Cost of equity indexation: Evaluating the case for indexation at PR24 and beyond

pwc

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Executive Summary

In previous Ofwat price controls, the cost of capital has been set as a fixed parameter for the duration of each control, but evidence from previous price controls suggests that the ex-ante forecasts of the allowed cost of capital can deviate significantly from the outturn cost of capital. Ofwat has outlined its intention to explore indexation as a method of mitigating some of the uncertainty about the timing and pace of potential interest rate changes in PR24 and beyond.

This report presents our assessment of the case for cost of equity indexation for future price controls in the UK water industry.

Ofwat and other UK regulators have traditionally applied the Capital Asset Pricing Model (CAPM) in determining the allowed cost of equity, which includes as components:

- **Risk-free rate of interest (RFR)** — the interest rate earned for investments without systematic risk
- **Equity beta** — a measure of how much the equity returns of individual assets move with the wider market
- **Total market return (TMR)** — the total returns an investor can expect from investing in the market portfolio (often considered as investors' ex-ante expectations of returns).

In this report we assess the benefits and costs of indexing each parameter against a set of defined evaluation criteria:

- **Criteria 1: Empirical case for indexation** — we evaluate the robustness of indexation and estimation methodologies and the potential gains in terms of reduction in forecast error.
- **Criteria 2: Impact on water companies' risk profile** — we consider two primary impact pathways, first how indexation affects water companies' resilience to financial shocks, and second, the impact on the allocation of risk and the impact of uncertainty.
- **Criteria 3: Impact on water customers** — we assess the materiality of the impact on customer bill volatility and service levels for customers.
- **Criteria 4: Overall complexity and practical challenges** — we assess how indexation could affect the overall administrative complexity for both Ofwat and water companies in implementing future price controls.

Indexation of each parameter within the cost of equity formula is possible, though as parameters that are not directly observable, the estimation of each comes with specific challenges and key methodological decisions. Key considerations include the selection of relevant comparators, use of backward-looking vs. forward-looking data, estimation methodologies, and accounting for inflation. We note also that applying any indexation approach in practice also requires considering the frequency of reconciliation, whether annual or end-of-period, as well as whether to apply indexation in full or introduce a materiality threshold to reduce overall volatility.

Estimates of all parameters are often highly sensitive to small methodology decisions, which presents difficulties both for a regulator determining a chosen method as well as our task in evaluating the merits of indexation itself. To focus our analysis we generally follow Ofwat's existing estimation approaches (for example, when unlevering and relevering equity beta). However, we also present estimates utilising alternative methodologies (for example, for indexing TMR where there is no preferred measure that is widely used by all regulators).

The table below presents an overview of our overall assessment against each criteria, with a RAG rating to indicate whether indexing each component presents a net positive or negative impact under the given criteria.

Table 0.1: RAG assessment of assessment criteria by component of cost of equity

Criteria	Component	RAG	Description
Criteria 1 - Empirical case for indexation	RFR		Marginally positive impact
	Equity Beta		No significant value
	TMR		No significant value
Criteria 2 - Impact of indexation on water companies' risk profile	RFR		Mixed impact
	Equity Beta	N/A	N/A
	TMR	N/A	N/A
Criteria 3 - Impact of indexation on water customers	RFR		Marginally negative impact
	Equity Beta	N/A	N/A
	TMR	N/A	N/A
Criteria 4 - Overall complexity and practical challenges from indexation	RFR		Marginally negative impact
	Equity Beta	N/A	N/A
	TMR	N/A	N/A

From our empirical analysis of indexing equity beta and TMR, we conclude that there is no significant value from indexing these components. The potential gains in terms of reduced forecast error are limited. Equity beta exhibits both short-term variability and some mean reversion such that fixed ex-ante estimates have been historically reasonably accurate predictors of outturn data. An indexed approach would not be a clear improvement and indeed could result in indexing to an erroneous datapoint. Our analysis of historical data suggests that TMR is also a relatively stable parameter over time, whereas indexing the TMR to forward-looking or ex-ante measures risks introducing material uncertainty to the calculation of the cost of equity. Furthermore, there are substantial challenges to indexing these measures, particularly for TMR, where there is no clear consensus on a preferred measure. Given these challenges in the face of limited benefits, we conclude there is a weak case for the indexation of equity beta and TMR and therefore do not assess equity beta or TMR indexation against criteria 2-4.

In contrast, our analysis of RFR indexation suggests it can increase forecast accuracy. The tendency of the RFR to have large and comparatively long-lived movements means there is greater potential for limiting windfall gains or losses to investors, through indexation. There are however challenges around the selection of risk-free instruments as well as having to manage alternative measures of inflation. If indexing the RFR alone, then there is the uncertainty of whether other (less observable) elements of the cost of equity calculation move to amplify or counteract the RFR movement. We therefore assign RFR a 'marginally positive impact' rating against Criteria 1.

With respect to criteria 2, the impact of RFR indexation on water companies' risk profile is mixed. In the current low interest rate environment, we find that substantial changes in financeability are unlikely in the near term. However, while indexing RFR mitigates some of the external market risk for the owners of water companies, it shifts these risks to customers who may be less suited to manage them. Investors may value this decrease in risk, but it does come at the cost of more uncertain revenues, which could deter some investment given that investors in the sector value stable revenues. Our analysis finds a clear trade off between risk and uncertainty, and consequently we assign a 'mixed impact' rating for this criteria.

The practical complexities of implementation and potential impacts on customers provide counterweights to the potential gains from indexation. The near term impact on bills would likely be relatively minor, but any volatility in bills would concern customers, with evidence indicating they prefer bill stability. The interaction between a rise in RFR increasing both water bills and overall borrowing costs would do the most harm to poorer, vulnerable customers, who are more likely to be net borrowers. As a result, we assign a 'marginal negative impact' rating for criteria 3.

Indexing RFR would complicate the regulator's task through additional methodology decisions, managing changes to inflation measures, interactions with other elements of the price control, and the additional time and resource costs involved. This alone should not be a determining factor, but practical challenges as well as other negatives must be offset by the potential benefits of indexation.

The final decision requires consideration of the trade-off between potential reductions in forecast error and an increase in customer exposure to interest rate volatility and the inevitable complications the change would bring to the price control process. The overall impact is mixed from a risk and uncertainty perspective.

On the basis of our assessment criteria, we conclude that cost of equity indexation is unlikely to produce sufficiently clear gains to make it a priority.

1. Introduction

Purpose of this report

PwC was commissioned by Ofwat to undertake a review of the evidence for and against indexation of the allowed return on equity in the UK water sector, with the aim of informing its approach to future price controls. In this report, we consider how indexation of the cost of equity could work in practice and we identify several indexation options, before defining the key criteria for evaluating the merits of each option and assessing our shortlisted options against the key criteria. This assessment incorporates a range of evidence, including quantitative analysis of the case for indexation as well as regulatory precedent, responses to Ofwat's recent consultation 'PR24 and beyond: Creating tomorrow, together'[1], and stakeholder views.

We conclude our report with an overall recommendation on whether Ofwat should consider adopting indexation for future price controls, and if so, how this could be robustly implemented.

Context to this report

In previous price controls, including the PR19 final determination published in December 2019, Ofwat has set an allowed return on equity which is fixed ex-ante for the duration of each price control. At PR19, Ofwat set ex-ante estimates for cost of equity parameters by using outturn data and adjusting for market expectations of how these parameters could evolve over the price control period. The CMA recently published its final determination of the PR19 appeals launched by four water companies, and whilst its approach to estimating the cost of equity differed from Ofwat in some respects, we note that it also used an ex-ante estimation approach rather than adopting indexation.

In its recent consultation on the design of the PR24 price review (and future price reviews more broadly), Ofwat notes its intention to explore the merits of indexing the allowed return on equity. A key potential advantage of indexation is that it could reduce potential forecast error[2], thereby placing less pressure on regulators to forecast cost of equity movements in an uncertain interest rate environment. Ofwat's consultation notes that its estimate of the risk-free rate was revised downwards significantly during the PR19 process, and evidence from previous price controls suggests that the outturn cost of equity has tended to be lower than the regulatory allowance, creating windfall gains for investors. At the time of writing, the Bank of England base rate is 0.10%, a record low. Looking ahead to PR24 and beyond, interest rates are more likely to rise than they are to fall given the UK's current position in the economic cycle. But there remains significant uncertainty about the timing and pace of any upward and downward changes to rates, which makes it challenging to set allowed equity returns on an ex-ante basis.

There is recent regulatory precedent for cost of equity indexation, with Ofgem adopting indexation of the risk-free rate for the RIIO-2 price controls. Our review of the relevant consultation documents suggests that Ofgem's decision was closely informed by the considerations above, with the regulator citing the significant uncertainty over future risk-free rate movements and the potential for substantial forecast errors, which could lead to large windfall gains or losses for investors due to market movements that are outside of network companies' control.

As part of the PR24 and beyond consultation, Ofwat commissioned CEPA to assess the allocation of risk in its regulatory framework, and consider how this could be reformed for future price controls. CEPA's report[3] considered the potential for cost of equity indexation in the water sector, and recommended that this proposal be explored further. The report identified two potential benefits from a risk allocation perspective:

[1] Ofwat (2021), PR24 and beyond: Creating tomorrow together: https://www.ofwat.gov.uk/regulated-companies/price-review/2024-price-review/pr24-and-beyond-creating-tomorrow-together/

[2] In this report forecast error refers to the difference between ex ante parameter estimates and it's outturn value. This is simpler to assess for directly observable parameters, but harder to determine in relation to unobservable parameters and the overall cost of equity.

[3] CEPA (2021), Allocation of risk, prepared for Ofwat: https://www.ofwat.gov.uk/wp-content/uploads/2021/06/CEPA-report-Allocation-of-risk.pdf

1. **Appropriate allocation of individual risks:** Changes in the risk-free rate are outside of company control.
2. **Adherence to best practice principles:** Ofwat introduced other mechanisms to reduce forecast error at PR19, including cost of new debt indexation, and indexing the cost of equity would achieve greater consistency with the wider regulatory framework whilst supporting the principle of minimising forecasting risk.

Our report considers these potential risk allocation benefits, as well as a range of other advantages and disadvantages of indexation, in reaching a holistic assessment of the merits of indexation and how it could be robustly implemented. This report provides an overall recommendation on whether cost of equity indexation should be adopted for PR24 and beyond, but it should not be interpreted as an indicator of future Ofwat policy. However, it will inform Ofwat's consideration of cost of equity indexation ahead of the draft PR24 methodology consultation in summer 2022, and it is intended to support further engagement with stakeholders.

Structure of this report

The rest of this report is structured as follows:

- **Chapter 2** explores how cost of equity indexation could work in the UK water sector. We first explain the different options for indexation, and highlight the key methodological decisions that must be made when indexing each parameter, before exploring Ofgem's indexation approach for RIIO-2 and articulating which indexation methodologies we have assessed in our evaluation.
- **Chapter 3** sets out our evaluation of the indexation options. We first explain the four evaluation criteria we have adopted, before assessing the indexation options against each criteria. We end with an overall assessment of the merits of indexation, drawing together our findings across each of the evaluation criteria.
- **Chapter 4** provides concluding remarks and recommendations for Ofwat on whether it should consider adopting indexation for future price controls, and if so, how this could be robustly implemented.

2. How indexation could work in the UK water sector

In this chapter, we explore how cost of equity indexation could work in practice within the UK water sector. We begin by briefly explaining how the cost of equity is calculated using the Capital Asset Pricing Model (CAPM) framework, and we set out different options for indexation of cost of equity parameters. The indexation of each individual parameter requires a range of methodological decisions in its own right, and we highlight the key considerations relating to each parameter, as well as overarching methodological considerations across all parameters. We then summarise the indexation approach taken by Ofgem at RIIO-2, and we end this chapter by explaining the indexation methodologies we have considered for each parameter in this report.

Overview of the CAPM cost of equity framework and options for cost of equity indexation

Ofwat and other UK economic regulators have traditionally set the allowed cost of equity based on the CAPM framework. This framework stipulates that the cost of equity for firm *i* at time *t* can be calculated as follows:

$$CoE_{i,t} = RFR_t + \beta_{i,t} * (TMR_t - RFR_t)$$

where RFR_t is the risk-free rate, $\beta_{i,t}$ is the equity beta for firm *i* and TMR_t is the total market return, and $TMR_t - RFR_t$ is referred to as the equity market risk premium (EMRP).

In deciding how to index the cost of equity, regulators must therefore identify which parameters of the cost of equity are subject to indexation, and which (if any) should remain fixed over a regulatory period (or indeed longer). This means there are numerous possible indexation options to consider. Based on regulatory precedent, and the relative observability of different cost of equity parameters, we consider that the risk-free rate is the most obvious candidate for indexation and therefore all indexation options assessed in this report include risk-free rate indexation. This leaves the following indexation options, which we assess in this report:

i. No indexation (the 'status quo' option)
ii. Indexation of the risk-free rate only, with equity beta and total market return fixed
iii. Indexation of the risk-free rate and equity beta, with total market return fixed
iv. Indexation of the risk-free rate and total market return, with equity beta fixed

We now turn to consider how the indexation of each cost of equity parameter could work in practice, briefly highlighting key methodological considerations. We do not seek to present an exhaustive list of considerations, but instead to highlight important methodological decisions required.

Indexation of the risk-free rate

The risk-free rate (RFR) is the interest rate earned for making an investment without systematic risk. In practice, the RFR cannot be readily observed and must be estimated using benchmark market-traded investments that involve negligible default and inflation risk. The indexation of the RFR requires decisions to be made about the benchmark series used, as well as how the risk-free rate is calculated from those series, as we explain below.

Benchmark selection

The selection of RFR benchmark series requires consideration of both benchmark sources and tenors:

- **Benchmark source:** It is common practice to estimate the RFR using the market yield on high-quality debt instruments. In the UK, regulatory authorities have tended to use yields on UK index-linked government gilts for estimating RFR[4], although the CMA recently also referenced yields on highly rated corporate bonds (such as those with a AAA credit rating) to inform RFR estimates.

[4] SONIA, the Bank of England's preferred measure of the risk free rate, has also been used as a cross check.

- **Benchmark tenor:** For each benchmark source there are a range of available series, representing different investment tenors. The regulator must choose those series which best represent the typical investment horizon in its sector.

RFR estimation approach

- **Backward-looking vs. forward-looking estimation approaches:** The RFR can be estimated based purely on outturn data from the benchmark series, although further market movements may occur prior to application in a price control. A potential remedy is to use forecast interest rates derived from forward yield curves in combination with outturn data to account for potential RFR movements in future years.
- **Length of estimation period:** An estimation period for RFR in each year must be defined. There is a trade-off between widening the estimation period to avoid short-term market volatility, and focussing the estimation window on the most recent time periods to avoid data which is outdated and less relevant.
- **Timing of estimation period (relative to regulatory year):** As well as having a suitable length, the RFR estimation period must have a suitable timing. There is a trade-off between setting an earlier timing which allows investors advance visibility of the RFR for the forthcoming regulatory year, and setting a later timing which reduces the time delay between RFR measurement and its use in a price control. It may also be advantageous to seek alignment with the estimation periods involved in other reconciliations running concurrently as part of the same price control.
- **Treatment of inflation:** A key challenge with UK index-linked financial instruments is that they are typically linked to RPI inflation, which is being phased out of use by UK regulators (including Ofwat) in favour of CPIH inflation. This creates a need to derive CPIH-real interest rates based on the RPI-denominated benchmark data, which can be achieved either through using RPI-linked instruments and adding an expected RPI-CPIH wedge and liquidity premium[5], or using nominal instruments and incorporating a forecast for CPIH (and adjusting for inflation risk premium).

Indexation of equity beta

The equity beta measures the covariance between the equity returns from individual assets (or a portfolio of assets) and the wider equity market, capturing the degree of sensitivity to market movements. Equity beta can be directly measured for companies that are publicly listed, but for non-listed companies it is typically estimated based on the equity returns of listed comparators which are a reasonable proxy for the non-listed companies. Similarly to RFR, the indexation of equity beta requires decisions to be made about the comparators used as well as how equity beta is calculated from those comparators, as we explain below.

Comparator selection

- **Comparator choice:** The most obvious comparators for equity beta in the UK water sector are the UK's listed water companies, whose beta can be measured using market data. However, there may be merit in considering additional listed comparators as a cross-check, such as other regulated companies in the UK or internationally.

Equity beta estimation approach

- **Econometric approach:** Equity beta can be derived by regressing returns from individual shares on wider equity market returns, to measure the degree of sensitivity. This can be achieved through Ordinary Least Squares (OLS) regression, or alternatively GARCH estimation can be used, which is designed to address time-variant volatility often found in financial time series.
- **Data frequency:** The regulator must choose the frequency of equity returns data used to compute equity beta for the chosen comparators, with common options being daily, weekly or monthly.
- **Estimation window:** The regulator must choose the sample period used to estimate equity beta, with common options being a 1-year, 2-year or 5-year sample period.
- **Timing of estimation (relative to regulatory year):** As for RFR, the beta estimation period must have a suitable timing relative to the regulatory year. Given the need to achieve sufficient sample size (i.e. use

[5] Some finance practitioners argue that a liquidity premium is required as the CPI linked debt market is far smaller than the RPI linked market.

sufficiently large estimation windows) when estimating beta there is less emphasis on producing results close to the cost of equity reconciliation date, but it is nonetheless important to justify the timing chosen.

- **Unlevering and relevering:** In a regulatory context, it is common practice to 'unlever' and 'relever' equity beta so that it is reflective of a notional company with some systematic risk exposure across its debt portfolio (i.e. a non-zero debt beta) and the notional level of gearing. For example, Ofwat did this at PR19 final determination by first converting raw equity beta into an unlevered beta, then applying a debt beta assumption to calculate asset beta, and finally converting asset beta into a relevered equity beta based on notional gearing.

Indexation of total market return

The total market return (TMR) captures the total returns an investor can expect to receive from investing in the market portfolio, which is a representative diversified basket of all equities trading in the market. TMR can be considered as investors' ex-ante expectations of returns, which are largely unobservable. The indexation of TMR requires decisions to be made about the estimation approach used, as we explain below.

TMR estimation approach

- **Backward-looking vs. forward-looking estimation approaches:** There are a range of approaches to estimating TMR, which fall into three broad categories: (i) historical ex-post approaches, which assume that historical realised returns are a reliable guide to investors' forward-looking expectations, (ii) historical ex-ante approaches, which also use historical realised returns but apply equity return modelling to separate ex-ante expectations from good or bad fortune observed historically, and (iii) forward-looking approaches, which use recent market data and investor surveys to infer investors' TMR expectations. Of these options, forward-looking approaches are generally given less weight relative to historical approaches, typically being used as a cross-check.
- **Nature of indexation:** One approach to TMR indexation - based on a historical TMR estimation methodology - would be to 'roll forward' TMR estimates to account for new TMR data as it becomes available. Although this would likely result in small changes to TMR, given the long sample periods used. If TMR is strongly correlated with RFR, then it may be possible to index TMR mechanistically based on movements in RFR. Another option would be to index based on a forward-looking method, such as dividend discount modelling.
- **Data source used:** There are different source datasets available for analysing historical equity returns, although the most commonly used source is the Dimson, Marsh and Staunton (DMS) dataset from the Credit Suisse Global Investment Returns Yearbook. Forward-looking approaches typically use market-based assumptions on GDP growth forecasts, dividend yields and buyback yields.
- **Time period used:** Different time periods can be used to derive TMR estimates, with historic equity returns data from earlier decades (especially the early 20th century) generally being of lower quality. Forward-looking approaches typically consider at least a 10 year time horizon.
- **Averaging methodology:** To estimate TMR based on historical returns, an averaging methodology and assumed investor holding period must be used to evaluate average returns. There are a range of averaging methods based on arithmetic and geometric averaging, and assumed holding periods also vary, ranging from 1 year to 20 years depending on the regulatory context. In contrast, forward-looking estimation approaches sometimes average historical observations to reduce monthly volatility[6].
- **Deflation approach:** To estimate TMR based on historical returns, historic nominal equity returns must be deflated based on historical inflation series. There is no single inflation metric that has been consistently recorded over the last century, meaning that composite approaches must be used which combine different series across historical time periods. Common approaches include using either the Bank of England's CED/CPI and/or CPI/RPI series to deflate historical equity returns. In contrast, forward-looking approaches typically use long run estimates of inflation to obtain real values.
- **Timing of estimation period (relative to regulatory year):** The precise timing of analysis is less important when using a long term historical estimation approach. . However, it may be advantageous for regulators to estimate TMR close enough to price control reconciliations, to ensure that the latest TMR evidence is

[6] For example, see the outputs from PwC's DDM model: https://www.ofwat.gov.uk/wp-content/uploads/2019/07/PwC-Updated-Dividend-Discount-Model-analysis-for-PR19.pdf

incorporated into reconciliations where possible. Forward-looking approaches typically produce monthly estimates of TMR, and can therefore be estimated closer to specific points in time.

Wider considerations regarding cost of equity indexation

As well as the parameter-specific considerations cited above, there are also two broader methodological considerations for how cost of equity indexation works in practice, which apply regardless of the specific indexation option chosen:

- **Frequency of reconciliation:** Whilst cost of equity parameters themselves may be indexed on an annual basis, their application in revising revenue allowances ('reconciliation') may occur on either an annual or end-of-period basis. Annual reconciliations help to align cashflows with market movements but can create in-period bill volatility for customers. Whereas end-of-period reconciliations reduce in-period complexity and administrative burden, but may lead to sharp bill movements between regulatory periods should the cost of equity change significantly in a consistent direction in-period.
- **Materiality threshold for indexation:** Cost of equity indexation can be applied in full, meaning that all changes in the indexed parameters are reflected in investor returns, but this may lead to relatively small changes in the overall weighted average cost of capital (WACC) despite significant effort being invested in reconciliation. An alternative approach is to apply adjustments only when the overall materiality of cost of equity adjustments exceeds a pre-defined threshold. This has its own drawbacks, such as challenges in defining an appropriate threshold and loss of indexation benefits below the threshold.

Ofgem's indexation approach for RIIO-2

Ofgem decided to introduce cost of equity indexation for its RIIO-2 price controls, with the final determination for many of these price controls published in December 2020. In this section we briefly summarise Ofgem's RIIO-2 indexation approach, which provides an important reference point for Ofwat's decision over whether to index the cost of equity for PR24 and beyond. In its RIIO-2 Framework consultation, Ofgem proposed three options for cost of equity indexation:

- Indexation of the risk-free rate only
- Indexation of the risk-free rate and equity risk premium
- Indexation of the risk-free rate and total market return

After further consideration, Ofgem decided to reject the latter two options on the basis that the RFR is readily accessible and less disputed, whereas there is debate around the nature of the equity risk premium, and TMR would not be expected to change significantly over the price control. Ofgem therefore focussed its detailed options evaluation on indexation of the RFR only, and it ultimately decided to adopt this approach rather than avoiding indexation[7].

Ofgem's RIIO-2 approach to indexation of the RFR incorporates the following estimation decisions:

- **Benchmark source and tenor:** Ofgem uses RPI-linked UK government bonds (gilts) with a 20-year tenor to calculate the indexed RFR.
- **Backward-looking vs. forward-looking estimation approaches:** Ofgem uses outturn gilt yields alone to produce indexed RFR estimates, and its approach does not incorporate use of forward yield curves to forecast future interest rate changes.
- **Length and timing of estimation period:** Ofgem uses the daily average RFR estimate for the October prior to the start of the financial year (which runs from April to March) to calculate the indexed RFR. It publishes an update on the allowed cost of equity for each financial year by 30th November, four months prior to the start of the financial year.
- **Treatment of inflation:** Ofgem uses OBR forecasts for RPI and CPI, taken from its *Economic and fiscal outlook* published in March prior to indexation, to calculate the difference between RPI and CPIH, assuming that the RPI-CPIH wedge is equal to the RPI-CPI wedge. It then adds the RPI-CPIH wedge to the yields on RPI-linked gilts to calculate a CPIH-derived RFR for the month of October each year.
- **Frequency of reconciliation:** Ofgem's approach involves annual reconciliation of the cost of equity and adjustment to allowed revenues as part of its Annual Iteration Process, rather than end-of-period adjustment.

[7] It should be noted that this approach does change the equity market risk premium over time as the TMR is fixed.

- **Materiality threshold for indexation:** Ofgem's approach involves full indexation, with all changes in RPI-linked gilt yields feeding through into allowed revenue adjustments regardless of their magnitude.

Indexation methodologies considered in this report

In this section we explain the indexation methodologies considered in our evaluation of indexation options, articulating the methodological assumptions we have made for each parameter. Given the range of methodological considerations set out earlier in this chapter, there are numerous specific ways indexation could be implemented, and it is not possible to analyse them all. In general, we have sought to adopt the most commonly used and widely accepted methods for parameter estimation, and our approach has also been influenced by previous regulatory decisions from the PR19 and RIIO-2 final determinations (as well as the CMA's latest decisions on the PR19 appeals and RIIO-2 appeals).

For the avoidance of doubt, our analysis of all parameters assumes that full indexation is applied regardless of parameter movement magnitude.[8]

RFR indexation

Our assessment of RFR indexation incorporates both outturn analysis examining the impacts of indexation had it been implemented at PR14 and PR19, and forward-looking analysis examining how indexation could impact the allowed return on equity over the remainder of PR19 and in the long term, under a range of plausible interest rate scenarios.

Our primary measure of RFR is the real spot return (yield) on index-linked UK gilts with a 15-year maturity, in keeping with Ofwat's PR19 approach to setting RFR. As explained further below, where indexation is applied we also follow Ofwat's PR19 approach in using the month-average gilt yield from the September preceding the regulatory year to set RFR.

Our analysis considers outturn or forecast market trajectories for 15-year gilt yields, and compares these against the following three RFR indexation options:

- **Fixed RFR:** No indexation is applied and RFR is set at the fixed value determined by Ofwat ahead of the price control.
- **Anchored indexation:** Indexation is applied based on year-on-year movements in 15-year gilt yields, with the yield for each regulatory year being informed by the month-average spot yield for the preceding September. However, the RFR value for the first year of each regulatory period is set equal to the fixed RFR value applied by Ofwat, regardless of the market yield. The RFR values for subsequent years are then determined by calculating the net year-on-year differences in market yield, and applying these to the 'anchored' first year RFR value. The rationale behind this approach is that it allows the regulator to apply some regulatory discretion prior to the regulatory period. For example, at PR19 final determination (where indexation was not applied) Ofwat applied an upward adjustment to the September 2019 yield, based on future interest rate increases incorporated in market-implied forward curves.
- **Non-anchored indexation:** Indexation is applied based on year-on-year movements in 15-year gilt yields, with the yield for each regulatory year being determined by the month-average spot yield for the preceding September. There is no anchoring in the first year of each regulatory period, so indexed RFR values are determined entirely by market yields.

As noted above, our forward-looking analysis is based on assessment of indexation performance under a range of plausible interest rate scenarios, with these scenarios being informed by market-implied forward yield curves, historical RFR variation over the regulatory cycle and the future economic outlook. We explain the precise calibration of each scenario more thoroughly in our evaluation (Chapter 3).

We note that index-linked gilt yields are not the only method for measuring RFR, and in its PR19 final redetermination the CMA decided to adopt a composite approach to measuring RFR, drawing on index-linked gilt yields (ILGs) and nominal yields on AAA-rated corporate bonds. However, the more established regulatory approach to measuring RFR is to use ILGs, and the CMA's provisional RIIO-2 redetermination finds that Ofgem was not wrong to rely solely on

[8] We note that full indexation is constrained by the number of decimal places the regulator uses to define each parameter, with parameter movements being picked up only where they impact rounded parameter estimates. In practice this is most likely to be a consideration for equity beta, which is typically defined to 2 decimal places (and where even a 0.01 unit movement can make a substantial difference to overall equity returns).

ILGs in setting RFR. Taking all of this into account, and the fact that indexing RFR on a composite measurement basis would increase indexation complexity, we focus our RFR analysis solely on ILGs.

Equity beta indexation

Our assessment of equity beta indexation focuses on outturn analysis examining the impacts of indexation had it been implemented at PR14 and PR19. Ofwat's approach to estimating beta at PR19 final determination placed most weight on raw equity beta derived from daily returns data, and in keeping with this we also analyse daily beta measures. Our analysis considers daily beta measured over 1 year, 2 year and 5 year estimation windows. Using our indexation approaches, beta for a given regulatory year is determined by the value measured at month-end for the preceding September, which aligns with Ofwat's PR19 approach. We focus our analysis on OLS econometric estimation.

To derive raw equity beta estimates for the UK water sector, we use data from two of the three listed water companies: Severn Trent (SVE) and United Utilities (UUW). Consistent with Ofwat's PR19 approach, we have not used data from Pennon Group (owner of South West Water) because over the time periods considered in this analysis a significant proportion of its revenues were derived from activities outside of regulated water. We also follow Ofwat's approach in deriving a composite raw equity beta based on the individual raw equity beta values for SVE and UUW, weighted by their respective market capitalisation.

To convert our raw equity beta estimates into our final estimates, we first apply a composite gearing measure (also weighted by market capitalisation) to the composite raw equity beta, calculating a composite unlevered beta. The gearing measure used to perform this conversion uses the same estimation window as raw equity beta (so for example, our 1 year beta analysis uses a 1 year average of gearing to perform the unlevering conversion). The next step is to calculate asset beta, for which we use a debt beta assumption of 0.125 in line with the PR19 final determination. Lastly, we apply Ofwat's notional gearing assumption of 60% to calculate our (composite) re-levered equity beta estimates, for comparability against Ofgem's final determination point estimate for equity beta.

Our assessment of indexation options for equity beta considers a Fixed equity beta approach and Non-anchored indexation approach. The logic behind these approaches is similar to RFR, with the same method used to calculate indexed values (noting that a month-end data cut-off rather than month-average is used for equity beta).

One aspect of Ofwat's PR19 final determination approach that our modelling does not incorporate is Ofwat's use of regulatory judgement[9] to define the unlevered equity beta. For reasons of transparency and simplicity we apply unlevering in the mechanical way described above, recognising that it is more challenging to convincingly apply regulatory discretion when indexation is used.

TMR indexation

Our assessment of TMR indexation focuses on how TMR has evolved over recent decades, including typical movements over a 5-year price control period. We recognise that there are numerous approaches to measuring TMR (as summarised earlier in this chapter), but we focus our analysis on historical measurement of long-term UK equity returns using the Credit Suisse Global Investment Returns Yearbook 2021, which incorporates the latest Dimson, Marsh and Staunton (DMS) equity returns dataset. We adopt this 'historical ex-post' approach as it is arguably the most common and least disputed methodology for estimating TMR, with other approaches tending to produce more varied TMR estimates.

Our analysis tracks changes in historical TMR over time, using DMS' nominal UK equity return series for 1900 to 2020. We deflate this for all years up to 2016 using historical CED/CPI inflation from the Bank of England's 'millennium of macroeconomic data' collection (which runs to 2016), and for 2017 to 2020 we use official annualised CPI estimates from the ONS.

We use four averaging approaches to estimate historical TMR, which are described below:

- Simple averaging - this takes the arithmetic average of non-overlapping holding periods of various length.
- Overlapping averaging - this takes the arithmetic average of overlapping holding periods of various length, greatly increasing the sample size but introducing potential serial correlation issues.

[9] Beta estimation requires careful judgment given the relatively wide range of unlevered beta estimates it is possible to derive from the data.

- Blume averaging - this takes a weighted average of the simple arithmetic and geometric means, with the weights calibrated to produce an unbiased estimator.
- JKM averaging - this is a more efficient (unbiased) estimator for small samples which assumes lognormal returns and uses a function of the returns' mean and variance to generate estimates.

While we compute historical equity returns using a range of holding periods (1-year, 2-year, 5-year, 10-year and 20-year), we focus our analysis primarily on 5-year and 10-year holding periods, in line with Ofwat's approach at PR19 final determination.

Using the above approach, we adopt two distinct indexation methodologies for TMR. Our first approach (the 'DMS moving average approach') involves indexing based on year-on-year changes in TMR measured through the DMS dataset, using an estimation period which starts in 1900 and expands by one year every time an updated DMS dataset is released (typically in February or March each year). Using this approach, low equity returns in the latest year reduce TMR by dragging down the long-run historical average, and vice versa.

Our second approach (the 'RFR co-movement approach') involves linking TMR indexation to RFR indexation, by assuming some positive co-movement between RFR and TMR. This effectively assumes that TMR is not constant over time, falling as RFR falls and rising as RFR rises. Equivalently, the EMRP (given by the difference between TMR and RFR) moves less than one-for-one with changes to RFR. There is debate amongst academics and regulatory practitioners over the extent to which TMR is constant, and recognising this, we begin by analysing the degree of co-movement between RFR and TMR over recent decades. This informs the correlation coefficient we use to index TMR.

Our analysis of indexation impacts considers how indexation would have impacted cost of equity forecast error had it been implemented at PR14. Under the 'DMS moving average approach', our indexation options are defined as follows:

- **Fixed TMR:** No indexation is applied and TMR is set at the fixed value determined by Ofwat ahead of the price control.
- **Non-anchored indexation:** TMR is set based on the latest available historical estimate of long-run UK equity returns at the start of each regulatory year (based on the DMS dataset). Given that new editions of the DMS dataset are typically released in February or March, we assume that long-run average TMR up to and including year *t-1* can be incorporated in the TMR estimate effective from 31st March of year *t*. In practice this may be challenging for a regulator to achieve given the short time period between DMS publication and the start of the regulatory year.
- **Anchored indexation:** The same approach as for non-anchored indexation is applied, except the TMR value for the first year of the regulatory period is set equal to the fixed value determined by Ofwat ahead of the price control. The TMR values for subsequent years are then determined by calculating the net year-on-year differences in historical TMR, and applying these to the 'anchored' first year TMR value.

Under the 'RFR co-movement approach', our indexation options are defined as follows:

- **Fixed TMR:** No indexation is applied and TMR is set at the fixed value determined by Ofwat ahead of the price control.
- **Non-anchored indexation:** TMR is set by first analysing the correlation between RFR and TMR, and then applying the correlation coefficient to RFR movements over the regulatory period to calculate indexed TMR values. The indexation is non-anchored in the sense that the starting TMR value (for the first year) is given by the latest available DMS estimate of historical UK equity returns (as also used in the 'DMS moving average approach'). The RFR movements used to determine TMR are defined consistently with our non-anchored approach to RFR estimation: RFR is measured using the average yield on 15-year ILGs for the preceding September.
- **Anchored indexation:** The same approach as for non-anchored indexation is applied, except the starting TMR value (for the first year) is set equal to the fixed value determined by Ofwat ahead of the price control. The TMR values for subsequent years are then determined using the correlation between RFR and TMR movements.

3. Our evaluation of indexation options

In this chapter, we assess our indexation options against a set of defined evaluation criteria. We first explain our criteria and the evidence sources we have used to inform our assessment, before presenting the findings from our assessment. We conclude this chapter with an overall assessment of the merits of indexation, drawing together our findings across each of the evaluation criteria.

The indexation options considered in this chapter, as set out earlier in this report, are:

i. No indexation (the 'status quo' option)
ii. Indexation of the risk-free rate only, with equity beta and total market return fixed
iii. Indexation of the risk-free rate and equity beta, with total market return fixed
iv. Indexation of the risk-free rate and total market return, with equity beta fixed

Evaluation criteria

We have identified four key evaluation criteria for assessing our indexation options, which we explain below. These criteria are designed to capture the costs and benefits of indexation holistically, considering the empirical case for indexation as well as the impacts on water sector stakeholders including customers, water companies, investors and Ofwat.

Criteria 1: Empirical case for indexation

This criteria assesses the strength of the empirical case for indexation, including the robustness of indexation methodologies. A core benefit of indexation is that it may reduce forecast error in setting the cost of equity, thereby reducing windfall gains or losses to water companies and their investors (which are outside of management control) over a price control. However, this criteria also recognises that cost of equity parameters cannot be perfectly measured, with all estimation approaches (including the CAPM framework itself) ultimately being imperfect proxies. Indexation may reduce the observed forecast error of a specific series, but if there are significant in-year differences between alternative measures for a parameter, this calls into question whether indexation truly improves the accuracy of parameter estimates.

Criteria 2: Impacts of indexation on water companies' risk profile

This criteria assesses how indexation affects water companies' risk profile, in consideration of how well they are able to bear such risk. We consider two primary impact pathways:

- **Financeability impact:** the extent to which indexation improves or weakens companies' resilience to financial shocks, noting that financeability impacts may vary across companies depending on their size and wider financing strategy.
- **Risk profile and uncertainty impact:** considers the impact of indexation on the degree of risk in cost of equity parameters, whether it enhances the allocation of risk across companies and customers and, on the other hand, how stakeholders value the certainty of a fixed cost equity allowance for each price control period.

We note that there may be a trade-off between uncertainty and risk, in the sense that indexation reduces the certainty of equity returns for investors whilst also reducing the risk of windfall gains or losses relative to the wider market. We also note that the nature of financeability impacts may depend on the current and expected trajectory for cost of equity parameters: for example, in the context of potential interest rate rises (above the level embedded in an ex-ante cost of equity estimate), indexation may be considered broadly credit positive.

Criteria 3: Impacts of indexation on water customers

This criteria assesses how indexation could affect water customers. Whilst indexation may reduce the potential for windfall gains or losses to investors, potentially increasing public trust in the sector, there is also a risk that indexation increases bill volatility (with the nature of the volatility partly determined by whether revenue reconciliation occurs on

an annual or end-of-period basis). For this reason we consider the extent to which water customers value bill stability, and we explore the extent to which indexation may affect this.

Criteria 4: Overall complexity and practical challenges from indexation

This criteria assesses how indexation could affect the overall regulatory burden on Ofwat and water companies during future price controls. There are a range of revenue reconciliation mechanisms already used in the water sector, and whilst indexation may lead to greater alignment between the cost of equity and other indexed parameters, it could also add complexity to these existing reconciliations, as well as creating an additional calculation and reconciliation process for Ofwat to work through. Our assessment considers the overall weight of evidence and whether the benefits of indexation justify the additional time input required from stakeholders (recognising that this has opportunity costs).

We use a range of evidence sources to assess the merits of our shortlisted indexation options against these four criteria, including:

- Qualitative and quantitative analysis of impacts from indexation
- Ofgem's RIIO-2 analysis of the costs and benefits of indexation
- Interviews with external stakeholders
- Stakeholder responses to Ofwat's recent consultation 'PR24 and beyond: Creating tomorrow, together', which invited stakeholder views on cost of equity indexation
- CEPA's recent report for Ofwat as part of the PR24 and beyond consultation, 'Allocation of risk'

Criteria 1 (Empirical case for indexation): Our assessment

We begin our assessment of Criteria 1 (Empirical case for indexation) by highlighting some important differences between indexing the cost of new debt (which Ofwat has done for PR19) and indexing the cost of equity. We then explore the empirical case for indexation across each cost of equity parameter (RFR, equity beta and TMR), drawing on outturn and forward-looking evidence to assess the extent to which indexation reduces forecast error. We additionally consider other advantages and disadvantages of indexation, including how indexation may limit opportunities to apply regulatory judgement, and the extent to which this is a problem. We conclude this section by assessing the strength of the empirical case for indexation across each parameter, and deciding whether there is a strong enough case for them to be assessed against our other criteria.

Differences between cost of debt and cost of equity indexation

In Ofwat's PR24 and beyond consultation, one respondent noted that it had supported Ofwat's decision to index the cost of new debt at PR19, and it set out several reasons why (in its view) indexation of the cost of equity is more challenging to achieve and less robust. One of the key reasons is that water companies in England and Wales regularly issue new debt, much of which takes the form of tradeable bonds with associated credit ratings. This allows for companies' cost of new debt to be compared against market benchmark indices (such as the iBoxx A and BBB bond yield indices), and for an initial allowance to be set which places weight on both notional benchmarks and actual observed costs. By contrast, cost of equity indexation is harder to achieve as two of the three cost of equity parameters (RFR and TMR) are market parameters, and equity beta cannot be measured for most water companies, as only a small number of companies are publicly listed. The same stakeholder also noted that equity issuance is less frequent than debt issuance. Clearly, when taken together, these factors make it more difficult to assess water companies' actual costs of raising equity finance, and this increases uncertainty over the extent to which any given indexation approach covers companies' efficient cost of equity. This is an added challenge relative to indexing the cost of new debt.

Another consideration is that the time horizon for determining the cost of equity is unclear. Whereas the maturity of debt financing is typically set with a known loan maturity or bond redemption date, equity is undated. Listed equity re-prices daily, so the opportunity cost of equity for the marginal investor can be considered to vary on a daily basis, but the typical equity investor has a holding period of many years, so, at the point of investment, return expectations are set for a number of years[10]. Private equity and other infrastructure investments are also made for significantly longer periods. The five year price control period straddles the typical investment horizon of public and private equity

[10] Some equity investors (market makers, traders) may have (very) short-term investment horizon. While they support liquidity and price discovery, they are not sources of long-term investment capital and hence their investment horizon is less relevant to economic regulators.

investors, so already has a return reset broadly aligned to investment horizons. Furthermore, equity investment in public listed companies is continuous and transactions in private equity stakes in water companies are regular, but unevenly distributed across the water industry (some water companies have recently attracted new equity investors, some have gone a number of years with a stable private equity investor(s). This means there is no clear indexation point which would apply evenly to all companies.

With the above in mind, it is important to consider the merits of indexation across each cost of equity parameter, recognising that the strength of the case may differ. We therefore discuss the empirical case for indexation across each parameter (RFR, equity beta and TMR) below and then consider how this could be used to index the cost of equity as a whole.

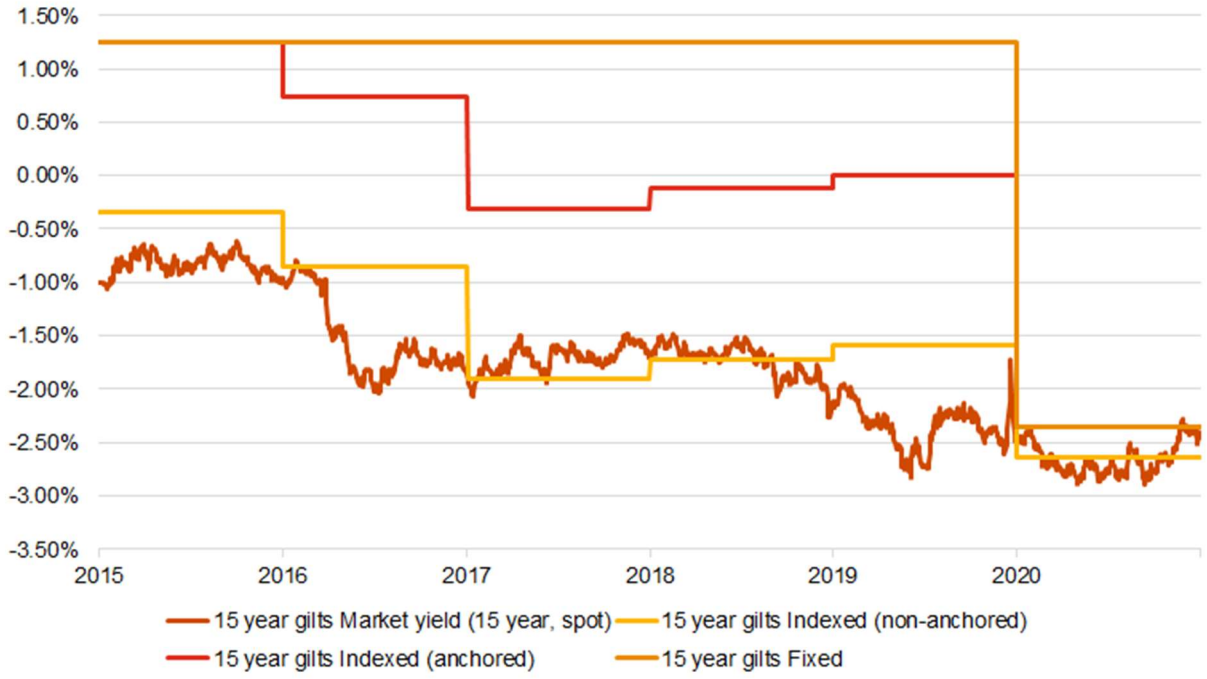
Indexation of the risk-free rate (RFR)

Analysis of forecast error

The best available measures of the risk-free rate (RFR) show that it has fluctuated considerably over recent decades, with substantial reductions over recent years to the historically low levels observed today. As such, a holistic assessment of RFR indexation must consider the net benefits it yields over multiple 5-year price controls, considering different macroeconomic environments and potential RFR trajectories. The most logical approach is to consider the recent past and the near future. As noted in the preceding chapter, our assessment of RFR indexation incorporates both outturn analysis examining the impacts of indexation had it been implemented at PR14 and PR19, and forward-looking analysis examining how indexation could impact the allowed return on equity over the remainder of PR19 and in the longer term, under a range of plausible interest rate scenarios.

We start by analysing outturn evidence from PR14 and PR19 over the 2015-21 period, during which the RFR experienced a large decrease of around 150 basis points (see Chapter 2 for an explanation of our RFR indexation methodology). Figure 3.1 below captures the RFR based on fixed, anchored indexation and non-anchored indexation approaches, as well as the benchmark, given by daily spot yields on 15-year Index Linked Gilts (ILGs).

Figure 3.1: Evolution of real RFR from 15-year ILGs, 2015-21



Source: Bank of England, PwC analysis

Another way to capture the extent to which different indexation options track market movements is to study the Gap to Benchmark (GTB), which we define as the difference between a given indexation option and the benchmark under consideration. In this case, the benchmark under consideration is the daily 15 year historical gilt spot rate. In Table 3.2 below, we show the average[11] GTB between the benchmark and each of our three indexation options over PR14 (2015-20) as well as our wider outturn sample (which includes the first year of PR19[12]).

Table 3.2: Average GTB across our RFR indexation options, PR14 and 2015-21

RFR estimation type	PR14	2015-21
Fixed RFR	+2.88%	+2.33%
Indexed RFR (anchored)	+1.95%	+1.58%
Indexed RFR (non-anchored)	+0.35%	+0.27%

Source: Bank of England, PwC analysis

Taken together, Figure 3.1 and Table 3.2 show that the fixed RFR value adopted at PR14 underestimated the subsequent RFR movements, and had indexation been applied at PR14, the average GTB would have been considerably smaller. As expected, anchored indexation has a much larger GTB than non-anchored indexation, and this is driven by the gap between the fixed PR14 RFR value and the benchmark in the first year of PR14. The difference in average GTB between the fixed and non-anchored indexation approaches is highly material, at 253 bps for PR14 and 207 bps when the first year of PR19 is included. The fixed RFR value adopted at PR19 is substantially lower than at PR14, and it has been much closer to the benchmark over its first year of application than the equivalent PR14 value, which reduces the average GTB differential between the fixed and non-anchored indexation approaches.

It is also important to consider the net effect of these GTB figures on the cost of equity, recognising that the impact of a one-unit movement in the RFR on the cost of equity is muted by equity beta (specifically, the derivative of cost of

[11] i.e. the average difference between the two over the period considered.
[12] The data is reset for PR19 e.g. For the fixed RFR option, the fixed estimate of RFR is updated to -2.35%.

equity with respect to the RFR is *1-β*, assuming a constant TMR). Table 3.3 converts the outputs from Table 3.2 into their implied cost of equity impacts, assuming that equity beta and TMR are held constant at their PR14 levels.[13]

Table 3.3: Impact of RFR GTB on the cost of equity, PR14 and 2015-21

RFR estimation type	PR14	2015-21
Fixed RFR	+0.58%	+0.47%
Indexed RFR (anchored)	+0.39%	+0.32%
Indexed RFR (non-anchored)	+0.07%	+0.05%

Source: Bank of England, PwC analysis

Table 3.3 shows that the impact on cost of equity is much reduced relative to the RFR GTB movements because of the importance of the TMR and equity beta in setting the cost of equity. Nevertheless, the GTB remains noticeably higher for a fixed RFR relative to an indexed RFR.

Overall, the outturn evidence considered shows that indexation can reduce forecast error considerably when gilt yields diverge from market expectations of the forward-looking RFR.

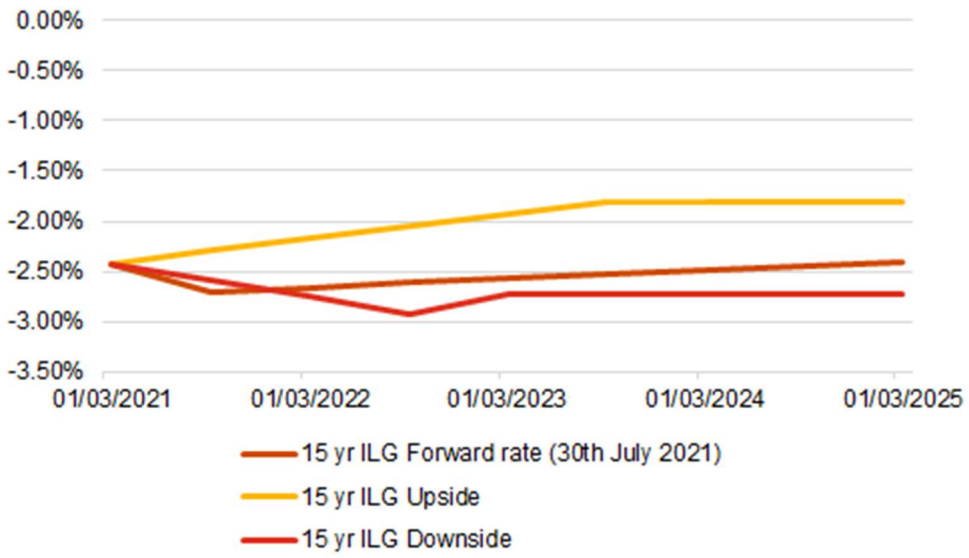
We now assess how the RFR benchmark (measured through the market implied 15-year ILG yields) could plausibly evolve over the remainder of PR19 and in the longer term, and what this means for the accuracy of indexation approaches. Starting with the remainder of PR19 (2021-25), we define three scenarios for potential RFR movements:

- **Scenario 1 (Baseline):** RFR moves in line with the market-implied forward curve as of 31st July 2021. We linearly interpolate from this forward curve to calculate how RFR can be expected to evolve over the last four years of PR19, which implies a very gradual rise in RFR.
- **Scenario 2 (Upside):** RFR rises by the maximum 2.5-year upward movement in 15-year ILG yields historically observed in our 2000-21 data sample (this is 61 bps), reaching its peak in September 2023 and remaining at this level for the remainder of PR19.
- **Scenario 3 (Downside):** RFR falls by a further 50 bps to September 2022, then rises again before settling at 30bps below 31st March 2021 levels.

Figure 3.3 below shows the RFR movements under each of these three scenarios for 2021-25. The changes in RFR in the Baseline scenario are relatively small, and there remains potential for much sharper interest rate rises should the UK economy experience fast GDP growth and/or high inflation increasing both short-term and long-term interest rates. These scenarios are not intended to capture an exhaustive set of possible RFR outcomes, but instead to illustrate plausible paths for RFR given that gilt yields are currently at historically low levels.

[13] We assume that other parameters are held constant at their PR14 levels (as opposed to PR19 levels) as our forecast error analysis for equity beta and TMR primarily considers outturn PR14 data, and therefore this approach best allows us to present cost of equity impacts consistently across different parameters, for comparability.

Figure 3.3: RFR movements under our PR19 forward-looking scenarios, 2021-25



Source: Bank of England, PwC analysis

Taking these scenarios as plausible trajectories for the RFR, we have simulated how a regulatory RFR set based on fixed RFR, anchored indexation and non-anchored indexation approaches would evolve across each scenario. Table 3.4 below captures the average GTB for each indexation approach across our three PR19 scenarios.

Table 3.4: Average GTB across our RFR scenarios and indexation options, PR19 (2021-25)

RFR estimation type	Baseline	Upside	Downside
Fixed RFR	+0.20%	-0.35%	+0.36%
Indexed RFR (anchored)	+0.16%	+0.02%	+0.22%
Indexed RFR (non-anchored)	-0.10%	-0.23%	-0.03%

Source: Bank of England, PwC analysis

Table 3.4 shows that the average GTB across our three PR19 forward-looking scenarios is considerably lower than the outturn for the prior period (PR14 and one year of PR19). This reflects expectations that market RFR volatility will be lower over the PR19 period than the actual volatility experienced during PR14, with limited prospects for further downward movement and the possibility of gradual RFR rises as interest rates across the wider economy steadily increase. We again find that indexation reduces forecast error relative to a fixed RFR approach, but to a much smaller extent than at PR14. A notable finding in the Upside scenario is that anchored indexation has a smaller GTB than non-anchored indexation. This result is driven by the fact that the 'anchor' (the first year PR19 RFR value, which incorporates an upward forward-looking adjustment) accurately anticipates future RFR movements in the Upside scenario, resulting in greater average accuracy than non-anchored indexation (although non-anchored indexation better aligns with the benchmark by the end of the period).

Consistent with the outturn analysis, we convert the above GTB figures into their implied cost of equity impacts. Table 3.5 converts the outputs from Table 3.4 into their implied cost of equity impacts, assuming that equity beta and TMR are held constant at their PR14 levels.

Table 3.5: Impact of RFR GTB on the cost of equity, PR19 (2021-25)

RFR estimation type	Baseline	Upside	Downside
Fixed RFR	+0.04%	-0.07%	+0.07%
Indexed RFR (anchored)	+0.03%	0.00%	+0.04%
Indexed RFR (non-anchored)	-0.02%	-0.05%	-0.01%

Source: Bank of England, PwC analysis

Table 3.5 demonstrates that after conversion, the forecast error reductions generated by indexation in our PR19 forward-looking scenarios have only a small impact on the cost of equity, at under 10 bps.

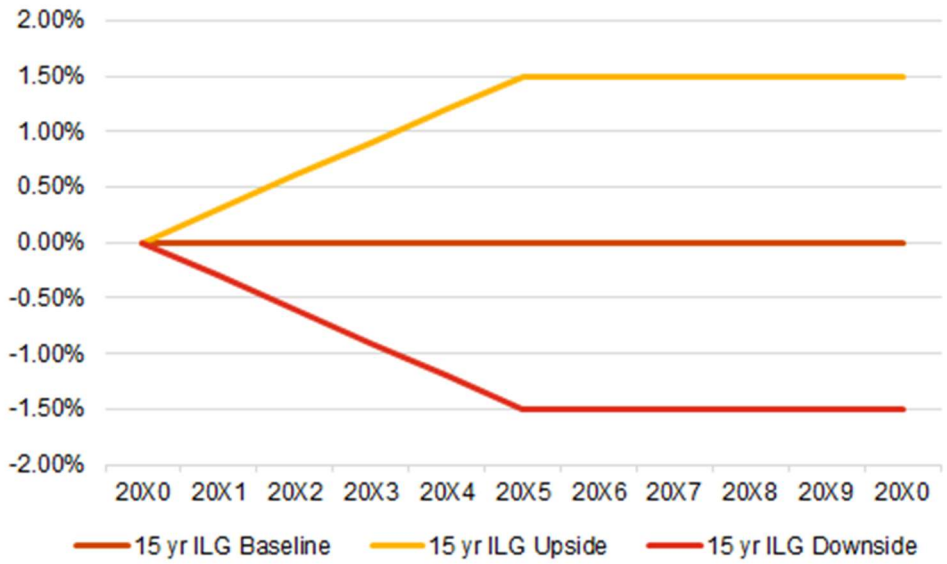
We can extend this modelling approach to consider potential RFR movements over the longer term. The aim of this analysis is to consider the impact of RFR indexation under a cycle-neutral 5-year period, recognising that UK gilt yields are currently at historic lows, with normalisation back towards equilibrium interest rates expected to take many years. We again define three scenarios for potential RFR movements:

- Scenario 1 (Baseline): RFR begins the price control at the equilibrium RPI-real level of 0.00%[14], and it stays at this level throughout the period.
- Scenario 2 (Upside): RFR begins the price control at 0.00%, then increases to +1.50% by mid-period, before flatlining at this level for the remainder of the period.
- Scenario 3 (Downside): RFR begins the price control at 0.00%, then falls to -1.50% by mid-period, before flatlining at this level for the remainder of the period.

As with our PR19 forward-looking analysis, these are stylised scenarios which aim to capture a range of possible RFR trajectories over the longer term. We consider that it is most informative to capture a cycle-neutral set of scenarios in which interest rates have normalised back to their equilibrium level (with upside and downside sensitivities around this). This allows us to compare against our outturn and PR19 forward-looking analyses, which are characterised by steeply falling and historically low gilt yields respectively. Figure 3.5 below shows the RFR movements under each of these three scenarios, and Table 3.6 captures the average GTB for each indexation approach across our scenarios. In this case, the benchmark is 0.0% as there is no variation in RFR in this scenario. Table 3.7 then converts the average GTB outputs from Table 3.6 into their implied cost of equity impacts, assuming that equity beta and TMR are held constant at their PR14 levels.

[14] We note that a RFR of 0.00% is consistent with a nominal Bank of England base rate ('Bank Rate') of 2.5%, assuming that long-term RPI is 3.0% and there is a 0.5% term premium relative to Bank Rate for holding a 15-year ILG. The Bank of England has previously produced estimates of the r*, which it defines as the equilibrium real interest rate which would sustain output at its potential level and inflation at its target level (assuming the economy starts without an output gap and inflation at the target level). The Bank published its most recent r* estimate in 2018, which was 2.5% in nominal terms and 0.5% in real CPI terms.

Figure 3.5: RFR movements under our cycle-neutral forward-looking scenarios, 20XX-XX



Source: Bank of England, PwC analysis

Table 3.6: Average GTB across our RFR scenarios and indexation options, PRXX (5 years)

RFR estimation type	Baseline	Upside	Downside
Fixed RFR	0.00%	-1.03%	+1.03%
Indexed RFR (anchored)	0.00%	-0.36%	+0.36%
Indexed RFR (non-anchored)	0.00%	-0.36%	+0.36%

Source: Bank of England, PwC analysis

Table 3.7: Impact of RFR GTB on the cost of equity, PRXX (2021-25)

RFR estimation type	Baseline	Upside	Downside
Fixed RFR	0.00%	-0.21%	+0.21%
Indexed RFR (anchored)	0.00%	-0.07%	+0.21%
Indexed RFR (non-anchored)	0.00%	-0.07%	+0.21%

Source: Bank of England, PwC analysis

Tables 3.6 and 3.7 show that for over a cycle neutral price control period, the average GTB differential between fixed RFR and indexation approaches is substantial across the Upside and Downside scenarios (67 bps in both cases), although this differential falls to 14 bps when converted into cost of equity terms. As the Upside and Downside RFR trajectories are symmetric around the Baseline scenario, the GTB results for the Upside and Downside scenarios are themselves symmetric. The GTB for the Baseline scenario is 0.00% across all indexation options as there is no RFR variation in this scenario.

The GTB results show that, as with PR14, indexation has the potential to significantly reduce forecast error, albeit to a lesser degree than PR14 itself. Viewed in this context, the PR19 forward-looking results appear unusually small compared to our outturn and long term findings, and this is due to the depressed interest rate conditions currently present in the UK economy. A holistic assessment of the case for RFR indexation should take a full-cycle view of its impact on forecast error, recognising that economic (and market) conditions can differ sharply across price controls. As a general rule, the greater the uncertainty over future RFR movements ahead of a price control (and the greater the potential for large RFR changes), the more indexation can be expected to reduce RFR forecast error.

Whilst the degree to which indexation reduces forecast error will naturally vary over time, there are other important wider disadvantages of both a fixed RFR and indexed RFR which should also be considered in assessing the empirical case for indexation. We discuss these factors below.

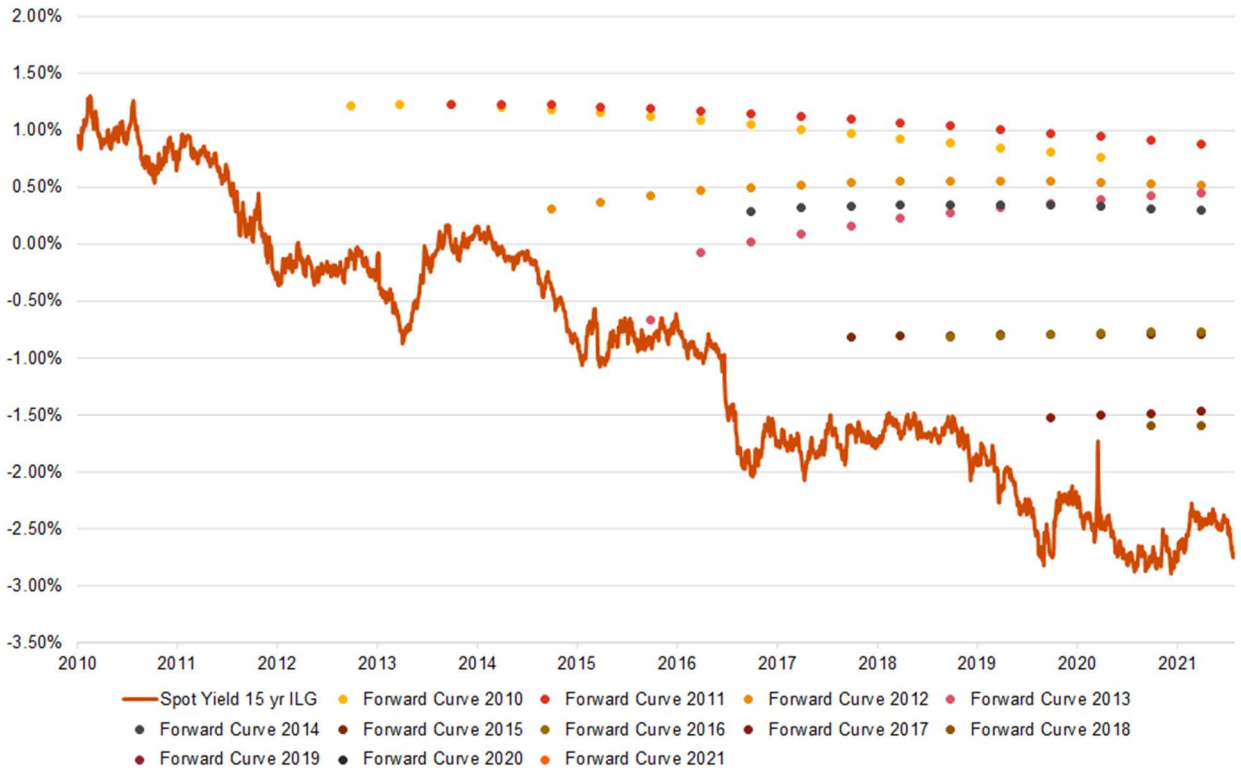
Wider disadvantages of a fixed RFR approach

- A fixed RFR approach can necessitate revisions to RFR estimates over the course of a price control development process, should there be significant market movements. This disadvantage is distinct from our analysis above, which focuses on market movements once a given price control has commenced. For example, Ofwat's PR24 and beyond consultation notes that at PR19 its December 2017 'early view' of RFR was 0.10% in CPIH terms, but this fell to -1.39% for final determinations.[15] Whilst such changes could equally occur using an indexation framework, their significance is arguably greater when a fixed RFR value is set for the entire price control period. Uncertainty over the RFR to be set at final determinations could impair companies' ability to plan ahead for future regulatory periods. This could ultimately lead to delayed or foregone investment, as companies wait for the final determination before finalising their investment decisions[16].
- Another key challenge of a fixed RFR approach is the difficulty of inferring future RFR changes based on market information. A common regulatory approach (which Ofwat used at PR19) is to calculate the future changes in gilt yields implied by the term structure of spot yields, which are published daily by the Bank of England. These changes can be calculated on a given day by inferring a market forward curve based on daily spot yields. However, a key drawback of this approach is that forward curves have been a poor predictor of future RFR movements over the last decade. Figure 3.7 below captures daily changes in the spot yield on 15-year ILGs since 2010, and compares these against market-implied forward from 31st March of each year, just before the start of the regulatory year.

[15] Ofwat (2021), PR24 and beyond: Creating tomorrow together, p. 117: https://www.ofwat.gov.uk/wp-content/uploads/2021/05/PR24-and-Beyond-Creating-tomorrow-together.pdf

[16] The empirical evidence on whether or not companies defer investment due to lack of forthcoming price control certainty is mixed. The CMA reviewed the expenditure patterns across price controls and found limited change in expenditure in the last year of the AMP4 and AMP5 price controls, but did find a substantial increase in expenditure in the last year of the water (as opposed to wastewater) price control in AMP6 (2020/21). See Appendix C of the CMA's final determination: "Anglian Water Services Limited, Bristol Water plc, Northumbrian Water Limited and Yorkshire Water Services Limited price determinations" March 2021.

Figure 3.7: Spot yield on 15-year ILGs and market-implied forward curves (at 31st March), 2010-21



Source: Bank of England, PwC analysis

Figure 3.7 shows that over the last decade, forward curves have tended to overestimate the level of RFR and underestimate the change in RFR over future years, failing to predict the downward RFR movements that have occurred. In its redetermination of PR19, the CMA[17] acknowledged the theoretical underpinnings of the forward curve approach, but it did not use forward rate adjustments because it did not receive sufficient evidence to support the view that forward curves offer a better indicator of future spot rates than the current market price. In contrast to an approach based on forward curves, indexation approaches allow for RFR to be updated should sharp market movements subsequently occur.

Wider weaknesses of RFR indexation approaches

- As noted in Chapter 2, there is debate about how the RFR should best be measured in a regulatory context. As highlighted in recent CMA appeals of the PR19 and RIIO-2 price controls, some stakeholders have argued that UK gilt yields are a weak proxy for regulated companies' borrowing costs, because they embed a convenience yield which allows the UK government to borrow more cheaply than regulated companies (including those with low default risk). In its final PR19 redetermination, the CMA decided to adopt a blended approach to setting RFR, basing its RFR range on UK ILG yields and AAA-rated corporate bond yields taken from the iBoxx £ Non-Gilt AAA 10+ and 10-15 year indices. When we compare the estimated real RPI yields from UK ILGs against these iBoxx corporate bond indices, we find that there is typically a significant yield difference between the series. However, using ILG yields to determine the RFR remains an established regulatory approach, and in its RIIO-2 final determination the CMA found that Ofgem was not wrong to rely on ILGs in setting the RFR.

[17] CMA (2020), Provisional Findings report: https://assets.publishing.service.gov.uk/media/5f7c467ee90e070dde709cee/Water_provisional_determinations_report_all_-_September_2020_---_web_-online-2.pdf

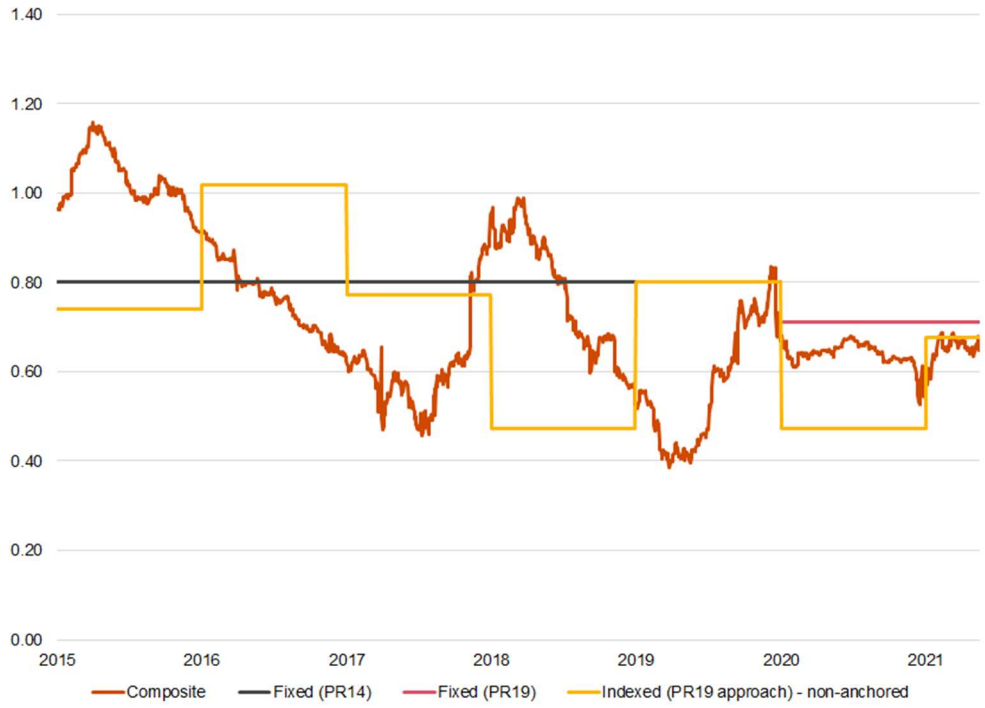
Indexation of equity beta

Analysis of forecast error

As with the RFR, we begin our empirical assessment of equity beta by first analysing the typical forecast error in beta estimation and quantifying the extent to which indexation may reduce forecast error in future price controls. Our analysis focuses on outturn data and examines the impacts of indexation had it been implemented at PR14 and PR19. In contrast to RFR we have not developed forward-looking analysis for equity beta, as it is very challenging to forecast beta movements with accuracy[18].

We refer the reader back to Chapter 2 for an explanation of our equity beta indexation methodology, which is comparable to the approach taken for RFR indexation. Our beta measures are derived using stock returns data from two of the three publicly listed water companies in England and Wales: Severn Trent (SVE) and United Utilities (UUW). Figures 3.8, 3.9 and 3.10 below all show how the 'benchmark' equity beta for our market capitalisation weighted SVE/UUW composite has evolved over the 2015-21 period, as well as how closely the regulatory equity beta would have tracked these market movements under fixed and non-anchored indexation approaches. The difference between Figures 3.8, 3.9 and 3.10 is the estimation window used to calculate beta: Figure 3.8 is based on 1-year daily beta estimates, whereas Figure 3.9 is based on 2-year daily beta estimates and Figure 3.10 is based on 5-year daily beta estimates.

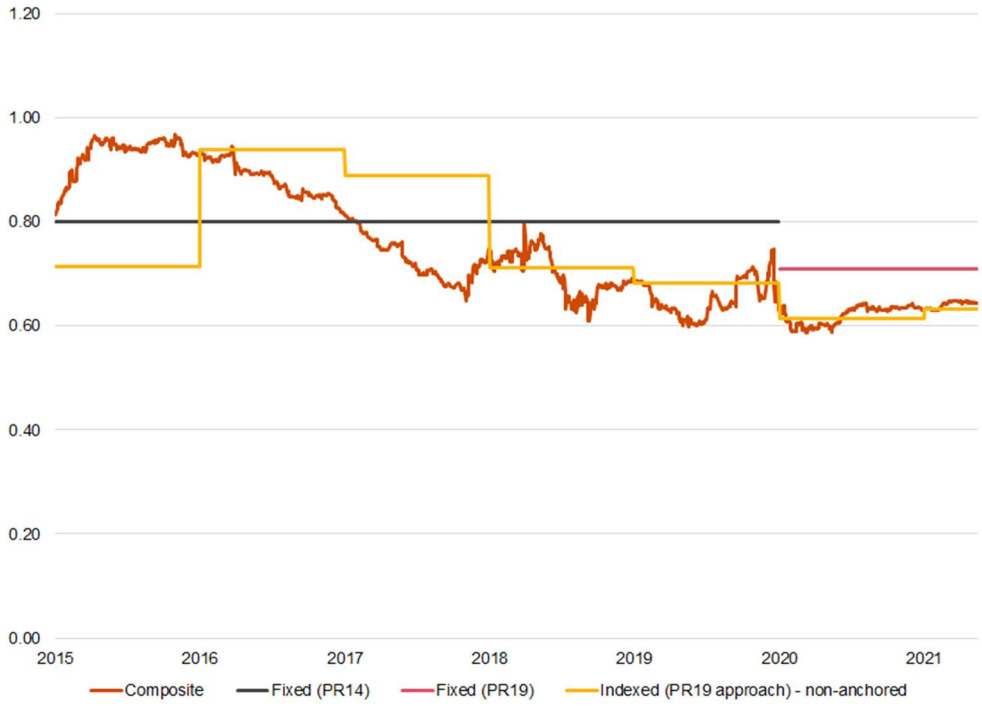
Figure 3.8: Evolution of equity beta based on 1-year daily estimates, 2015-21



Source: Refinitiv, PwC analysis

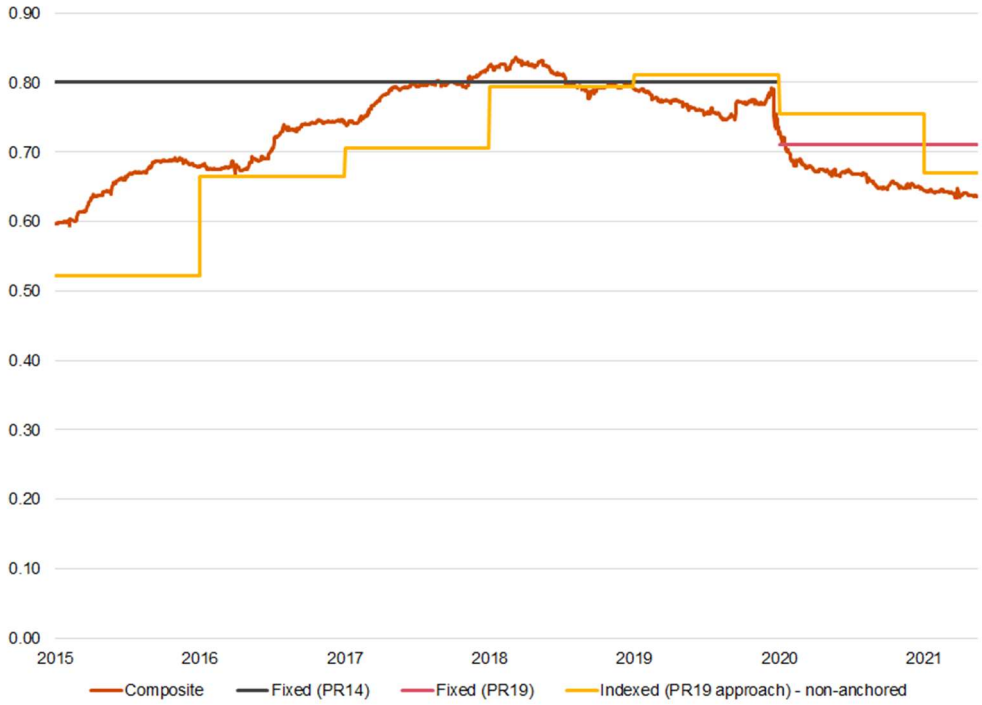
[18] Some practitioners have tried to develop predictive beta based on a multi factor model but these are not widely adopted (See forecast beta work of Vasicek and Blume.

Figure 3.9: Evolution of equity beta based on 2-year daily estimates, 2015-21



Source: Refinitiv, PwC analysis

Figure 3.10: Evolution of equity beta based on 5-year daily estimates, 2015-21



Source: Refinitiv, PwC analysis

These figures show that the estimation window used to estimate equity beta has a significant influence on the stability of the estimates: the 5-year beta series in Figure 3.10 is much less volatile than the 1-year beta series in Figure 3.8. The fact that the 5-year beta estimates fall broadly in the middle of the 1-year beta estimate range, coupled with the lack of a clear trend over the sample period, suggests that equity beta data exhibits some mean reversion properties. A notable difference from our RFR findings is that the fixed beta estimate set at PR14 did not systematically overestimate or underestimate market movements: it proved to be a fairly accurate forecast.

Table 3.11 complements the above charts by capturing the average GTB between the market equity beta and the regulatory equity beta (set using either fixed or indexation approaches). GTB is shown for all beta estimation windows, for comparability.

Table 3.11: Average GTB across our equity beta indexation options and estimation windows, 2015-21

Equity beta estimation type	1-year daily	2-year daily	5-year daily
Fixed beta (PR14)	0.05	0.02	0.05
Fixed beta (PR19)	0.07	0.08	0.05
Indexed beta (PR14 & PR19)	-0.02	0.00	-0.02

Source: Refinitiv, PwC analysis

As done for RFR, we can also consider the net effect of these GTB figures on the cost of equity, recognising that a one-unit movement in equity beta has a substantial effect on the cost of equity (specifically the derivative of cost of equity with respect to equity beta is *TMR-RFR*). Table 3.12 converts the outputs from Table 3.11 into their implied cost of equity impacts, assuming that the RFR and TMR are held constant at their PR14 levels.

Table 3.12: Impact of equity beta GTB on the cost of equity, 2015-21

Equity beta estimation type	1-year daily	2-year daily	5-year daily
Fixed beta (PR14)	+0.28%	+0.11%	+0.28%
Fixed beta (PR19)	+0.39%	+0.44%	+0.28%
Indexed beta (PR14 & PR19)	-0.11%	-0.02%	-0.11%

Source: Refinitiv, PwC analysis

Taken collectively, these results show that the average GTB is relatively low across both fixed and indexation approaches for all beta estimation methods and time periods. By implication, the GTB differential between fixed equity beta and indexed equity beta is relatively small, especially for the 2-year daily beta series. Nonetheless, the conversion of these results into their implied cost of equity impacts demonstrates how even small changes in equity beta can have a significant impact on the overall cost of equity.

Whilst equity beta indexation could in principle achieve a forecast error reduction comparable to RFR indexation, it is important to note that equity beta data is naturally volatile, exhibiting short-term fluctuations and some mean reversion properties. It is not therefore clear that fixed equity beta approaches create a net windfall gain or loss over the long term, given how they have historically predicted beta movements fairly accurately. By contrast, trends in the RFR can be long-lived, creating the potential for substantial overestimation or underestimation of market movements.

As for RFR, there are other important benefits and drawbacks from a fixed equity beta approach which should also be considered in assessing the empirical case for indexation. We discuss these factors below.

Additional considerations regarding equity beta indexation

- As is the case for RFR, a potential disadvantage of indexation is that it gives regulators less scope to apply judgement or discretion in setting parameter values. Indexation would likely force greater reliance on a single estimation approach, which risks generating a more balanced view of TMR. For example, in the case of equity beta there are many specific estimation methodologies that can be applied, and there are also several calculation steps required to compute equity beta under Ofwat's unlevering and relevering approach (see Chapter 2). This means that regulators need to apply discretion in cross-checking different results and deciding on an appropriate point estimate. For example, at PR19 final determinations Ofwat applied regulatory judgement to determine its point estimate for unlevered beta, based on a range of estimates. It is challenging to apply such discretion under an indexation approach, and if a blend of different estimates is used, there needs to be sufficient ex-ante transparency on the weightings assigned to different estimates. Indexation

could therefore lead to equity beta point estimates deviating from the level a regulator would have preferred to set if it had greater scope to apply regulatory judgement.

- Our conversations with stakeholders have also cited additional challenges associated with indexation of equity beta. Stakeholders noted the short-term volatility in equity beta measures, and the difficulty of indexing equity beta reliably (especially given that beta is not a market-wide parameter, meaning that indexation assumes beta movements for SVE and UUW are representative of cost of equity changes for the notional water company, despite their differing characteristics).[19]
- Stakeholders also cited the potential for circularity risks associated with equity beta indexation. There is the potential for indexation to influence investors' overall valuation of water companies, thereby driving movements in share prices, and in turn affecting measures of gearing used for calculating unlevered beta, asset beta and relevered equity beta in subsequent years[20]. As such, indexation itself may influence equity beta in a circular feedback loop, and therefore it is debatable whether equity beta is truly an exogenous parameter which can be reliably indexed ahead of each regulatory year.

Indexation of total market return (TMR)

Analysis of historical TMR trends and correlation with RFR

In Chapter 2, we explain that we have considered two approaches for indexing TMR: the 'DMS moving average approach' and the 'RFR co-movement approach'. We begin our analysis of TMR indexation by first examining movements in historical ex-post measures of TMR since 2000, and the extent to which TMR movements correlate with RFR movements over this period. We then use this to derive estimates of indexed TMR (under both approaches) over the PR14 period, which allows us to evaluate the impact of indexation on forecast error, as done for RFR and equity beta.

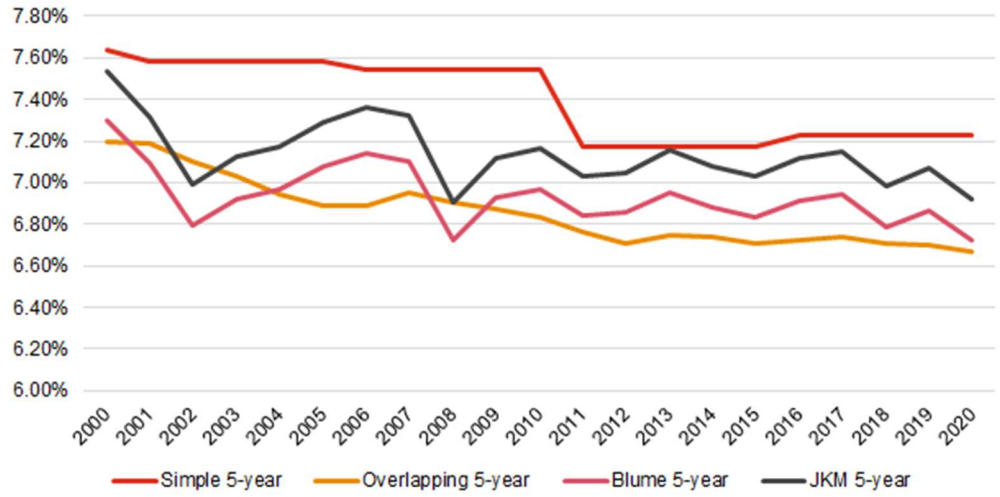
To calculate historical changes in TMR, we have used the Dimson, Marsh and Staunton (DMS) dataset taken from the Credit Suisse Global Investment Returns Yearbook 2021, and we have calculated how long-run average TMR has changed over the 2000 to 2020 period. We have done this by rolling the latest (2020) estimate backwards year by year to exclude the most recent datapoint, whilst maintaining the same sample start date (1900). As a reminder, we have used DMS' nominal UK equity return series and deflated this by historical CED/CPI inflation, taken from the Bank of England's 'millennium of macroeconomic data' collection and the ONS. As explained in Chapter 2, we have computed TMR using a range of averaging approaches and assumed holding periods.

Figures 3.11 and 3.12 below capture how different TMR measures have evolved over the 2000-2020 period, assuming a 5-year holding period and 10-year holding period respectively.

[19] Although we note that the PR19 estimation approach uses enterprise value gearing, which means that most of the impact of outperformance and differential net debt is stripped out, thereby making it a better proxy.

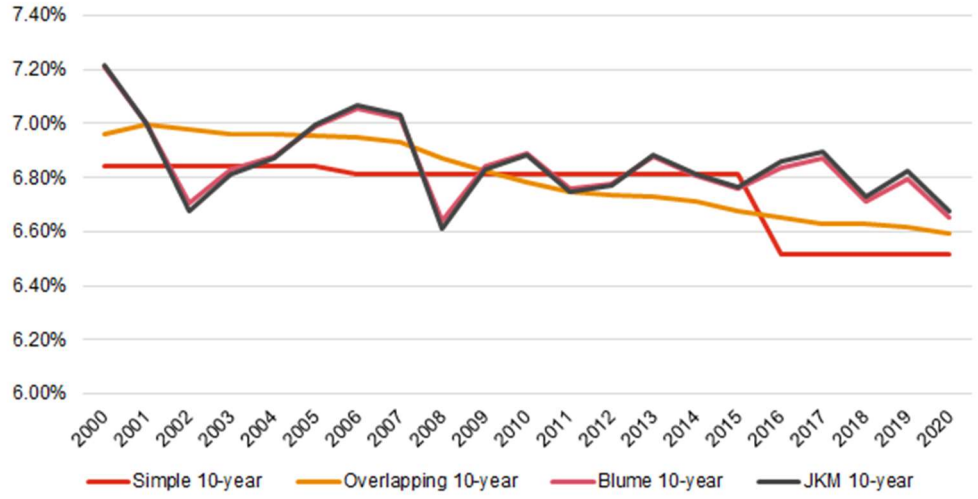
[20] For example, one possibility could be that investors sell shares in the listed companies used to estimate the notional beta prior to the period in which the regulator estimates the cost of equity. This would reduce the share prices of these companies and likely increase the equity beta estimate, which would result in a higher cost of equity.

Figure 3.11: Evolution of historical ex-post TMR (CPI-deflated), 2000-20 - 5-year holding period



Source: DMS, Bank of England, PwC analysis

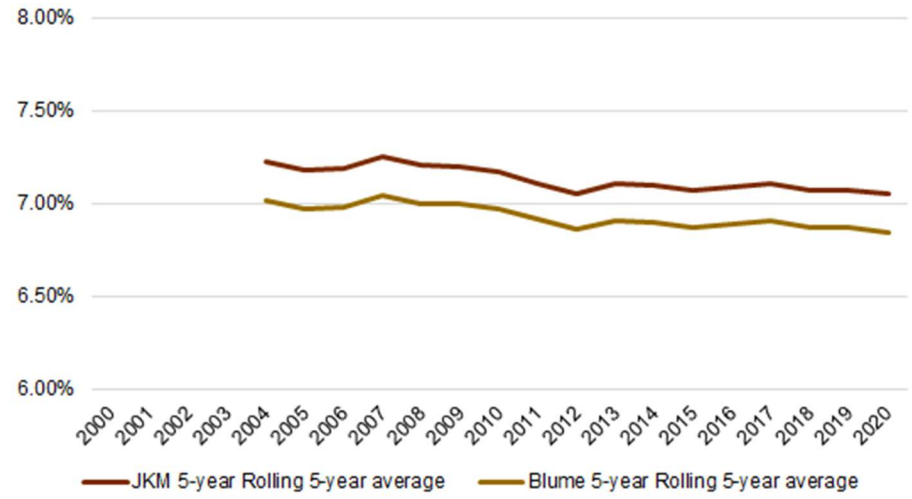
Figure 3.12: Evolution of historical ex-post TMR (CPI-deflated), 2000-20 - 10-year holding period



Source: DMS, Bank of England, PwC analysis

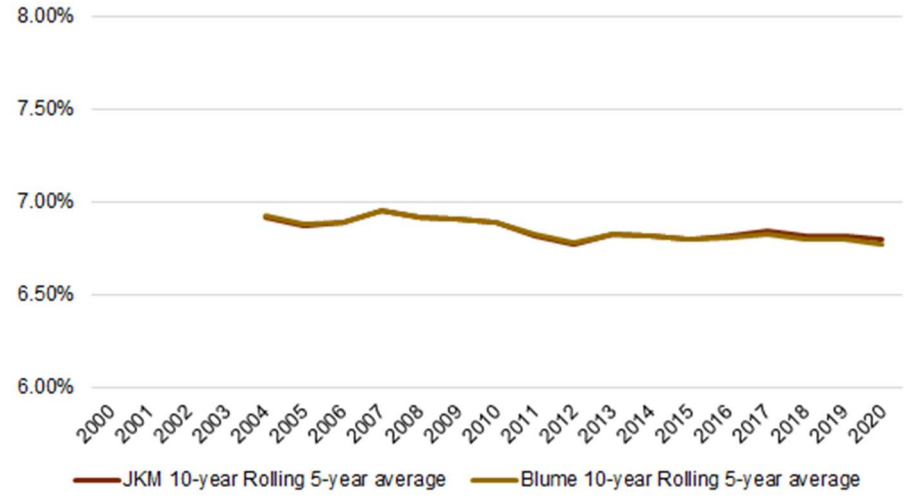
Taken together, these charts suggest that there has been a gradual downward movement in long-run average TMR since 2000. However, the extent of this reduction varies by TMR measure, and there are notable differences between TMR estimates when a 5-year holding period is assumed. The two most sophisticated TMR measures in our sample (the Blume and JKM estimators) also show significant year-on-year volatility, but when we compute 5-year rolling averages of these series (as captured in Figures 3.13 and 3.14 below), we find that this volatility is reduced substantially, leaving a trend of gradual TMR reduction.

Figure 3.13: 5-year averages of Blume and JKM estimates for TMR, 2000-20 - 5-year holding period



Source: DMS, Bank of England, PwC analysis

Figure 3.14: 5-year averages of Blume and JKM estimates for TMR, 2000-20 - 10-year holding period

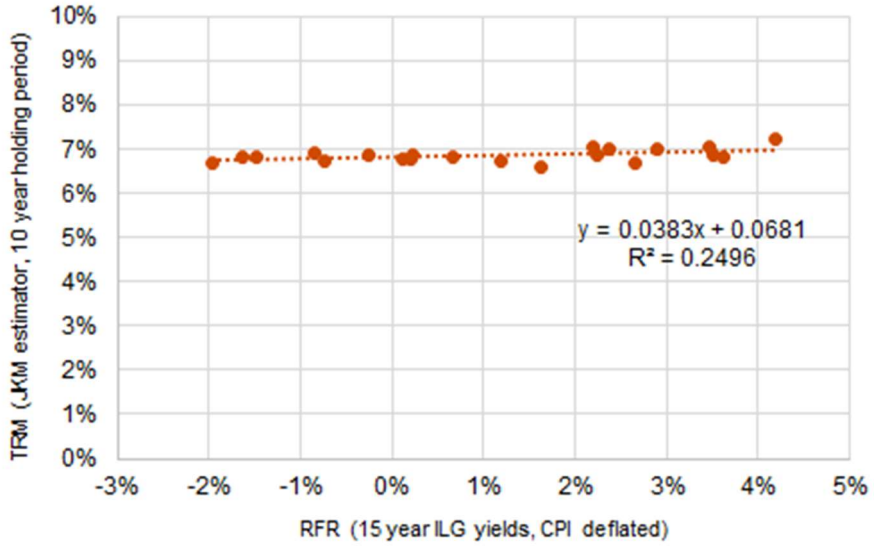


Source: DMS, Bank of England, PwC analysis

Overall, our analysis suggests that the ex-post TMR has fallen over recent decades, but not greatly. All of the 5-year rolling averages considered in Figures 3.13 and 3.14 show a TMR reduction of between 10 bps and 20 bps over the 2004-2020 period. This supports the hypothesis that TMR is more constant than RFR over time, exhibiting relative stability.

We now assess how TMR movements have correlated with RFR movements over recent decades. Figure 3.15 below plots year-by-year TMR estimates from the JKM estimator (assuming a 10-year holding period) against annual average estimates of RFR taken from 15-year ILG yields, deflated by historical CPI for comparability, and the figure also captures the linear relationship between these two variables (including the correlation coefficient).

Figure 3.15: Relationship between ex-post TMR (JKM estimator, 10-year holding period) and RFR (15-year ILG yields, CPI deflated), 2000-20



Source: DMS, Bank of England, PwC analysis

Figure 3.15 shows that there is a positive correlation between RFR and TMR movements, although the magnitude of the correlation is very small, with a 1 basis point change in RFR being associated with a 0.038 basis point change in TMR. The small coefficient is largely driven by the use of long term historical estimates of TMR that do not vary much over time. We achieve a similar finding when alternative estimates for RFR and TMR are considered (such as 10-year ILG yields, or the Blume estimator for TMR), with our analysis supporting a correlation coefficient in the 0.030 to 0.040 range. In keeping with our analysis of historical TMR movements, these findings suggest that long-term historical estimates of TMR are much more stable than RFR, although there is some evidence of co-movement between the two variables. Based on these findings, we use an assumed correlation coefficient of +0.035 to index TMR under the RFR co-movement approach.

We note however that different approaches to estimating TMR produce different coefficients. Europe Economics[21], on behalf of Ofcom, investigated the relationship between RFR and TMR over time using dividend growth models (DGM) to estimate TMR. They compared monthly estimates of the real TMR from their DGM variants with monthly real yields on 5, 10 and 20-year zero coupon government bonds. They found a statistically significant relationship between RFR and TMR, with the coefficient ranging from +0.3 to +0.6. Similarly, we also studied this relationship on behalf of Ofwat[22], and found a negative correlation between the real risk-free rate and the real ERP, with a coefficient of -0.62 (using monthly data from 2000 to 2017). This corresponds to a coefficient of +0.38 between the risk-free rate and the TMR, which lies at the lower end of the range estimated by Europe Economics. Given the proximity of our estimate to the low end of EE's range, we use +0.3 to index TMR under the RFR co-movement approach.

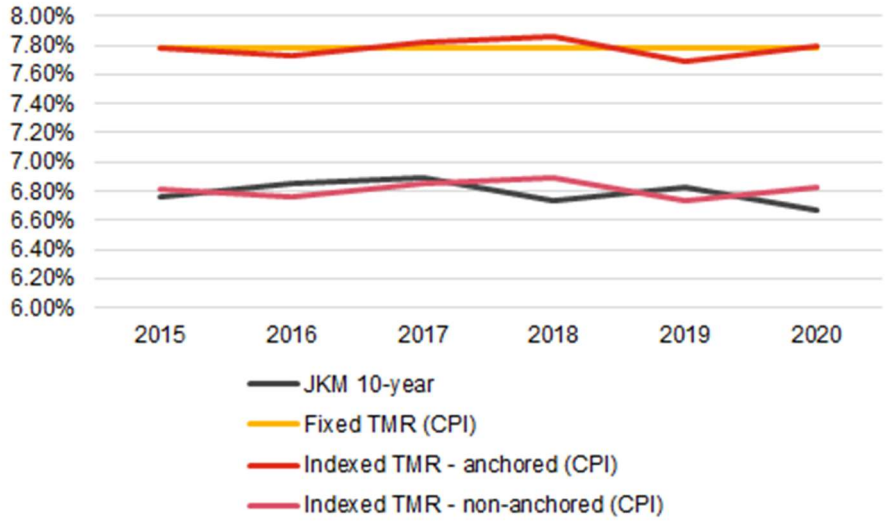
Analysis of forecast error

Having analysed how TMR has evolved over recent years, we now examine the impact of TMR indexation had it been implemented at PR14. We first assess TMR indexation based on the DMS moving average approach, considering how TMR would have evolved under fixed, anchored indexation and non-indexation methodologies. We refer the reader back to Chapter 2 for an explanation of how indexation works under this approach.

Figure 3.16 shows the evolution of TMR over PR14 under each indexation methodology, whilst Table 3.17 captures the average GTB between each of these methodologies and the 'market' TMR estimate, which we define as the DMS-based historical TMR estimate corresponding to a particular year. Our analysis focuses on the JKM estimator and assumes a 10-year holding period.

[21] Europe Economics (2019), Comments on BT's response to the BCMR consultation in relation to WACC market parameters: https://www.ofcom.org.uk/__data/assets/pdf_file/0022/149323/Europe-Economics-WACC-report.pdf
[22] PwC (2017), Updated analysis on cost of equity for PR19: https://www.ofwat.gov.uk/wpcontent/ uploads/2017/12/PwC-Updated-analysis-on-cost-of-equity-for-PR19-Dec-2017.pdf

Figure 3.16: Evolution of TMR under fixed and indexation approaches, PR14 (2015-20) - DMS moving average approach



Source: DMS, Bank of England, PwC analysis

Table 3.17: Average GTB across our TMR indexation options, PR14 (2015-20) - DMS moving average approach

TMR estimation type	PR14
Fixed TMR	+0.97%
Indexed TMR (anchored)	+0.97%
Indexed TMR (non-anchored)	0.00%

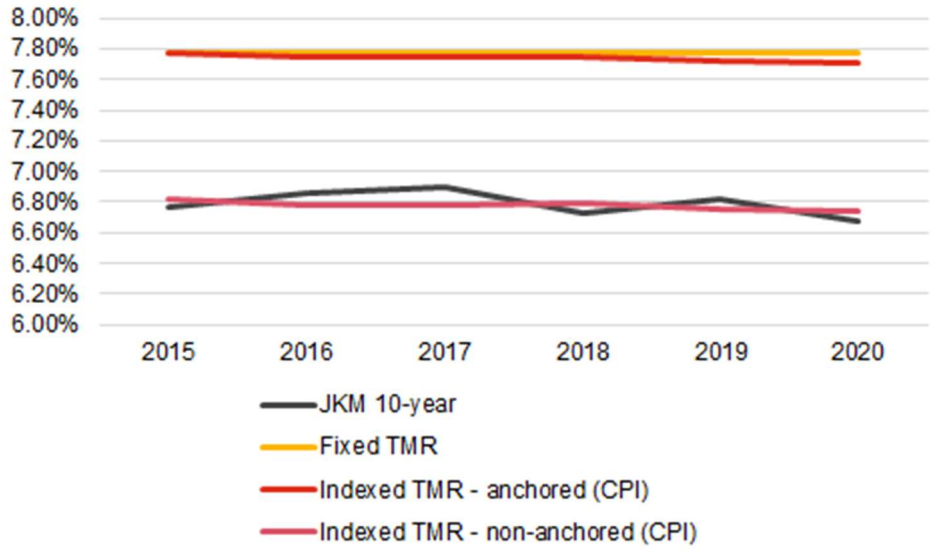
Source: DMS, Bank of England, PwC analysis

Collectively, Figure 3.16 and Table 3.17 show that there is very little difference in forecast error between the fixed TMR approach and the anchored indexation approach, whereas the non-anchored indexation approach has much smaller forecast error. This result arises because there was little movement in DMS-based TMR estimates over PR14, meaning that the most important factor in determining forecast error is the predictive accuracy of the start-of-period TMR estimate. The fixed TMR estimate set at PR14 proved to be higher than the subsequent DMS-based estimates, which explains why the fixed and anchored indexation approaches have a higher forecast error.

Whilst our GTB findings for the RFR and equity beta change substantially when converted into their implied cost of equity impacts, our TMR GTB findings do not change significantly. This is because the implied cost of equity impact for TMR is calculated simply by multiplying the figures in Table 3.17 by equity beta, which gives an implied impact of +0.78% for fixed TMR and anchored indexation, and 0.00% for non-anchored indexation.

We also replicate this analysis for the RFR co-movement approach, to see whether the findings differ. Figure 3.18 shows the evolution of TMR over PR14 under each indexation methodology, whilst Table 3.19 captures the average GTB between each of these methodologies and the market TMR estimate.

Figure 3.18: Evolution of TMR under fixed and indexation approaches, PR14 (2015-20) - RFR co-movement approach



Source: DMS, Bank of England, PwC analysis

Table 3.19: Average GTB across our TMR indexation options, PR14 (2015-20) - RFR co-movement approach

TMR estimation type	PR14 (Coefficient 0.038 - based on historical TMR)	Sensitivity - PR14 (Coefficient 0.30 - based on EE estimate)
Fixed TMR	0.97%	0.97%
Indexed TMR (anchored)	0.94%	0.69%
Indexed TMR (non-anchored)	-0.03%	-0.29%

Source: DMS, Bank of England, PwC analysis

The results from the RFR co-movement approach are very similar to the DMS moving average approach, with a much smaller forecast error for non-anchored indexation compared to fixed or anchored indexation approaches. This finding arises partly because the assumed correlation coefficient between RFR and TMR is small, meaning that the deviations from the starting (first year) TMR value induced by subsequent RFR movements are small. As such, it is primarily the starting TMR value which determines the extent of the forecast error.

As with the DMS moving average approach findings above, the above results do not change significantly when converted into their implied cost of equity impacts. The implied impacts are +0.78% for fixed TMR, +0.75% for anchored indexation and -0.02% for non-anchored indexation.

We also run a sensitivity analysis using the +0.3 coefficient estimated by Europe Economics in their work for Ofcom. As seen in the above table, this results in a smaller forecast error for non-anchored indexation compared to fixed or anchored indexation approaches, although the GTB is larger than under the main scenario.

As a caveat to our forecast error analysis, we note that it is inherently difficult to define a 'market' TMR estimate given the considerable debate over what the true TMR is, and the many available methods for estimating it. We discuss this challenge further in our discussion of wider considerations below. Our forecast error findings are therefore conditional on the assumption that a DMS-based historical averaging approach, or DGM approaches, yield reliable estimates of the true TMR.

Overall, our analysis of using ex-post TMR suggests that our estimate of this parameter is relatively stable over time, with only relatively small movements over a 5-year price control timeframe. Moreover, some measures of TMR are characterised by year-on-year volatility around a fairly stable trend, implying that indexation could result in revenue volatility for water companies and bill volatility for customers despite having little benefit in terms of reducing forecast

error. This collectively calls into question whether the incremental benefits of TMR indexation on this basis exceed the incremental costs, and suggests that the incremental benefit of TMR indexation is likely to be lower than the incremental benefit of RFR indexation.

As done for RFR and equity beta, it is important to assess the wider benefits and drawbacks of indexing TMR relative to retaining a fixed TMR approach. We discuss key considerations regarding the empirical case for indexation below.

Additional considerations regarding TMR indexation

- As is the case for RFR and equity beta, a disadvantage of indexation is that it gives regulators less scope to apply judgement or discretion in setting parameter values. For TMR, this is a key consideration given the range of possible estimation approaches, and the wider debate over how market participants evaluate overall equity returns. A common approach taken by regulators - recognising the range of estimates - is to adopt a preferred estimation approach and then cross-check against the results from other approaches, applying judgement and discretionary adjustments to derive a point estimate. Indexation makes it more difficult to adopt a diversified estimation approach of this kind, and it could therefore force greater reliance on a single estimation approach (with less use of cross-checks), which risks generating a biased view of TMR.
- Similarly, whilst the effectiveness of indexation relative to a specific 'market TMR' benchmark can be evaluated on an ex-post basis, there is no consensus over how the market TMR itself should be defined, with many assumptions being required. This is an inherent challenge associated with analysis of TMR forecast error, especially from the perspective of testing different indexation approaches and identifying the most robust indexation method.
- Our conversations with stakeholders have also highlighted wider concerns with the hypothesis often adopted by regulators that TMR is constant (or near-constant), exhibiting very little change even when RFR moves significantly. One stakeholder expressed a view that a one-unit movement in gilt yields would likely trigger a greater than one-unit movement in TMR, with TMR showing considerable sensitivity to interest rate movements. This view falls outside the most common interpretations of the CAPM framework, namely that either TMR or the EMRP are constant, by suggesting a positive correlation between RFR and the EMRP. Whilst this view is not supported by the empirical evidence we present above, it does demonstrate the diversity of opinion with regard to TMR stability, which underlines the challenge of developing a robust TMR indexation methodology.

Criteria 1: Our overall assessment

In this section, we have evaluated the empirical case for indexation of cost of equity parameters, considering the relative challenges of indexing these parameters compared to the cost of new debt as well as parameter-specific evidence regarding the potential advantages and disadvantages of indexation.

Overall, we assess that RFR is the most suitable cost of equity parameter for potential indexation, for several reasons. Firstly, it is relatively straightforward to observe RFR, and it is a market-wide parameter which is common to all water companies. Secondly, our analysis of forecast error indicates that indexation has the potential to significantly reduce RFR forecast error (and cost of equity forecast error), given the potential for substantial deviation from ex-ante expectations over the course of a price control. Thirdly, relative to other parameters we find that movements in RFR are heavily influenced by the economic cycle and are often long-lived, with the potential for very different RFR trajectories across successive price controls. Fourthly, regulators' approaches to setting a fixed RFR often involve adjustments based on future movements in interest rates implied by spot yield curves. Evidence from the last decade shows that this method is a weak predictor of future RFR movements, creating the potential for significant forecast error. Together, these factors suggest that RFR indexation merits further consideration, and we therefore assess this option through Criteria 2-4.

By contrast, there are relatively weaker incremental benefits and significant challenges associated with the indexation of equity beta and TMR.

For equity beta, PR14 evidence suggests that the reduction in cost of equity forecast error delivered through indexation is lower than for RFR, with less potential for systematic overestimation or underestimation of market movements based on a fixed estimation approach. Moreover, there is evidence that some formulations of beta display mean-reverting tendencies, with short-term movements sometimes reversing themselves within a price control period.

This reduces the extent to which sustained forecast error can occur. Furthermore, a key challenge with indexing equity beta is the potential for circularity arising from the possible impacts of indexation on share prices and gearing. This questions whether equity beta is truly an exogenous market variable which can be reliably indexed. Another important drawback in using indexation of equity beta is that it reduces the potential for regulators to consider a wide range of evidence and apply judgement in defining an equity beta point estimate.

For TMR, our analysis of historical ex-post measures finds limited evidence that TMR has changed significantly since 2000, with only a small correlation between falling RFR values and TMR values, which questions whether indexation is necessary. Some historical TMR measures (including the Blume and JKM estimators) also exhibit significant year-on-year volatility, implying that indexation could result in revenue volatility for water companies and bill volatility for customers despite having little overall benefit in terms of reducing forecast error. A further complication of TMR indexation is the considerable debate over how to define an indexation approach and reliably measure its accuracy, given that there are many estimation approaches and no consensus measures of market TMR.

Taking all of the above factors into account, as well as recent regulatory precedent, we consider that indexation of equity beta and/or TMR is less desirable than indexation of RFR, and that there is little merit in considering equity beta or TMR indexation against our other criteria given the overall weakness of the empirical case. We therefore focus on examining the case for RFR indexation in greater detail through Criteria 2-4 below.

Criteria 2 (Impacts of indexation on water companies' risk profile): Our assessment

We begin our assessment of Criteria 2 by presenting quantitative analysis of how cost of equity indexation (specifically risk-free rate indexation) could impact water companies' financeability over the PR19 period (2020-25), using published PR19 financial models. Our analysis considers key financeability ratios and assesses how these change in response to cost of equity movements. We then turn to consider wider advantages and disadvantages of indexation, taking account of risk and uncertainty factors. As done for Criteria 1, we conclude this section by assessing the overall strength of the case for indexation, this time from a risk profile perspective.

Indexation of the risk-free rate (RFR)

Analysis of financeability impacts

An important feature of indexation is that it embeds greater uncertainty into regulated companies' future revenues, which in turn affects their financeability. Empirical analysis can help to shed light on the potential significance of these financeability movements, recognising that substantial deterioration in financeability is a cause for regulatory, company and customer concern and could necessitate remedial measures.

We therefore use the PR19 financial models (published by Ofwat at PR19 final determinations) to analyse how water companies' financeability ratios could evolve using cost of equity indexation. The focus of these models is the PR19 (2020-25) period, and we therefore explore how indexation could have impacted financeability had it been adopted at PR19. We specifically examine how companies' financeability ratios respond to the Baseline, Upside and Downside scenario RFR trajectories from our PR19 forward-looking analysis, as presented in our Criteria 1 evaluation. We focus our analysis on four water companies intended to give a broad sample of the industry: Portsmouth Water (a small water-only company), South East Water (a large water-only company), Thames Water (a water and sewerage company with relatively high gearing) and United Utilities (a publicly listed water company).[23] The key financeability indicators we report are the adjusted cash interest cover ratio (AICR) and funds from operations relative to debt (FFO/debt). For simplicity our analysis assumes that underlying RFR changes only affect the cost of equity, with no impact upon the cost of financing new debt.

Table 3.20 below shows how the key financeability indicators differ for each company in the PR19 final determination (which embeds the fixed cost of equity allowance set by Ofwat in December 2019) relative to non-anchored indexation across the Baseline, Upside and Downside PR19 RFR scenarios. For ease of interpretation, we also report the range between the highest and lowest ratio estimates.

[23] In this report we use the following common acronyms to describe water companies: PRT (Portsmouth Water); SEW (South East Water); TMS (Thames Water); UUW (United Utilities); WOC (water only company); WASC (water and sewerage company).

Table 3.20: Financeability impacts of our PR19 forward-looking RFR scenarios, by company (2020-25 average)

Company	Indicator	PR19 final determination	RFR indexation (Baseline)	RFR indexation (Upside)	RFR indexation (Downside)	Estimate range
PRT	AICR	1.50	1.48	1.50	1.47	0.03
PRT	FFO/Debt	9.0%	8.9%	9.0%	8.9%	0.1%
SEW	AICR	1.53	1.50	1.53	1.50	0.03
SEW	FFO/Debt	9.9%	9.8%	9.9%	9.8%	0.1%
TMS	AICR	1.5	1.48	1.50	1.47	0.03
TMS	FFO/Debt	8.9%	8.8%	8.9%	8.8%	0.1%
UUW	AICR	1.55	1.54	1.55	1.52	0.03
UUW	FFO/Debt	10.9%	10.9%	10.9%	10.8%	0.1%

Source: Ofwat, Bank of England, PwC analysis

Our results show that the impacts of our PR19 RFR scenario trajectories on financeability metrics are relatively modest, with only minor differences in AICR and FFO/Debt between the Upside and Downside scenarios. There are several explanations for this. Firstly, as previously noted the impact of a one-unit movement in RFR on the cost of equity is heavily muted by the equity beta, and this restricts the cost of equity movements entered into the PR19 models. Secondly, our PR19 scenario trajectories are necessarily narrow due to the current economic climate, with the Downside RFR scenario trajectory relatively similar to the Baseline trajectory because there is limited scope for interest rates (including gilt yields) to move significantly lower. Both of these factors depress financeability impacts. At different points in the economic cycle (for example, in the cycle-neutral scenario presented under Criteria 1), we would expect to find greater potential for downside cost of equity movements and therefore greater potential for negative financeability impacts.

However, there are also factors which support even lower financeability movements. The above analysis does not account for positive historical co-movement between ILG yields (which determine the RFR), and corporate bond yields (which determine the benchmarked cost of new debt). In reality, we would expect that a fall in the RFR would not only reduce the allowed cost of equity but also reduce the realised cost of servicing new debt, due to this co-movement. The latter effect improves companies' financeability in the short-term as cost of new debt reconciliation only happens at the end of the regulatory period under Ofwat's PR19 approach. This serves to offset some of the negative cost of equity driven financeability impacts from a falling RFR.

We now turn to consider wider advantages and disadvantages of indexation from a risk profile perspective.

Wider advantages of RFR indexation from a risk profile perspective

- Adjusting allowed revenues to reflect cost of equity indexation can reduce risks to water companies and investors of windfall (market-driven) profits or losses which are outside of their control. For example, if the RFR increases then the yield on new and floating rate debt will likely increase. But given the regulatory regime already has new debt indexation the company value impact of this will be reduced. There could be some short-term cash pressure but this will be unwound at the end of the regulatory period with the cost of debt being reset, so the ratings agency treatment would likely discount the short-term interest rate pressure. In this situation, an increase in the cost of equity from a higher RFR will help financeability. However, conversely, it's plausible that rating agencies could consider that in a falling interest rate environment that CoE allowance reductions exceed the benefit from falling floating rate debt rate, and so the net impact is a pressure on financeability. The overall effect could be seen to reduce the downside risks of investing in the water sector and thereby increase investor confidence, especially if interest rates have the potential to increase sharply over the coming years. By contrast, under a fixed RFR approach water companies would be financially

exposed to sharp increases in the RFR, especially if the realised cost of new debt rose simultaneously. However, the materiality of this is limited by the fact that the regulatory regime is reset every 5 years, and consequently a short-term deviation is likely to be manageable from a credit risk perspective.

- Changes in the RFR are market-wide and therefore outside of water companies' direct control. Indexation of the RFR prevents companies from bearing this external market risk and allows company management to focus on risks within their control. As referenced in the Introduction, CEPA make a similar point in their recent allocation of risk report for Ofwat.
- As noted above, the realised cost of new debt and the cost of equity may exhibit positive co-movement, especially when cost of equity movements are driven by interest rate changes across the economy. Indexation allows for greater alignment between the cost of debt and cost of equity, which has the potential to mitigate financeability impacts.

Wider disadvantages of RFR indexation from a risk profile perspective

- Whilst indexation reduces market risk, it also creates additional uncertainty over future revenues. As such, there is arguably a trade-off between risk and uncertainty. An increase in revenue uncertainty may have a net cost to water companies, if it reduces investor confidence and leads to a more cautious investment approach (based on the principle of planning for a downside outcome or even a worst-case outcome, rather than an average outcome).
- There are two potential counter-arguments to the case that indexation is consistent with risk allocation best practice. Firstly, water companies should arguably build and maintain resilience to external risks, including market risk, by adopting strategies to mitigate the impact of such risks. If all external risks are passed to consumers, this weakens companies' incentives to develop resilient businesses which are able to withstand a range of economic shocks. We note that this is a key priority for Ofwat, which made improving resilience one of its key priorities for PR19. Secondly, even if one accepts that water companies should prioritise controllable risks, indexation effectively passes market risk onto customers. Whilst customers should contribute towards the efficient costs that their water companies face, customers are less well placed to manage market risk than investors, who are used to bearing risks from regulators' cost of capital decisions. There is arguably a stronger case for customers to support cost of new debt indexation, as it is in customers' interests to ensure that companies can finance debt efficiently and reduce their default risk. By contrast, the risks from equity ownership are borne by equity investors, with no default risk present.
- The revenue uncertainty resulting from indexation could disrupt water companies' ability to set a stable and sustainable dividend policy, increasing the volatility of investor returns. Stakeholders have suggested that this could lead to investors demanding higher returns to compensate for the increased volatility. Companies and investors may also seek to hedge equity return volatility risk, incurring transaction costs in the process.

Criteria 2: Our overall assessment

In this section we evaluate the impact of indexing the risk-free rate on water companies' risk profile, considering the forward-looking impact on financeability using PR19 financial models, as well as the wider effect on risk allocation and uncertainty.

Overall, our analysis does not provide a clear case in favour of, or against, indexing RFR on the basis of risk. Our analysis of financeability suggests that indexing RFR would have only a modest impact on the AICR and FFO/Debt measures over PR19. However, we acknowledge this is driven by relatively small movements in RFR in our scenarios, and that a change in the economic environment that allows RFR to fall substantially would increase the downside risks to financeability as a result of indexation.

From a wider risk profile perspective, indexing market risk would mitigate market risks for company owners that are outside of their control, at the cost of increasing customers' exposure to this risk. Similarly the impact on investor sentiment may be mixed, reducing downside market risks yet also decreasing certainty over revenues and dividend stability.

Criteria 3 (Impacts of indexation on water customers): Our assessment

We begin our assessment of Criteria 3 by presenting quantitative analysis of how cost of equity indexation (driven by RFR movements) could impact water customers' average bills over the PR19 period, again using the published PR19

financial models for four water companies. We then turn to consider wider advantages and disadvantages of indexation from a customer impact perspective. As done for our other criteria, we conclude this section by assessing the overall strength of the case for indexation.

Indexation of the risk-free rate (RFR)

Analysis of customer bill impacts

As noted earlier in this report, indexation of the cost of equity represents a transfer of market risk from the owners of water companies to their customers, increasing uncertainty over future allowed revenues and customer bills. Indexation therefore has the potential to significantly change average bills incurred by customers over a regulatory period. We assess the potential materiality of these average bill changes, recognising that significant bill increases could weaken affordability and therefore reduce customer trust.

We use the PR19 financial models to analyse how average customer bills could evolve under cost of equity indexation, drawing on the same model runs used for our financeability analysis. The scenarios and companies used in our bill impact analysis are therefore identical to our financeability analysis. The results we report do not take account of revenue re-profiling, in order to better capture how RFR trajectories would flow mechanistically through to yearly customer bills.

Table 3.21 below shows how average annual customer bills for 2020-25 (measured in 2017-18 prices) vary for each company across the PR19 final determination and in our Baseline, Upside and Downside PR19 scenarios. We also report the range of estimates for each company to show the extent of the variation.

Table 3.21: Customer bill impacts of our PR19 forward-looking RFR scenarios, by company (2020-25 average annual bill, reported in 2017-18 real-CPIH prices)

Company	PR19 final determination	RFR indexation (Baseline)	RFR indexation (Upside)	RFR indexation (Downside)	Estimate range (% of PR19 FD)
PRT	£95.60	£95.45	£95.61	£95.41	£0.20 (0.21%)
SEW	£194.20	£193.65	£194.24	£193.52	£0.72 (0.37%)
TMS	£366.78	£365.76	£366.94	£365.49	£1.45 (0.40%)
UUW	£385.57	£385.41	£385.64	£384.13	£1.51 (0.39%)

Source: Ofwat, Bank of England, PwC analysis

Our results show that the impacts of our PR19 RFR scenario trajectories on average customer bills are relatively modest, with the variation between our Upside and Downside scenarios being 0.2% to 0.4% of the PR19 final determination levels. These findings are consistent with the financeability analysis, which also finds relatively modest impacts from RFR scenario variation on financial outcomes. Many of the factors which drive our financeability results are also relevant to our customer bill analysis: the relatively modest bill impacts are partly a function of (i) limited pass-through of RFR movements into the cost of equity (due to equity beta) and (ii) the narrow nature of our PR19 scenario trajectories and the limited headroom for downside interest movements in the current economic climate. As also noted for our financeability analysis, at different points in the economic cycle we would expect to find greater potential for downside cost of equity movements and therefore greater potential for significant bill reductions (potentially exceeding 1% of PR19 final determination levels). We may also find greater potential for significant upward cost of equity movements, which could raise customer bills more substantially. Nonetheless, based on this evidence it does not appear that RFR movements alone are likely to induce dramatic changes (of multiple percentage points) in average customer bills.

We now turn to consider wider advantages and disadvantages of indexation from a customer impact perspective.

Wider advantages of RFR indexation from a customer impact perspective

- Indexation may help to increase customer trust in the water sector by linking allowed revenues to market movements and therefore reducing the potential for windfall profits or losses accruing to water companies and investors due to market-driven factors outside of their control. As discussed under our Criteria 1 evaluation,

the PR14 period saw water companies earn such windfall profits due to outturn RFR being lower than expected at the time of the PR14 final determination. This outcome has also been observed in historical price controls more generally across the UK water and energy sectors. Even if this outcome does not happen again over future regulatory periods, it could still be argued that indexation improves trust by increasing transparency over the drivers of water companies' revenues and investors' returns. However, customer trust is hard to reliably measure, making it difficult to assess the degree to which indexation improves trust.

- Indexation is already applied to other components of UK price controls, and therefore there is regulatory precedent for economic change affecting customer bills within a regulatory period.

Wider disadvantages of RFR indexation from a customer impact perspective

- Even if RFR indexation does not greatly change the average bills incurred by water customers, it could still increase bill volatility, especially if the underlying RFR movements are themselves volatile over the regulatory period. Research from WICS, CC Water as well as individual water companies shows that customers tend to prefer stable and predictable water bills, so any increase in year-on-year bill volatility will come at an implied cost to customers.[24] However, the nature of the bill volatility induced by indexation will depend significantly on the reconciliation approach adopted. If indexation is applied as an end-of-period reconciliation (like Ofwat's approach to cost of new debt indexation), then the impacts of RFR movements will not be felt in-period, and there are bill smoothing mechanisms which can be applied to adjust bills evenly for the RFR movements in the following regulatory period. By contrast, if indexation is applied on an in-period basis then it will be more challenging for Ofwat to apply bill smoothing (not knowing how RFR might evolve over future years), creating greater potential for bill volatility.
- Any bill movement impacts from indexation are likely to have a much greater effect on some water customers than others. A particularly important factor to consider is households' net borrowing or lending position, which influences their financial exposure to RFR movements (and interest rate movements across the economy more widely). Households which are net lenders tend to benefit from rising interest rates, meaning that these households have some financial protection should rising interest rates lead to higher water bills under cost of equity indexation. By contrast, households which are net borrowers could face rising borrowing costs and rising water bills simultaneously, hindering their financial position. A compounding factor is that poorer households tend to be net borrowers, meaning that negative financial impacts from indexation (via rising bills) could fall disproportionately on the poorest customers. This makes it particularly important for sharp bill increases to be avoided, with bill smoothing applied where possible. As a caveat, it is important to note that there is financial support available for poorer households (including social tariffs), and some customer borrowing involves fixed interest rates, especially in the short term, which won't respond to short-term interest rate movements.

Criteria 3: Our overall assessment

Under Criteria 3 we consider how indexation of RFR might affect customers in terms of the level and stability of bills, as well as the quality of services provided by water companies.

Firstly, our analysis of customer bills over PR19 using forward looking RFR scenarios suggests that the impact of indexation on the level of bills would be relatively minor, with the caveat that this is driven in part by the current economic cycle and the low interest rate environment. Under different economic conditions, there may be more potential for downward or upward interest rate movements that may affect bills more substantially.

Further, the choice of reconciliation approach may nonetheless result in volatile bills for customers, which goes against customer preferences. This factor is likely to be more salient for customers than any increased confidence in water companies from the prevention of windfall profits or losses, given the extent to which customers are knowledgeable about the regulatory regime. This volatility may affect net borrowers to a greater extent, as they are more likely to be poorer, vulnerable customers. We recognise that with end-of-period reconciliation, bills could be smoothed to a greater extent and volatility avoided. However, non-bill factors may also be significant as service levels could be lower for all customers if investment falls in response to more uncertain revenues following indexation.

[24] Ofwat (2016), Water 2020: Regulatory framework for wholesale markets and the 2019 price review - Appendix 1, https://www.ofwat.gov.uk/wp-content/uploads/2015/12/pap_tec20150525w2020app1.pdf

Therefore, on the basis of how indexation may affect customers, our analysis does not provide strong support for indexation.

Criteria 4 (Overall complexity and practical challenges from indexation): Our assessment

Our assessment of Criteria 4 considers the key arguments for and against RFR indexation from a practical implementation perspective. We begin by assessing the key arguments for indexation, recognising that its adoption is very likely to require at least some additional resource input from regulators and regulated companies. As such, arguments for indexation include the degree to which it causes added implementation burden, and potential indirect benefits or synchronisation resulting from its use. We then turn to consider the key arguments against indexation.

Wider advantages of RFR indexation from a practical implementation perspective

- In our Criteria 2 evaluation, we note that a potential advantage of indexation is the alignment it could create between the allowed cost of equity and the realised cost of new debt. Should indexation be applied on an in-period basis then this could reduce pressures on company financeability when interest rates rise over a regulatory period, as this will be compensated through cost of equity indexation, thereby providing additional revenues to support the rising costs of debt financing.
- Indexation may reduce (or even remove) the need for some regulatory activities, offsetting some of the additional burden it creates. For example, fixed approaches to setting RFR require regulators to consider (and if necessary, estimate) forward-looking adjustments. Indexation of the RFR may reduce the perceived need for such adjustments, as there is less potential for an indexed RFR to systematically underestimate the market RFR over a regulatory period.
- The implementation burden did not prevent Ofgem from adopting cost of equity indexation for RIIO-2. It should be noted that Ofgem already has a well-established annual iteration process (AIP) for its price controls, which incorporated cost of debt indexation prior to RIIO-2, and this likely reduces the difficulty of implementing cost of equity indexation. However, the first AIP of the RIIO-2 period is yet to take place, meaning that additional implementation challenges associated with cost of equity indexation may emerge over time.

Wider disadvantages of RFR indexation from a practical implementation perspective

- Most obviously, the implementation of RFR indexation requires many decisions to be made about how indexation works in practice, as highlighted in Chapter 2. These decisions include how indexed RFR values are calculated, and how the reconciliation process works. All such choices must be consulted upon extensively with stakeholders in the run-up to final determinations, allowing opportunities for challenge and refinement. Some choices may prompt significant debate between stakeholders, for example, stakeholders challenged Ofgem's use of a one-month averaging period for calculating indexed RFR, arguing instead for a longer estimation period.
- A further complication associated with RFR indexation is the approach to inflation. UK index-linked gilts (ILGs) are currently pegged to RPI inflation. However, when RPI becomes aligned with CPI in 2030 then these instruments are effectively pegged to CPI in all but name, which will clearly impact on yields. Ofwat is currently transitioning its price controls from RPI indexation to CPIH indexation, with all new RCV additions being indexed to CPIH. Insofar as ILG yields are used to determine indexed RFR, this creates a need to convert RPI-real ILG yields into CPIH-real terms for use in the price control, based on an assumed wedge between RPI and CPIH inflation. However, this could present an issue in the 2025-30 regulatory period, as towards the end of the regulatory period there will be no long term wedge between the two measures of inflation.
- There is also a materiality consideration of implementing indexation. If underlying RFR movements are small, indexation may result in negligible changes to the cost of equity yet still require significant time input from stakeholders. Whilst recent UK price controls have seen substantial year-on-year reductions in RFR, this pattern is unlikely to occur again for some time. Should RFR movements prove to be more gradual in the future, this creates a challenge of whether indexation is worthwhile on a cycle-neutral basis, with the incremental benefits potentially not matching the incremental costs. Whilst it could be possible to adopt 'threshold-based indexation' in principle, under which indexation would only be applied if defined materiality thresholds (deadbands) were breached, this would be challenging to implement in practice. The most obvious difficulty with this approach is how the materiality thresholds should be calculated, recognising that it is challenging to holistically quantify the incremental costs and benefits of indexation. Any regulatory decisions

regarding such materiality thresholds would likely initiate significant stakeholder debate. For example, our stakeholder engagement has highlighted differing views on the use of deadbands, caps and collars within indexation, with one stakeholder advocating the application of caps and collars (without deadbands) on allowed cost of equity adjustments to limit potential negative financeability impacts. This is very different to threshold-based indexation, which uses deadbands without caps or collars.

- As well as requiring significant resource input from a methodology development and calculation perspective, indexation could also create additional time costs across other aspects of water sector price reviews. The increased revenue uncertainty (and potential volatility) that indexation creates could necessitate detailed financial resilience assessments, to monitor changes in companies' financing and identify any deteriorations in companies' financial position which require remedial action. In their responses to the PR24 and beyond consultation, water companies have highlighted that this would likely add complexity and time costs to the annual reporting process, potentially requiring additional engagement with Ofwat should financeability challenges emerge within a regulatory period. Another knock-on effect of indexation is that it could make other reconciliations harder to perform, both in terms of calculating allowed revenue adjustments and forecasting how allowed revenues and customer bills are likely to evolve over future years. This is a particularly important consideration for in-period reconciliations such as in-period ODI reconciliations, since the latest (indexed) cost of equity estimate would not be known until near the reconciliation date, and therefore forecasting the likely trajectory of allowed revenues over future years would be challenging. By contrast, the impact on end-of-period reconciliations would not be as large, since the outturn cost of equity movements over the regulatory period would already be known at the time of reconciliation.

Criteria 4: Our overall assessment

In this section we consider practical challenges and how indexation might affect the complexity of the price control process. Indexation of RFR would undoubtedly require several methodology decisions that will likely prompt debate amongst stakeholders, while being unlikely to materially reduce the regulatory burden in other areas. In fact, the additional revenue uncertainty may create further time costs in detailed financeability assessments or reconciliations. However, Ofgem did not perceive such practical issues as a major obstacle to implementing cost of equity indexation.

It is clear that indexation would lead to some additional administrative burden to the regulator and regulated companies. This criteria alone should not be a determining factor, but practical challenges as well as other negatives must be offset by the potential benefits of indexation.

4. Conclusions and recommendations

In this report we assess the case for and against the indexation of water companies' allowed cost of equity, with a view to informing future price controls. The table and text below provides our final conclusions on each of our 4 assessment criteria.

Table 4.1: RAG assessment of PwC evaluation criteria by component of cost of equity

Criteria	Component	RAG	Description
Criteria 1 - Empirical case for indexation	RFR		Marginally positive impact
	Equity Beta		No significant value
	TMR		No significant value
Criteria 2 - Impact of indexation on water companies' risk profile	RFR		Mixed impact
	Equity Beta	N/A	N/A
	TMR	N/A	N/A
Criteria 3 - Impact of indexation on water customers	RFR		Marginally negative impact
	Equity Beta	N/A	N/A
	TMR	N/A	N/A
Criteria 4 - Overall complexity and practical challenges from indexation	RFR		Marginally negative impact
	Equity Beta	N/A	N/A
	TMR	N/A	N/A

Equity beta and total market return (TMR)

For Criteria 1 — the empirical case for indexation — our analysis for equity beta and TMR finds that these components may not be well suited to indexation. Equity beta exhibits some mean reversion properties, which means that a fixed estimate is less likely to severely under or overestimate the market. Estimates of TMR using long term historical approaches indicate that TMR is a relatively stable parameter. As a result, indexing these two parameters presents limited gains in terms of reducing potential forecast error.

There are also several challenges involved when indexing these measures. Firstly, there is no clear consensus on a single estimation method for TMR or equity beta. In both cases this limits Ofwat's flexibility to consider alternative definitions and could prompt disagreement amongst industry stakeholders. Second, equity beta indexation may introduce circularity, with estimates influencing share prices, gearing measures and, as a result, future estimates of beta. Taking these challenges into account, we assign a 'no significant value rating' for both equity beta and TMR, and conclude that these parameters are not suitable for indexation. Consequently, we did not test them against criteria 2-4.

Risk-free rate (RFR)

For Criteria 1, our analysis of historical evidence shows that forecast error has been relatively large in some periods, resulting in windfall gains for water companies. Consequently, indexing RFR can significantly reduce forecast error, as movements in the RFR can be relatively large and long-lived, unlike TMR or equity beta. However, while indexing RFR reduces forecast error there remains challenges in determining a single estimation approach. Despite RFR being a market wide parameter that is more observable, there remains significant debate on how best to estimate it. We therefore assign a 'marginal positive impact' rating against this criteria.

With respect to Criteria 2, the impact of RFR indexation on water companies' risk profile is mixed. In the current low interest rate environment, we view that substantial changes in financeability are unlikely in the near term. However, while indexing RFR mitigates some of the external market risk for the owners of water companies, it shifts these risks to customers who may be less suited to manage them. Investors may value this decrease in risk, but it does come at the cost of more uncertain revenues, which could deter some investment given that investors in the sector value stable

revenues. There is clearly a trade off between risk and uncertainty, and consequently we have assigned a ‘mixed impact’ rating for this criteria.

The practical complexities of implementation and potential impacts on customers provide counterweights to the potential gains from indexation. The near term impact on bills would likely be relatively minor, but any volatility in bills — which would be more likely when using in-period reconciliation — would concern customers, who typically prefer bill stability. The interaction between a rise in RFR increasing both water bills and overall borrowing costs would do the most harm to poorer, vulnerable customers, who are more likely to be net borrowers. We view this as a particularly important consideration, given that interest rates are more likely to rise (than fall) given the UK economy’s position in the business cycle and the importance of protecting vulnerable customers.

Indexing RFR would complicate the regulator’s task through additional methodology decisions, the handling of changes to inflation measures, interactions with other elements of the price control and the additional time and resource costs required. However, this alone should not be a determining factor. But practical challenges as well as other downsides must be offset by the benefits of indexation.

The final decision requires consideration of the trade-off between reductions in forecast error and mixed effects on risk, with an increase in customer exposure to interest rate volatility and the inevitable complications the change would bring to the price control process. On the basis of our assessment criteria, we conclude that cost of equity indexation is unlikely to produce sufficient gains to make it a priority.