by Barclays consisting of the 30 largest shares by market capitalisation in each year; between 1935 and 1962, they are calculated from the FT 30 Index, and from 1962 onward, they are derived from the FTSE All-Share Index.

5.3.1. Ofwat's approach in the PR24 DD

The PR24 DD ex ante TMR range is 5.98 – 6.60%, with a midpoint of 6.29%. This range is higher than that estimated in the PR24 FM due to substantial methodological changes. Specifically, Ofwat has removed two novel and untested approaches[125] and implemented some analytical improvements to the retained approaches. The table below summaries the PR24 DD approach.

Table 14: Ofwat's methodology for estimating ex ante TMR

Approach	Description	Changes from FM Approach
DMS decompositional approach	Combines the UK-specific geometric mean dividend yield and real dividend growth assumptions from DMS with adjustments for (1) geometric-to-arithmetic-mean conversion, (2) differences between COLI-CED inflation[126].	The adjustment for serial correlation has been removed as the original Fama-French (2002) DGM does not feature such an adjustment. The conversion factor is now calculated as half the variance of log returns for the UK, as opposed to the generic 1.50% used in the PR24 FM based on World data.
Fama-French DGM approach	Combines the UK-specific geometric mean dividend yield and real dividend growth assumptions from BEGS data with adjustments for (1) geometric-to-arithmetic-mean conversion, (2) differences between COLI-CED inflation and (3) RPI-CPIH wedge.	The adjustment for serial correlation has been removed.

Source: KPMG analysis and PR24 DD

These adjustments have materially increased the ex ante TMR range relative to the PR24 FM. However, the range remains understated, primarily due to continued reliance on BEGS data. Ofwat did not adopt the alternative composite index proposed in the September 2023 report, noting its lack of peer review, its unpublished status and absence of a track record of use in prior regulatory determinations unlike BEGS and DMS. The selection of the appropriate dataset for ex ante TMR estimation is discussed in detail below.

5.3.2. The appropriate data for ex ante estimates

BEGS has well documented and material flaws that render it unsuitable for the derivation of a robust TMR estimate. This is most evident when the constituents of the BEGS index are benchmarked against reputable academic research. The September 2023 report pointed to research from two sets of authors that cast doubt on the robustness and suitability of BEGS data for the estimation of regulatory TMR[127].

In the PR24 DD, Ofwat only comments on one cited paper (Foreman-Peck et al. (2011)) and attributes the differences in constituents compared to BEGS to the former's use of "*a more specific and time-bound criterion*" for constituent selection.

[125] Ofwat amended its approach to exclude estimates based on the World index. Ofwat recognised that – in line with the September 2023 report – different legals systems would have a bearing on the relevance and comparability of returns from the World index for the estimation of PR24 TMR. It considered that reflecting the role of different legal systems is an added complexity and that the use of a purely UK-derived TMR may be more aligned with the use of other CAPM components that also derive from UK data.

[126] This adjustment is to reflect that the DMS data uses COLI in the early years, which is a viewed as a less robust dataset than the CED equivalent. For example, there are known issues with the weightings used for different categories of consumer expenditure. These are discussed and addressed in O'Donoghue et al (2004), within which the CED is derived. The value of the adjustment is based on the CMA's PR19 decision.

[127] The research undertaken by Foreman-Peck and Hannah and Campbell, Grossman, and Turner is published in highly respected, peer-reviewed journals. Based on this research one would expect railway companies to denominate the BEGS index in early 1900s, but they are absent from the index. Foreman-Peck, J. and Hannah, L. (2011), 'Extreme divorce: the managerial revolution in UK companies before 1914' and Foreman-Peck, J. and Hannah, L. (2013), 'Some consequences of the early twentieth-century British divorce of ownership from control' and Campbell, G., Grossman, R. and Turner, J. (2021), 'Before the cult of equity: the British stock market, 1829–1929',

The 'Blue Chip' index constructed by Campbell, Grossman, and Turner (2021)[128] is conceptually equivalent to the BEGS index for the period 1899-1935, as both indices select constituents based on market capitalisation. A comparison of the membership of (1) the Blue Chip index in 1929 and BEGS in 1934 and (2) the Blue Chip index in 1870 and BEGS in 1899 shows material differences. Railway companies are included in the Blue Chip index in both 1870 and 1929, consistent with Foreman-Peck et al. In contrast, railway companies are absent from the BEGS list in both 1899 and 1934. This corroborates the view that the differences between Foreman-Peck et al. and BEGS are more likely due to limitations in the BEGS dataset.

Historically, there has not been a published and peer reviewed alternative dataset that could replace BEGS for regulatory decision-making. DMS – the main source of historical returns information – only provided calculated values for the Decompositional approach and did not include the granular data[129] required to either replicate estimates under this approach or implement the Fama-French DGM approach.

However, this is no longer the case as DMS 2024, for the first time, contains the data necessary to implement both Decompositional and Fama-French DGM approaches. The availability of this data eliminates the need for alternative sources and ensures internal consistency with the ex post estimates.

The overall purpose of historical ex ante approaches is to *"identify investors reasonable TMR expectations by* ***using historic data but making adjustments*** *to take into account one-off good or bad 'luck' that investors might not expect to be repeated in the future"*[130] (emphasis added). This purpose is best served by ensuring that ex ante estimates adjust historical data from the same source as used for the historical ex post estimate.

This Report adopts the DMS data for both ex ante approaches.

5.3.3. TMR estimate from the historical ex ante approach

DMS Decompositional approach

This Report adopts the same approach as the PR24 DD but re-calculates the ex ante estimate directly in CPIH terms instead of using the published value in Table 12 of DMS 2024[131] and converting it to CPIH. The values cited in this table are quoted in CPI-real terms based on the DMS' own series, which is based on COLI[132] in the earlier years. COLI is rated as a lower quality data series by the ONS[133] and has been recognised to result in overstated real values. Consequently, when using the estimate from DMS regulators have historically applied a downwards COLI-CED adjustment.

As it is now possible to replicate the values in DMS Table 12, it is also possible to replace the DMS CPI series with a CPIH inflation series in the calculation. Expressing returns directly in CPIH terms is a more precise approach which eliminates the impact of COLI at source, meaning that there is no empirical or conceptual requirement to apply a COLI-CED adjustment.

[128] Campbell, G., Grossman, R. and Turner, J. (2021), 'Before the cult of equity: the British stock market, 1829–1929'.
[129] The DMS data previously lacked a timeseries of the detailed splits between returns from dividends and capital gains.
[130] CMA (2021), PR19 Final Determination, para. 9.340.
[131] DMS 2024, Table 12, p.76.
[132] COLI is viewed as a less robust dataset than the CED equivalent. For example, there are known issues with the weightings used for different categories of consumer expenditure. These are discussed and addressed in O'Donoghue et al (2004), within which the CED is derived.
[133] The ONS notes that COLI has 'relatively limited coverage in terms of both products and population, and concerns about the quality of the weights. See ONS, Consumer Price Indices Technical Manual – 2007, p73 available here.

Table 15: Estimation of the ex ante TMR under the DMS Decompositional approach

	DMS Decompositional approach estimated in CPIH directly	The PR24 DD	Cumulative differential
Geometric mean dividend yield	4.55%	4.55%	-
Growth rate of real dividends	0.65%	0.75%	(0.10%)
Unadjusted ex ante TMR	5.20%	5.30%	(0.10%)
Geometric-to-arithmetic conversion	1.62%	1.65%	(0.13%)
COLI-CED adjustment	0.00%	(0.35%)	0.22%
Ex ante TMR (arithmetic)	**6.82%**	**6.60%**	**0.22%**

Source: KPMG analysis

Applying the Decompositional approach in CPIH terms results in a decrease of the growth rate by 10bps. This is unsurprising, given the COLI series is known to be upwards biased. At the same time, the fact that the growth rate decreased by only 10bps suggests that the 0.35% adjustment was likely overstated[134].

The net impact is a 22bps increase in the estimate relative to the PR24 DD.

Fama-French DDM approach

The Fama-French DGM approach adopted in this Report follows the same methodology as the PR24 DD, though it substitutes the BEGS series with DMS 2024 data.

The Fama-French DGM approach is similar to the DMS decompositional approach, though they differ in averaging methods. As detailed in the 2002 paper[135], the former uses arithmetic averages for dividend yield and growth rate. When projected forward these averages yield an equivalent of an expected geometric return. It is necessary to then apply an adjustment to account for the fact that dividend growth is less volatile than price growth[136].

[134] The adjustment was originally estimated based on differences in ex post data, not ex ante. Adjusting the inflation at source is significantly more accurate and requires much less subjective judgment.

[135] Fama, E. and French, K. (2002), 'The Equity Premium'.

[136] This is the same approach as applied by Ofwat, which this Report has confirmed by replicating the numbers in the PR24 FM. Ofwat refers to the figures as geometric averages in the DDs/FM as in practice they are geometric averages.

Table 16: Estimation of the ex ante TMR under the DMS Decompositional approach

	Fama-French DGM approach using DMS Data	Fama-French DGM approach using BEGS Data (Ofwat)	Cumulative differential
Average dividend yield[137,138]	4.41%	4.42%	(0.03%)
Average dividend growth rate	1.74%	0.95%	0.76%
Unadjusted ex ante TMR	6.13%	5.38%	0.76%[139]
Bias adjustment	0.53%	0.61%	0.68%
Ex ante TMR (arithmetic)	**6.68%**	**5.98%**	**0.68%**

Source: KPMG analysis

Replacing BEGS with the DMS 2024 data – a reputable and well-established dataset with a long track record of being used in the estimation of regulatory returns – increases the TMR estimate from this approach by approximately 68bps.

TMR estimate from the historical ex ante TMR approach

The two approaches adopted in this Report result in an ex ante TMR range of 6.68% to 6.82% CPIH-real. The overall methodology is consistent with that adopted in the PR24 DD and by the CMA at PR19. The increase in the estimates is driven by data improvements resulting from additional information being made available in DMS 2024.

Table 17: Ex ante TMR estimates

Parameter	Assumption
DMS decompositional approach	6.82%
Fama-French DGM approach	6.68%

Source: KPMG analysis

5.4. Derivation of the TMR range for PR24

This Report derives a TMR range of 6.75 – 6.93% CPIH-real compared to the PR24 DD range of 6.29 – 6.87%. The key drivers of differences with the DD range are ex ante estimates, where this Report (1) uses DMS 2024 rather than the BEGS study to implement the Fama-French DGM approach and (2) calculates the DMS Decompositional approach directly in CPIH terms.

The TMR midpoint in this Report of 6.84% is aligned with the CMA PR19 midpoint of 6.81%. This is in line with the standard regulatory assumption that the TMR is a relatively stable parameter.

Table 18 sets out the TMR estimates derived in this Report based on approaches best justified based on a balanced evaluation of the most current market data, pertinent financial literature, and relevant regulatory precedent.

137 Fama and French (2002) calculate a real dividend based upon opening market values. Conversely, DMS Table 12 appears to be contemporaneous dividend yields that are not adjusted for inflation.

138 DMS provides indices for total returns and capital gains, necessitating the formulation of an income index. Fama and French calculate a real dividend yield based on the opening value of the price index. Depending on the assumptions underpinning DMS data, additional transformation may be required to ensure the inputs are compatible with the Fama-French calculation. If the dividend stream is assumed to be continually reinvested, DMS inputs can be used in the Fama-French without additional transformation. If the dividend stream is assumed to be reinvested once at the end of the year, it needs to be divided by the opening price index. DMS does not explicitly state the assumed method. Clarification from the authors revealed that pre-1955 data assumes annual reinvestment, while post-1955 data assumes dividends are reinvested when received (although monthly data is not available). The calculation in this report has been tailored to accommodate this switch in assumptions. However, maintaining the pre-1955 assumption of annual reinvestment would increase the Fama-French estimator by approximately 23bps.

139 Rounding in Ofwat's estimate causes a +/-1bps variance.

Table 18: Summary of TMR evidence

CPIH	Lower bound	Upper bound
Historical ex post	6.93%	
Historical ex ante	6.68%	6.82%

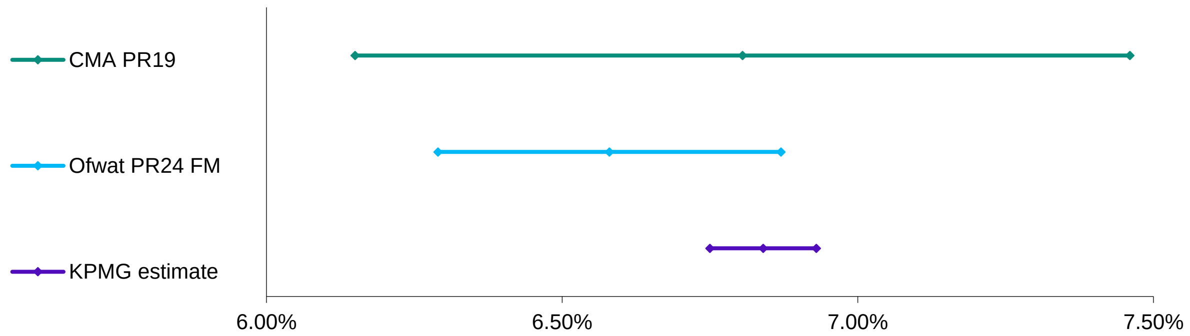
Source: KPMG analysis

Consistent with the PR24 DD, this Report uses the midpoint of both estimates to form the overall TMR range. This Report therefore adopts a range of 6.75% to 6.93% CPIH-real, with a midpoint of 6.84%.

This midpoint aligns closely with the CMA's PR19 point estimate of 6.81%[140]. This is in line with the standard regulatory assumption that the TMR is a relatively stable parameter and that estimates developed in quick succession should be broadly consistent with one another. In contrast, the point estimate from the PR24 DD is 23bps lower than the CMA's and falls within the lower half of the CMA's range.

The figure below compares the KPMG TMR range to the CMA PR19 and PR24 FM ranges.

Figure 2: The KPMG TMR range compared to CMA PR19 and PR24 DD



The KPMG estimate is fully encompassed within the CMA's PR19 range. The significant narrowing of the range in this Report compared to CMA PR19, is primarily due to data-driven factors:

- The lower bound of the KPMG range is materially higher than the CMA's, mainly due to the incorporation of new data from the DMS dataset that was not available to the CMA during the PR19 redetermination. This new information affects the implementation of both ex ante approaches.
- The upper end of the KPMG range is lower than the CMA's primarily due to the movement in market data since the CMA's final decision.

By contrast the Ofwat approach implies TMR estimates in the lower half of the CMA's range.

[140] CMA (2021), PR19 Final Determination, Table 7.

6. Beta

Beta measures the sensitivity of a firm or sector's returns to the overall market's returns. This sensitivity reflects the level of systematic risk which affects the entire market and cannot be diversified away.

For the allowed CoE to represent a true expected return over the chosen investment horizon, beta should be estimated such that it is expected to apply over a forward-looking period consistent with that used to estimate other CAPM parameters. This has been recognised by both Ofwat and the CMA. For example:

- In the PR24 DD, Ofwat notes that its "*estimate of beta attempts to proxy for market participants' view of long-run (10-20 year) systematic risk exposure over 2025-30*".
- During the H7 appeal, the CMA noted that "*the cost of capital should reflect the forward-looking risk of investing in the regulated activities*"[141] and that "*the purpose of the asset beta assessment is…to determine a forward-looking estimate that will capture appropriately the systematic risks expected by investors* [in HAL] *in the long run*"[142].
- The CMA further noted that "*the available evidence on risk is backward-looking*"[143] and that "*it does not follow that betas based on historical data are necessarily the most appropriate guide to the future assessment of risk*"[144].
- In the SSMD for RIIO-3, Ofgem noted that "*regulators typically use historical beta data as the base of the estimate for beta on a forward-looking basis. This means that estimating beta is easier in a 'steady state' environment than a dynamic environment*"[145] and that "*to ensure that we are capturing the risk of the sector on a forward-looking basis as accurately as possible, we have considered ways to make our beta assessment more robust*"[146].

The exam question when estimating beta is therefore how to use available comparators and estimation techniques to derive estimates that best reflect systematic risk on a forward-looking basis over the assumed long-run investment horizon.

In this context, this section develops a beta estimate that reflects the systematic risk of the sector over the forward-looking 20Y investment horizon. It is structured as follows:

1 It sets out a summary of the methodology and the estimate adopted in the PR24 DD.

2 It considers the nature and materiality of the distortive events affecting water company betas and their appropriate treatment in the estimation of the forward-looking beta for PR24.

3 It considers the impact of the step up in capital intensity on forward-looking risk and beta estimation.

4 It considers which available comparators can most closely capture the underlying systematic risk for the sector on a forward-looking basis.

5 It comments on available data frequencies and averaging techniques and their relevance and reliability for the estimation of PR24 beta.

6 It derives an overall beta range for PR24.

[141] CMA (2023), H7 Final Determination, para. 6.69.
[142] Ibid., para. 6.87.
[143] Ibid., para. 6.69.
[144] Ibid., para. 6.74.
[145] Ofgem (2024), RIIO-3 Sector Specific Methodology Decision – Finance Annex, para. 3.192.
[146] Ibid., para. 3.192.

6.1. Ofwat's approach to and estimate of beta

Ofwat estimated a range for unlevered beta of 0.26 to 0.29 in the PR24 DD. This range is based on the approach set out in the table below.

Table 19: Ofwat's approach to beta estimation

Component	Approach
Treatment of distortive events	15 years of data incorporated into the estimate to capture diverse range of systematic risk events.
Treatment of forward-looking risk	No adjustment for forward-looking risk. Ofwat's approach assumes that risk is unchanged relative to that implied by historical data.
Comparators	SVT and UUW only. No weight attached to PNN.
Data frequency	Daily frequency betas are the primary basis of estimation, but weekly and monthly betas are also considered.
Estimation windows	2-, 5-, 10-year betas calculated but the range formed based on the latter two.
Averaging windows	Spot, 1-, 2-, and 5-year averages calculated but the range formed based on the latter two.
Debt beta	Debt beta of 0.10. This Reports adopts the same assumption.

Source: KPMG analysis and PR24 DD

6.2. Treatment of distortive events

The impact of distortions from Covid-19 and the Russia-Ukraine war on water company betas was both material and transient. The flight-to-safety (FTS) effect led to a notable reduction in the volatility ratio between SVT/UUW and FTSE All Share returns, causing a significant decrease in betas. This decrease, driven by the FTS effect, is temporary, as evidenced by empirical data on water company betas. Methods designed to address the impact of such distortive events indicate that unlevered beta estimates below 0.28, based on SVT/UUW data, would not be appropriate. By contrast, Ofwat has adopted 0.26 as the lower bound of the PR24 DD range.

6.2.1. The impact of Covid19 and Russia-Ukraine war on water company betas

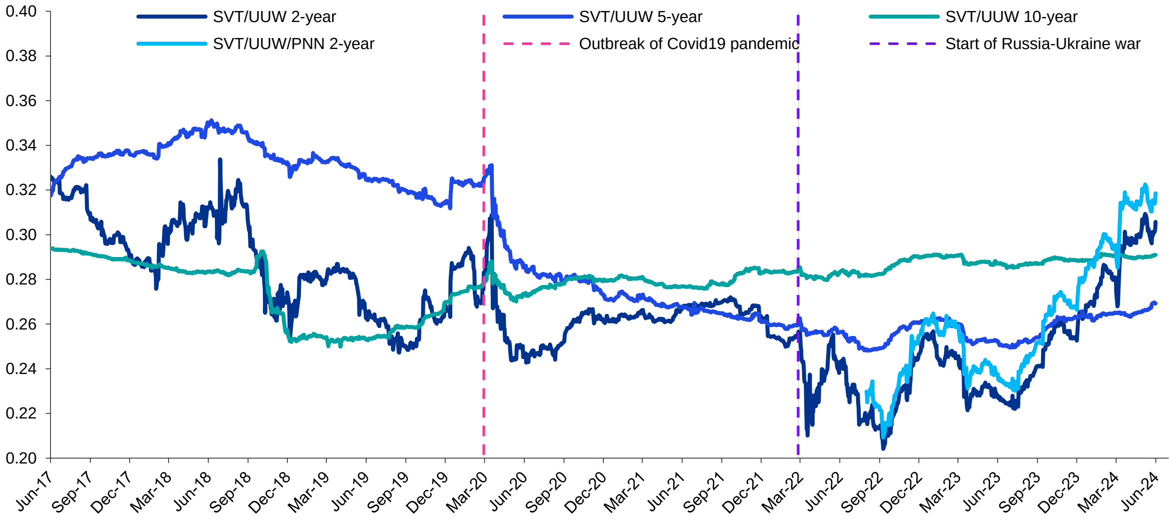
The estimation of a forward-looking beta which appropriately captures the systematic risks expected by investors over the long term requires careful consideration of distortive events and their potential impact on estimates of systematic risk over a long-run horizon. In the context of estimating betas for PR24, it is essential to consider how much weight should be assigned to data distorted by the Covid-19 pandemic, the Russia-Ukraine war, and their economic repercussions.

The impact of these events on water sector betas is both material and transient. It is driven by the 'flight to safety' (FTS) phenomenon, whereby investors shift from higher-risk to lower-risk assets during market turbulence. FTS is inherently temporary and linked to specific economic conditions, which is also evidenced by the empirical data on water company betas.

Since the onset of Covid-19, 2-year unlevered betas for SVT/UUW were consistently below the 5-year and 10-year betas, including after the start of the Russia-Ukraine war. This is intuitive as shorter-term betas are the most responsive to market movements and are more affected by distortions. However, from mid-December 2023, 2-year betas have been consistently higher than 5-year betas. Since March 2024, 2-year betas have exceeded 10-year betas. The sustained increase of 2-year betas suggests that at a minimum there has been a reversal of the Covid-19 and Russia-Ukraine war distortions. The increase of 2-year betas above 10-year betas could also signal that the market is pricing in higher systematic risk for water stocks. For example, market commentary in relation to the

DD indicates that cost and performance risks to which the sector is exposed are increasing. As such, this Report adopts December 2023 as the end date for the distorted period.

Figure 3: Evolution of SVT/UUW unlevered betas



Source: KPMG analysis using Refinitiv Eikon and Refinitiv Datastream data.

Based on this FTS end date, the table below shows the impact of distortions on various beta estimates compared to those observed in February 2020. The numbers in brackets indicate the extent of the decrease relative to undistorted betas. Ofwat considers that Covid19 is an "*uninfluential factor*" and does not warrant a reweighting approach applied by the CAA. The table below indicates that this position is not consistent with the empirical data.

Table 20: Impact of distortions due to Covid19 and Russia-Ukraine war

Timeframe	Spot	1-year average	2-year average	5-year average
2-year	-0.02 (-7%)	-0.03 (-10%)	-0.04 (-16%)	-0.07 (-22%)
5-year	-0.06 (-19%)	-0.07 (-21%)	-0.08 (-23%)	-0.03 (-10%)
10-year[147]	0.01 (+3%)	0.03 (+10%)	0.02 (+7%)	-0.00 (-2%)

Source: KPMG analysis using Refinitiv Eikon and Refinitiv Datastream data.

The effect of the FTS behaviour is to simultaneously (1) increase prices and reduce the return of lower risk assets; and (2) lower prices and increase the expected return on higher risk assets.

However, Ofwat considers that a flight to safety (FTS) would primarily affect enterprise value (EV) gearing, leading to higher unlevered betas due to a reduced de- and re-levering adjustment. There are two critical flaws with this argument.

First, the argument appears to assume that equity beta would remain unchanged, leading to a higher unlevered beta due to lower observed gearing. However, this assumption is not justifiable because:

- Equity beta reflects both business and financial risks. Lower gearing would imply lower financial risk, which would likely lead to a change in equity beta.
- Unlevered beta solely reflects underlying business risk. It should not change as a result of changes in gearing.

Second, the argument does not take into account how market turbulence affects the perception of the sector's riskiness *relative* to the market.

[147] The observed increase in 10-year betas is likely driven by the relatively lower betas before the regime change at PR14 being assigned less weight relative to 2020. Refer to section 8 of the September 2023 report.

These issues are explored in more detail below.

Equity beta can be decomposed to the following:

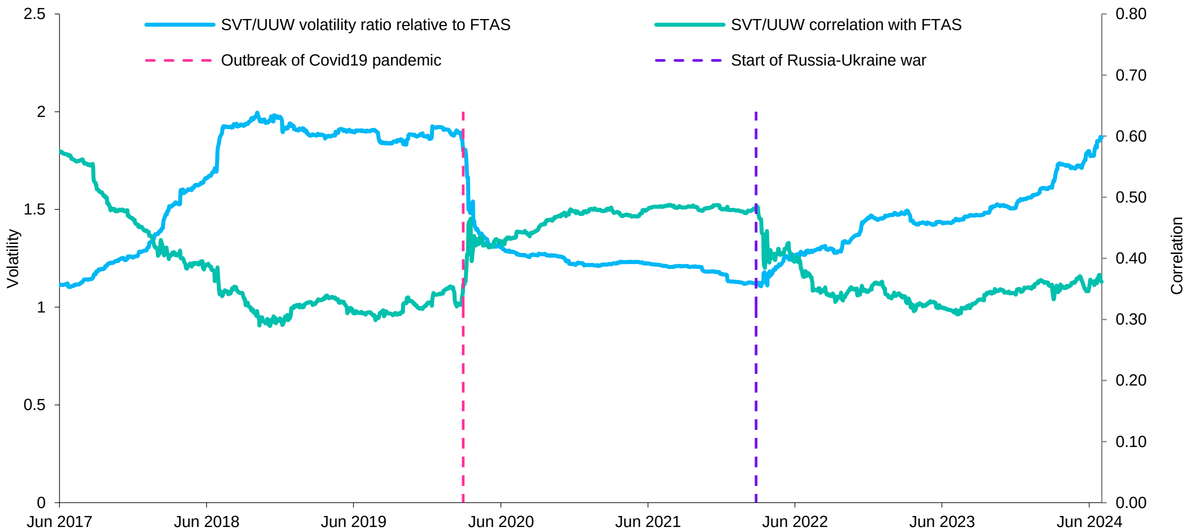
$$\beta_i = \rho_{i,m} \frac{\sigma_i}{\sigma_m}$$

Where:

- $\rho_{i,m}$ is the correlation between the returns of a company and the market portfolio.
- σ_i is the standard deviation of a company's returns.
- σ_m is the standard deviation of the market portfolio's returns.
- $\frac{\sigma_i}{\sigma_m}$ is the volatility of the company's returns relative to the market portfolio's returns (volatility ratio).

The chart below illustrates the movement of the correlation between SVT/UUW and the FTSE, as well as the volatility ratio between SVT/UUW and the FTSE over a 2-year rolling window. A 2-year window is chosen for illustrative purposes due to its responsiveness to market information which allows for a more direct capture of the impact of the outbreak of Covid19.

Figure 4: 2-year correlation and volatility ratio between SVT/UUW and the market



Source: KPMG analysis using Refinitiv Eikon and Refinitiv Datastream data.

The pandemic had a material impact on both metrics:

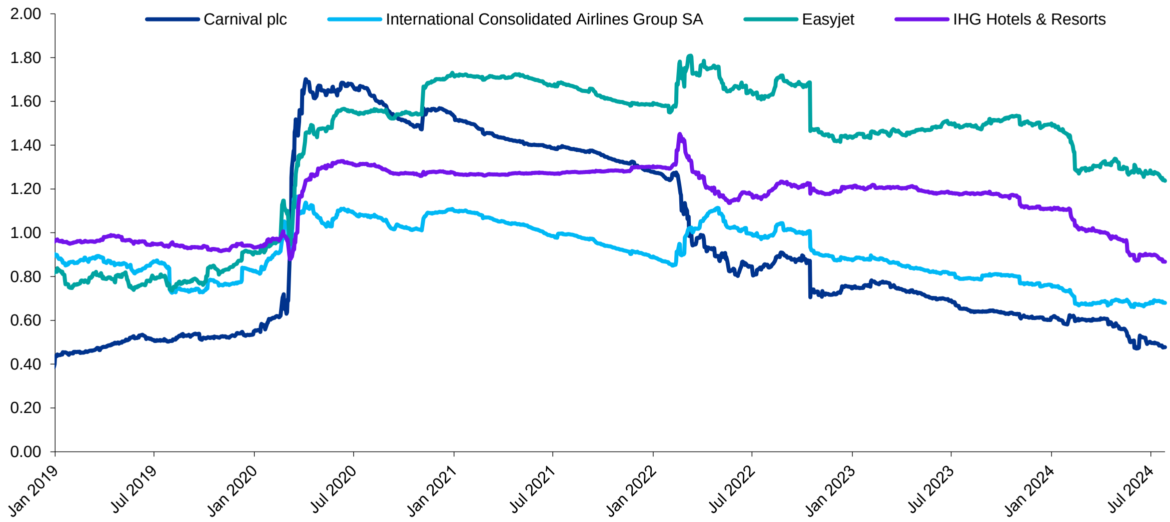
- The correlation between SVT/UUW returns and the market, which was at relatively low levels fromn late 2018, increased significantly at the onset of the Covid-19 pandemic. This elevated correlation persisted for approximately two years before reverting to pre-pandemic levels.
- Conversely, the volatility ratio, which had been increasing and stabilising at historically high levels by late 2018, decreased significantly at the onset of the pandemic. This decrease is in line with expectations for regulated water companies during periods of macroeconomic volatility, which are generally considered defensive stocks and thus less sensitive to market downturns. The volatility ratio is now on an upward trajectory, as reflected in the increasing 2-year betas.

The decrease in the volatility ratio offset the increase in correlation, leading to a net reduction in equity betas. Had gearing remained constant, this reduction would have resulted in a higher reduction in unlevered betas. However, a reduction in gearing *partially mitigated* the decrease in equity betas, resulting in unlevered betas that were higher than they would have been otherwise.

Betas measure relative risk compared to the overall market index. Consequently, betas may increase or decrease due to fluctuations in broader market risk, even if the inherent risk of the underlying business remains unchanged. Intuitively, it is expected that during periods of market stress, betas of defensive stocks would decrease, while those of discretionary sectors would increase, due to changes in the relative volatility of these stocks compared to the broader market. Defensive stocks are typically less sensitive to economic downturns as the demand for their services remains relatively stable regardless of the economic cycle. By contrast, discretionary sectors, such as travel and leisure, are more sensitive to economic fluctuations as consumer spending on non-essential goods and services tends to decrease during economic downturns.

Covid19 represented an extraordinary level of stress and disruption for companies in the travel and leisure sectors. The chart below illustrates the evolution of unlevered betas for companies these sectors. These companies experienced a significant increase in betas at the onset of the pandemic, although this increase was temporary, and the betas are now trending downwards. This case study illustrates that an increase in unlevered betas as a result of market turmoil is a characteristic of cyclical, discretionary stocks which are inherently riskier than water companies. Furthermore, as the value-weighted beta of the overall market is assumed to be 1, the observed increase in betas for discretionary sectors must be accompanied by a corresponding decrease in betas for sectors perceived as less risky, such as utilities. This ensures the market beta remains balanced at 1.

Figure 5: Evolution of 2-year unlevered betas for companies in the travel and leisure sectors



Source: KPMG analysis using Refinitiv Eikon and Refinitiv Datastream data.

The economic impact of the Russia-Ukraine war is also temporary and not correlated with the duration of the war itself. Initially, the war triggered a massive shock to the global economy, especially to energy and food markets, squeezing supply and pushing up prices to unprecedented levels and exacerbating the inflationary pressures building up in the post-pandemic recovery. According to the Bank of England, the main channel through which the war affected the UK economy was inflation[148] and the war was one of the shocks driving high inflation during 2022 and 2023[149][150]. Whilst the war continues, the corresponding economic impacts have become significantly less pronounced over time, with BoE noting that "*inflationary pressures from external cost shocks have dissipated over the past 18 months*"[151]. In consequence, this Report assumes that the economic impacts of the war are transient in nature.

The material and transient nature of these distortive events on water company betas means that placing excessive weight on data from these periods would distort beta estimates intended to reflect systematic risk over a long-term investment horizon.

[148] Bank of England (May 2022), Monetary Policy Report.
[149] Bank of England (August 2023), Monetary Policy Report.
[150] With the other two shocks being the pandemic itself and a big fall in the number of people available to work which is also linked to the pandemic.
[151] Bank of England (February 2024), Monetary Policy Report.

6.2.2. Consideration of approaches to address the impact of distortive events on water company betas

Regulatory precedents offer potential approaches for mitigating the impact of distortive events to derive a representative pricing of systematic risk over a long-term forward-looking window.

- At PR19, the CMA calculated beta estimates using February 2020 (i.e. before the onset of the Covid-19 pandemic) and December 2020 cut-off dates. It limited the weight assigned to estimates affected by distortions (i.e. December 2020 cut-off) by excluding outliers[152], which were all December 2020 estimates. It also set a range that encompassed the upper end of the data to December 2020 and the full range of that to February 2020[153]. The CMA considered that an economic crisis such as the one caused by Covid-19 is relatively rare and that would likely be over-weighted in its range of beta estimates. The approach adopted by the CMA is replicated in this Report.
- The CAA in the Final Decision for the H7 price control for Heathrow set a beta which assumed that a pandemic-like event would occur once in every 20 or 50 years and last 17 or 30 months[154]. This approach recognised that similar events may occur again in the future, but not with the same prominence implied by the then recent market data. CAA's objective was to ensure the impact of the pandemic was not over-represented in the asset beta estimate. A reweighting approach informed by the CAA's methodology is also considered in this Report. Notably, during the H7 appeal, the CMA considered that assigning bespoke weighting to historical data was "*in many respects…similar to standard regulatory practice*" with the main difference being that the CAA applied different weights to historical datapoints to reflect its view that historical betas (if taken unadjusted) would not be reflective of the forward-looking balance of risk[155].

These two approaches inform the analysis set out in the remainder of this subsection.

I The CMA PR19 approach

The CMA's PR19 approach is replicated below based on daily data in line with the focus in PR24 DD and this Report on daily beta estimates (see section 6.5).

Beta estimates are calculated using 2-, 5-, and 10-year estimation windows, alongside spot, 1-, 2-, and 5-year averaging windows, with data as at February 2020, June 2024, and March 2024 for comparison with the PR24 DD. Outlier testing, based on the interquartile range, did not identify any outliers. Average betas are calculated for each averaging window and timeframe.

Using the upper end of the estimates from June 2024 and the full range from February 2020, consistent with the CMA's approach, implies a beta range of 0.28 to 0.30.

Table 21: Average unlevered daily betas per timeframe (June 2024)

Timeframe	Spot	1-year average	2-year average	5-year average
Feb 2005 to Feb 2020	0.30	0.28	0.29	0.31
May 2009 to Jun 2024	0.30	0.27	0.27	0.27

Source: KPMG analysis using Refinitiv Eikon and Refinitiv Datastream data.

The same approach implies a range of 0.28 to 0.30 based on a March 2024 cut-off.

[152] The CMA identified and excluded outliers using a statistical rule based on the interquartile range. The CMA did not identify any outliers for the beta estimates as at 28 February 2020 (i.e. pre-Covid) but excluded both individual data points and headline estimates from the 31 December 2020 estimates as outliers. CMA (2021), PR19 Final Determination, para. 9.475.
[153] Ibid., para. 9.494.
[154] The CAA (2023), Economic regulation of Heathrow Airport Limited: H7 Final Decision, Section 3: Financial issues and implementation, para 9.83 and The CAA (2023), Economic regulation of Heathrow Airport Limited: H7 Final Decision, Section 3: Financial issues and implementation, section 9.
[155] CMA (2023), H7 Final Determination, para. 6.72.

Table 22: Average unlevered daily betas per timeframe (March 2024)

Timeframe	Spot	1-year average	2-year average	5-year average
Feb 2005 to Feb 2020	0.30	0.28	0.29	0.31
Feb 2009 to Mar 2024	0.28	0.27	0.26	0.27

Source: KPMG analysis using Refinitiv Eikon and Refinitiv Datastream data.

These ranges align with the 0.28 to 0.30 range determined by the CMA at PR19. In contrast, the lower bound of the PR24 DD range (0.26) is significantly lower.

II Reweighting approach

Adjusted betas are calculated based on the assumption that a distortive event which is similar in impact to the pandemic and war, would affect 1, 2 or 3 out of 20 years[156]. This recurrence frequency informs the weighting of distorted versus undistorted data.

Undistorted betas are calculated as at 28 February 2020, consistent with the CMA's approach at PR19, while distorted betas are calculated as at 18 December 2023. The calculations utilise several spot estimation windows: (1) from 2014 to the cut-off date, (2) a 10-year estimation window to the cut-off date, and (3) an average of 5-year and 10-year estimation windows to the cut-off date.

The analysis considers different assumptions regarding recurrence and estimation windows to mitigate the dependency on specific assumptions.

The analysis indicates an adjusted beta range of 0.28 to 0.32, compared to the PR24 DD range of 0.26 to 0.29.

Table 23: Betas adjusted to assume some reoccurrence of distortive events

Estimation window	Total number of distorted years out of 20		
	1	2	3
From 2014	0.32	0.32	0.31
10-year	0.28	0.28	0.28
Average of 5- and 10-year	0.30	0.30	0.30

Source: KPMG analysis using Refinitiv Eikon and Refinitiv Datastream data.

Both this approach and the replication of the CMA methodology suggest that beta estimates below 0.28 are not appropriate as they are significantly distorted by Covid-19 and the Russia-Ukraine war and are not representative of systematic risk on a forward-looking basis.

6.3. Treatment of forward-looking risk

PR24 capital programmes continue to imply increasing risk exposure for companies even after accounting for new risk mitigations introduced in the PR24 DD. This increase is not yet reflected in beta estimates, which lag in capturing the impact on share prices and total returns due to their reliance on historical data.

Analysis of non-financial UK stocks within the FTSE 350 reveals a positive and statistically significant relationship between capital intensity and beta. Consequently, beta estimates based on historical data for listed water companies are unlikely to fully account for forward-looking risks. Additional comparators and cross-checks are necessary to accurately capture and price these forward-looking systematic risks.

[156] This analysis differs from that included in the September 2023 report. That report effectively assumed that a distortive event would affect 2 years out of 20; this Report assumes that 1, 2, or 3 years would be affected. The September 2023 report also did not take into account data after the start of Russia-Ukraine war in February 2022. This Report calculates distorted betas as of mid-December 2023.

There is an unprecedented step change in the scale of required investment for PR24 and beyond, driven by environmental obligations. To the extent that these additional investments introduce new risks or amplify existing ones, after the application of regulatory mitigations, adjustments to required returns may be necessary to estimate risk-reflective and investable returns.

As a result, it is important to consider whether (1) the marked increase in capital intensity at PR24 changes capital delivery risk and the overall risk exposure of the sector; and (2) betas based on historical data can appropriately price this risk over a long-term forward-looking horizon.

The capital programmes for PR24 and beyond are likely to exacerbate exposure to several risk drivers – *inter alia,* higher complexity of spend, higher uncertainty in ex ante cost forecasts, supply chain risk, input price risk – and increase risk exposure relative to returns. Step changes in forward-looking risk have been highlighted by Moody's, who considers that "*risk of cost overruns or future underperformance has increased*"[157].

The analysis of the risk exposure implied by the PR24 DD Totex using KPMG's stochastic risk model (the KPMG model) finds that there is a material increase in Totex risk relative to PR19 even after accounting for new risk mitigations introduced in the DD (including increased cost sharing, true-up mechanisms for energy costs, Aggregate Sharing Mechanisms and greater use of gated allowances).

To assess the impact of increasing capex intensity on the RoRE range, the PR24 RoRE range from the KPMG model[158] is considered (1) based on a Totex range reflecting risk in previous price controls in line with the PR19 FD[159] (2) based on a Totex range reflecting forward-risk for PR24, holding all other risk factors constant. The change in the Totex RoRE is assumed to be predominantly driven by increased capex intensity.

The resulting variance in the total RoRE range (the average of P10-P50 and P90-P50) for PR24 Totex is *higher* than the corresponding variance based on PR19 Totex[160]. This is in line with CEPA's consideration of capital intensity, which notes that "*larger capex-to-RCV ratios create a greater potential impact on financial returns from cost efficiency incentives, relative to their base return. This can be shown by changes in Return on Regulatory Equity (RoRE)*"[161].

This risk analysis may underestimate the scale of incremental risk exposure driven by AMP8 capital programs due to its reliance on historical data from the water sector and the wider infrastructure project database complied by KPMG. Past data is unlikely to reflect the full extent of the delivery challenge that large infrastructure programmes will face going forwards and may understate forward-looking risk. For example, supply chains will be strained by unprecedented competition for resources due to simultaneous large-scale infrastructure investments across various sectors and globally, significantly impacting delivery risk for water companies.

The appropriate pricing approach for changes in risks depends on whether the drivers of higher risk are systematic (to be captured in beta), asymmetric (factored into the point estimate for CoE), or idiosyncratic (not reflected in pricing).

The drivers of increasing capital delivery risk are likely to have a systematic component, as they are linked to broader economy-wide factors. For example, factors contributing to increased supply chain risk include constraints in the availability of suppliers and materials, compounded by residual impact of disruptions from Brexit, Covid-19, and the war in Ukraine. The competition for resources from other

[157] Moody's (2024), Ofwat's draft determination increases sector risk, p.1.

[158] Moody's (2024), Ofwat's draft determination increases sector risk, p.1. KPMG risk analysis assesses, based on the available empirical evidence and historical sector performance data, whether the DD parameters and mechanisms allow the notional company to earn base allowed return on a median expected basis. The stochastic risk model is constructed to simulate the notional company's risk exposure in RoRE terms by key risk drivers, accounting for risk mitigations purposed by Ofwat in PR24 DD. In this report, the RoRE outputs are based on the "Unmitigated rebased" numbers in the club risk model, which is the scenario with full estimated risk exposure of the notional company under DD regulatory regime, but removing the miscalibration risk, i.e. assuming that companies are able to improve their performance to the levels required in AMP8 to meet the submitted BP targets.

[159] Sourced from Ofwat's published wholesale cost RoRE model in PR24 draft determination, which assumes a +/- 8.5% variance in wholesale Totex over/underspend based on the 2015-2020 data. This information would have been available at the time of PR19 Final Determination, thus this Totex is used as a stand-in for PR19 Totex RoRE.

[160] See Appendix B for detailed results.

[161] CEPA (2024) PR24 Cost of Equity, page. 78.

infrastructure projects adds to these pressures, while the scale and complexity of investments can stress the reliability and stability of the supply chain. These issues relate to broader economic and business environment factors. Similarly, incremental input price risks are influenced by macroeconomic factors that affect a wide range of industries and companies within the economy. As a result, the step change in capital intensity is likely to increase systematic risk and will need to be taken into account in beta estimation.

In the PR24 DD Ofwat noted that while not entirely discounting the possibility that the PR24 capex programme may increase systematic risk, it did not consider the plausible magnitude of such risk increases to support a departure from relying on econometric water company beta estimates.

Ofwat considers that the link between higher capital intensity and increased beta risk is weak. This Report investigates the relationship between capital intensity and beta based on the analysis of non-financial UK stocks included in the FTSE 350[162]. Portfolios formed from FTSE 350 constituents, which are well-diversified and hence 'look through' company-specific factors, can isolate the impact of capital intensity on market beta.

The analysis covers the period from 1 July 1993 to 28 June 2024. This timeframe reflects data availability on capex[163].

The capex-to-opening-total-assets ratio is used as a measure of capital intensity based on which stocks are ranked to form ten equally populated decile portfolios[164] each year. On average, there are 193[165] non-financial UK listed firms with capital intensity ratio available each year.

Table 24: Average capital intensity ratio for each decile (from FY1993/94 to FY2023/24)

Decile	Capital intensity ratio for each decile
1st	0.8%
2nd	1.8%
3rd	2.6%
4th	3.4%
5th	4.3%
6th	5.2%
7th	6.4%
8th	7.9%
9th	10.6%
10th	21.8%

Source: KPMG analysis using Refinitiv Datastream data

162 Financials firms are excluded from the sample, given that the interpretation and implications of ratios, such as the leverage ratio and book-to-market ratios, are different across financials and non-financials firms. Foreign firms are excluded to be consistent with regulatory approach of focusing on the UK listed stocks.

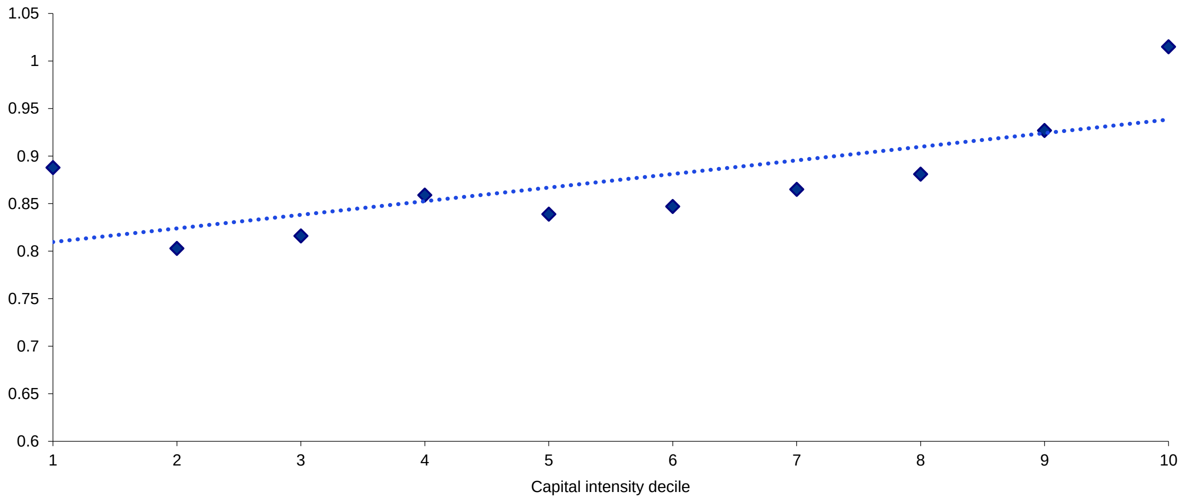
163 The earliest year with sufficient data availability for capex is 1993. Before 1993, more than 50 companies lacked capex data. In 1993, the number of companies with missing capex data dropped significantly to 2, and since then, an average of only 4 companies per year have missing capex data.

164 The portfolios get rebalanced as of July 1st each year to reflect the capital intensity ranking of the year. Stocks are weighted equally within deciles.

165 There are in total 5958 observations from FY 1993/94 to FY 2023/24, i.e. an average of 193 non-financial UK listed firms with capital intensity ratio available each year.

The CAPM beta is estimated for each decile portfolio. As shown in the figure below, a positive relationship between equity beta and capital intensity ratio is evident in the majority of decile portfolios.

Figure 6: Relationship between capital intensity and equity beta based on FTSE350 market-wide evidence



Source: KPMG analysis using Refinitiv Datastream data

The figure indicates a clear and statistically significant relationship between increases in capital intensity and betas. It is intuitive that first and last deciles are relative outliers as they will include firms with no capex and very significant capex respectively – and in consequence a linear relationship with adjacent deciles would not be expected.

Ofwat expects that betas would reflect signalled regulatory changes to some extent as share prices – which inform betas – incorporate views about the future, including news of future regulatory changes. As such it considers that there is a risk of double counting impacts if econometric estimates of betas are adjusted for forward-looking risk.

In principle, it is reasonable to expect the market to incorporate the impact of additional risks into prices once information about the scale of investment and related regulatory policies becomes widely disseminated and understood. However, there is a lag between the impact on share prices and total returns and when betas meaningfully reflect this new information, due to the reliance of beta estimates on historical data. This is consistent with the CMA's view from the H7 appeal that "*while at any point in time a stock's share price is expected to reflect the market's latest expectations of future cash flows and returns, assuming markets are efficient, it does not follow that betas based on historical data are necessarily the most appropriate guide to the future assessment of risk*"[166]. In practice, the scale of required investment has become clear only recently and whilst it is likely to be reflected in shorter-term estimates, it does not follow that it would be reflected in the long-term beta estimates used by Ofwat which assign significantly greater weight to periods with significantly lower investment levels.

Ofwat suggests that betas should reflect changes in risk but does not account for the material increase in 2-year betas in its DD beta estimates. This is particularly notable given that Ofwat commented on the importance of considering "*whether more recent beta data may indicate potential trends that may contradict the 0.26-0.29 unlevered beta range that we have implicitly anchored on 15 years of historical data*".

Ofwat also notes that if the capture of signalled regulatory changes in betas is "*imperfect, data from the affected period will in any case feed into the beta calculations used for the subsequent price control ensuring that data from that period is reflected in the allowed return – albeit with a lag*".

[166] CMA (2023), H7 Final Determination, para. 6.74.

However, the current investability of the price control cannot be contingent on future corrections of under-pricing, as investors base decisions on current market conditions and risk assessments. Additionally, relying on long-term beta estimates means that data from any single price control period will be significantly diluted and may not sufficiently influence beta estimates unless the methodology is revised.

Overall, this Report considers that delivery risk associated with capital programmes is increasing based on the PR24 DD. Capital programmes and associated risks faced in previous price controls are not a good guide for the forward-looking risk exposure. As a result, beta estimates calculated from historical listed water company data are unlikely to price forward-looking risk. Consideration of additional comparators and cross-checks is required to adequately capture and price in forward-looking systematic risks.

6.4. Selection of comparators

Additional data from PNN is both valuable and relevant for estimating the beta for PR24 as SVT and UUW reflect only a subset of the industry whose betas embed historical outperformance that is not representative of the notional company. To account for the limitations inherent in the PNN data, PNN has been excluded from determining the lower bound of the beta range in this Report.

Incorporating NG at the higher end of the beta range could better capture the forward-looking risk exposure for the water sector because (1) the regulatory frameworks for the two sectors are relatively similar, and (2) NG's historical RCV growth aligns more closely with the growth anticipated for water, (3) empirical evidence indicates that the market is pricing higher risk for water relative to energy.

6.4.1. Pennon (PNN)

Historically, SVT/UUW have been used as proxies for the systematic risk of the notional company as the only pure play listed water comparators.

PNN has been a pure play water company following the sale of its waste management subsidiary, Viridor, in July 2020[167]. Initially, its gearing was distorted due to the cash proceeds from the sale resulting in a net cash position. However, this impact was limited to one year can be adjusted for by normalising gearing. In any event, 2-year betas can be calculated from January 2024 onwards based on undistorted gearing data[168].

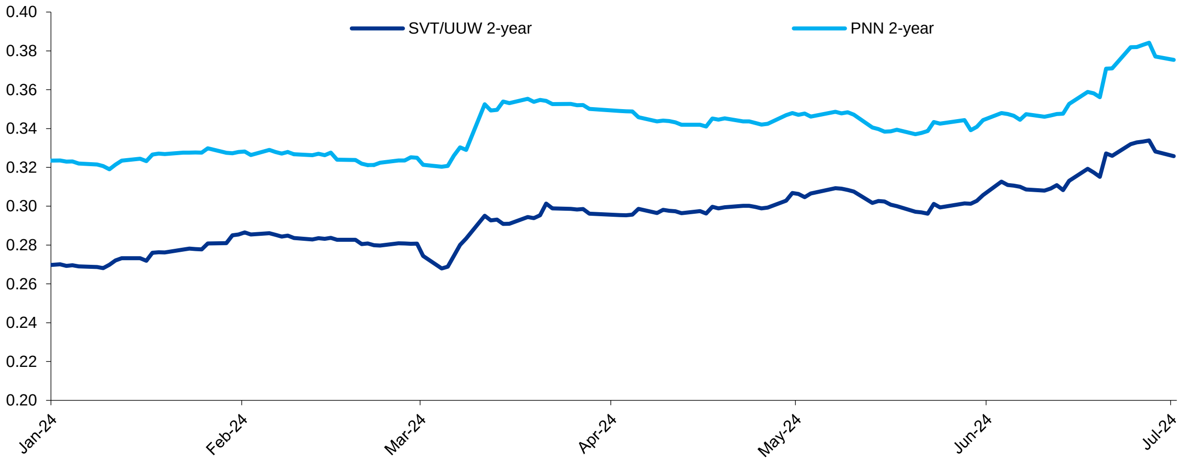
A comparison of the 2-year beta for PNN with the SVT/UUW beta indicates a material differential. In the PR24 DD Ofwat observed that SVT and UUW betas have tracked each other closely over time, while the PNN beta is more volatile and on average higher.

Ofwat questioned whether PNN's higher beta is a persistent feature of the historical data. It also challenged the use of the differential between 2-year betas for SVT/UUW/PNN and SVT/UUW betas for adjusting longer-term beta estimates for SVT/UUW.

[167] Pennon's announcement of disposal of the Viridor Business.

[168] In Thomson Reuters Eikon, the sale of Viridor affects the EV gearing of PNN from 25/11/2020 to 30/11/2021 (the dates at which the Net Debt values from Half Year results of respective years were reflected in the Eikon database). As such 2-year betas from January 2024 can be calculated without normalising for gearing.

Figure 7: Evolution of the differential between pure play PNN and SVT/UUW 2-year betas



Source: KPMG analysis using Refinitiv Eikon and Refinitiv Datastream data.
Note: The chart only covers the periods after the unwinding of the PNN net cash position. These values are based on observed, unadjusted gearing.

The PR24 DD suggests that the lack of convergence between PNN and SVT/UUW betas after the sale of Viridor means that PNN betas are overstated. However, there is no basis for assuming that PNN betas are overstated relative to SVT or UUW. Reliance on SVT/UUW betas as the only pure play listed water companies inherently reflects only a subset of the industry and constrains the breadth and reliability of the beta estimates.

A more plausible hypothesis might be that betas for SVT and UUW are lower relative to PNN as a result of the historical outperformance of these two companies relative to the industry. This outperformance is (1) not representative of the average company, (2) in some cases structural and long term, for example in relation to long term financing arrangements, and (3) crucially, not representative of the notional company, which is assumed to neither out- nor under-perform.

Incorporating additional data from PNN is both valuable and relevant for estimating the beta for PR24, although it must be weighed against the limitation of PNN's data, which is available for only a relatively short period.

To account for the limitations inherent in the PNN data and the uncertainty regarding whether its higher beta is a persistent feature of historical data, PNN has been excluded from determining the lower bound of the beta range in this Report.

6.4.2. National Grid (NG)

Historical betas in the water sector do not sufficiently reflect the forward-looking risks associated with the unprecedented increase in the scale of required investment for PR24. To better capture and price this systematic risk, it is essential to consider comparators that reflect these risks, including data from other UK regulated sectors that have historically exhibited a more significant capital programmes.

In principle, sectors like energy, aviation, and telecoms could serve as useful references for pricing in the risks associated with increased investment intensity. However, the regulatory regimes in the aviation and telecoms sectors differ significantly from that of the water sector, implying distinct exposures to regulatory risk. This contributes to differences between water sector and aviation/telecoms betas and introduces challenges in isolating the impact of investment intensity on beta estimates.

By contrast, the regulatory frameworks for energy networks are more closely aligned to water, making National Grid (NG) a potentially appropriate benchmark for pricing the risk associated with substantial capital programs. The CMA noted at the GD&T2 appeal that "*both sectors enjoy extremely high levels of regulatory protections, in particular in relation to regulated asset bases, inflation protection, revenue certainty and the funding of operating and investment costs. We considered that the most powerful influence on water and energy network unlevered betas is likely to be the fact that they are UK regulated monopolies. As such, water companies are, in principle, reasonable and useful comparators when estimating the beta for the energy networks. This usefulness only increases when the lack of pure-play listed energy networks is taken into account*"[169].

The CMA's comment implies that it is reasonable to consider NG's beta as a proxy. Ofgem also views "*water networks in England and Wales as having very similar characteristics to the GB Energy networks, including a very similar regulatory regime and thematically similar challenges relating to ensuring resilience, managing investment and adapting to climate change*"[170].

There is increasing evidence that the water sector may now be perceived as equally or even more risky than energy networks along some dimensions by equity and credit market participants. For example:

- Barclays notes that "*Ofwat sees water as a lower-risk asset than other regulated assets. We do not see evidence of this, nor do investors... for example, we now see an asset beta for water of 0.40 versus 0.37[171] for power*"[172]. Barclays refers to the same investor survey cited by Ofwat in the DD, where both debt and equity investors rated the water sector as the riskiest utility sector and the U.K. as the riskiest country in Europe.
- Moody's notes that "*the lower cost of equity allowance for water companies* [relative to energy networks] *implies that the overall risk should be lower in the water sector. However, the water companies in England and Wales face heightened public and political attention, and tougher performance incentives may prevent them from achieving the allowed returns*"[173]. The score for the stability, predictability, and supportiveness of the regulatory framework for water is currently under review[174], and if downgraded would result in a two-notch delta between water and energy.

Table 25: Comparison of the assessment of business profile factors between NG and water

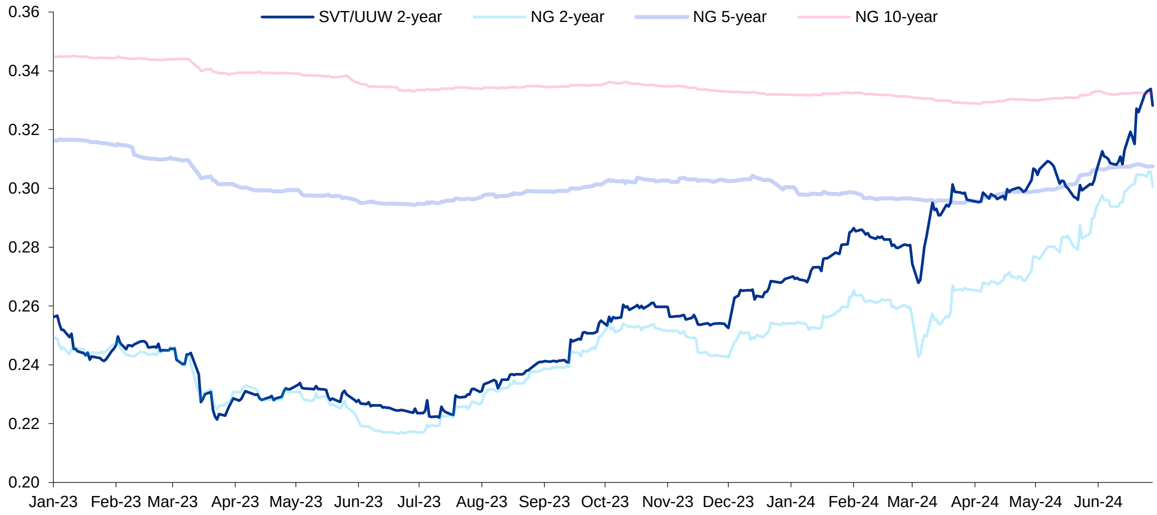
Factor	NG[175]	UK Water[176]	Differential
Stability and predictability of regulatory regime	Aaa	Aa	One notch
Cost and investment recovery (ability and timeliness)	A	Baa	One notch
Revenue risk	Aa	Aa	-

Source: Moody's rating reports

The growing perception of increased risk for the water sector is supported by current market evidence. Since December 2023, the gap between 2-year betas for SVT/UUW and NG has widened. Water sector betas now exceed both 2- and 5-year betas for NG and are aligning closely with NG's 10-year betas.

[169] CMA (2021), GD&T2 Final determination, Volume 2A: Joined Grounds: Cost of equity, para. 5.347.
[170] Ofgem (2024), RIIO-3 Sector Specific Methodology Decision – Finance Annex, para. 3.197.
[171] Barclays uses a debt beta of 0.2.
[172] Barclays (2024), Breaking the water cycle – no longer, so positive, p.64.
[173] Moody's (2024), Ofwat's draft determination increases sector risk, p.8.
[174] Ibid., p.1.
[175] Moody's (April 2024), National Grid Electricity Transmission plc, Update to credit analysis, p.12.
[176] Moody's (2024), Ofwat's draft determination increases sector risk, p.12.

Figure 8: Evolution of the differential between SVT/UUW 2-year and NG 2-, 5- and 10-year betas



Source: KPMG analysis using Refinitiv Eikon and Refinitiv Datastream data.

These factors support the inclusion of NG among the comparators for PR24. Incorporating NG at the upper end of the beta range could better capture the forward-looking risk exposure for the water sector because (1) the regulatory frameworks for the two sectors are similar, and (2) NG's historical RCV growth aligns more closely with the growth anticipated for water, (3) empirical evidence indicates that the market is pricing higher risk for water relative to energy.

Ofgem is similarly considering the inclusion of additional comparators, specifically European energy networks, to enhance the pricing of forward-looking risk, despite these networks not being directly comparable to GB energy networks. Ofgem noted that "*to ensure that we are capturing the risk of the sector on a forward-looking basis as accurately as possible, we have considered ways to make our beta assessment more robust. As we cannot 'create' pure-play listed comparators, and manual adjustments to historical data (as suggested by the GDNs) are likely to be extremely subjective, we view the best improvements are likely to focus on including other relevant comparators in our dataset.*"[177] This supports inclusion of NG at the upper end of the range as the primary approach to pricing in forward-looking risk for the water sector.

6.5. Data frequency

The Report relies on daily betas which are more statistically robust for liquid stocks. No weight has been attached to weekly or monthly estimates as these have higher standard errors and are subject to a reference day effect.

Typical frequencies used in the estimation of betas include daily, weekly, and monthly. For liquid stocks, which are less prone to asynchronous trading[178], daily betas provide the highest precision due to their lower standard errors and absence of the reference day effect[179]. The PR24 DD considers daily, weekly, and monthly estimates but focuses on the former for these reasons, while recognising that "*this is not the only way of looking at the data*".

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[177] Ofgem (2024), RIIO-3 Sector Specific Methodology Decision – Finance Annex, para. 3.192.
[178] Asynchronous trading occurs when a stock trades less frequently than the overall market portfolio, resulting in a lag between the assimilation of new information in the stock price and its reflection in the broader market.
[179] The reference day effect refers to the phenomenon where the calculation of a stock's beta is influenced by the specific days selected as the reference period for the analysis.

6.6. Averaging windows

This Report does not use rolling averages of beta estimates, as these introduce arbitrary weighting of the underlying data and amplify the impact of distortive events compared to spot estimates. Using longer averaging windows does not adequately address the limitations inherent in rolling averages.

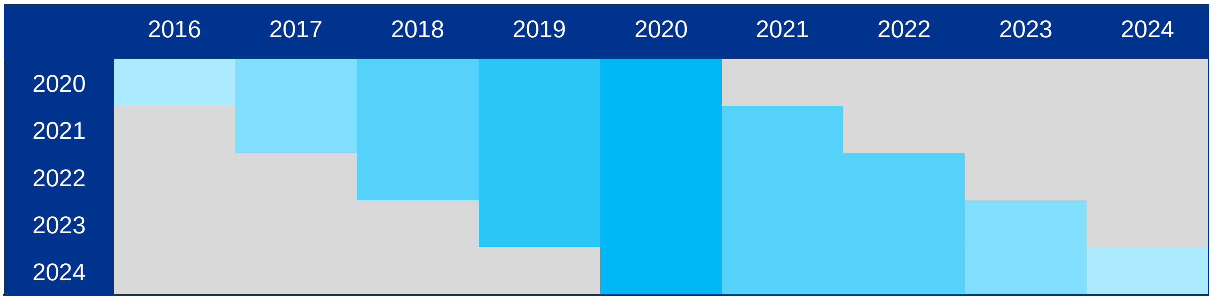
The PR24 DD beta range is based on 2- and 5-year rolling average beta estimates. Rolling averages significantly alter both the period covered and the weight assigned to each data point compared to a spot estimate.

For a given estimation window, spot estimates reflect only the data from that specific window, whereas rolling averages incorporate data from periods before the start of the estimation window.

In a spot regression, each data point (i.e. market and asset return pair) receives equal weighting.

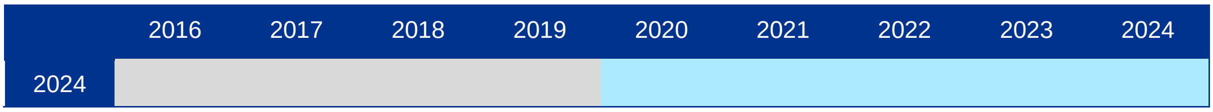
In contrast, rolling regressions assign increasing weight to data points as they approach the centre of the window, such that data within the centre receives greater weight than data at both ends. The figures below illustrate this weighting effect by comparing the relative weight assigned to data by spot and 5-year rolling averages of a 5-year beta. Darker blue indicates higher relative weight.

Figure 9: The relative weighting of data in a 5-year rolling average of a 5-year beta estimate



Source: KPMG analysis

Figure 10: The relative weighting of data in a spot 5-year beta estimates



Source: KPMG analysis

As rolling averages place greater weight on data within the middle of the estimation period, they can introduce bias if beta estimates are unstable, leading to potential upward or downward distortion of the beta estimates.

There is alignment between various parties regarding the shortcomings of rolling averages:

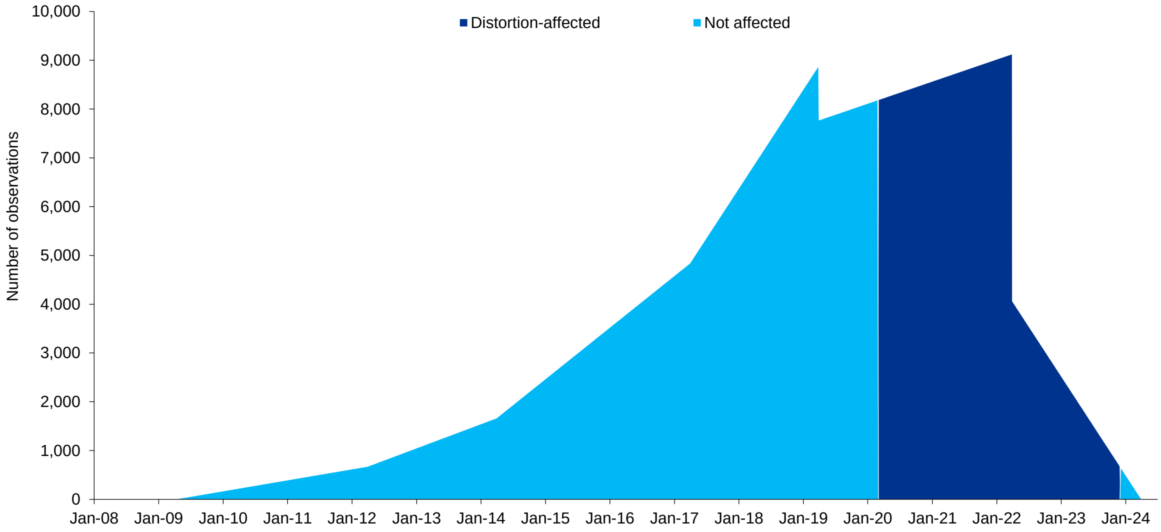
- The CMA at PR19 noted that "*rolling averages place different weight on the various underlying data points and that this can give rise to potential distortions in the figures*"[180] .
- The UKRN CoE Study highlighted that "*the econometric basis for this approach is actually fairly shaky: in particular all parameter standard errors are invalidated by this methodology*"[181].
- Ofgem is proposing to amend its beta methodology for RIIO3 to exclude rolling averages, on the basis that "*this approach can overweight certain parts of the data, providing an inappropriately skewed assessment of the beta over the period*"[182].

[180] CMA (2021), PR19 Final Determination, para. 9.473.
[181] UKRN CoE Study, p.50 footnote 67.
[182] Ofgem (2024), RIIO-3 Sector Specific Methodology Decision – Finance Annex, para. 3.333.

- Professors Wright and Mason – Ofwat's advisers during the PR19 appeal – consider that rolling beta estimates are a legitimate diagnostic tool for addressing the issue of whether the true (and unobservable) beta is stable over time. However, if the true beta is assumed not to be stable over time, rolling betas have a number of problems as estimators of this time-varying value at any point in time – and most notably standard errors (whether OLS or heteroscedastic-consistent) are spurious[183].

Ofwat recognises that rolling betas can affect the weight placed on data (and particularly more recent data) but considers that using rolling average periods encompassing 15 years of data (up from five at PR19) compensates for this. However, rolling averages tend to amplify the impact of distorted data compared to spot estimates. Under Ofwat's rolling average approach, approximately 40% of the data is affected by distortions. In contrast, a spot 15-year beta as of March 2024 would allocate only 25% of the weight to the affected data.

Figure 11: The proportion of data affected by distortions in the Ofwat DD beta estimate



Source: KPMG analysis and PR24 DD

For these reasons, while this Report considers that rolling beta estimates might be useful for visual inspection of the data, and to indicate possible changes in risk and structural breaks in the data, 'averaging' across the estimates is not an appropriate interpretation of the data. This is because conceptually the average rolling beta estimate does not result in any more 'relevant' estimate of the current pricing of risk than a spot estimate, whilst introducing arbitrary weighting of the underlying pricing signals within the sample under consideration.

6.7. Derivation of the beta range for PR24

An overall beta range of 0.28 to 0.35 is adopted in this Report. This estimate (1) substantially mitigates the impact of transient distortive factors and (2) takes into account – at the upper end of the range – the likely increase in systematic risk going forwards.

[183] Wright, S. and Mason, R. (2020), Comments prepared for Ofwat on the CMA's Provisional Findings Anglian Water Services Limited, Bristol Water plc, Northumbrian Water Limited and Yorkshire Water Services Limited price determinations: Cost of capital considerations, para. 5.6.

6.7.1. Business-as-usual beta (BAU)

The first step in the estimation of the BAU beta, which reflects the fundamental business risk for water stocks, involves deriving a beta for SVT/UUW that is not significantly impacted by transient events. Replicating the CMA's PR19 approach yields an unlevered beta range of 0.28 to 0.30, aligning with the CMA's estimate[184]. This range is further supported by the beta reweighting method informed by the CAA's H7 methodology.

This beta is then adjusted to include the impact of PNN at the upper end of the range based on the difference between 2-year betas for SVT/UUW/PNN and SVT/UUW. This increases the range to 0.28 to 0.33.

6.7.2. Forward-looking beta

The upper end of the unlevered beta range is derived from NG, whose historical RCV growth more accurately represents the anticipated growth levels for the water sector going forward. This results in an unlevered beta estimate of 0.35[185].

I Cross-checks

Evidence from the relationship between capital intensity and beta based on FTSE 350 excluding financials

The potential impact of the step change in capital intensity on water betas is assessed through a long-short portfolio analysis[186] based on the regression below.

$$r_{\text{long-short porfolio}} = r_{\text{high capital intensity portfolio}} - r_{\text{low capital intensity portfolio}}$$

The long portfolio reflects the forecast capital intensity ratio for the water sector in AMP8 based on the PR24 DD. The short portfolio represents the outturn capital intensity ratio for water companies from recent price control periods. Both ratios are compared to the values from Table 24 to determine their corresponding deciles. The overall approach is set out in the table below.

Table 26: Specification of the long-short portfolio analysis

	Case 1	Case 2
Regression window	FY1993/94 to FY2023/24	
Calculation of the historical capital intensity decile	Based on a 10-year capital intensity ratio	
Resulting capital intensity decile	Between 6th and 7th deciles	
Calculation of the forecast capital intensity decile	Based on the PR24 DD projection of SVT/UUW capex and RCV (7.83%)	Based on the PR24 DD projection of WASC capex and RCV (8.78%)
Resulting capital intensity decile	8th decile	Between 8th and 9th deciles

Source: KPMG analysis using Refinitiv Datastream data

[184] CMA (2021), PR19 Final Determination, table 9-17.
[185] The estimate is derived based on a replication of the PR19 approach consistent with SVT/UUW betas
[186] $r_{\text{long-short porfolio}} = \alpha + \beta_m (r_m - r_f)$.

The deciles used in this analysis – namely the 6th through 9th – encompass a total of approximately 80 stocks per year[187]. The sector decomposition for each of the portfolio is listed in the table below.

Table 27: Sector breakdown in proportion (%) for each decile portfolio

	6th decile	7th decile	8th decile	9th decile
Basic materials	8	10	11	11
Consumer discretionary	29	24	20	24
Consumer staples	13	9	11	10
Energy	2	4	9	9
Healthcare	5	8	5	2
Industrials	30	24	20	18
Technology	3	5	2	3
Telecommunications	2	4	4	8
Utilities	7	12	18	14
Total (%)	100	100	100	100

Source: KPMG analysis using Refinitiv Datastream and Bloomberg data

The long-short portfolio for case 1 is:

$$r_{\text{long-short porfolio}} = r_{\text{8th decile portfolio}} - r_{\text{equally weighted (EW) 6th and 7th decile portfolios}}$$

The long-short portfolio for case 2 is:

$$r_{\text{long-short porfolio}} = r_{\text{EW 8th and 9th decile portfolios}} - r_{\text{EW 6th and 7th decile portfolios}}$$

The CAPM-beta for the portfolio is then calculated. Where the market beta β_m is positive and statistically significant, this indicates that the high capital intensity portfolio has a higher market beta compared to the low capital intensity portfolio. This suggests that higher capital intensity may be associated with greater systematic risk.

$$r_{\text{long-short porfolio}} = \alpha + \beta_m (r_m - r_f)$$

The results show a statistically significant (with p-value of 0.00%) increase in priced systematic risk between the deciles. The beta estimates have a relatively tight 95% confidence interval that is very close to the coefficient estimates, suggesting a high level of precision and certainty on the estimation of beta[188]. The regression outputs suggest an increase in capital intensity ratio for PR24 corresponds to an increase in equity beta ranging from 0.0251 to 0.0479 before adjusting for gearing.

Table 28: Equity beta value from the long-short portfolio analysis, case 1

Coefficient	Coefficient value	Standard error	p-value	95% confidence interval	
Equity beta (β_m)	0.0251	0.0065	0.00%	0.0122	0.0379
Constant term (α)	-0.0000	0.0001	85.8%	-0.000	0.000

Source: KPMG analysis using Refinitiv Datastream data

Table 29: Equity beta value of the long-short portfolio analysis, case 2

Coefficient	Coefficient value	Standard error	p-value	95% confidence interval	
Equity beta (β_m)	0.0479	0.0056	0.00%	0.0370	0.0589
Constant term (α)	0.0000	0.0001	72.8%	-0.000	0.000

Source: KPMG analysis using Refinitiv Datastream data

187 There are in total 1199 and 1192 total number of observations in the equally weighted 6th and 7th decile portfolios and equally weighted 8th and 9th decile portfolios, respectively, from FY1993/94 to FY2023/24. This means on average 20 stocks per decile portfolio per year and in total approximately 80 stocks from 6th to 9th decile portfolios per year.

188 The 95% confidence interval suggests that 95% of the time the equity beta will fall within the range.

Based on the average EV gearing of the constituent stocks under the relevant decile portfolios, changes in the capital intensity ratio for PR24 correspond to an increase in unlevered beta ranging from in an unlevered beta range of 0.02 to 0.04. This results in implied forward-looking beta of 0.35 to 0.37.

Table 30: Results of the long-short portfolio analysis, unlevered beta impact

	Case 1	Case 2
Equity beta impact	0.03	0.05
Average EV gearing level of the 6-8th decile portfolio	16.3%	
Average EV gearing level of the 6-9th decile portfolio		16.1%
Unlevered beta impact	0.02	0.04
BAU beta for SVT/UUW *plus* PNN	0.33	
Implied forward-looking beta	0.35	0.37

Source: KPMG analysis using Refinitiv Datastream data

Evidence from translating the impact of the increasing capex intensity on RoRE range to the equity beta

Regulators typically consider risk in RoRE terms and calibrate risk allocation such that the allowed CoE reflects the risks implied by ex ante RoRE ranges.

In this context, the potential impact of the increasing capex intensity on the equity beta is assessed through the associated change in RoRE risk exposure arising from the step change in the scale and complexity of capital programmes at PR24.

The increase in PR24 Totex RoRE relative to previous price controls (see section 6.3) is expected to be at least partly driven by systematic factors, such as heightened supply chain risks influenced by broader economic conditions, input prices as well as complexity of investment.

In this analysis, the marginal change in Totex RoRE is assumed to be driven entirely by systematic risk and translated in beta. This could overstate the impact on betas. At the same time, as discussed in section 6.3 risk analysis may underestimate the scale of incremental risk exposure driven by AMP8 capital programs due to its reliance on historical data which would understate the impact on betas.

The variance in RoRE range is converted to an implied standard deviation of the company return, which is a traditional measure of the total risk exposure faced by companies, assuming that each risk driver performance is normally distributed.[189] Based on the RoRE outputs from the KPMG risk model, the total risk exposure of a notional company with higher capital intensity at PR24 is 0.54%, compared to 0.50% with lower capital intensity from previous price controls. This implies a scaling factor of 1.07x in the standard deviation of returns.

The scaled-up standard deviation is translated into equity beta uplift based on the following decomposition of beta:

$$\beta_i = \rho_{i,m} \frac{\sigma_i}{\sigma_m}$$

Where:

- $\rho_{i,m}$ is the correlation between the returns of a company and the market portfolio.
- σ_i is the standard deviation of a company's returns.
- σ_m is the standard deviation of the market portfolio's returns.

[189] See Appendix B for technical details.

This decomposition implies that equity beta should increase proportionally to the increase in total risk exposure of a notional efficient company, assuming that the correlation between the company and the overall market, as well as the volatility of market returns, remains constant. The assumption of a constant correlation holds when the total equity risk exposure is scaled up by a constant multiplier.[190]

A reverse stress test has been carried out to assess whether it is plausible that correlation would change to offset the increased equity risk exposure[191]. The results show that the likelihood of a lower correlation completely offsetting the increase in equity return volatility is less than 10% for the 5- and 10-year estimation windows used for the DD beta.

Based on the difference in the total risk exposure associated with the increasing capex intensity, the unlevered beta expected to be uplifted by the same scaling factor from the BAU beta to 0.35, as shown in the table below:

Table 31: Results of the translating RoRE variance to equity beta, unlevered beta impact

	Unlevered beta
BAU beta for SVT/UUW *plus* PNN	0.33
Scaling factor on beta	1.07x
Implied forward-looking beta	0.35

Source: KPMG analysis using KPMG club risk model and Ofwat PR24 DD wholesale cost model.

Overall, the two cross-checks indicate an unlevered beta range post the impact of higher systematic risk due to the increased capital intensity of 0.35 to 0.37. NG's beta is consistent with the lower end of this range.

6.7.3. Overall beta range

An overall unlevered beta range of 0.28 to 0.35 is adopted in this Report.

Table 32: Overall unlevered beta range for PR24

	Lower bound	Upper bound
BAU beta	0.28	0.33
Forward-looking beta		0.35
Overall range	0.28	0.35

Source: KPMG analysis

[190] $\rho_{i,m}$ (Pearson's correlation coefficient) can be rewritten as follows:

$$\rho_{i,m} = \frac{Covariance(i,m)}{\sigma_i * \sigma_m}$$

The analysis above suggests the totex risk associated with PR24 expected scale of investment, is 1.07 times greater than that of PR19 FD level. Based on the decomposition of $\rho_{i,m}$, the impact of the scaled-up total equity risk exposure of the totex risk will cancel out on the upper and lower side of the formula, due to the fact that:
$Covariance(1.07 * i,m) = 1.07 * Covariance(i,m)$, and

$$\sigma_{1.07*i} = 1.07 * \sigma_i$$

Resulting in:

$$\rho_{1.07*i,m} = \frac{1.07 * Covariance(i,m)}{1.07 * \sigma_i * \sigma_m} = \rho_{i,m}$$

Therefore, the Pearson's correlation coefficient can be assumed to be constant when the total equity risk exposure is scaled up by a constant scaling factor of 1.07.

[191] See Appendix B for details.

7. Notional gearing

7.1. Ofwat's approach in the PR24 DD

Ofwat has retained the 55% notional gearing assumption from the FM, intending for it act as a "*clear signal to companies about the allocation of risk where they adopt financial structures which depart from the notional structure"* [192].

As with the FM, Ofwat's primary motivation for reducing notional gearing is to increase the financial resilience of the notional company and to ensure that it is able to raise finance efficiently. Ofwat maintains its position from the FM that recent high inflation has resulted in a natural reduction in gearing for the notional company. Ofwat also notes that the impact of PR14 'blind year' and PR19 reconciliation models allows for a further organic reduction in notional gearing.

7.2. Commentary on the assumed reduction in notional gearing

The proposed reduction in notional gearing to 55% is not supported by robust market evidence or corporate finance principles. Critically, assuming a lower level of notional gearing does not improve the overall financial position if business risk has increased – assuming lower gearing in practice reallocates risk from debt to equity. In consequence, this Report adopts notional gearing of 60% in line with CMA PR19.

This section comments on each rationale for a reduction in notional gearing as set out in the PR24 DD.

Financial resilience

Assuming a lower notional gearing cannot improve the company's overall financial position with the same level of business risk; rather it transfers risk exposure from debt to equity. Where financial headroom implied by a given level of returns is not adequate to support financial resilience or management of forward-looking risk, the efficient market outcome would be a higher required return on capital to reflect changes in business risk. A reduction in notional gearing to reflect, inter alia, higher risk without adequately pricing in changes in risk through beta could introduce a significant misalignment between risk and return. This approach is not appropriate in isolation as it assumes that a change in capital structure can sufficiently price in higher risk at the enterprise level for the notional firm.

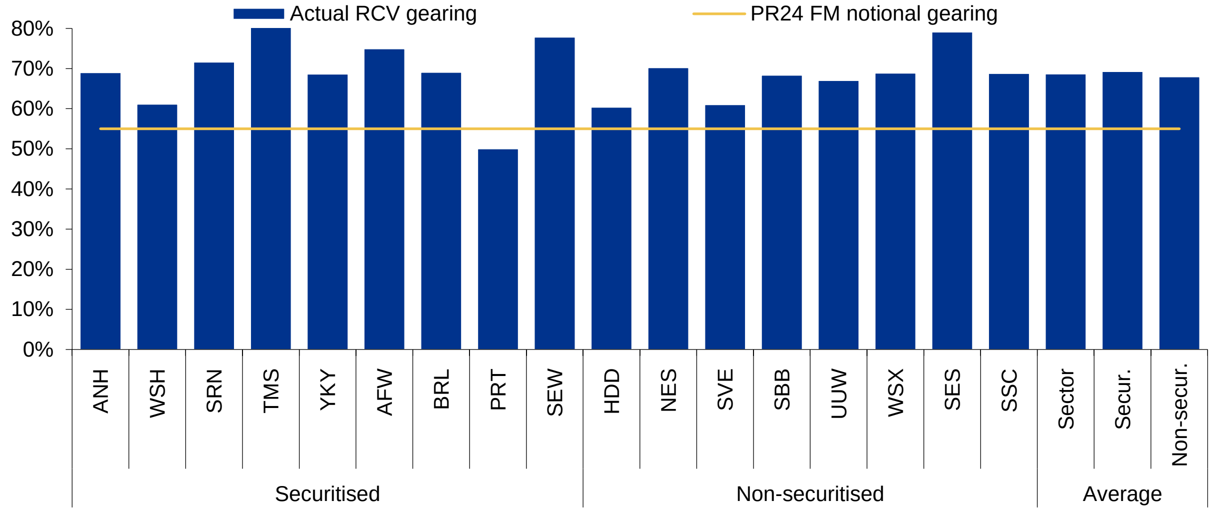
Appropriate benchmarks

Ofwat considers the decision to reduce notional gearing is well justified by the EV gearing of listed water companies (including movement), and the gearing of regulated energy companies in the UK and Europe.

[192] Ofwat (2024), PR24 Draft Determination, Aligning risk and return appendix, p. 24.

The regulatory gearing of water companies – as measured by rating agencies – is more relevant, given rating agency metrics form a critical part of the financeability assessment. As shown in the figure below, the proposed gearing of 55% sits materially below the average for the sector, including companies which have recently sought to de-gear. All else equal, this suggests that 55% gearing is below efficient market levels for the water sector.

Figure 12: Sector gearing, 2023-24



Source: KPMG analysis of 2023-24 APRs.
Note: BRL gearing is for FY23, as the FY24 figure is not separate from the overall SBB figure

7.3. Evolution of gearing in AMP7

In the PR24 DD, Ofwat notes that companies should be able to organically achieve a gearing reduction of at least 5% and that additional equity is not required. However, Ofwat's assumed method for achieving this reduction appears to omit relevant evidence.

Impact of inflation

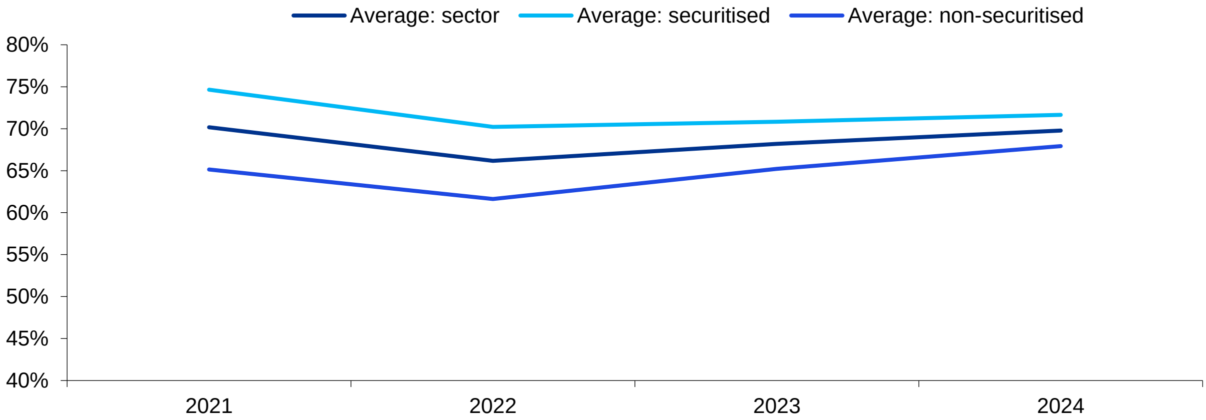
Higher than forecast inflation did act to reduce observed gearing in the sector, particularly in 2022, though inflation has subsequently stabilised at close to BoE target levels and sector average gearing has increased.

However, consideration of outturn inflation in isolation does not capture all drivers of company gearing levels. There are other factors which exert upwards pressure on gearing across the sector in AMP7, most prominently performance in AMP7. Net RoRE[193], which considers all risk drivers including financing, is significantly below allowed returns on a sectorial basis. All else equal, this exerts upwards pressure on gearing which is reflected in the sector's upwards trend in gearing post-2022.

Further, it is necessary to consider drivers of cashflows across the long-run investment horizon, such as the cashflow negative profile expected to arise from the scale of capital programmes in AMP8 and beyond.

[193] Cumulative for AMP7, to end of year 4.

Figure 13: Sector gearing, 2021 to 2024



Source: KPMG analysis

Impact of PR19 reconciliation models

Ofwat also supports a reduction in notional gearing by relying on RCV uplifts arising from PR19 (and PR14) reconciliation models, noting that the average reduction in gearing is 2.7%.

The consideration of specific reconciliation adjustments from the preceding price control for the calibration of AMP8 is inconsistent with the long-standing regulatory stance that each price control is set on a standalone basis and on its own merits, with financeability assessments and notional company specification excluding positive or negative impacts of true ups from previous price control periods.

Consequently, the impact of reconciliation models is not considered relevant for the calibration of notional gearing at PR24.

8. Retail margin adjustment

This Report does not apply a retail margin adjustment (RMA).

The assumption that the retail creditor balance is entirely comprised of trade creditors drives half of the RMA adjustment but does not hold in practice as c.90% of the creditor balance is intercompany. Using the appropriate working capital balance excluding intercompany reduces the RMA from 6bps to 3bps. Updating the assumed financing rate to be internally consistent with the cost of new debt reduces the RMA to less than 1bp.

Ofwat remunerates financing costs for the household retail price control with a net margin which is applied to retail cost-to-serve and wholesale revenues and funds financing costs. A margin approach is applied to this control as the asset-light nature of the retail business means traditional return on capital approaches are less suited to estimation of required returns.

The DD incorporates a 6bps deduction to the appointee WACC in the form of a retail margin adjustment (RMA) to prevent double counting of retail returns. The risk of double count arises because allowed returns are set at the appointee level, incorporating risk from all controls (including retail), while the retail margin also provides compensation for systematic risk in the retail business.

Key assumptions underpinning the RMA

In the DD, Ofwat increased the retail margin from 1% to 1.2%. The application of the RMA in the DD is underpinned by the following assumptions:

1. The systematic risk of retail activities is higher than that of wholesale activities. This assumption is necessary because otherwise, the wholesale WACC would either be equal to or higher than the appointee WACC.
2. The risks attributable to retail activities are fully priced in by the allowed retail margin. If this assumption did not hold, the margin would already be understated, reducing the scope for double counting.

The DD does not include evidence to support these assumptions. The retail margin is estimated using an imprecise approach based on the ratio of allowed household retail revenues at PR24 relative to PR19, rather than based on analysis of retail risks and benchmarking the remuneration required for these risks. For example, the retail business is exposed to inflation risks. While Ofwat has applied a labour cost RPE for retail costs, labour costs account for only 45% of retail costs on average across the sector, leaving a significant residual exposure to inflation risk on non-labour costs. It is unclear whether the 1.2% margin adequately compensates for these residual risks.

Treatment of creditor balances

The calculation of the RMA is materially affected by the inclusion of creditor balances within the working capital requirement. However, the retail creditor balance primarily represents amounts owed to the wholesale business and is largely offset by an equivalent debtor balance therein.

Ofwat does not consider that the creditor balance is fully intercompany as it includes trade creditors as well. However, the inclusion of the full creditor balance in the RMA calculation assumes that none of the balance is intercompany, whereas based on the DD financial models, almost 90%[194] of the creditor balance is attributable to wholesale.

This means that almost all the creditor balance effectively cancels out against wholesale debtors at the consolidated appointee level. The consolidated position is the relevant position for estimation of any RMA as beta is estimated at the appointee level and is de- and re-levered based on gearing which reflects appointee-level cash flows and movements in working capital. Adjusting the calculation to only include 10% of the creditor balance and exclude intercompany creditor positions reduces the adjustment from 6bps to 3bps.

[194] As can be seen from rows 856 on the <Retail Residential> tab and 527 on the <Retail Business> tab.

Working capital financing assumptions

The RMA calculation in the DD uses a working capital financing rate of 4.61% based on BP submissions. There is a wide distribution of financing cost rates across companies, and it is not clear that these estimates have been developed on a consistent basis or cut-off date.

In practice, for an integrated wholesale-retail business, the financing used to manage the retail working capital requirements may be indistinguishable from the rest of the company's debt portfolio as financing is managed at the appointee level. In consequence, this Report considers that it is appropriate to adopt the cost of new debt as the working capital financing assumption. Using the cost of new debt reduces the RMA adjustment from 3bps to less than 1bp.

Alternatively, if the retail business is assumed to be standalone, as implied by the inclusion of the creditor balance in the RMA, all forms of capital a standalone retailer might utilise should be factored into the calculation. A review of credit arrangements for the non-household retail market[195] indicates that associated retailers operating on a standalone basis make extensive use of contingent forms of capital such as Parent Company Guarantees (PCGs) which are a form of contingent capital. Where creditor balances are included in the calculation of capital requirements for a standalone retailer, contingent capital should be included and priced appropriately.

Conclusion

Overall, the DD RMA calculation remains heavily reliant on assumptions. Using the appropriate working capital balance and financing rate reduces the adjustment to less than 1bp. In consequence, this Report does not apply an RMA.

[195] KPMG (2018), Review of credit arrangements for the non-household retail market.

9. Cross-checks

9.1. The role of and evidential bar applied to CoE cross-checks

The DD does not apply a structured and consistent approach to cross-check evaluation. Only the multi-factor model (MFMs) evidence has been evaluated as a cross-check based on stringent criteria that are inconsistent with its intended role as a cross-check rather than a primary model for estimation of returns. Notably, the MAR cross-check used in the DD is not subject to any form of systematic evaluation, suggesting a significantly lower bar compared to the cross-checks proposed by companies.

Applying different criteria and hurdles to different cross-checks risks introducing bias and omission of relevant evidence for cross-checking returns. To ensure a comprehensive and objective assessment, criteria should be applied consistently to all cross-checks.

The primary criteria used to assess cross-checks in this Report are whether they are transparent, targeted, objective, and unbiased and consistent with established academic research. Cross-checks that meet these criteria can, in principle, be effective in increasing the reliability and robustness of the CoE estimate derived based on the CAPM.

The assessment against these criteria indicates that MFMs and inference analysis are likely to represent balanced cross-checks which are targeted, unbiased and grounded in academic research.

By contrast, MAR and market-based cross-checks are less targeted at CoE, more reliant on assumptions and exhibit significant volatility, which all else equal, suggests that less weight should be assigned to these approaches to cross-check CAPM-implied returns.

The role of cross-checks is to validate CAPM estimates using market data and other estimation methodologies, ensuring they are neither excessively high nor low, and to mitigate potential limitations inherent in the CAPM.

However, not all cross-checks are effective, accurate, or unbiased. As a result, it is essential to develop criteria that can reliably assess the effectiveness and accuracy of different cross-checks.

Cross-checks inherently are not designed to replace the CAPM as the primary method for estimation of returns but to ensure that its outputs are aligned with other potential indicators. The criteria applied to determine whether to attach weight to specific cross-checks should reflect their role as supplementary tools.

Balancing the need for meaningful cross-checks with their inherent limitations is crucial when establishing inclusion criteria. While the focus should be on identifying effective and unbiased cross-checks to enhance the reliability of the CAPM-based estimate, overly stringent criteria could restrict the availability of useful inputs. This Report applies the following criteria to evaluate the usefulness of cross-checks in calibrating the allowed CoE:

- Transparent: The cross-check should use widely observable and verifiable information and reflect replicable methodologies, calculations, and results. Any variation in outcomes should be explainable by reference to plausible and defensible assumptions.
- Targeted: The cross-check should effectively isolate variable it is intended to assess from other factors. If the cross-check introduces significant noise, it becomes difficult to distinguish the variable’s influence from irrelevant factors, undermining its robustness.
- Objective and unbiased: The cross-check should be an unbiased indicator, free from underlying assumptions that skew towards a predetermined outcome. There should be a degree of independence between the cross-check and the variable that it is intended to assess.
- Consistent with established academic research: The cross-check should be consistent with reputable academic research, providing confidence that regulatory approaches follow best practice.

These criteria are applied to the cross-checks considered in this Report, namely the multi-factor model (MFMs) and inference analysis cross-checks developed by KPMG, as well as market-asset-ratio (MAR) and market-based cross-checks typically applied by regulators. The table below sets out the results of the assessment.

Table 33: Assessment of cross-checks against inclusion criteria

Criteria	MFMs		Inference analysis		MAR		Market-based cross-checks	
Transparent	MFMs use observable and verifiable but extensive data. MFMs are based on prescriptive methodologies set out in seminal academic papers. Results can be replicated consistently.	Amber	Inference analysis uses observable and verifiable data. It follows a methodology that is clearly laid out in an academic paper. Results can be replicated consistently.	Green	It is difficult to consistently decompose MAR to isolate the contribution of the regulatory CoE given the calculation is assumption-driven and judgmental. There is a wide range of estimates assigned to each value driver by analysts.	Amber	The consistency of results from market-based cross-checks, such as infrastructure fund IRRs, and survey evidence, is challenged by their dependence on the specific sample chosen.	Amber
Targeted	MFMs estimate CoE directly for water companies.	Green	Inference analysis estimates CoE directly for water companies but not precisely due to the presence of some noise in the estimation of equity risk premia from debt risk premia, driven by the different nature and risk exposures of each type of capital.	Amber	MAR is not targeted, as it is influenced by multiple factors beyond the regulatory CoE. Isolating the CoE's contribution requires forward-looking assumptions, which inherently involve a degree of uncertainty.	Red	Infrastructure fund IRRs are affected by different investment mandates (in terms of sectors and geographies) so do not provide a direct signal for the required returns of UK network utilities. Survey evidence and Dividend Discount Models (DDMs) are more targeted.	Amber
Objective and unbiased	MFMs can yield both higher and lower CoE estimates compared to the CAPM, depending on a given company's exposure to the additional factors, which can be positive or negative.	Green	Inference analysis can yield both higher and lower CoE estimates compared to the CAPM, depending on the relationship of a company's ERP to its DRP.	Amber	The objectivity of MAR is limited by its reliance on assumptions and also depends on the inputs and methodologies used.	Amber	Objectivity is inherently limited by reliance on assumptions. These cross-checks can exhibit high volatility.	Red
Consistent with established academic research	Academic research widely recognises the superior explanatory power of MFMs relative to the CAPM. The q-factor and FF5F models are leading MFMs.	Green	Inference analysis is grounded in Merton's contingent claim framework and its practical application by Campello, Chen, and Zhang (CCZ).	Green	There is academic support for the use of Tobin's Q, which is analogous to MARs. It suggests that establishing a meaningful correlation between enterprise value and a specific determinant requires controlling for all other quantifiable and controllable variables. This is not feasible conclusively.	Amber	Academic literature recognises both the value and limitations of forward-looking evidence like DDMs and survey evidence, using them in combination with other methods rather than in isolation.	Amber

Source: KPMG analysis Note: Green indicates that the cross-check meets the criterion well; Amber that it partially does so; and Red that it does not do so.It is important to acknowledge that any cross-check will be necessarily subject to some limitations, and it is unlikely that a single cross-check could fully satisfy all relevant criteria.

The assessment indicates that MFMs and inference analysis are likely to represent balanced cross-checks which are transparent, targeted, unbiased, and grounded in academic research.

MFMs are the only cross-check that has been demonstrated to enhance the explanatory power of the CAPM, meaning that it can most directly and effectively address any potential misstatements in the CAPM-derived returns.

Inference analysis, while yielding a less precise estimate of the required CoE, provides a useful cross-check as it allows the directly unobservable CoE to be estimated based on generally observable debt pricing.

By contrast, MAR and market-based cross-checks are less targeted, more reliant on assumptions and exhibit significant volatility. This suggests that all else equal, less weight should be assigned to these approaches in cross-checking CAPM-implied returns.

The DD does not set out a structured and consistent approach to cross-check evaluation. In their evaluation of MFM evidence, for example, Robertson & Wright draw on the principles of implementability[196] and defensibility[197] that they applied in the formation of recommendations in the UKRN CoE Study (2018)[198] to introduce specific criteria that alternative asset pricing models such as MFMs must meet to be considered capable of providing reliable CoE estimates.

These criteria include: (1) stronger explanatory power than the CAPM, (2) replicable data construction yielding consistent estimates, (3) stable, statistically significant factor loadings, betas, and risk premia. These criteria imply a high bar, requiring stronger performance across several dimensions than the CAPM, the primary methodology for return estimation. Consequently, they may be more appropriate for evaluating asset pricing models intended to replace the CAPM as the primary model and are unlikely to be proportionate in the evaluation of cross-checks.

These overly stringent criteria increase the risk of miscalibration of the regulatory CoE by excluding evidence that could indicate potential miscalibration of the CAPM-derived estimate. Notably, the MAR cross-check used in the DD is not subject to any form of systematic evaluation, suggesting a significantly lower bar compared to the cross-checks proposed by companies.

Overall, inclusion criteria are not applied systematically and consistently to each cross-check based on the DD. Applying different criteria and hurdles to different cross-checks risks introducing bias and omission of relevant evidence for cross-checking returns. To ensure a comprehensive and unbiased assessment, criteria should be applied consistently to all cross-checks.

9.2. Multifactor models (MFMs)

The differential between q-factor- and CAPM-derived CoE is 0.71 – 1.54% as at June 2024, indicating that listed water companies (SVT/UUW) have higher systematic risk exposure than is priced in by the CAPM.

The updated MFM analysis presented in this Report is based on an academic paper available on SSRN[199] and incorporates enhancements that have increased the size of the dataset which underpins the analysis and improved the statistical performance of the q-factor model.

This Report includes the q-factor model as a cross-check to CAPM-implied CoE, with the weight assigned to it reflecting its stronger explanatory power than the CAPM for the UK market and its ability to enhance the accuracy of regulatory CoE estimates.

The initial commentary on the q-factor model from Ofwat's advisers does not provide sufficient and robust grounds for its exclusion from the suite of cross-checks at PR24 FD. The analysis developed by Ofwat's advisers has significant shortcomings, including mischaracterisation of the analysis, flawed statistical testing methods that deviate from established academic approaches, and the dismissal of robust statistical testing evidence included in the original MFM report.

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196 An approach is considered implementable if it does not entail excessive cost or complexity to carry out.
197 An approach is considered defensible if it is robust to reasonable criticism.
198 UKRN CoE Study, p. 5.
199 Available at SSRN: An investigation of multi-factor asset pricing models in the UK.

MFMs are an extension of the CAPM. Both the CAPM and MFMs start with observed stock returns and use the same basic empirical methodology to explain the variation in returns. However, while the CAPM relies on a single factor to explain observed returns, MFMs incorporate multiple explanatory factors.

The additional factors in MFMs serve as proxies for market-wide systematic, non-diversifiable risks that investors demand compensation for but that are not directly observable[200].

Over time, academic research has converged on a small number of factors to augment the market factor and derive better asset pricing models. These additional factors are integrated into MFMs to better explain observed returns, optimise model accuracy based on observed data, and enhance the robustness of expected return estimates for specific assets.

MFMs have been widely adopted in both corporate finance and academic research for explaining observed returns. A recent study in the Journal of Finance has noted that the use of MFMs has substantially increased in popularity over the last 20 years, with 69% of large corporate users adopting at least one MFM as a measure of the CoE[201].

9.2.1. The methodology for MFM analysis and analytical improvements since the 2022 report

This Report relies on the academic analysis of Tharyan, Gregory and Chen (2024), available on SSRN. The academic paper calibrates and evaluates the performance of the leading MFMs[202], Hou et al's q-factor model (2015)[203] and Fama and French's five-factor model (FF5F) (2015)[204], based on UK data.

[200] Importantly, the factors themselves are not systematic risks; rather, they signal systematic risks faced by a firm that are not directly observable to outsiders. For example, the size factor proxies macroeconomic risks that impact stocks differently based on their size.

[201] Graham, J. (2022). Presidential Address: Corporate Finance and Reality, The Journal of Finance VOL. LXXVII, NO. 4, 1993-1995.

[202] Both the q-factor model and the FF5F have been shown to have strong empirical performance based on US data. The two papers which established these models have, more than 2000 and 6000 citations respectively, which confirms their relevance for the estimation of returns.

[203] Hou, K., Xue, C., & Zhang, L. (2015). Digesting anomalies: An investment approach. The Review of Financial Studies, 28(3), 650-705.

[204] Fama, E. F., and K. R. French. “A Five-Factor Asset Pricing Model.” Journal of Financial Economics,116 (2015), 1–22.

Figure 14: Overview of the methodology for the estimation of MFM-CoE

Data collection

Inputs include:

- data to enable the filtration to exclude companies with non-viable market and book values, foreign companies, financial services and real estate companies and AIM listings.
- returns, market value and accounting data required for the construction of factors.

Factor construction

The premia for additional factors are derived by (1) grouping stocks into portfolios based on characteristics and (2) subtracting the return of lower-risk portfolios from higher-risk portfolios.

Statistical testing

Statistical tests are carried out and regression statistics examined to determine (1) whether the models are superior in terms of explanatory power to the CAPM, and (2) whether one of the two models is superior to the other, based on UK data.

Calculation of MFM-CoE

Factor betas are derived for each factor by running separate multivariate regressions for each estimation window.

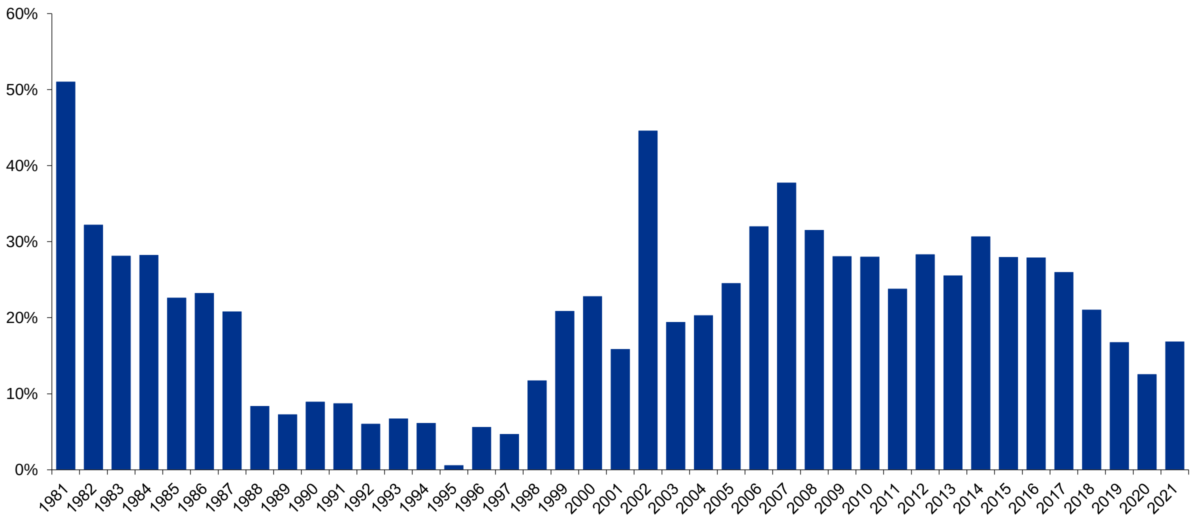
MFM-CoE is estimated under the MFM which (1) is superior to the CAPM and (2) has the best empirical performance based on statistical tests and regression statistics

This CoE is compared to CAPM-CoE

Compared to previous iteration of the analysis developed by KPMG in 2022, the analysis in Tharyan et al. (2024) has been enhanced in several respects. As the 2022 analysis was the first time that these models had been calibrated using UK data, it was anticipated that further improvements would likely be required.

First, the previous analysis had identified significant gaps in DataStream and Bloomberg before 2000, primarily related to companies which have since de-listed. It has now been possible to obtain additional, primary accounting, data from DataStream[205] and significantly increase the sample size.

Figure 15: Percentage increase in the number of companies meeting filtration criteria



Source: KPMG analysis

[205] As noted in Tharyan et al. (2024), this has been made possible by an academic source providing information that enables mapping of company identifiers in LSPD to identifiers from Datastream. It appears that some of the data which previously appeared deleted is accessible but only with a Datastream-specific identifier.

Second, previous analysis followed the Gregory et al. (2013) methodology[206], aligning September market capitalisation data with accounting data from March of the same year. This differed from the approach used in US-based studies, which matched December accounting data with June market capitalisation data. The UK convention was originally based on the prevalence of March year-ends. However, recent analysis indicates a shift towards more December year-ends[207]. As a result, the analysis now aligns December year-end accounting data with end-June market data.

Third, the logic for breakpoint cut-offs was re-examined. The US convention is to use NYSE to establish breakpoints. The nearest equivalent for this in the UK context is the FTSE 350 which can be used as a proxy for the NYSE (the latter has a much higher threshold for inclusion than LSE in terms of market capitalisation). However, the LSPD data only provides a flag for current membership. To address this issue, a “Pseudo 350” index was constructed by ranking all firms on the LSPD each end-June (the point of portfolio formation) according to their market capitalisation. Breakpoints are based on membership of this “Pseudo 350” index to proxy the NYSE.

Fourth, the analysis is updated to the latest cut-off date, June 28th, 2024.

There have no other changes to the construction and application of MFMs.

The enhancements above have resulted in a material increase in sample size and improvement in statistical test results.

[206] Gregory, Alan & Tharyan, Rajesh & Christidis, Angela. (2013). Constructing and Testing Alternative Versions of the Fama-French and Carhart Models in the UK. Journal of Business Finance & Accounting. 40. 172-214.

[207] Agarwal and Taffler (2008) showed that 22% of UK firms had March year ends while 37% of firms had December year ends, based on non-finance industry UK firms listed on the London Stock Exchange from 1979 to 2002. A larger proportion of companies now have a fiscal year end in December. According to the dataset of UK non-financial firms used in this report from 2003 to 2023, 47% of the firms have a December year end, whereas only 19% have a March year end.

9.2.2. Analysis of Robertson & Wright commentary on the application of MFMs

The table below provides an overview of the main technical points raised by Ofwat and Robertson & Wright regarding the MFM analysis in the DD. A more detailed evaluation is included in section 11.1.

Table 34: Overview of the main technical points raised by Ofwat and Robertson & Wright regarding MFM analysis

Key technical points raised by Ofwat and Robertson & Wright	Analysis and commentary
For the water portfolio, the unexplained component of the returns (alpha) is indistinguishable between CAPM and q-factor The improvement in goodness-of-fit from the q-factor model is marginal.	First, it is not appropriate to assess the goodness-of-fit of a model using only two stocks, as this conflates model validity with individual stock performance. Validity should be assessed with well-diversified portfolios that cover the listed equities in an exchange, as the idiosyncratic volatility in individual stocks is expected to significantly reduce the goodness-of-fit. Second, Robertson & Wright do not acknowledge the evidence from the factor spanning test, the standard method in asset pricing literature, which shows that the q-factor model subsumes the CAPM and provides additional explanatory power for returns. Third, although Robertson & Wright's method is not appropriate for evaluating model performance, the updated alpha test based on their approach shows that the value of alpha for the q-factor model is always lower than that of the CAPM, which suggests that the excess returns unexplained by q-factor model is smaller than that by CAPM. Further, the q-factor model's alpha terms are not statistically significant, indicating that the q-factor can explain a significant proportion of the returns of the water portfolios. By comparison, the alpha term of CAPM is statistically significant at 10% in some cases.
Both the CAPM and q-factor model fail the standard GRS test[208], indicating that significant excess returns remain unexplained by these models.	Based on updated analysis of UK non-financial stocks in the FTSE350 from July 1980 to June 2024, the q-factor model passes the GRS test for portfolios sorted by (1) standard deviation and (2) investment ratios, which CAPM fails. This indicates that the q-factor model accounts for a significant proportion of excess returns in well-diversified portfolios that the CAPM fails to explain.
Ofwat notes that "*rerunning KPMG's multi-factor model on daily data instead...generates almost identical estimates on the allowed cost of equity compared to using the simpler CAPM approach*". This finding is attributed to Robertson & Wright's analysis.	The basis of this comment is not entirely clear, but it does not appear to capture the nature of the KPMG analysis as well as of the findings from Robertson & Wright. All the q-factor regressions conducted by KPMG for estimating the CoE are based on daily data. Robertson & Wright's assertion that the CoE derived from the q-factor model being identical to that from the CAPM pertains to their analysis over a long-term window from 2000 to 2020, rather than to changes in data frequency. Note that Robertson & Wright estimate the CoE using raw factor betas without de-levering based on the portfolio gearing

[208] The GRS test indicates whether an asset pricing model could explain the observed returns of all the test portfolios. The test regresses portfolio returns on factor premia for each portfolio separately. If the intercept terms of all the tested portfolios are jointly indistinguishable from zero, the model passes GRS test. The test is binary in the sense that a model could either pass or fail the test, but to assess the performance of different models on a relative basis, the next question would be how much of the variation in observed returns could be explained by the model.

Key technical points raised by Ofwat and Robertson & Wright	Analysis and commentary
	and re-levering to 55% notional gearing. In addition, the window from 2000 to 2020 is not the longest possible regression window. Rerunning Robertson & Wright's analysis based on the updated dataset and a full-period regression from December 13th, 1989, to June 31st, 2024, shows that the q-factor model CoE is materially higher than the CAPM-derived CoE by 70bps.
Two out of three factor premia (size and RoE) are statistically insignificant.	First, based on the enhanced analysis set out in this Report, two out of three premia are statistically significant (RoE and investment). Second, the insignificance of some premia does not invalidate the q-factor model. This model is designed to capture the combined effect of multiple factors, including their interactions. Evaluating MFMs solely based on individual factor significance is inappropriate. Unlike the CAPM, which relies on a single factor, MFMs derive their explanatory power from the interplay of multiple factors. Thus, the overall performance of an MFM should be assessed by its combined ability to explain returns, not by the significance of individual factors in isolation. Overall, based on the analysis set out in this Report: (1) two out of three factor premia are significant, and (2) the GRS and factor spanning tests confirm that these factors, together, improve the q-factor model's empirical performance compared to the CAPM.
The additional factors in the q-factor model exhibit wide confidence intervals. Notably, the 2-year beta for the size factor as of February 28, 2020, is positive, unlike in other cases where the size beta is negative.	Ofwat's advisors use 2-year and 5-year factor betas to demonstrate that additional factor betas may exhibit higher instability compared to the market beta. However, factor betas derived from 10-year regressions tend to be relatively stable. CAPM-betas show significant variability when calculated over 2-year periods. Both CAPM-betas and factor betas fluctuate over time, and this does not appear to represent a robust basis to dismiss the q-factor model. This Report attaches weight primarily to 10-year regression windows.
The daily return of the additional factors does not cumulate exactly to monthly returns, which leads to differences in cumulative returns based on monthly and daily factors over the sample period.	It appears that Robertson & Wright have carried out this check incorrectly as they appear to be compounding factor returns rather than compounding underlying portfolio returns. Additionally, exact reconciliation between daily and monthly factors is not feasible because daily returns for delisted firms cease around the date of delisting, whereas monthly returns for the same firms stop one month before the delisting date.

Source: KPMG analysis

9.2.3. MFM analysis results and implications for CAPM-implied returns at PR24

Each step of the MFM analysis has been re-performed in Tharyan et al. (2024) to incorporate additional accounting data and methodological refinements set out above.

The performance of the q-factor and FF5F models is evaluated relative to the CAPM. The statistical tests deployed – the factor spanning test – is the standard test applied in the academic literature to assess the statistical robustness of asset pricing models. The factor spanning test assesses whether one model has more explanatory power than another by examining if the factors in one model can explain the factors in another. The spanning test directly assesses whether one model is superior to or subsumes another model.

Overall, the results show the q-factor model subsumes both CAPM and FF5F, while FF5F subsumes CAPM but not the q-factor model. Both MFMs add to the explanatory power of the CAPM, however the q-factor model performs better empirically than the FF5F model.

These results are consistent with the findings from the US which show that the q-factor model (1) has stronger empirical performance than older MFMs and (2) outperforms the FF5F in head-to-head spanning tests. Academic literature recognises that (1) the inclusion of the redundant value factor in the FF5F may add 'noise' to the model, (2) cross-correlations amongst factors and a weaker explanatory power due to the hidden investment effect[209], and (3) divergence from the definition of profit in the well-established Peasnell model which may result in a weaker explanatory power for observed returns[210].

Table 35: Summarised factor spanning tests on MFMs (for detailed test results see Tables 2 and 3 in Tharyan et al. (2024), and section 12.3 Appendix C in this Report)

	FF5F vs. the CAPM	q-factor vs. the CAPM	q-factor vs. FF5F	FF5F vs. q-factor
Additional factors	SMB, HML, RMW, CMA	ROE, investment, size	ROE, investment, size	SMB, HML, RMW, CMA
Existing factors	$R_M - R_f$	$R_M - R_f$	$R_M - R_f$, SMB, HML, RMW, CMA	$R_M - R_f$, ROE, investment, size
Pass / fail	Individually: Pass (CMA), Fail (SMB, HML, RMW) Jointly: Pass	Individually: Pass (ROE, investment), Fail (size) Jointly: Pass	Individually: Pass (RoE), Fail (size, investment) Jointly: Pass	Individually: Pass (CMA), Fail (SMB, HML, RMW) Jointly: Fail
Implication	FF5F model subsumes the CAPM[211]	q-factor model subsumes the CAPM[212]	q-factor model subsumes FF5F[213]	FF5F does not subsume the q-factor[214]

[209] This is because the FF5F measure of profitability divides in-year profit by contemporaneous book equity which, relative to the q-factor approach for calculating this value, incorporates an extra measure of the investment factor (difference between contemporaneous assets and one-year lagged assets).

[210] Some academics have posited that the structure behind the FF5F could be seen as another variant of the accounting model described by Peasnell (1982). Peasnell derives a discount model which computes the economic valuation of firms using accounting measures of profit, provided the accounting is clean surplus. In "clean surplus" accounting all valuation changes in book value (e.g. depreciation and revaluation) must flow through the P&L account. The FF5F measure of profitability uses a definition of in-year profit that is close to a pre-tax operating profit definition. This is quite different to the clean surplus definition of profit assumed by Peasnell which is instead closer to the bottom line. The Peasnell model has long been established and is widely recognised in academic literature. Thus, by adopting a different definition of in-year profit to Peasnell, the FF5F profitability factor may have weaker explanatory power for observed returns.

[211] Whilst the size, value and profitability factors fail individually, the investment factor passes individually and the model passes the joint test, the overall result is a pass.

[212] Whilst the size factor fails individually, as two of the three additional factors pass individually and the model passes the joint test, the overall result is a pass.

[213] While the size and investment factor individually are subsumed by FF5F, the q-factor model overall subsumes FF5F.

[214] SMB, HML and RMW are individually subsumed by q-factor, and all FF5F factors are jointly subsumed by q-factor model.

On that basis, the q-factor model is used in this Report as a cross-check for CAPM-based estimates of the CoE.

The table below sets out the estimates derived using the q-factor model and the CAPM for the SVT/UUW portfolio based on regressions using daily data.

Extending the cut-off date to June 2024 and incorporating the PR24 DD TMR and RFR methodologies implies a differential between q-factor- and CAPM-derived CoE of 0.71 – 1.54%.

Table 36: Differentials between q-factor- and CAPM-derived CoE

Cut-off date	Estimation window	Differential (q-factor CoE less the CAPM)
28/06/2024	10-year	0.71%
28/06/2024	5-year	1.06%
28/06/2024	2-year	1.54%

Source: KPMG analysis
Note: The results are for a value-weighted portfolio.

This suggests that listed water companies have higher systematic risk exposure than that priced by the CAPM.

Overall, MFM evidence *improves* the explanatory power of the CAPM based on a more granular and nuanced assessment of risk than the CAPM.

The evidence considered in this Report implies that the q-factor model should be included in the suite of cross-checks for PR24, with the weight assigned to it reflecting its stronger explanatory power than the CAPM for the UK market and its ability to enhance the accuracy of regulatory CoE estimates.

9.3. Inference analysis

Inference analysis indicates that the CAPM-derived CoE based on the PR24 DD methodology as of June 2024 is c.153bps below the lower bound of the inferred CoE range.

Inference analysis is an asset pricing model that estimates the expected return on equity based on a *relative* pricing approach. This method derives asset returns based on the prices of other assets, specifically the cost of debt and the ratio of return on equity to the return on debt (i.e. elasticity).

Following the analytical approach developed by Campello, Chen, and Zhang (CCZ), inference analysis uses elasticity to estimate expected equity returns for water stocks. This estimate is then used as a cross-check for the regulatory CoE.

The evaluation of inference analysis by Ofwat’s advisers has significant shortcomings and does not provide sufficient and robust grounds for its exclusion from the suite of cross-checks in the FD. These include mischaracterisation of the conceptual and analytical foundations of inference analysis, as well as flawed statistical testing methods.

9.3.1. The premise and basis for inference analysis

Inference analysis uses observed debt pricing and the relationship between the costs of equity and debt to infer the CoE which can be applied as a sense-check to a CAPM-derived estimate. The methodology for inference analysis is grounded in the principles that (1) debt and equity are both claims on the same underlying asset and are sensitive to the underlying factors that affect the firm's asset value[215] and (2) due to its higher risk profile, equity requires a substantially higher expected return compared to debt to attract investor interest.

[215] When the firm's asset value rises, equity holders benefit from larger residual claims, and debt value benefits from the reduction in the firm's leverage and the lower likelihood of default. Conversely, a decline in asset value diminishes the residual claims of equity holders and heightens the risk of default.

9.3.2. Analysis of Mason & Wright commentary on the application of the CCZ analytical approach

As Cochrane (2009)[216] notes, asset pricing theory seeks to "*understand why prices or returns are what they are*". Cochrane differentiates between absolute pricing and relative pricing approaches. In absolute pricing, an asset is priced by "*reference to its exposure to fundamental sources of macroeconomics risks*". This approach is most common in academia, with the CAPM and multi-factor models serving as prime examples. Conversely, the relative pricing approach aims to "*learn about an asset's value given the prices of some other assets*".

Inference analysis is an example of a relative pricing approach. Like the CAPM, inference analysis is an asset pricing model; however, while the CAPM represents an absolute pricing approach, inference analysis is grounded in relative pricing.

Inference analysis serves as a cross-check that is derived from outside the CAPM framework while still being based on an asset pricing model. In this context, Ofwat's advisors Mason & Wright[217] incorrectly characterise inference analysis as an approach that "*bypasses asset pricing models entirely*".

There are clear parallels between CAPM and inference analysis, both of which adopt market-based approaches to CoE estimation by estimating a factor that reflects the risks of a specific company. The key difference is that CAPM estimates required returns based on the sensitivity of a company's equity returns to market returns, whilst inference analysis considers the sensitivity of a company's equity returns relative to debt returns of the same company[218]. The CAPM relates expected returns for the company to expected market returns. In doing so it relies on historical data which may not accurately reflect future expected returns. Inference analysis offers a key advantage by utilising generally observable expected debt returns, over a long-term forward-looking horizon, to estimate the CoE.

Inference analysis uses the analytical formula and methodology developed by Campello, Chen and Zhang (2008)[219] to estimate the expected equity return based on the relationship between equity and debt. This approach draws on Merton's[220] contingent claim framework[221] developed as part of his work on option and derivative pricing.

The objective of the CCZ paper is to derive firm-level expected equity returns using elasticity and corporate bond yields and to investigate whether the different factors in multi-factor models can explain the cross-sectional variation in expected returns. The CCZ paper ultimately develops two asset pricing models:

1 The inference analysis model which infers expected equity returns based on the relationship between equity and debt, specifically using the yield spreads.

2 A multi-factor model incorporating market, size, value, and momentum factors. Typically, factor models are estimated by regressing realised stock returns on realised factor returns, but this methodology requires realised returns to be an accurate proxy for expected returns. CCZ are able to directly regress expected stock returns on expected factor returns by using the expected returns estimated from the first asset pricing model. They find that factor models based on expected returns have significantly more explanatory power than factor models based on realised returns.

[216] Cochrane, J. (2009), Asset pricing: Revised edition. Princeton university press, p. 8.
[217] Robin Mason and Stephen Wright (2024), A Note for Ofwat on what the cost of debt means for the cost of equity.
[218] A comparison between the CAPM and inference analysis in terms of estimation approaches and underlying intuition is set out in Appendix A.
[219] Campello, M., Chen, L., & Zhang, L. (2008). Expected returns, yield spreads, and asset pricing tests. *The Review of Financial Studies*, 21(3), 1297-1338.
[220] Merton, R. C. (1974). On the pricing of corporate debt: The risk structure of interest rates. *The Journal of Finance*, 29(2), 449-470.
[221] In Merton's framework, debt and equity are considered contingent claims over a firm's assets and their values are intrinsically related to the value of the firm's assets.

CCZ is an academic paper and thus it needs to test a hypothesis. Without the second asset pricing model, they would have no way of demonstrating to the reader that the expected returns derived from the first asset pricing model are accurate. The second asset pricing model allows them to test the hypothesis that expected stock returns are related to expected factor returns. They find support for this hypothesis, providing evidence that the expected returns estimated from the first asset pricing model are reliable.

The objective of the KPMG analysis is not to test a hypothesis. It is interested in the expected returns themselves, rather than whether they are related to factors. Its goal is to derive expected returns for water stocks based on debt-equity relationship and debt pricing as a cross-check to the regulatory CoE. The first asset pricing model from CCZ is sufficient for the estimation of expected returns. There is no need to estimate an additional factor model, unlike CCZ.

Mason & Wright contend that KPMG's approach deviates from CCZ by using their method to develop an asset pricing model, rather than employing elasticities "*as an intermediate step to be used subsequently in an asset pricing model*".

This critique misrepresents the CCZ approach, which does not utilise elasticities as an intermediate step but directly derives expected returns through elasticities. Although they then use the expected returns to calibrate multi-factor models and assess the usefulness of expected factor premia, this second step is not pertinent to the KPMG analysis, and thus, constructing the second model is unnecessary in this context.

The table below provides an overview of the primary technical points raised by Ofwat and Mason & Wright regarding inference analysis. A more detailed evaluation is included in section 11.2.

Table 37: Overview of the main technical points raised by Ofwat and Mason & Wright regarding inference analysis

Key technical points raised by Ofwat and Mason & Wright	Analysis and commentary
The regression-based estimates underpinning inference analysis have low statistical significance – in terms of the t-statistics of independent variables and the regression R-squared – and as a result a wide 95% confidence interval which encompasses elasticities which are negative as well as positive.	The F-test, rather than the t-statistics, is relevant for assessing the model's statistical significance as it considers whether the model overall has explanatory power, whereas the t-statistics are better suited for assessing the significance of individual independent variables in isolation, in particular to test a hypothesis concerning a particular independent variable (which is not the goal of this analysis). F-test indicates that the independent variables are able to jointly explain the variation of elasticity and are jointly significant at a 5% significance level. Based on the fixed effect model, the 95% confidence interval on expected elasticity does not incorporate any negative values and is much narrower than suggested by Mason & Wright. In consequence, the expected elasticity is positive and statistically significant. In addition, due to the specific nature of the regressions[222], the R-square is likely to result in lower values.

[222] (1) The regression is performed at the individual firm level rather than on a well-diversified portfolio, which is expected to significantly reduce the model's goodness-of-fit due to the material idiosyncratic volatility in individual stock debt and equity returns. It is well-known that individual stock returns are difficult to predict, which is why tests of asset pricing models are typically performed on portfolios rather than individual stocks. (2) Elasticity is calculated as the return on equity divided by the return on debt where small changes in the return on debt can lead to large variations in elasticity. The dependent variable in this regression – i.e. the ratio of return on equity to return on debt – is inherently more volatile than the dependent variable in the CAPM regression, which is the equity return.

Key technical points raised by Ofwat and Mason & Wright	Analysis and commentary
Elasticity estimates for SVT and UUW differ significantly by 17%, which is implausible given that their betas are similar.	The differences in elasticity between two comparable companies will has no bearing on the differences in their equity betas. Elasticity measures the sensitivity of a company's equity returns to changes in its debt returns, while beta measures sensitivity to overall market fluctuations. As elasticity and beta capture different types of risk, their values are not directly comparable.

Source: KPMG analysis

9.3.3. The methodology for inference analysis and analytical improvements since BP submission

The inferred CoE is calculated based on the expected elasticity of the water portfolio and estimates of debt risk premia and risk-free rate. The figure below summarises the methodology for the analysis.

Figure 16: Overview of the methodology for the estimation of inferred CoE

Data collection
Data inputs based on the CCZ methodology include firm-level bond and stock returns – outturn elasticity, market leverage, equity volatility and risk-free rate.

Regression analysis

- Outturn elasticity is regressed on market leverage, equity volatility and the risk-free rate based on the regression specified by CCZ.
- The outputs of the regression analysis are (1) coefficients representing the relationship between elasticity and market leverage, equity volatility and risk-free rate and (2) firm-specific regression intercepts.

Calculation of inferred CoE

- The inferred CoE is derived based on expected elasticity, debt risk premia and risk-free rate.
- The range for the inferred CoE for each cut-off date is formed based on the minimum and maximum CoE implied by the 1-, 3-, 6- and 12-month averaging windows as at that date.

Compared to previous analysis submitted alongside BPs which incorporated data since October 2014, the latest iteration has been enhanced by extending the start date to October 2013, the earliest date that allows for a robust sample size on bond returns[223]. There are no identified structural breaks in the regression data from October 2013 onwards[224], so the analysis now covers the full period from this date. Additionally, the analysis in this Report incorporates data up to June 2024.

The table below provides the specification of methodology and assumptions underpinning the calculation of inferred CoE in this Report, along with associated rationale. The averaging windows of 1-, 3-, 6- and 12-month are used to calculate the expected elasticity and debt risk premium to be consistent with the averaging window typically used for estimation of risk-free rate and cost of debt and to stabilise the estimation of inferred CoE.

The market pricing of debt is based on the yields on the iBoxx Non-financials A/BBB 10+ index plus 34bps. This reflects the findings from KPMG's analysis of the yield-at-issue performance of water company issuances during AMP7 that[225]:

[223] Relative to the later years, the number of companies with bond data available before 2013 decreases significantly to be less than 50 companies. This could be because Bloomberg does not have the bond data for stocks listed in the earlier years which subsequently de-listed and could result in the results being affected by survivorship bias should these periods be included in the analysis.
[224] Based on all the three structural break tests: Supremum Wald test, Average Wald test and Average LR test. The null hypothesis of no structural break cannot be rejected at 5% significance level. Therefore, no structural break is identified.
[225] KPMG (2024), Estimating the Cost of New Debt and Additional Borrowing Costs for PR24.

- Issuances after November 2022, which are the most representative and relevant for estimating the allowance for PR24, underperform on all metrics against the A/BBB index, including like-for-like comparison and that without controlling for tenor or rating. Baa1/BBB+ rated issuances specifically underperform the A/BBB 10+ index.
- Whilst Ofwat has removed the benchmark index adjustment in the DD, this measure alone does not ensure the allowance is reasonable and achievable for the notional company. The exclusion of issuances post-March 2023 significantly understates the extent of underperformance of water company bonds.
- An adjustment of 34bps to the yields on the iBoxx A/BBB 10+ index is required to ensure the benchmark is reasonable and achievable for water companies.

Table 38: Methodology and assumptions underpinning the estimation of inferred CoE

	Approach	Rationale
Cut-off date	28 June 2024	Market data cut-off used in the DD (31 March 31) extended to reflect the impact of latest market data.
Averaging window	1-, 3-, 6-, 12-month averages used	Consistent with averaging windows typically considered for estimation of risk-free rate and cost of debt.
Debt risk premium	Market pricing of debt is derived based on outturn yields on the benchmark index, adjusted for default risk by subtracting an expected default loss rate. It is assumed that the effective rating of iBoxx Utilities £ 10+ is A/BBB. The expected default loss rate of 0.15% is calculated based on a 0.24% annualised default rate (the average of highlighted values in Table 2 below) and a 37.6%[226] recovery rate for senior unsecured bonds sourced from Moody's 2024 default study. Debt risk premium is derived by subtracting the yields on the 20Y nominal gilt from default-adjusted nominal yields on the benchmark index. This subtraction isolates the additional return required for credit risk relative to the nominal gilt.	Consistent with the regulatory approach for setting the allowance for debt. CCZ apply a similar default loss rate adjustment based on Moody's data in their analysis.

[226] Moody's (2023), Annual default study: Corporate default rate will rise in 2023 and peak in early 2024, Exhibit 7.

	Approach	Rationale
Treatment of inflation[227]	Inferred CoE is derived in CPIH-deflated terms in three steps: First, an equity risk premium is calculated by multiplying expected elasticity by the debt risk premium. Then an inferred CoE is calculated as the sum of the yields on the 1-month average 20Y nominal gilt and the equity risk premium. Lastly, the nominal inferred CoE is converted into a CPIH-deflated value based on the 20Y CPI swap rate[228].	Consistent with the approach for estimating the regulatory CoE which does not reflect compensation for the inflation risk premium (given that it is estimated using index-linked gilts and a real TMR). The deflation using the CPI-swap rate strips out both market-based inflation expectation and the inflation risk premium from nominal inferred CoE. The resulting inferred CoE is thus consistent with the regulatory methodology.

Source: KPMG analysis

Table 39: Cumulative and annualised default rates for A/BBB corporate issuers

Rating category	Time period	Time horizon	Cumulative default rate	Annualised default rate	Source
A3	1983 – 2023	10Y	2.15%	0.22%	[1]
		20Y	5.48%	0.27%	[1]
Baa1	1983 – 2023	10Y	2.15%	0.22%	[1]
		20Y	5.82%	0.29%	[1]
A/BBB	1983 – 2023	10Y	2.15%	0.22%	[1]
		20Y	5.65%	0.28%	[1]
A3	1998 – 2023	10Y	2.35%	0.24%	[2]
Baa1	1998 – 2023	10Y	2.16%	0.22%	[2]
A/BBB	1998 – 2023	10Y	2.26%	0.23%	[2]

Note: Cumulative default rates are issuer-weighted; (2) Annualised default rate = cumulative default rate / time horizon.
Source: KPMG analysis of Moody's 2024 Annual default study, [1]: Moody's 2024 Annual default study Exhibit 41; and [2] Moody's 2024 Annual default study Exhibit 42.

The range for the inferred CoE for each cut-off date is formed based on the minimum and maximum CoE implied by the 1-, 3-, 6- and 12-month averaging windows as at that date.

Differentials between the inferred CoE and debt pricing for comparison with the CAPM-implied differentials are calculated as follows:

- 1-month average iBoxx yields are converted to CPIH-real values using long-term inflation of 2% consistent with the approach used in the PR24 DD. The same debt pricing is used for the calculation of CAPM- and inferred CoE-implied differentials[229].
- The real iBoxx yields are deducted from the real inferred CoE (derived using CPI swaps) and CAPM-derived CoE.

[227] Consistent with the regulatory CoE, the inferred CoE estimates are derived in real terms, and are assumed to be unaffected by inflation and inflation risk premia. First, although the inputs in the elasticity regression are nominal, both the numerator and denominator of the elasticity ratio (i.e., the dependent variable) incorporate inflation which is likely to limit the extent to which inflation affects elasticity and means that elasticity can be used to underpin estimation of CoE in real terms. Second, the debt risk premium is calculated by subtracting the yield on a 20-year nominal gilt from the yield on a similarly long-term corporate benchmark. This approach isolates the impact of credit risk differences, adjusted for default, without including inflation risk premia, as inflation expectations are similar for bonds of the same maturity. Third, while the company-specific ERP is combined with a nominal risk-free rate to derive the CoE in nominal terms, the resulting nominal CoE is deflated using inflation swaps. This deflation removes any inflation risk premia introduced by the nominal risk-free rate.

[228] Sourced from Bloomberg.

[229] This means that the differentials are not affected by whether 2% inflation or inflation swaps are used for deflation.

9.3.4. Inference analysis results and implications for CAPM-implied returns at PR24

The starting point for the derivation of inferred CoE is the estimation of expected elasticity.

The firm fixed effect regression, excluding outliers[230], results in the following coefficients for α and β.

$$\frac{\partial E/E}{\partial D/D}_{it} = \alpha_i - 0.03\ Leverage_{it} + 110.2\ Volatility_{it} - 0.33\ r_{f_t} + \varepsilon_{it}$$

Stock volatility is positively correlated with elasticity, while the market leverage and risk-free rate are negatively correlated. F-statistics indicate that all three independent variables are jointly statistically significant and can jointly explain the elasticity at a 5% significance level. Additionally, stock volatility is individually statistically significant at a 5% significance level.

To assess the impact and implications of the inference analysis for the allowed CoE at PR24, the Report undertakes two comparisons, which consider (1) how the CAPM-derived CoE estimates compare to inferred CoE estimates and (2) how the differentials between CoE and current debt pricing implied by the CAPM-derived CoE compare to those implied by the inferred CoE (this effectively represents the difference between implied equity and debt risk premia)[231].

The CAPM-derived CoE based on the PR24 DD methodology as of June 2024 is c.153bps below the lower bound of the inferred CoE range.

Table 40: Comparison of CAPM-derived CoE and inferred CoE (June 2024)

CAPM-CoE methodology	Inferred CoE	CAPM-derived CoE	Difference between the CAPM-derived CoE and the lower bound of the inferred CoE range
PR24 DD	6.39 – 6.85%	4.86%	-153bps

Source: KPMG analysis

The differential with current debt pricing implied by the CAPM-derived CoE based on the PR24 DD methodology is similarly significantly below the range implied by inference analysis (152bps).

Table 41: Comparison the differentials with current debt pricing implied by CAPM-derived and inferred CoE (June 2024)

CAPM-CoE methodology	Differential between inferred CoE and current debt pricing	Differential between CAPM-derived CoE and current debt pricing	Difference between the CAPM-implied differential and the lower bound of the inference analysis-implied differential range
PR24 DD	2.42 – 2.88%	0.90%	-152bps

Source: KPMG analysis

All else equal, this suggests that the CAPM-derived CoE based on the PR24 DD is not consistent with current market pricing of debt and the relationship between debt and equity pricing.

The scale of the disconnect between equity and debt pricing implied by the CAPM-derived CoE based on the PR24 DD may be indicative of a material miscalibration of the allowed CoE. This, in turn, could mean that the cost of capital materially exceeds allowed returns for AMP8, making investment in water less attractive compared to other opportunities with better risk-reward profiles. Investors are likely to be disincentivised to invest in water sector equity where CAPM-derived equity risk premia,

[230] This is done by winsorisation, a data cleaning technique commonly adopted in statistics to mitigate the impact of extreme values (outliers) on the coefficient estimates of the regression, which reduces estimation bias and provides more accurate regression outputs. In this Report outliers are 'capped' meaning that they are replaced with the nearest non-outlying values within a specified range. A 5% winsorisation is applied to elasticity ($\frac{\partial E/E}{\partial D/D}_{it}$), which means that all observations greater than the 97.5th percentile are set to be equal to the 97.5th percentile, and all observations lower than 2.5th percentile are set to be equal to 2.5th percentile.

[231] The ranges for inferred CoE and inferred differentials between inferred CoE and current pricing of debt for each cut-off date are formed based on the (1) minimum and maximum CoE and (2) minimum maximum differentials implied by the 1-, 3-, 6- and 12-month averaging windows as at that date.

which underpin allowed returns, do not align practically with and reflect appropriate differentials to lower-risk debt pricing. An investor wishing to invest in the water sector may be significantly more likely to choose debt rather than equity since equity returns are not high enough to compensate for their greater risk.

The availability of equity capital required to meet the substantial investment needs in PR24 is contingent on allowed returns that adequately compensate for forward-looking risk exposure and the opportunity cost of capital in current market conditions. Limitations in the available equity capital could result in a significant customer detriment as well as potential increases in gearing to address the shortfall.

The inference analysis evidence implies that a careful re-examination of the methodology and estimates of the PR24 DD allowed CoE is required to ensure that allowed returns and equity risk premia are sufficient to attract equity capital in current macroeconomic conditions and relative to current levels of observed debt pricing.

9.4. Market-based cross-checks

Market-based cross-checks typically used by regulators like Ofwat and Ofgem indicate that the expected market return has significantly increased relative to PR19.

These approaches, although reliant and sensitive to assumptions, can provide a directional signal on the evolution of expected market return.

The evidence from a dividend growth model, equity analyst estimates, infrastructure fund internal rates of return (IRR) and a survey indicate that expected market return has increased by 115 – 282bps relative to equivalent figures in 2019.

This section examines the implications of market-based cross-checks, such as those typically used by Ofwat and Ofgem, on the PR24 CoE. These market-based cross-checks are inherently more subjective and sensitive to assumptions and have not been demonstrated to improve the accuracy of CoE estimates derived from the CAPM.

Consequently, these approaches are not used as primary cross-checks in this Report but instead provide a directional signal on the evolution of expected market return relative to PR19. They aid in the estimation of an investable CoE for PR24, ensuring water companies remain competitive in attracting capital.

This Report considers evidence from a dividend discount model (DDM), equity analyst estimates, infrastructure fund internal rates of return (IRR) and a survey. Each of these cross-checks indicates that the expected market return has increased relative to PR19.

9.4.1. Dividend discount model

This Report constructs a two-stage DDM model following the approach from the Bank of England (BoE)[232].

However, it departs from this methodology by using long-run dividend growth from the DMS Decompositional approach (in nominal terms) rather than GDP forecasts as a proxy for long-term growth. This approach reflects the CMA's PR19 view that "*historic real dividend growth has been significantly lower than historic GDP growth (at around 2% in the UK) over the longer term and hence it was not clear that assuming that dividends should grow in line with GDP growth forecasts was reasonable*"[233]. In its commentary, the CMA referred to the growth rate of dividends from DMS which is adopted in this Report[234].

[232] Bank of England Quarterly Bulletin (2017), An improved model for understanding equity prices. The detail of the DDM model approach can be found in the appendix.

[233] The ranges for inferred CoE and inferred differentials between inferred CoE and current pricing of debt for each cut-off date are formed based on the (1) minimum and maximum CoE and (2) minimum maximum differentials implied by the 1-, 3-, 6- and 12-month averaging windows as at that date.

[234] For each year this is derived as the average of the historical nominal dividend growth rate between 1899 and that year.

The resulting estimates are set out in the table below. They indicate that the implied estimate of expected market return has increased by 115bps relative to the equivalent figure in 2019.

Table 42: Estimates from the DDM

Calendar year	Estimate (CPIH-real)[235]	Change relative to 2019 (PR19)
2019	8.87%	-
2020	8.04%	(0.83%)
2021	6.71%	(2.16%)
2022	8.47%	(0.40%)
2023	10.02%	1.15%

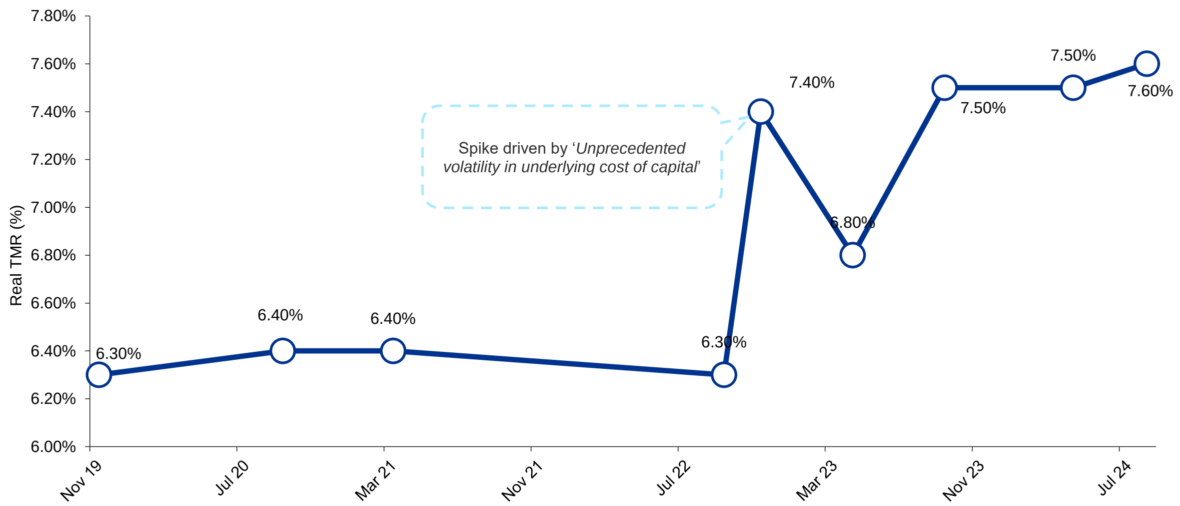
Source: KPMG analysis using Bloomberg and Refinitiv Datastream data

9.4.2. Equity analyst estimates

This report uses Barclays broker reports, as they are one of few investment banks who regularly publish a house view of the real CAPM-CoE.

As of August 2024, the estimate of expected market return has increased by 130bps relative to the equivalent figure in 2019.

Figure 17: Barclays estimates of market returns (CPIH[236])



Source: KPMG analysis using Barclays Equity Research on UK Water

9.4.3. Infrastructure fund IRRs

This Report replicated Ofgem's RIIO-2 approach[237], including the selection of funds[238], used to derive implied IRR values for infrastructure funds.

Implied IRR has increased by approximately 282bps relative to the PR19 level. This figure is higher than the other market-based cross-checks, potentially reflecting the different investment mandates of these funds in terms of sector and geography focus, for example.

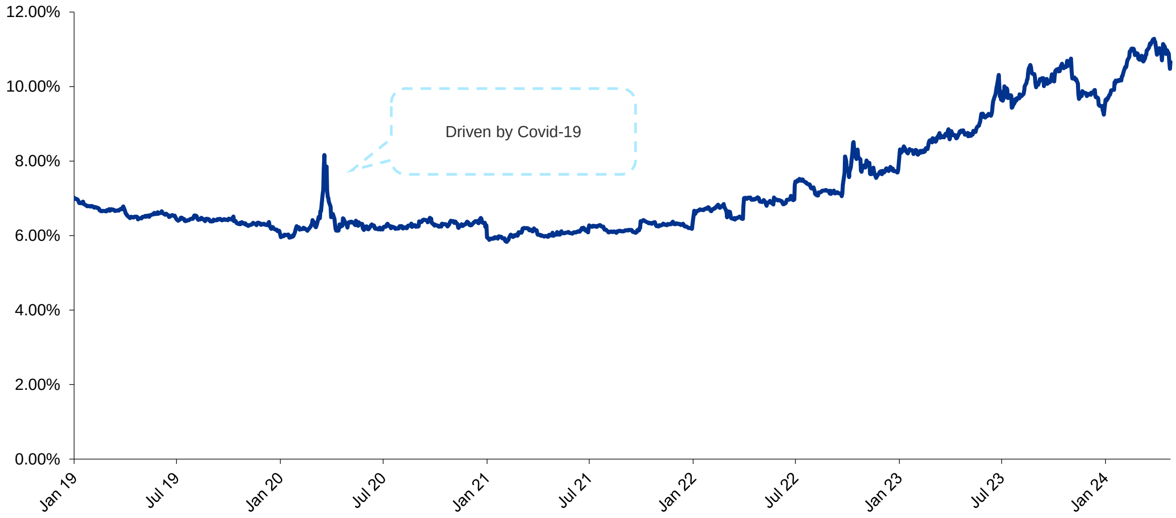
[235] Derived using a long-term inflation assumption of 2%.

[236] The model covers the period between 2004 – 2023 due to data availability. Inputs required to derived expected equity cash flow and the price index are sourced from Bloomberg. Analyst forecasts used for short-term growth for the first three years are sourced from the IBES database from Refinitiv Datastream. Long-term dividend growth rate is sourced from DMS.

[237] Ofgem (2020), RIIO-2 Draft Determinations – Finance Annex, p62.

[238] Ibid. This report excludes JLIF LN Equity as data was unavailable.

Figure 18: Infrastructure fund implied IRRs, simple average (CPIH[239])



Source: KPMG analysis using infrastructure fund annual report, Bloomberg and Refinitiv DataStream data

9.4.4. Survey evidence

This Report incorporates evidence from Fernandez et al.[240], a periodical publication that gathers insights from finance and economics professors, analysts, and company managers on the required equity risk premium.

Based on these forecasts, the implied expected market return (defined as MRP plus RFR) has increased by 127bps relative to the equivalent figure in 2019.

Table 43: Estimates from Fernandez et al. survey (CPIH[241])

Forecasts	2019	2020	2021	2022	2023	2024
Expected market return	6.18%	4.80%	4.71%	6.27%	7.65%	7.55%

Source: KPMG analysis

[239] Derived using a long-term inflation assumption of 2%.

[240] Fernandez at al. (2024), Survey: Market Risk Premium and Risk-Free Rate used for 96 countries in 2024. The implied UK TMR is derived as the sum of the average estimate on the risk-free rate and equity risk premium for the UK produced by respondents. The data can be accessed here.

[241] Derived using a long-term inflation assumption of 2%.

10. CoE range and estimate for PR24

The preceding sections of this Report considered the estimation of each of the CoE parameters. The resulting CoE range is set out in the table below on a 55% and 60% notional gearing basis.

This section focuses on the selection of the point estimate for allowed return on equity from a range constructed based on parameter-level estimates. It explores the potential application of an adjustment to the CoE to account for parameter uncertainty, investability and evidence from cross-checks, including alternative pricing models.

Table 44: PR24 CoE range based on parameter-level estimates

Parameter (CPIH)	KPMG (Jun 2024) 55% gearing Lower bound	KPMG (Jun 2024) 55% gearing Upper bound	KPMG (Jun 2024) 60% gearing Lower bound	KPMG (Jun 2024) 60% gearing Upper bound
Notional gearing	55%	55%	60%	60%
TMR	6.75%	6.93%	6.75%	6.93%
RFR	1.55%	2.22%	1.55%	2.22%
Unlevered beta	0.28	0.35	0.28	0.35
Debt beta	0.10	0.10	0.10	0.10
Observed gearing	53.74%	43.72%	53.74%	43.72%
Asset beta	0.34	0.39	0.34	0.39
Notional equity beta	0.63	0.74	0.70	0.83
CoE, appointee	4.82%	5.73%	5.16%	6.11%
RMA	0.00%	0.00%	0.00%	0.00%
CoE, wholesale	4.82%	5.73%	5.16%	6.11%

Source: KPMG analysis

10.1. Aiming up

The CMA considered that the need to promote investment should be a consideration in selecting the point estimate for CoE, stating that *"there are risks of an exit of capital from the long-term investors in the sector, should the cost of capital be set too low"* and *"there are risks that there will be underinvestment in new assets, if the expected return on capital on new investment in AMP8 and beyond does not provide incentives to reinvest capital and maintain or grow the asset base over time"*[242].

The CMA in its PR19 redetermination set the point estimate for CoE 25bps above the midpoint of the CoE range to address investment incentives, comprised of c15bps[243] for parameter uncertainty and 10bps for asymmetric risk on ODIs.

However, the risks to underinvestment identified by the CMA at PR19 are likely to be particularly acute at PR24, driven by the step-change in investment and the associated requirement for equity injections to maintain the financeability of the notional structure. It is imperative that the sector is able to attract capital to finance these investments to avoid the real risk of significant detriment to consumer welfare.

242 CMA (2021), PR19 Final Determination, para. 9.1394.

243 The CMA does not provide an explicit split of the 25bps adjustment into that related to investment incentives and to asymmetry. However, the CMA does comment that the 15bps adjustment indicated by Ofwat as "sufficient if we were to make any adjustment to the midpoint at all" in the context of parameter uncertainty is insufficient to address all the concerns that have informed the CMA's decision to aim up. Furthermore, the CMA's estimate of structural asymmetry was 0.1-0.2% RoRE. In this context, it is not unreasonable to assume that 15bps of the 25bps adjustment related to investment incentives and 10bps to asymmetry.

The core principle underpinning aiming up is to mitigate the greater welfare loss arising from underestimation rather than over-estimation of the cost of capital. If the allowed return is set too high, customers end up paying more in their bills than they would have had the allowance been based on the true cost of capital. On the other hand, if the allowed return is set too low, companies are discouraged from making new investments or adequately maintaining existing ones, resulting in suboptimal levels of investment and a significant loss in consumer welfare. As the demand for most regulated services is driven by the essential nature of the services provided, the welfare loss from under-investment is substantial. Consequently, the detrimental impact on consumers is not symmetric when the allowed return deviates significantly from the true cost of capital.

This is in line with the UKRN CoE study, which demonstrates that the consumer welfare loss from under-investment is greater than the consumer welfare loss from marginally higher prices. The study notes that "*with relatively low elasticities, the reduction in consumer surplus from setting the RAR, and hence the regulated price, too high is relatively small. In contrast, the welfare loss from setting the RAR (and hence the price) too low is relatively large. This leads to considerable aiming up, as the optimal choice by the regulator*"[244].

In this context, evidence from alternative pricing models with better explanatory power than the CAPM can be critical in assessing whether the CAPM is appropriately calibrated or whether it requires adjustment. Consequently, the MFM cross-check evidence explored in this Report is used as the primary method for assessing whether and how much aiming up is required.

The table below sets out the aiming up implied by the CoE cross-checks adopted in this Report, namely MFMs, inference analysis and market-based cross-checks. All cross-checks imply that significant aiming up, ranging from 56 to 170bps, is required to address parameter uncertainty and to support investability in current market conditions.

[244] UKRN CoE Study, p. 72.

Table 45: Commentary on cross-check evidence

Cross-check	Implied aiming up adjustment	Commentary on cross-check evidence
MFMs	CAPM may understate the systematic risk of water companies by between 71bps and 154bps.	• By virtue of their additional factors, MFMs more completely capture a stock's systematic risk, which leads to a more accurate estimate of returns than the CAPM. • The q-factor model considered in this Report has stronger explanatory power than the CAPM. • In consequence, MFMs can directly inform the selection of an investable CoE point estimate. MFMs can indicate which CoE outcomes in the CAPM-implied range are investable, ensuring the CoE point estimate is set to attract and retain equity capital. • MFM evidence is assigned the most weight in the calibration of the aiming up adjustment. • The lower bound of the MFM range reflects the 10Y differential between MFMs and CAPM for water companies[245].
Inference analysis	CAPM may understate the required CoE by 66bps.	• Equity investors often have multiple investment options, each with varying risk and return profiles. When making capital allocation decisions, an investor would carefully consider the risk-return profile of each opportunity. Given the riskier nature of equity, the expected return on equity needs to be substantively above the expected return on debt of the same company, as otherwise an investor is unlikely to be incentivised to invest in equity. • If the allowed WACC does not consistently reflect the subordinated nature of equity relative to debt, equity investors may seek alternative investments that appropriately reflect these factors, which could undermine the investability of the sector. • In the context of relative debt-to equity pricing and the need to attract more capital, it is necessary to ensure that the price control is sufficiently attractive to equity. Moody's notes that '*based on the proposed parameters, the cost of equity allowance provides a slightly better buffer to the cost of new debt allowance than the early view estimate. However, it still indicates a rather low equity premium to attract new funding in a higher interest rate environment*[246]. • Inference analysis suggests that the CAPM-derived CoE in this Report (midpoint, pre-aiming up) is at least 66bps lower than would be expected relative to the current market pricing of debt in the sector and the relationship between debt and equity pricing.

[245] June 2024 cut off.
[246] Moody's (2024), Ofwat's draft determination increases sector risk, p.7.

Cross-check	Implied aiming up adjustment	Commentary on cross-check evidence
Market based cross-checks	When combined with midpoint CAPM parameters in this Report, the observed evolution of expected market return relative to 2019 suggests upward pressure on CAPM-derived CoE, ranging from 56 to 170bps[247].	• A range of market-based cross-checks, which consider contemporaneous market evidence, indicates that expected market return has significantly increased relative to PR19. • These cross-checks vary in application but consider a range of benchmarks to assess the market required returns. In this report, the following sources are used: a DDM, equity analyst reports, survey evidence and infrastructure fund discount rates. • Regulators have used these cross-checks in the past to calibrate the TMR range, predominantly Ofgem at RIIO-T2.
Market-to-asset ratios (MARs)	N/A	• This Report considers that MAR as a cross-check is unlikely to assist regulators in determining an investable CoE estimate as it cannot be relied upon as an unbiased indicator. This is driven by the fact there are many unknowns in the determination of a company's value, which means that MAR cannot be accurately attributed to a difference in investors' assumed return of equity from the allowed return. Notwithstanding this, it is noted that Ofwat's MAR-implied cost of equity implies a midpoint of 5.2% CPIH real, approximately 41bps higher than Ofwat's CAPM midpoint.

Source: KPMG analysis

[247] These figures are calculated by subtracting the mid-point CoE estimate, pre-aiming up, at the 55% notional gearing level (5.31% per Table 44) from the same estimate, but with the TMR replaced by the value implied by the sum of the delta and the PR19 FD TMR. For DDM and infrastructure funds, the figures used are averages for the last full year of data (2023).

CPIH-real	DDM	Analyst estimates from Barclays	Infrastructure fund IRRs	Fernandez survey
Delta to 2019	115	130	282	127
RFR	1.96%			
TMR	7.65%	7.80%	9.32%	7.77%
Equity beta	0.69			
CoE	5.87%	5.97%	7.02%	5.95%
Delta mid-point CoE estimate, pre-aiming up, at the 55% notional gearing	*56*	*66*	*170*	*64*

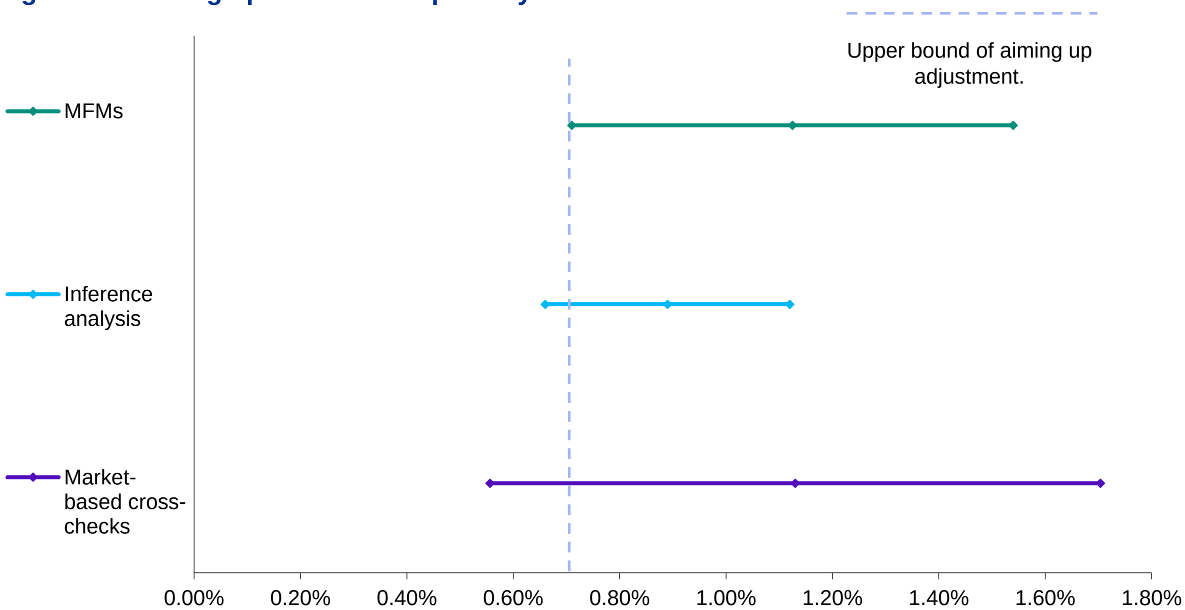
The Report adopts a **lower bound adjustment of 15bps** – in line with the CMA's decision at PR19 – which represents the minimum required to avoid disincentivising high levels of investment projected for AMP8 and beyond in the context of parameter uncertainty.

There is inherent uncertainty in estimating the unobservable CoE and greater potential harm from underestimation of returns compared to overestimation. As a result, there is merit in setting the point estimate for the allowed CoE of essential service providers above the midpoint. The CMA recognised the validity of this rationale when it aimed up on the PR19 CoE to maximise consumer welfare in the context of estimation uncertainty.

The CMA's decision indicates that its concerns around incentives for investment and customer welfare would be particularly acute in case of a step change in investment. In referencing the need for sufficient financial incentives to ensure that appropriate capital projects were identified and designed at a desirable level, the CMA noted that this "*would be particularly the case if Ofwat required a step change in investment to meet changing resilience requirements in the face of climate change challenges or other stresses on existing infrastructure*"[248].

This Report considers that an adjustment of 15bps – in line with the CMA's decision at PR19 – is the minimum required to avoid disincentivising levels of investment required for AMP8 and beyond in the context of parameter uncertainty. This estimate does not take into account cross-check evidence which indicates that higher aiming up would be appropriate to support investability at PR24 as set out in the figure below.

Figure 19: Aiming up estimates implied by CoE cross-checks



Source: KPMG analysis

MFM evidence – and in particular the CoE derived using the q-factor model – is considered the primary cross-check to the CAPM-derived CoE. This is because, *inter alia*, the q-factor model provides a more granular view of risk than the CAPM, improves upon the empirical performance of the CAPM based on UK data and has met the high bar for statistical robustness applied in academic literature for the evaluation of asset pricing models. The q-factor model evidence suggests that the CAPM materially under-prices systematic risk for water companies by at least 70bps. The Report in consequence adopts an **upper bound adjustment of 75bps** based on the MFM evidence.

The Report adopts the midpoint of the implied aiming up range of 45bps but notes that it may be necessary to increase the point estimate to at least the upper end of the aiming up range to support investability.

[248] CMA (2021), PR19 Final Determination, para. 9.1391.

This Report does not aim up to reflect asymmetric risk exposure. The presence of unremunerated asymmetric exposure can undermine the financeability of an investment. This is because investments with (1) expected returns materially below required returns (i.e. with expected loss) and (2) material negative skewness[249] may be deemed less attractive than other available opportunities with better risk-reward profiles.

As a result, the distribution of expected returns is a relevant and important criterion for selection of a point estimate for CoE. Analysis of the DD indicates that the proposed calibration of regulatory mechanisms implies material asymmetry due to the presence of both expected loss and negative skewness. In practice, these factors are likely to affect different notional companies to varying degrees. In consequence, this Report recommends that each company undertake this analysis based on the DD and their DD representations. Where companies identify the presence of expected loss or negative skewness, they should apply an adjustment when selecting a point estimate from the CoE range implied by the analysis in this Report.

10.2. CoE range and point estimate for PR24

The CoE range below is presented pre and post aiming up. On a 60% gearing basis – i.e. reflecting the notional gearing assumption adopted in this Report – the CoE range is 5.16 – 6.11% pre aiming up, and 5.31 – 6.86% post aiming up.

The CoE estimate is also presented on a 55% notional gearing basis to enable like-for-like comparison with the DD estimate. This implies a CoE range of 4.82 – 5.73% pre aiming up and 4.97 – 6.48% post aiming up.

Table 46: PR24 CoE range based on parameter-level estimates, with aiming up included

Parameter (CPIH)	KPMG (Jun 2024) 55% gearing Lower bound	KPMG (Jun 2024) 55% gearing Upper bound	KPMG (Jun 2024) 60% gearing Lower bound	KPMG (Jun 2024) 60% gearing Upper bound
Notional gearing	55%	55%	60%	60%
TMR	6.75%	6.93%	6.75%	6.93%
RFR	1.55%	2.22%	1.55%	2.22%
Unlevered beta	0.28	0.35	0.28	0.35
Debt beta	0.10	0.10	0.10	0.10
Observed gearing	53.74%	43.72%	53.74%	43.72%
Asset beta	0.34	0.39	0.34	0.39
Notional equity beta	0.63	0.74	0.70	0.83
Coe before aiming up, appointee	4.82%	5.73%	5.16%	6.11%
Aiming up	0.15%	0.75%	0.15%	0.75%
CoE, appointee	4.97%	6.48%	5.31%	6.86%
RMA	0.00%	0.00%	0.00%	0.00%
CoE, wholesale	4.97%	6.48%	5.31%	6.86%

Source: KPMG analysis

249 Skewness measures the lack of symmetry in a distribution. If the distribution is negatively skewed, it means that there is a longer left tail, and extreme negative returns are more likely to occur. Conversely, if the distribution is positively skewed, it means that there is a longer right tail, and extreme positive returns are more likely. When an investment exhibits a greater negative skewness compared to available alternative opportunities, risk-averse investors might perceive it as less appealing due to the increased likelihood of unfavourable outcomes, potentially hampering its ability to secure financing and compete effectively with other opportunities.

The point estimate for CoE is 6.12% on a 60% notional gearing basis, incorporating aiming up of 45bps relative to the midpoint. The point estimate on a 55% notional gearing basis is 5.76% which compares to the DD estimate of 4.71% (updated for June 2024 cut-off).

Table 47: Point estimates of PR24 CoE

Parameter (CPIH)	KPMG (Jun 2024) 55% gearing	KPMG (Jun 2024) 60% gearing	Ofwat DD (Jun 2024) Point estimate
Notional gearing	55%	60%	55%
TMR	6.84%	6.84%	6.58%
RFR	1.96%	1.96%	1.55%
Unlevered beta	0.32	0.32	0.27
Debt beta	0.10	0.10	0.10
Observed gearing	48.73%	48.73%	52.91%
Asset beta	0.36	0.36	0.33
Notional equity beta	0.69	0.76	0.60
Coe before aiming up, appointee	5.31%	5.67%	4.57%
Aiming up	0.45%	0.45%	0.28%
CoE, appointee	5.76%	6.12%	4.85%
RMA	0.00%	0.00%	0.13%
CoE, wholesale	5.76%	6.12%	4.71%

Source: KPMG analysis

The key drivers of difference between the KPMG CoE estimate (55% gearing basis) and the DD (updated for June 2024 cut-off) are as follows:

- RFR: The difference relates to the inclusion of adjustments to reflect the convenience yield in ILGs and that investors' risk-free borrowing rate is higher than their risk-free saving rate.
- TMR: The difference relates to the use of a reputable and established data source (DMS 2024) to calculate both ex ante estimates, replacing BEGS, a data source with well-documented deficiencies. Additionally, the data available in DMS 2024 facilitates the direct calculation of the DMS Decompositional estimate in CPIH terms and enables the elimination of likely overstated downwards adjustment for inflation differences.
- Beta: The difference relates to the pricing of systematic risk expected by water investors in the long run:
  - BAU-beta: This estimate replicates the CMA's PR19 approach to mitigate the impact of distortive events, capturing the fundamental business risk for SVT/UUW. The beta is then adjusted to include the impact of PNN at the upper end of the range, based on the difference between 2-year betas for SVT/UUW/PNN and SVT/UUW.
  - Forward-looking beta: The upper end of the beta range is based on NG to better capture the forward-looking risk exposure for the water sector given that (1) the regulatory frameworks for the two sectors are similar, (2) NG's historical RCV growth aligns more closely with the growth anticipated for water, and (3) empirical evidence indicates that the market is pricing higher risk for water relative to energy.
- Aiming up: The estimate adopted in this Report reflects cross-check evidence and the need to incentivise investment. In contrast, the DD adjustment focuses solely on incentivising investment, although it is unclear how the exact estimate has been derived.

- RMA: The RMA is not applied in this Report. When the flaws in the calculation are corrected, the implied adjustment reduces to less than 1bp.

The CoE estimate derived in this Report is consistent with several principles implied by the CMA's determination of the allowed CoE at PR19, supporting consistency with the outcomes of previous price control whilst recognising the new challenges faced by the sector. These principles are important for investor confidence and availability of capital given the long-term financing commitments made by investors in regulated infrastructure. Most drivers of difference between the CoE estimate in this Report and the DD stem from the application of these principles.

Table 48: Analysis of consistency with CMA PR19 principles for CoE estimation

CMA PR19 principles	KPMG CoE estimate	DD CoE estimate
The appropriate risk-free rate for the CAPM lies above the yield on index-linked gilts as gilts and other government bonds benefit from the convenience yield[250].	✓	×
The appropriate risk-free rate for the CAPM lies between the risk-free saving and borrowing rates in line with Brennan (1971) [251].	✓	×
Ex post and ex ante approaches are the most robust basis for deriving the TMR[252].	✓	✓
Beta estimates should not attach significant weight to very rare events such as Covid19 as this could be distortive[253]. The CMA's approach to deriving the beta range resulted in an estimate that was relatively unaffected by observations from the Covid period.	✓	×
Reductions in notional gearing are not required to alleviate financeability constraints, as the WACC is the primary factor which ensures that an efficient firm can finance its functions[254].	✓	×
It is important to avoid disincentivising levels of investment required in the context of parameter uncertainty which supports aiming up when selecting a point estimate for CoE[255].	✓	✓
The need for sufficient financial incentives would be particularly acute "*if Ofwat required a step change in investment to meet changing resilience requirements in the face of climate change challenges or other stresses on existing infrastructure*" [256].	✓	×
Investors should have a reasonable expectation of earning required returns[257].	✓	×
The RMA is required to the cost of capital for the appointee is required to avoid double counting compensation for systematic retail risks given that allowed returns are set at the appointee level taking into account risk from all controls (including retail).	×	✓

Source: KPMG analysis

[250] CMA (2021), PR19 Final Determination, para. 9.264.
[251] Ibid., paras. 9.263-4.
[252] Ibid., para. 9.393.
[253] Ibid., para. 9.493.
[254] Ibid., para. 10.72.
[255] Ibid., para. 9.1402.
[256] Ibid., para. 9.1391.
[257] Ibid., para. 9.1339.

11. Analysis of the commentary from Ofwat and its advisers on MFMs and inference analysis

11.1. Analysis of the commentary on MFM analysis from Ofwat and Robertson & Wright

This section provides responses to the technical points raised by Ofwat and Robertson & Wright regarding MFM analysis.

11.1.1. The empirical performance of q-factor model compared to the CAPM at the water portfolio level

Ofwat and its advisers consider that applying the q-factor model to the water portfolio results in only a marginal improvement in the goodness-of-fit. They also consider that the unexplained component of returns, α, is indistinguishable between the CAPM and q-factor. Consequently, they conclude that the q-factor model does not offer any substantial advantage over the CAPM.

Instead of relying on the factor spanning and GRS tests typically applied in asset pricing literature to well diversified portfolios, Ofwat's advisers adopt an unconventional approach of assessing the validity of q-factor model based on a portfolio comprised of two water stocks. Evaluating performance based on individual stocks does not provide a robust test of the model's overall validity. The adjusted R-squared of both CAPM and q-factor models is expected to be relatively low due to the high idiosyncratic volatility associated with individual stocks, which diminishes the goodness-of-fit for any model.

Although evaluating model performance with a portfolio of only two stocks is inappropriate, applying the alpha test on water portfolios based on the updated analysis shows that the q-factor model has better empirical performance than the CAPM. In particular, as set out in the table below:

- The value of alpha for q-factor model is always lower than that of the CAPM, which suggests that the excess return unexplained by the q-factor model is smaller than that by the CAPM.
- For the q-factor model, the alpha terms are statistically insignificant across various cut-off dates and regression windows, indicating that the q-factor model effectively explains the returns of the water portfolio.
- In comparison, the alpha terms of the CAPM are statistically significant at the 10% level in both the 2-year and 10-year regressions with a February 28, 2020 cut-off, which suggests that a significant proportion of returns remains unexplained by the CAPM.

Table 49: Alpha test based on applying CAPM and q-factor model on the water portfolio (SVT/UUW) based on the current cut-off date and previous cut-off dates submitted to Ofwat

Model	Parameter	Cut-off date	Regression window		
			10-year	5-year	2-year
CAPM	alpha	28/06/2024	0.0001	0.0003	-0.0002
	p-value	28/06/2024	0.534	0.499	0.693
q-factor	alpha	28/06/2024	0.0001	0.0002	-0.0001
	p-value	28/06/2024	0.658	0.587	0.836
CAPM	alpha	31/03/2022	0.0003	0.0003	0.0004
	p-value	31/03/2022	0.132	0.420	0.463
q-factor	alpha	31/03/2022	0.0003	0.0003	0.0001
	p-value	31/03/2022	0.125	0.409	0.188
CAPM	alpha	28/02/2020	0.0003	0.0002	0.0010
	p-value	28/02/2020	0.095	0.511	0.091
q-factor	alpha	28/02/2020	0.0003	0.0001	0.0008
	p-value	28/02/2020	0.128	0.624	0.115

Source: KPMG analysis

In summary, while evaluating performance based on individual stocks does not provide a robust test of the model's overall validity, the q-factor model demonstrates a superior ability to explain returns for the water portfolio compared to the CAPM.

11.1.2. The empirical performance of q-factor model compared to the CAPM based on test portfolios

I GRS test

The appropriate method for evaluating whether an asset pricing model can explain returns is through the GRS test, which is performed based on a set of test portfolios. The null hypothesis is that all alphas across the test portfolios are jointly equal to zero, indicating that an asset pricing model can explain the returns on the test portfolios.

This test is applied to the updated MFM dataset as described in Table 6 in Tharyan et al. (2024). Four types of test portfolios are constructed using UK non-financial stocks listed in FTSE350 during the period from July 1980 to June 2024:

1 Based on the ranking of investment ratio measure employed by the q-factor and FF5F models.

2 Based on the ranking of the standard deviation of annual returns calculated over the previous twelve months, a method that is neutral[258] in terms of model construction (Llewellyn and Shanken, 2010)[259] and used as a UK test portfolio in Gregory et al. (2013).

3 Based on the ranking of market capitalisation, which aligns with the size measurement used in the q-factor and FF5F models.

4 Based on the ranking of momentum of returns over the previous 12 months.

[258] In this setting, neutral means that the measurement is not incorporated as a factor in an asset pricing model and therefore does not favour a particular model.

[259] Lewellen, J., S. Nagel and J. Shanken (2010). A Skeptical Appraisal of Asset-Pricing Tests, Journal of Financial Economics, Vol. 96, pp. 175-194.

Table 50: Results of GRS tests on test portfolios formed by deciles, full period from July 1980 to June 2024 (based on Table 6 of Tharyan et al. (2024))

Test portfolio	Element	CAPM	q-factor
Investment ratio	p-value	0.01	0.31
	Result	Fail	Pass
Standard deviation	p-value	0.10	0.23
	Result	Pass	Pass
Size	p-value	0.03	0.03
	Result	Fail	Fail
Momentum	p-value	0.09	0.04
	Result	Fail	Fail

Source: Source: Tharyan et al. (2024)

Both models fail the GRS test for value-weighted size and momentum portfolios. However, the q-factor model passes the GRS test for investment ratio and standard deviation test portfolios, indicating it can explain the returns of these test portfolios. Conversely, the CAPM fails the GRS test based on the investment ratio, and marginally passes the neutral test based on standard deviation of returns at 10% significance level. This suggests that a significant portion of excess returns in the test portfolios remains unexplained by the CAPM. Additionally, the CAPM's failure to price portfolios based on investment ratio, particularly given the scale of investment required in the water sector for AMP8 and beyond, underscores a significant and relevant limitation of the model.

Taken as a whole, the GRS test results suggest that the factors in the q-factor model are relatively complete in explaining return variations and demonstrate superior explanatory power compared to the CAPM.

II Alpha test on hedged portfolios

Rather than relying on the alpha terms of a water portfolio consisting of two stocks, a more systematic approach involves testing the statistical significance of alpha terms using hedge portfolios constructed from the test portfolios. This method is also used in the statistical tests of Hou et al. (2021), where a hedge portfolio is created by subtracting the bottom decile from the top decile. A CAPM regression is then performed on this hedge portfolio.

$$r_{\text{hedged portfolio}} = r_{\text{top decile portfolio}} - r_{\text{bottom decile portfolios}}$$

The results in the table below confirm that there is a substantial proportion of returns that remains unexplained by CAPM for the hedge portfolio constructed using investment ratio. Additionally, the adjusted R-squared for the q-factor model is at least 21% higher than that for the CAPM, and nearly 60% higher compared to the CAPM for large-minus-small size portfolios.

Table 51: Alpha tests on the hedged portfolios, full period from July 1980 to June 2024 (based on Table 7 of Tharyan et al. (2024))

Test portfolio	Element	CAPM	q-factor
Investment ratio	alpha	-0.76%	-0.37%
	t-stat	-3.31	-1.79
	Adjusted R^2	0.019	0.229
Standard deviation	alpha	-0.40%	0.08%
	t-stat	-1.22	0.28
	Adjusted R^2	0.139	0.357
Size	alpha	-0.23%	-0.16%
	t-stat	-1.19	-1.35
	Adjusted R^2	0.028	0.622

Source: Tharyan et al. (2024).

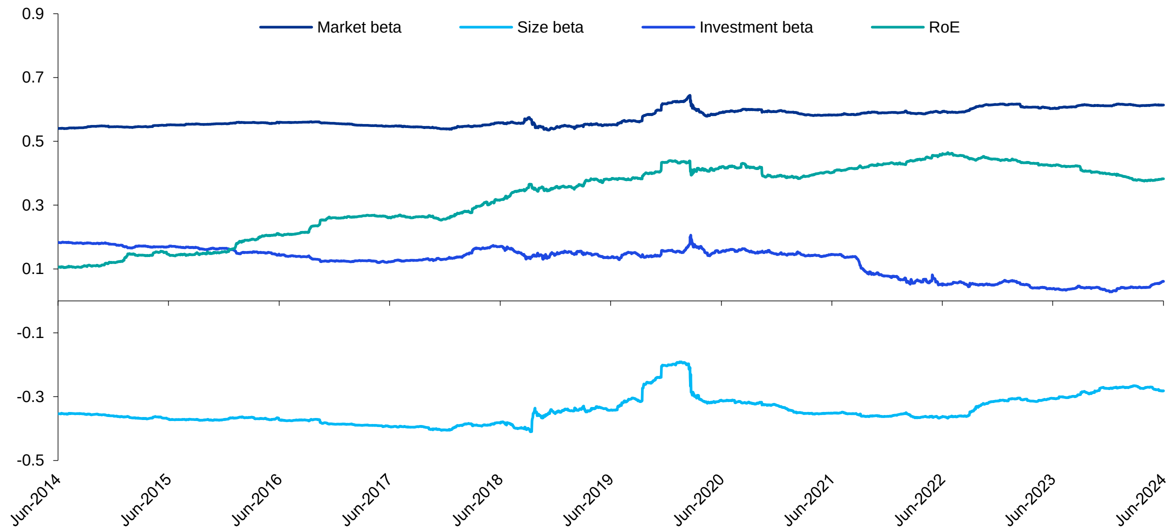
11.1.3. The stability of the factor loadings in q-factor model

Robertson & Wright highlight the instability of the 2-year and 5-year betas for the additional factors in the q-factor model without considering the relatively stable 10-year factor betas. This appears to be somewhat inconsistent with Ofwat's stated focus on longer-term beta estimates.

While they acknowledge that this instability also affects the market beta, which exhibits nontrivial variation over time, they appear to apply a higher bar the q-factor model evidence in terms of factor stability.

Figure 20 illustrates the evolution of the 10-year factor betas over the last decade. While there is some volatility in both market beta and the additional factor betas, they generally exhibit greater stability than the 2- and 5-year factor betas highlighted by Robertson & Wright.

Figure 20: Evolution of 10-year factor beta over the last decade



Source: KPMG analysis

11.1.4. The CoE differentials between CAPM and q-factor based on full period regression window

To evaluate the impact of factor loading volatility on the CoE, Robertson & Wright re-estimate the CoE using regression analysis for the period from April 1, 2000, to March 31, 2022. They state that this is the longest timeframe considered feasible based on the data submitted by KPMG in 2022. They find that the CoE estimated using the q-factor model is 3.35%, which is almost identical to the CoE derived using the CAPM (3.32%).

First, the dataset submitted to Ofwat includes daily returns for all factors in the q-factor model, as well as daily returns for SVT and UUW from December 13th, 1989, to March 31st, 2022. This represents the longest possible period since the water stocks were listed. As a result, it is feasible to conduct a full-period regression starting from 1989.

Second, Robertson & Wright estimate the CoE using raw factor betas without de-levering based on the portfolio gearing and re-levering to 55% notional gearing. The rationale for using raw betas in the context of determining the differential for setting the notional CoE is not clear.

A full-period regression from December 13th, 1989, to June 31st, 2024, is conducted to estimate the CoE for the water portfolio based on the longest possible window. The outputs from the CAPM and q-factor regressions are set out in Table 52 below. All factor betas from the CAPM and q-factor model are statistically significant, with p-value of 0.00%. The 95% confidence intervals for all factors are tightly clustered around the coefficient estimates, indicating a high level of precision and certainty. This precision translates into a robust estimate of the CoE derived from the full-period regression.

Table 52: Factor betas from CAPM and q-factor regressions based on full period

Coefficient	Coefficient value	Standard error	p-value	95% confidence interval	
β_{market} coefficient (CAPM)	0.5842	0.0124	0.0000	0.5599	0.6085
β_{market} coefficient (q-factor)	0.5335	0.0139	0.0000	0.5062	0.5608
β_{size} coefficient (q-factor)	-0.2271	0.0205	0.0000	-0.2672	-0.1870
$\beta_{investment}$ coefficient (q-factor)	0.1666	0.0249	0.0000	0.1177	0.2155
β_{RoE} coefficient (q-factor)	0.0891	0.0263	0.0010	0.0375	0.1407

Source: KPMG analysis

The raw betas obtained from the regressions are de-levered based on the full-period market cap weighted EV gearing of SVT and UUW (41.61%), and re-levered using the 55% notional gearing. The resulting CoE estimates are 5.32% for the CAPM and 6.02% for the q-factor model, leading to a CoE differential of 70bps. This figure is closely aligned to the differential for the 10-year regression window of 71bps as of June 28th, 2024, cut-off date.

Overall, the CoE differential between the q-factor model and CAPM, based on the updated q-factor model and full-period regressions, is significantly higher than that calculated by Robertson & Wright.

11.2. Analysis of the commentary on inference analysis from Ofwat and Mason & Wright

This section provides responses on the technical points raised by Ofwat and Mason & Wright regarding inference analysis.

11.2.1. Specification of the panel regression model

CCZ use a pooled Ordinary Least Square (OLS) regression, which assumes that the average elasticity is the same across firms. If the assumption of uniform average elasticity across firms does not hold, alternative models, such as the fixed effect model, should be used. The fixed effect model incorporates firm-specific, time-invariant effects, relaxing the assumption of uniform elasticity and accounting for individual heterogeneity[260] across firms that affects elasticity.

The pooled OLS regression can be expressed as follows, where the intercept term α is fixed across firms.

$$\frac{\partial E/E}{\partial D/D}_{it} = \alpha + \beta_L Leverage_{it} + \beta_V\ Volatility_{it} + \beta_r\, r_{f_t} + \varepsilon_{it}$$

The fixed effect model can be expressed as follows, where the term u_i represents the firm-specific, time-invariant effects.

$$\frac{\partial E/E}{\partial D/D}_{it} = \alpha + u_i + \beta_L\ Leverage_{it} + \beta_V\ Volatility_{it} + \beta_r\, r_{f_t} + \varepsilon_{it}$$

The fixed effect model can also be expressed as:

[260] Individual heterogeneity, in statistical terms, refers to differences among individuals or firms that are not completely random.

$$\frac{\partial E/E}{\partial D/D}_{it} = \alpha_i + \beta_L \, Leverage_{it} + \beta_V \, Volatility_{it} + \beta_r \, r_{f_t} + \varepsilon_{it}$$

This alternative expression may be more intuitive, as the firm-specific, time-invariant effect is represented by a firm-specific intercept α_i, rather than a constant intercept term (α) as in the pooled OLS regression.

It is standard practice for econometricians to base the selection of the panel regression model on statistical testing[261]. While CCZ do not mention any such tests and directly use pooled OLS regression for estimating elasticity, this Report performs statistical tests to select the appropriate panel regression models. The tests are implemented based on the practical guide by Park (2011)[262]. In particular, the F-test and Breusch-Pagan Lagrange Multiplier (LM) test are conducted to inform the selection of the appropriate model. The null hypotheses for these tests are as follows:

- F-test: the firm-specific fixed effects (u_i) are jointly zero.
- Breusch-Pagan Lagrange Multiplier (LM) test: random effects are insignificant.

The table below summarises the suggested approach based on the guide depending on the conclusion of the F-test and the LM test:

Table 53: Guidance on the selection of the model for panel data[263]

F-test (for fixed effect)	Breusch-Pagan LM test (for random effect)	Suggested approach
H_0 is not rejected (no fixed effect)	H_0 is not rejected (no random effect)	Pooled OLS
H_0 is rejected (fixed effect)	H_0 is not rejected (no random effect)	Fixed effect model
H_0 is not rejected (no fixed effect)	H_0 is rejected (random effect)	Random effect model
H_0 is rejected (fixed effect)	H_0 is rejected (random effect)	Conduct Hausman test to decide between fixed effect and random effect models

First, applying the F-test on the fixed effect regression on elasticity yields a p-value of 0.02%, which indicates that the null hypothesis of no firm-specific fixed effects should be rejected at the 1% significance level. This suggests the presence of fixed effects. Second, applying the Breusch-Pagan LM test yields a p-value of 100%, which means the null hypothesis of no random effects cannot be rejected. Based on these results and the guidance provided in the table above, the fixed effect model is deemed the appropriate choice for the regression on elasticity.

The results of this empirical testing align with economic intuition. It is reasonable to expect that the average elasticity would vary across firms due to factors such as sector, business segment, and geography. These characteristics are firm-specific and time-invariant, which corresponds to the firm-specific intercept term (α_i) in the fixed effect model. Indeed, firm fixed effects are used in the vast majority of corporate finance analysis and research.

11.2.2. Statistical significance of inference analysis

Ofwat and its advisers argue that that the regression-based estimates underpinning inference analysis have low statistical significance – in terms of the t-statistics of independent variables and the regression R-squared – and as a result a wide 95% confidence interval which encompasses elasticities which are negative as well as positive. The section below comments on each measure of statistical significance in turn.

[261] See, for example, sections 10.4 and 10.5, Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data*. MIT press.

[262] Park, H. M. (2011). Practical guides to panel data modelling: a step-by-step analysis using Stata. Public Management and Policy Analysis Program, Graduate School of International Relations, International University of Japan, 12, 1-52.

[263] Based on the table in p. 50, Park (2011).

I The 95% confidence interval of expected elasticity

Confidence intervals provide a range within which the true value of a population parameter is likely to fall. They quantify the uncertainty around an estimate, with wider intervals indicating greater uncertainty.

Ofwat's advisers use the wrong model for this purpose. They estimate the confidence interval for the expected elasticity of the fixed effect constant of SVT and UUW based on the Least Square Dummy Variable (LSDV) model rather than the fixed effect model.

The fixed effect model can be expressed as follows, where α_i represents the firm-specific intercept.

$$\frac{\partial E/E}{\partial D/D}_{it} = \alpha_i + 0.096\ Leverage_{it} + 91.391\ Volatility_{it} - 0.299\ r_{f_t} + \varepsilon_{it}$$

Note that this regression is based on the period underpinning the previous iteration of the analysis (i.e. October 2014 to June 2023) for comparability with Mason & Wright. The regression presented in section 9.3.4 is based on the window of October 2013 to June 2024.

The LSDV model can be expressed as follows, where D is a dummy variable that equals 1 for firm i.

$$\frac{\partial E/E}{\partial D/D}_{it} = \alpha + \mu_1 D_1 + \mu_2 D_2 + \mu_3 D_3 + \cdots + \mu_n D_n + 0.096\ Leverage_{it} + 91.391\ Volatility_{it} - 0.299\ r_{f_t} + \varepsilon_{it}$$

The coefficient values and standard errors for leverage, volatility and risk-free rate are consistent between the two models. The distinction lies in how the models account for firm-specific, time-invariant effects[264]: the fixed effect model considers these effects through de-meaning the individual specific effects, while the LSDV model uses dummy variables ($D_1, D_2, \ldots, D_n$) to explicitly account for the specific effect for each firm.

Applying the LSDV model to the elasticity regression results in 189 dummy variables, which correspond to 190 non-financial non-AIM listed UK firms listed in London Stock Exchange with data availability[265]. As a result, the LSDV model includes a total of 192 independent variables (189 dummy variables plus leverage, volatility, and risk-free rate), whereas the fixed effect model includes only three independent variables.

The use of the LSDV model can be problematic when the number of dummy variables is this high, as each additional dummy variable consumes one degree of freedom. The significant reduction in degrees of freedom due to the inclusion of 189 dummy variables results in a wider confidence interval and lower efficiency. In statistical terms, efficiency refers to the precision of an estimate; a less efficient estimator has higher variance between the estimated value and the true parameter value. In addition, the significant number of independent variables could also lead to issues such as near multicollinearity[266] and model overfitting. As a result, the confidence interval on the dependent variable becomes wider and the ability to achieve statistical significance is compromised. All else equal, researchers prefer more efficient models because they offer greater precision and confidence in estimating the true population parameter.

The impact of using an LSDV model with 189 dummy variables is demonstrated by the wide 95% confidence intervals on the intercept term and the dummy variables for SVT and UUW reported by Ofwat's advisers in Table 1 of their report. In the LSDV model, the intercept term represents the baseline level of the firm that is not included as the dummy variable. The presence of the many dummy variables introduces greater uncertainty in estimation of the baseline level. As a result, the confidence interval for expected elasticity ranges is wide, ranging from negative to positive.

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[264] Firm-specific, time-invariant effect refers to firm characteristics that are not expected to change over time. Some examples of firm-specific and time-invariant factors include sectors, business profile, and geography.

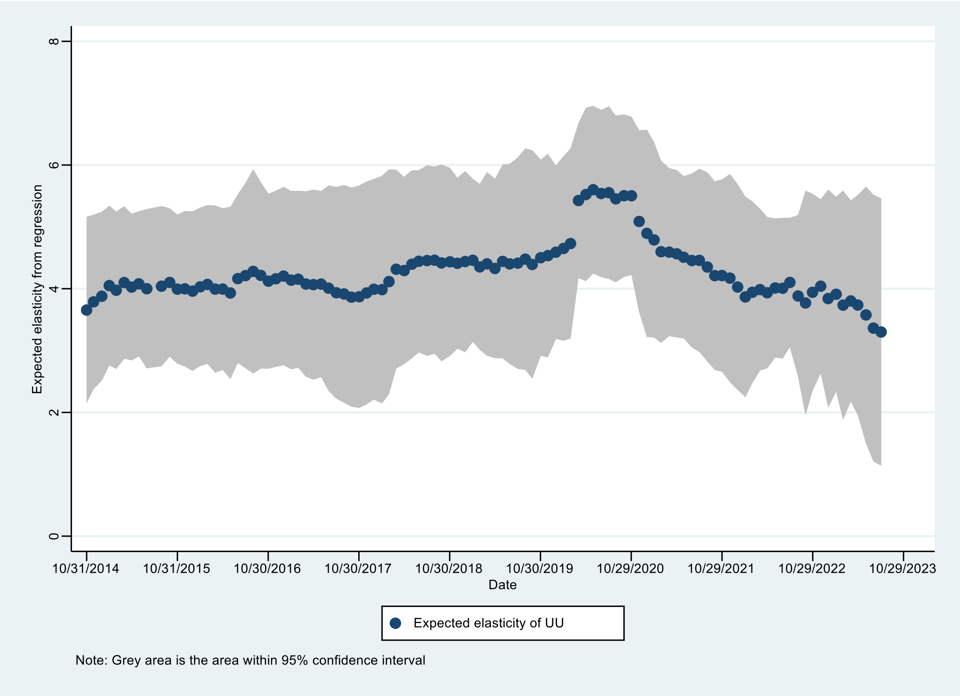
[265] Note that the number of dummy variables needs to be less than the total number of firms, otherwise it will lead to perfect multicollinearity. Stata automatically considers this in its model specification to avoid perfect multicollinearity.

[266] Multicollinearity occurs where two or more independent variables in a regression are highly correlated. This high correlation makes it difficult to separate the individual effects of these variables on the dependent variable, potentially leading to inflated standard errors and unreliable coefficient estimates.

In summary, the effectiveness of the LSDV model diminishes as the number of dummy variables increases and this reduction would be particularly pronounced with 189 dummy variables. Further, although both models control for the firm-specific, time-invariant effects, the fixed effect model focuses on how the elasticity varies over time for a firm, while the LSDV model captures all the variations, including the variation of elasticity within a firm and across all the firms. As the objective of the analysis is to examine temporal variation in elasticity for SVT and UUW, rather than to capture the variation across all the UK firms, the fixed effect model should be used.

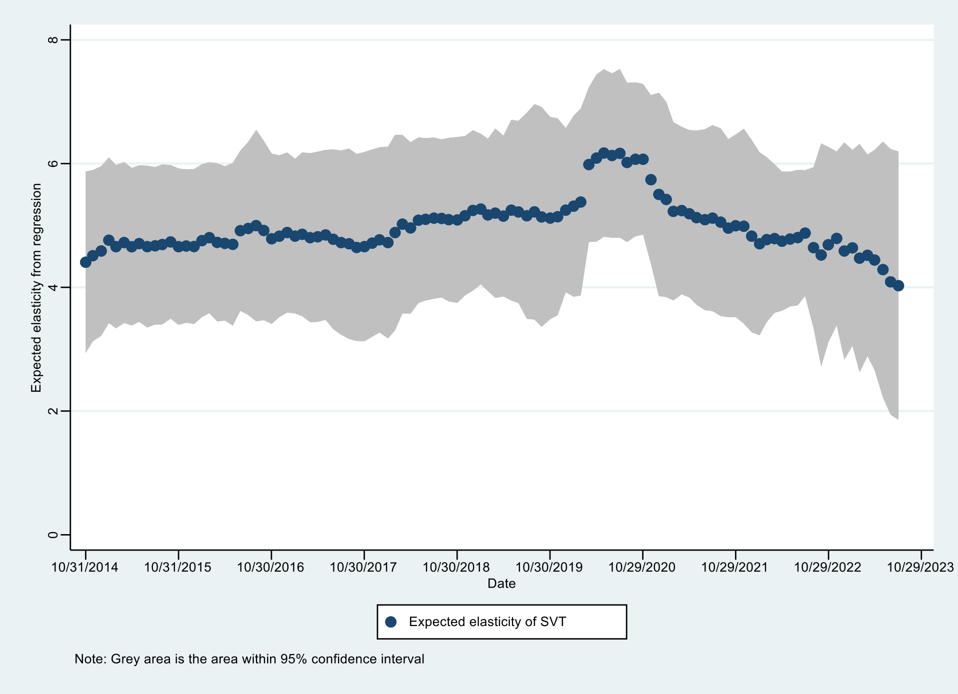
This Report uses the fixed effect model to re-estimate the confidence interval of the expected elasticity. Based on the dataset submitted to Ofwat alongside the previous iteration of the analysis, the results show a significant narrowing of the confidence intervals for the expected elasticity of SVT and UUW , with no negative values observed in any period (refer to the grey areas in Figure 21 and Figure 22). The same applies to the expected elasticity derived based on the extended regression window between October 2013 and June 2024 (which underpins the inferred CoE values in this Report).

Figure 21: Expected elasticity estimated from the regression and 95% confidence interval – United Utilities



KPMG analysis, output generated using Stata.

Figure 22: Expected elasticity estimated from the regression and 95% confidence interval – Severn Trent



KPMG analysis, output generated using Stata.

II Statistical significance of market leverage and risk-free rate

The updated analysis with the latest cut-off of June 2024 gives a p-value of 4.35% for the F-statistics, which suggests that the independent variables are able to jointly explain the variation of elasticity and are jointly significant at a 5% significance level.

The use of F-statistics is appropriate in the context it assesses the overall statistical significance of the regression model based on the collective impact of all independent variables.

In contrast, t-statistics used by Ofwat's advisers are better suited for assessing the significance of individual independent variables in isolation, in particular to test a hypothesis concerning a particular independent variable (which is not the goal of this analysis). It does not assess the combined effect of all variables. This means t-statistics alone are not suitable for evaluating the overall explanatory power of the regression model for inference analysis.

III The R-squared for the regression on elasticity

R-squared measures the proportion of variation in the dependent variable that is explained by the independent variables.

CCZ observe a relatively low R-squared for the elasticity regression, though the exact value is not reported.

KPMG's analysis also finds a relatively low R-squared for the elasticity regression.

The low R-squared is primarily due to two factors inherent to the analysis:

1 The regression is performed at the individual firm level rather than on a well-diversified portfolio, which is expected to significantly reduce the model's goodness-of-fit due to the material idiosyncratic volatility in individual stock debt and equity returns. It is well-known that individual stock returns are difficult to predict, which is why tests of asset pricing models are typically performed on portfolios rather than individual stocks.

2 Elasticity is calculated as the return on equity divided by the return on debt where small changes in the return on debt can lead to large variations in elasticity. The dependent variable in this

regression – i.e. the ratio of return on equity to return on debt – is inherently more volatile than the dependent variable in the CAPM regression, which is the equity return.

Ofwat's advisers observe that the regression on elasticity yields a low R-squared, suggesting limited explanatory power. However, it is important to recognise that due to the specific nature of the analysis, R-squared is likely to be low.

Other statistical measures, such as the F-test and 95% confidence intervals for the expected elasticity, provide more direct insights into the model's statistical significance and the estimation certainty and should be given primary consideration in the assessment of the model's effectiveness. The F-test indicates that market leverage, volatilities and risk-free rate collectively explain the variation in elasticity to a reasonable degree of accuracy. A positive and relatively narrow confidence interval for the expected elasticity, based on the fixed effect model, indicates that the expected elasticity is positive and statistically significant.

IV The comparison of the differences between elasticity and beta estimates for SVT and UUW

Ofwat and its advisers note that the elasticity estimates for SVT and UUW differ significantly by 17%, which they contend is implausible given that their betas are similar.

The differences in elasticity between two comparable companies has no bearing on the differences in their equity betas.

Elasticity measures the sensitivity of a company's equity returns to changes its debt returns, reflecting how variations in debt impact equity. Beta measures the sensitivity of a company's equity returns to fluctuations in overall market returns, capturing how a company's stock reacts to market-wide movements. As elasticity and beta assess different types of risk[267] their values and differences between companies are not directly comparable. As a result, variations in elasticity between companies will not necessarily align with differences in beta.

V The use of debt risk premia and debt returns in inference analysis

Mason & Wright argue that the debt risk premium used in the analysis is generic, derived from iBoxx A/BBB indices for investment-grade companies, whereas CCZ calculate firm-specific bond excess returns. They highlight significant differences in firm-specific bond credit spreads for SVT and UUW and suggest that elasticity estimates would be lower if the firm-specific returns on debt were used.

This argument appears to conflate how debt risk premia and bond returns are used in the analysis.

- Realised (outturn) elasticity, the dependent variable in the regression analysis, is calculated as the ratio of month-on-month total return on equity to total return on debt. The return on debt is the weighted average total return of fixed-rate bonds. This input is firm-specific and is necessary for all companies included in the sample, which consists of stocks listed on the London Stock Exchange each year, excluding foreign, financials[268] and AIM-listed firms[269].

[267] The CAPM (and hence the CAPM-beta) prices required equity returns relative to the risk and return of the wider market. Inference analysis (and hence elasticity) prices required returns relative to the risk and return of a specific company's debt or a debt benchmark.

[268] The implications of high leverage are different across financial and non-financial firms (consistent with CCZ). Whilst high leverage is common for financial firms and not indicative of financial distress, in non-financial firms, high leverage may indicate financial distress or difficulty.

[269] AIM-listed firms are excluded to capture the tradable and investable universe for institutional investors. AIM-listings include many small and illiquid stocks. AIM stocks have not historically been viewed as investible by many fund managers due to their high failure rates and poorer standards of reporting. Therefore, the UK studies focus on the Main Market of the London Stock Exchange and exclude AIMs.

- The debt risk premium, derived from the benchmark index, is used to calculate the inferred CoE based on expected elasticity. The benchmark index yields proxy the current borrowing costs of the notional company, consistent with the approach used for setting the allowed cost of new debt which effectively assumes that all companies in the sector have the spread on a forward-looking basis.

Mason & Wright conflate the firm-specific total return on debt used to derive realised elasticity with the iBoxx benchmark rate used for the debt risk premium. As the firm-specific total return on debt is already incorporated in the elasticity calculation, the argument that elasticity estimates would be lower if the firm-specific returns on debt were used is unfounded.

Mason & Wright also cite the cost of debt differences reported for UUW and SVT in the 2023 Monitoring Financial Resilience Report as evidence of significant variations in firm-specific bond credit spreads. However, the overall outturn cost of debt for a portfolio does not directly indicate differences in credit spreads. Instead, it reflects a combination of factors, including different financing strategies, debt mix, currency mix, timing of issuance, weighted-average tenor. To accurately compare credit spreads, one should examine the pricing of instruments with identical features, such as for 15-year fixed-rate GBP-denominated issuances made at the same time.

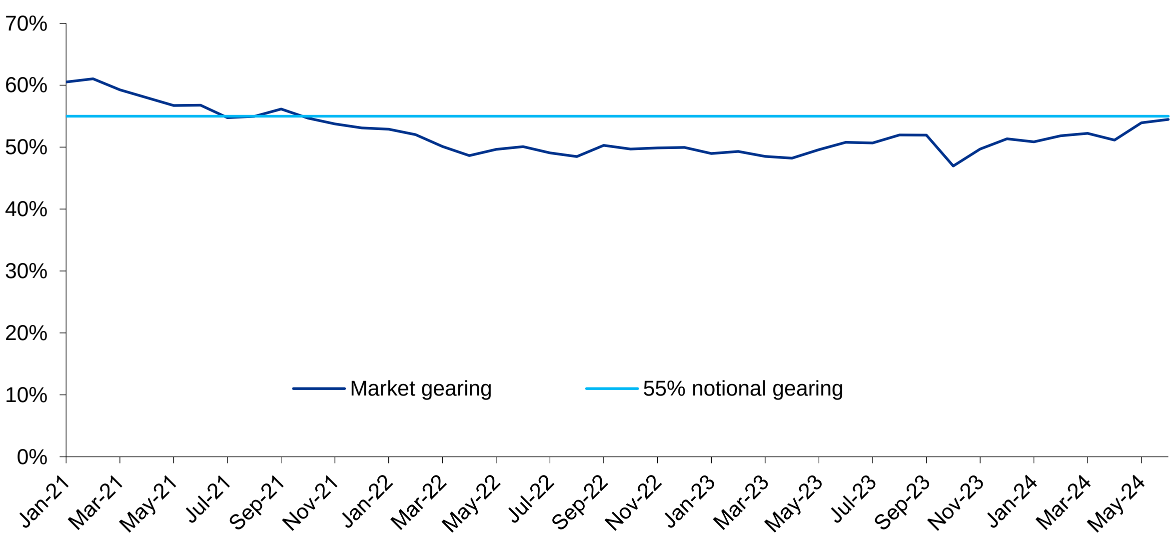
In summary, the calculation of expected elasticity via regression analysis relies on firm-specific inputs for the return on debt for all companies in the sample, while the inferred CoE for SVT/UUW is based on the assumed debt risk premium for the notional company. Critically, attributing differences in the outturn cost of debt to variations in firm-specific bond spreads is inaccurate.

VI The impact of re-levering on expected elasticity and inferred CoE

Elasticity is derived from regression analysis based on market leverage which may differ from the 55% notional gearing assumption used in the PR24 DD.

As illustrated in the figure below, market leverage for SVT/UUW has been below the assumed notional gearing level since late 2021. The longest averaging window used in the calculation of inferred CoE is 12 months, with expected elasticity estimates extending back from June 2024. During this period, the average market leverage for SVT/UUW was 51%, ranging from 47% to 54%.

Figure 23: Evolution of market leverage (SVT/UUW average) relative to the PR24 notional gearing



Source: KPMG analysis, output generated using Stata.

Mason & Wright argue that elasticity is sensitive to de- and re-levering. However, given that market leverage is below notional gearing, de- and re-levering would increase elasticity and CoE estimates. As the Report does not perform this conversion, inferred CoE estimates are likely to somewhat *understate* the required returns at the notional gearing level for PR24 and can thus be considered conservative.

12. Appendices

12.1. Appendix A: Comparison between the CAPM and inference analysis

The inferred CoE is derived based on expected elasticity, debt risk premia and risk-free rate. The table below sets out a comparison between the CAPM and inference analysis in terms of estimation approaches and underlying intuition.

Table 54: Comparison between CAPM and inference analysis

	CAPM	Inference analysis (based CCZ approach)
Intuitive interpretation	Investors require higher returns for holding stocks that exhibit greater sensitivity to market movements, with the magnitude of this premium contingent upon the asset's systematic risk	Investors require higher returns for assuming the higher risk associated with holding equity – the lowest priority claim against a firm's assets and returns – compared to debt which has a higher priority. This premium is contingent upon the firm's security structure, equity volatility, and the underlying macroeconomic conditions
Formula for estimating returns	$E[r_E] = r_f + \beta_{equity} (E[r_M] - r_f)$	$E[r_E] = r_f + \frac{\partial E/E}{\partial D/D} (E[r_D] - r_f)$ Where: $(\frac{\partial E/E}{\partial D/D})$ represents the elasticity of equity to debt and reflects the % change in the value of equity relative to the % change in the value of debt (elasticity). It measures the sensitivity of equity value to debt value
Reference for pricing required equity returns	Relative to the risk and return of the wider market	Relative to the risk and return of a specific company's debt or a debt benchmark
Estimation of a company's equity risk premium	A product of equity beta and market risk premium	A product of elasticity and debt risk premium
Risk factor	Equity beta (β), a systematic risk factor, measures the sensitivity of a company's equity return to the changes in the overall market return. Higher sensitivity indicates higher compensation required by the investors	Elasticity $(\frac{\partial E/E}{\partial D/D})$, a relative risk factor, measures the sensitivity of a company's equity return to its debt return. Higher sensitivity implies higher compensation required by equity investors compared to the debt investors of the same company
Determinant of the risk factor	Equity beta (β) is determined by: 1) the covariance between a stock's return and the market return, which can be positive, negative or zero; 2) the volatility of the stock's return relative to the market return	Elasticity $(\frac{\partial E/E}{\partial D/D})$ is determined by several factors such as risk-free rate, asset volatility, and market leverage

	CAPM	Inference analysis (based CCZ approach)
Regression model	Regress a stock's realised equity return on realised market return	Regress realised elasticity on risk-free rate, volatility, and market leverage which are the determinants of elasticity commonly cited in academic research Realised elasticity = $\alpha + \beta_{lev}$ leverage + β_{vol} volatility + β_{rf} risk-free rate
Regression output	Equity beta (β_{equity})	Betas for realised risk-free rate, volatility, and market leverage ($\beta_{lev}, \beta_{vol}, \beta_{rf}$) To derive expected elasticity, betas from the regression are multiplied by the outturn leverage, volatility, and risk-free rate, plus α Expected elasticity = $\alpha + \beta_{lev}$ company's outturn leverage + β_{vol} company's outturn volatility + β_{rf} risk free rate

The table above underscores the clear parallels between CAPM and inference analysis, both of which adopt market-based approaches to CoE estimation by estimating a factor that reflects risks of a specific company. The key difference is that CAPM estimates required returns based on the sensitivity of a company's equity returns to market returns, whilst inference analysis considers the sensitivity of a company's equity returns to debt returns of the same company.

12.2. Appendix B: Methodology for translating the RoRE variance into standard deviation of the company return

This appendix describes a three-step approach for translating the RoRE variance, arising from increasing capital intensity, into changes in total risk exposure. This is expressed as the standard deviation of total return, a traditional measure of risk.

To assess the impact of increasing capex intensity on the RoRE range, the PR24 RoRE range from the KPMG risk model[270] is considered (1) based on a Totex range reflecting risk in previous price controls in line with the PR19 FD[271] (2) based on a Totex range reflecting forward-risk for PR24, holding all other risk factors constant. The change in the Totex RoRE is assumed to be predominantly driven by increased capex intensity.

Step 1 – Simulate RoRE performance in terms of P10/P50/P90 for each risk driver using the KPMG risk model

The tables below set out the RoRE outputs from the KPMG risk model for PR24, 'as is' and with the PR24 Totex RoRE being replaced by PR19 FD level, holding all other risk factors constant. P10 and P90 represent the downside and upside of the expected performance for each factor. The only difference between the tables is the Totex RoRE range (in terms of average variance P90-P50/P10-P50 at 1.43% vs. 0.92%).

270 KPMG risk analysis assesses, based on the available empirical evidence and historical sector performance data, whether the DD parameters and mechanisms allow the notional company to earn base allowed return on a median expected basis. The stochastic risk model is constructed to simulate the notional company's risk exposure in RoRE terms by key risk drivers, accounting for risk mitigations purposed by Ofwat in PR24 DD. In this report, the RoRE outputs are based on the "Unmitigated rebased" numbers in the club risk model, which is the scenario with full estimated risk exposure of the notional company under DD regulatory regime, but removing the miscalibration risk, i.e. assuming that companies are able to improve their performance to the levels required in AMP8 to meet the submitted BP targets.

271 Sourced from Ofwat's published wholesale cost RoRE model in PR24 draft determination, which assumes a +/- 8.5% variance in wholesale Totex over/underspend based on the 2015-2020 data. This information would have been available at the time of PR19 Final Determination, thus this Totex is used as a stand-in for PR19 Totex RoRE.

Step 2 – Calculate the risk exposure for each risk factor

The standard deviation for each risk factor is derived by averaging the P10-P50 and P90-P50 ranges and dividing by 1.268[272].

This approach aligns with the CAPM assumption that returns are normally distributed, meaning they are symmetrically clustered around the mean. While there may be asymmetric downside risks in the expected performance of each risk factor under the PR24 DD regulatory framework, such risks are beyond the scope of this specific analysis.

Step 3 – Aggregate the individual risk exposure to the whole company

The standard deviation of each risk factor is aggregated to determine the total risk exposure for the notional company using the following formula:

$$\sigma_P^2 = \sum_{i=1}^{n} \omega_i^2 \, \sigma_i^2$$

$$\sigma_P = \sqrt{\sigma_P^2}$$

Where:

- σ_P is the total risk exposure measured as standard deviation
- σ_i is the risk exposure of each driver, e.g. Totex risk
- ω_i is the relative weight of each risk driver.[273]

The tables set out the total risk exposure for a notional water company, measured as the weighted average of the standard deviations for each risk driver, based on PR24 and PR19 Totex RoRE ranges. Keeping all risks constant except for Totex risk, the total risk exposure of a notional company with higher capital intensity in PR24 is 0.54%, compared to 0.50% with the lower capital intensity from PR19, which implies an increase in total risk by a scaling factor of 1.07x[274].

Table 55: Simulated RoRE outcome and total risk exposure for a water company in PR24 vs. PR19

PR24 DD	Implied P10	Implied P50	Implied P90	Average of Variance	Standard Deviation of risk drivers (σ_i)	*Relative weight (ω_i)*	Implied risk variance ($\sigma_i^2 \omega_i^2$)	Implied total risk (σ_P)
Totex	**-2.43%**	**-0.91%**	**0.42%**	**1.43%**	**1.11%**	***22.02%***	**0.00060%**	
Retail	-1.55%	0.00%	1.55%	1.55%	1.21%	*23.96%*	0.00084%	
ODIs	-2.56%	-0.84%	0.37%	1.47%	1.14%	*22.64%*	0.00067%	
Financing	-1.49%	0.05%	1.55%	1.52%	1.19%	*23.49%*	0.00078%	
C-MeX	-0.33%	0.04%	0.48%	0.41%	0.32%	*6.26%*	0.00000%	
Revenue & other	-0.05%	-0.03%	0.00%	0.03%	0.02%	*0.39%*	0.00000%	
DPC	-0.16%	0.00%	0.00%	0.08%	0.06%	*1.24%*	0.00000%	
Total	**-8.57%**	**-1.69%**	**4.37%**	**6.47%**	**5.05%**	***100.00%***	**0.00289%**	**0.54%**

Source: KPMG analysis using the KPMG risk model, extracted August 19, 2024.

[272] This methodology assumes that performance is normally distributed, and thus that (1) P50, mean, and median values for each risk driver are equivalent and (2) the range of P90-P50 and P10-P50 should conceptually be the same and equal to 1.285 standard deviation (SD), where 1.285 is the critical value for the 10% confidence level in a normal distribution. Where the P90-P50 and P10-P50 ranges from the simulation differ, standard deviation is assumed to be the average of P90-P50 and P10-P50.

[273] The relative weight of each risk driver is derived as the proportion of its P90-P50/P10-P50 average variance to total RoRE variance. The same weights are applied to PR19 as derived from the KPMG risk model for PR24.

[274] Scaling factor 1.07 = 0.54%/0.50%.

PR24 DD with PR19 Totex	Implied P10	Implied P50	Implied P90	Average of Variance	Standard Deviation of risk drivers (σ_i)	*Relative weight (ω_i)*	Implied risk variance ($\sigma_i^2 \omega_i^2$)	Implied total risk (σ_P)
Totex	**-0.92**	**0.00%**	**0.92%**	**0.92%**	**0.72%**	***22.02%***	**0.00025%**	
Retail	-1.55%	0.00%	1.55%	1.55%	1.21%	23.96%	0.00084%	
ODIs	-2.56%	-0.84%	0.37%	1.47%	1.14%	22.64%	0.00067%	
Financing	-1.49%	0.05%	1.55%	1.52%	1.19%	23.49%	0.00078%	
C-MeX	-0.33%	0.04%	0.48%	0.41%	0.32%	6.26%	0.00000%	
Revenue & other	-0.05%	-0.03%	0.00%	0.03%	0.02%	0.39%	0.00000%	
DPC	-0.16%	0.00%	0.00%	0.08%	0.06%	1.24%	0.00000%	
Total	**-7.06%**	**-0.78%**	**4.87%**	**5.97%**	**4.66%**	***100.00%***	**0.00254%**	**0.50%**

Source: KPMG analysis using the KPMG risk model, extracted August 19, 2024.

Reverse stress test on the correlation

Accurately estimating the potential change in correlation resulting from the increased standard deviation of company returns due to capital intensity is challenging.

As such, a reverse stress test is conducted to assess the plausibility of a reduced correlation to offset the increased equity risk exposure. This involves calculating how much the correlation would need to decrease to keep the beta unchanged and evaluating whether such a decrease is realistic based on historical correlation trends. If the required correlation to offset the increased volatility is lower than the P10 of historical levels, it would indicate that maintaining a constant beta might be unrealistic. For completeness, the offsetting correlation is compared with 2-year, 5-year and 10-year windows with historical data since 2006.

The results of the test are shown in the table below. Based on the scaled-up standard deviation in equity return, the likelihood of correlation decreasing enough to maintain beta unchanged is lower than 10% for the 5- and 10-year windows used for beta estimation in the DD. Therefore, the possibility of a lower correlation to completely offset the increase in equity return volatility is low, thus the equity beta is more likely to increase.

Table 56: Correlation reverse stress test results

Estimation Window	2-year	5-year	10-year
Correlation as of 30 Jun 2024	0.36	0.42	0.44
Required correlation to offset the increased volatility	**0.34**	**0.39**	**0.41**
Historical correlation from Jan 2004 to 30 Jun 2024 (P10)	0.33	0.41	0.44
Historical correlation from 1 Oct 2014 to 30 Jun 2024 (P10)	0.32	0.41	0.44
Compare with Jan 2004 to 30 Jun 2024	Likelihood > 10%	Likelihood < 10%	Likelihood < 10%
Compare with 1 Oct 2014 to 30 Jun 2024	Likelihood > 10%	Likelihood < 10%	Likelihood < 10%

Source: KPMG analysis using Refinitiv Datastream data

12.3. Appendix C: Factor spanning test results

The factor spanning tests set out below are sourced from from Tharyan et al. (2024), which replicates the tests in Hou, Xue and Zhang (2019)[275]. In the context of evaluating the empirical performance of MFMs compared with CAPM, the ability of CAPM to explain the factor premia of both the q-factor model and the FF5F model is also tested.

[275] Hou, K., Mo, H., Xue, C., & Zhang, L. (2019). Which factors? *Review of Finance*, 23(1), 1-35.

I Factor spanning test on the FF5F model

Regarding the explanatory power of the CAPM for the individual factors in the FF5F model, although the hypothesis that the CAPM can explain the SMB, HML, and RMW factor premiums cannot be rejected, it is evident that the CAPM fails to capture the FF5F investment premium, the CMA factor.

Table 57: Explanation of the individual factors in the FF5F model using the CAPM

Factor	Parameter	Alpha	RMRF	Adjusted R^2
SMB	Coefficient	0.001	0.088	0.013
	t-statistics	0.580	2.820	
HML	Coefficient	0.002	0.101	0.014
	t-statistics	1.000	2.920	
CMA	Coefficient	0.005	-0.085	0.023
	t-statistics	4.710	-3.690	
RMW	Coefficient	0.001	0.020	0.001
	t-statistics	1.180	1.110	

Source: Tharyan et al. (2024)

Regarding the explanatory power of the q-factor model for the individual factors in the FF5F model, it subsumes the SMB, HML, and RMW factors, but not the CMA factor. Nonetheless, the alpha is materially smaller than that under the CAPM, and the explanatory power, as measured by adjusted R^2, is substantially higher.

Table 58: Explanation of the individual factors in the FF5F model using the q-factor model

Factor	Parameter	Alpha	RMRF	SIZE	INV	ROE	Adjusted R^2
SMB	Coefficient	0.000	0.020	1.031	-0.046	-0.072	0.923
	t-statistics	0.850	2.260	76.180	-2.840	-4.300	
HML	Coefficient	0.000	0.090	0.064	0.652	-0.707	0.392
	t-statistics	-0.290	3.200	1.510	12.770	-13.550	
CMA	Coefficient	0.001	-0.032	0.019	0.886	-0.266	0.858
	t-statistics	2.150	-3.540	1.420	54.160	-15.900	
RMW	Coefficient	0.001	0.018	0.042	0.059	-0.053	0.009
	t-statistics	0.880	0.980	1.530	1.790	-1.560	

Source: Tharyan et al. (2024)

In the joint factor spanning test for the FF5F model, the null hypothesis is that the pricing errors of the additional factors in FF5F are jointly zero. Rejecting this hypothesis indicates that the FF5F model provides additional explanatory power compared to the model it is being evaluated against.

A p-value of 0.0% for the CAPM indicates that the null hypothesis is rejected, suggesting that the additional factors in the FF5F model provide additional explanatory power compared to the CAPM.

In contrast, the p-value of 20.6% for the q-factor model indicates that the FF5F model does not add to the explanatory power of the q-factor model, and therefore, is subsumed by the q-factor model.

Table 59: Factor spanning tests with null hypothesis that the factors in FF5F model are jointly subsumed by another model

Tested by	The CAPM	Q-factor
p-value	0.000	0.206

Source: Tharyan et al. (2024)

II Factor spanning test on the q-factor model

The individual factor spanning test for the q-factor model indicates that the CAPM fails to explain both the investment factor and the RoE factor within the q-factor model. This suggests that these two factors provide additional explanatory power for returns compared to the market factor in the CAPM.

Notably, two out of three additional factors in the q-factor model add to the explanation of returns compared to CAPM. In contrast, only one of the four additional factors in the FF5F model adds to the explanation of returns compared to CAPM.

Table 60: Explaining the individual factors in q-factor model using CAPM

Factor	Parameter	Alpha	RMRF	Adjusted R^2
Size	Coefficient	0.001	0.055	0.005
	t-statistics	0.64	1.92	
Investment	Coefficient	0.005	-0.089	0.025
	t-statistics	4.82	-3.77	
RoE	Coefficient	0.002	-0.093	0.028
	t-statistics	1.98	-4.04	

Source: Tharyan et al. (2024)

Regarding the explanatory power of the FF5F model for the individual factors in the q-factor model, the FF5F model subsumes the size and investment factor, but not the ROE factor.

Table 61: Explanation of the individual factors in the q-factor model using the FF5F model

Factor	Parameter	Alpha	RMRF	SMB	HML	CMA	RMW	Adjusted R^2
Size	Coefficient	0.000	-0.029	0.877	0.045	-0.024	0.009	0.920
	t-statistics	0.410	-3.390	76.940	3.890	-1.380	0.440	
Investment	Coefficient	0.001	-0.004	-0.078	-0.014	0.909	0.012	0.797
	t-statistics	1.530	-0.340	-5.200	-0.890	39.150	0.450	
RoE	Coefficient	0.003	-0.052	-0.134	-0.290	-0.003	-0.028	0.246
	t-statistics	2.830	-2.440	-4.720	-9.960	-0.070	-0.550	

Source: Tharyan et al. (2024)

Regarding the factor spanning tests that examine all variables in the q-factor model jointly, a p-value of 0.0% for the CAPM and 4.5% for the FF5F indicate that the null hypotheses are rejected in both cases. This suggests that the additional factors in the q-factor model offer additional explanatory power for returns compared to both the CAPM and the FF5F. Consequently, the q-factor model subsumes both the CAPM and the FF5F models.

Table 62: Factor spanning tests with null hypothesis that the factors in q-factor model are jointly subsumed by another model

Tested on	CAPM	FF5F
p-value	0.000	0.045

Source: Tharyan et al. (2024)

Overall, while both the FF5F model and the q-factor model subsume the CAPM, the q-factor model also subsumes the FF5F model, whereas the reverse is not true. Therefore, the q-factor model provides additional explanatory power for returns compared to both the CAPM and the FF5F model and is the preferred MFM based on the UK dataset.

12.4. Appendix D: P/E ratios and the predictability of returns

At the RIIO-2 CMA appeals, Ofgem argued that a lack of serial correlation "*would imply that commonly used valuation criteria (such as price-earnings ratios) were spurious information in terms of predicting whether returns were likely to be high or low in the future*"[276].

The predictive power of price-to-earnings (P/E) ratios for future returns is independent of any assumptions regarding the presence or absence of serial correlation in the data. To demonstrate this, the relationship between the cost of equity, earnings, reinvestment ratios, and return on equity needs to be examined.

The basic dividend growth formula, which values a share or firm as the year 1 dividend divided by the discount rate minus the growth rate (*r-g*) can be re-written in terms of earnings as follows:

$$P_0 = \frac{(1-b)E_1}{r-bR}$$

Where:

- *b* is the retention ratio (the proportion of earnings retained by the company rather than paid out as dividends),
- *r* is the CoE,
- *R* is the long run return on equity (ROE),
- P_0 is the current price,
- E_1 represents the forecasted earnings for the next period.

b, r and *R* are assumed to be constant in perpetuity.

Growth, *g*, is calculated as the product of the retention rate and the achieved returns, represented by *bR.*

Deriving this in terms of current earnings is slightly more complex, as it is necessary to specify the short-run ROE and the short-run retention ratio. E_1 will be a function of current earnings, E_0, the short-run retention ratio, b_0 and the short-run ROE, R_0:

$$P_0 = \frac{(1-b)(1+b_0R_0)E_0}{r-bR}$$

Dividing by E_0 gives the trailing P/E ratio:

$$\frac{P_0}{E_0} = \frac{(1-b)(1+b_0R_0)}{r-bR}$$

Based on earnings, prices, expected return on equity (ROE), and payout ratios, one can solve for the expected return on equity capital using the following formula:

$$r = \frac{(1-b)(1+b_0R_0)}{P_0/E_0} + bR$$

It is also possible to derive an implied cost of capital using various accounting variables, such as book-to-market ratios and forecast earnings. This methodology is extensively documented in financial literature. Importantly, this analytical approach is independent of serial correlation and does not assume any form of serial correlation in the data.

The relationships between accounting variables, firm value, and the cost of equity are fundamentally influenced by the assumptions regarding both short-term and long-term ROE, as well as short-term and long-term payout policies. Any discussion of these relationships should be considered within the context of these assumptions, without conflating them with issues of serial correlation.

[276] CMA (2021), RIIO-2 Final Determination Volume 2A: Cost of equity, para. 5.250.

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