A review of the methodology used to estimate the allowed cost of equity for regulated companies

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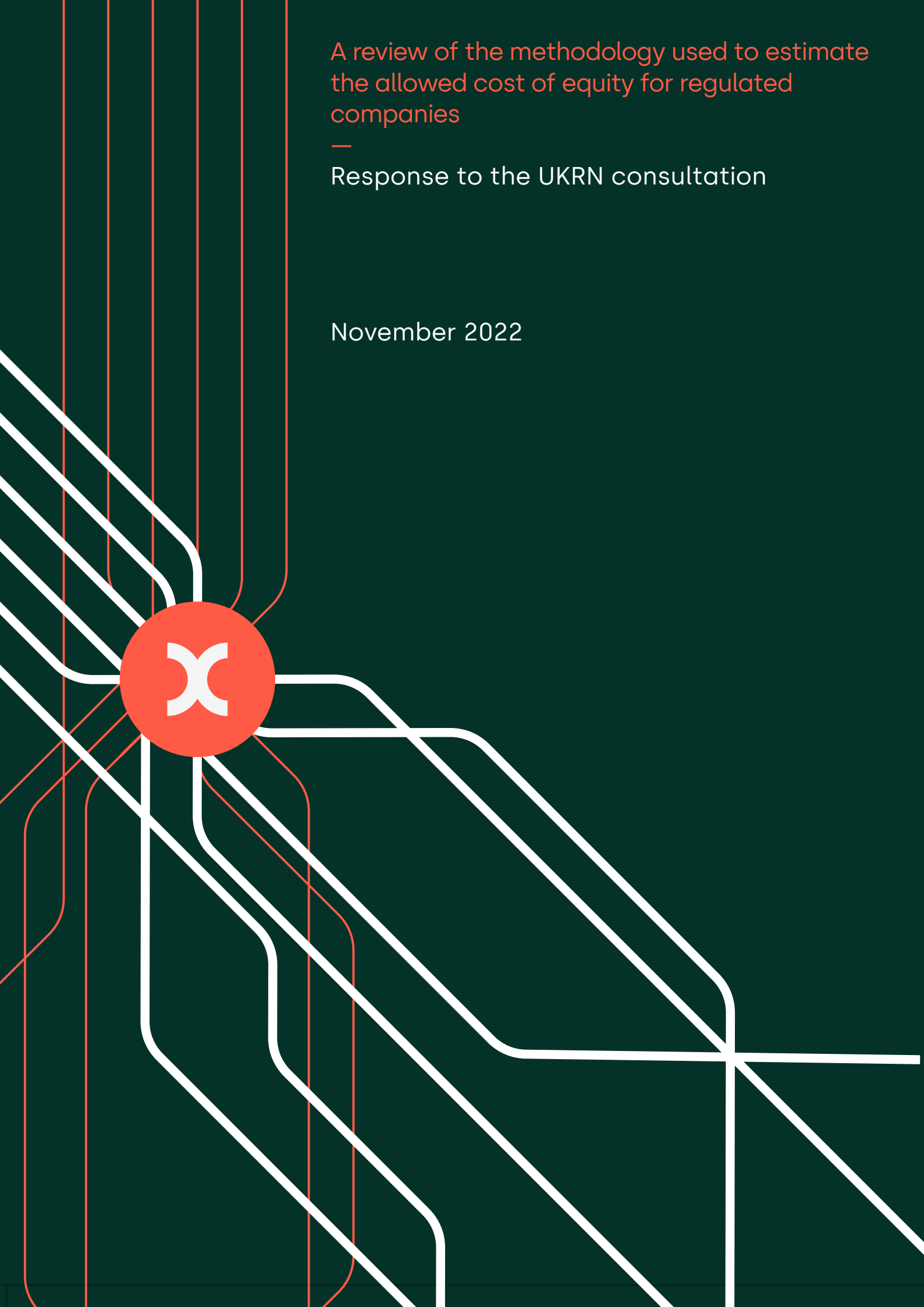
Response to the UKRN consultation

November 2022



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Executive summary

In September 2022, the UK Regulator's Network (UKRN) published a consultation on the methodology for setting the cost of capital (the UKRN report or UKRN paper). The Energy Networks Association (ENA) has commissioned Oxera to review the UKRN report and provide advice on issues relating to the allowed cost of equity (CoE) for regulated networks.

The UKRN report focuses on the use of the capital asset pricing model (CAPM) to estimate the CoE. The CAPM includes three parameters: the risk-free rate (RFR), the total market return (TMR), and the equity beta. In this report, we present our review of the UKRN's methodology to estimate each of the CAPM parameters. We also present a review of cross-checks to the CAPM-based estimates, such as the market-to-asset ratios and the ARP–DRP framework. Finally, we comment on the UKRN guidance for selecting a point estimate within the CoE range, and support the recommendation for a regular review of the methodology used to estimate the cost of capital of regulated utilities. Our conclusions are summarised in the paragraphs below.

Risk-free rate

The UKRN report is proposing to draw on gilt yields as its primary source of evidence and to employ long-term SONIA swap rates as a potentially useful cross-check.

First, we provide evidence that supports the existence of a convenience premium, which demonstrates that using gilt yields to estimate the RFR results in an underestimation of the 'true' rate.

Second, we provide evidence demonstrating that SONIA swap rates do not represent an appropriate cross-check for the RFR. In particular, there is a non-zero spread between SONIA swap rates and gilts. The spread tends to be positive on shorter maturities and negative on longer ones. This spread is caused by frictions, such as the convenience premium of shorter-end gilts and excess demand for SONIA swaps at the long end, which have persisted over time due to limits to arbitrage. Hence, using SONIA swap rates as a cross-check adds unnecessary noise to the estimate of the yield curve obtained from bonds.

Beta

The UKRN report is proposing to estimate the beta with reference to a sample of 'pure play' comparators.

To de-lever the equity betas of the comparators, the UKRN is proposing to use the observed gearing ratios of the comparators and a debt beta of 0–0.15.

In principle, we agree with the UKRN guidance on how to estimate the raw equity beta of comparator companies. We note, however, that the de-levering and re-levering exercise should result in minimal discrepancies to the level of the weighted average cost of capital. To

achieve that, regulators should use a debt beta that appropriately reflects the credit ratings of the comparator companies. In our contemporaneous estimations for RIIO-2, which cover a sample of regulated networks in the UK, the indirect regression-based approach from Schaefer and Strebulaev (2008)[1] supported a debt beta assumption of a maximum of 0.05.

Furthermore, in relation to the notional gearing level, we note that it should not solely reflect the regulator's best estimation of an efficiently-run notional company, disregarding the actual level of gearing that the company assumes. This is because the actual level of gearing that is undertaken signals the level that investors and the company consider optimal. The optimal level of gearing of a regulated firm should ultimately be left for managers and investors to decide. This decision will reflect the characteristics of the firm's investment needs, financial performance, and regulatory package.

Total market return

The UKRN paper is proposing to estimate the TMR using primarily the historical ex post and ex ante approaches.

First, in relation to the ex post approach, we note that the correct inflation series should be used to deflate nominal returns. The ONS has recently published a new CPIH backcast which addresses issues of concern with the old backcast series. We consider that the revised series should be used to estimate the CPIH-real TMR. In addition, we note that the correct averaging method of historical returns should be used to estimate the unbiased expected TMR. We provide evidence that demonstrates that an arithmetic average should be used. Specifically, we demonstrate that there is no evidence of serial correlation of annual returns and hence there is no basis to rely on the geometric average and a subjective uplift to estimate the TMR.

Second, in relation to the ex ante approach, we note that this methodology does not add new evidence to the ex post approach. The arbitrary classification of the elements and events that are 'unlikely to be repeatable' make the results of this approach more subjective than the results of the ex post approach. Therefore, we consider that regulators should place much less weight on this approach compared to the ex post approach.

Cross-checks

The UKRN paper also reflects on the practice of using alternative approaches as a cross-check to the CAPM output. Specifically, the UKRN paper suggests the use of market benchmarks as a cross-check.

First, we discuss a market-based methodology mentioned in the UKRN paper as a cross-check for the CoE—the market-to-asset ratio (MAR). We outline a list of factors that need to be accounted for and adjusted for when working with MARs. We also provide evidence that there is no relationship between MARs and proxy measures when it

[1] Schaefer, S. M. and Strebulaev, I. A. (2008), 'Structural models of credit risk are useful: Evidence from hedge ratios on corporate bonds', *Journal of Financial Economics*, 90:1, pp. 1–19.

comes to how challenging or lenient the regulatory CoE allowance is. Therefore, this invalidates the use of the MAR as an effective measure of the appropriateness of the level of the CoE allowance.

Second, we put forward support for the differential between the asset risk premium (ARP) and debt risk premium (DRP) to be used as a cross-check to the CAPM estimation. The use of the ARP–DRP framework is advantageous as it inherently incorporates contemporaneous market data while correcting several estimation biases and therefore provides important additional information.

Point estimate

The UKRN report considers a number of additional factors that can lead to the selection of a point estimate within the WACC range that is higher than the mid-point such as the welfare impact from underinvestment, asymmetry in the package of incentives or in the choice of parameters, and financeability. While the UKRN considers that regulators should only deviate from the mid-point of the CAPM-based CoE range if there are strong reasons to do so, we consider that the UKRN report understates the importance of several factors that may merit an uplift to the CoE in certain circumstances, as we explain in the corresponding section of this report.

1 Introduction

In September 2022, the UK Regulator's Network (UKRN) published a consultation on the methodology for setting the cost of capital. The Energy Networks Association (ENA) has commissioned Oxera to review the UKRN report, and provide advice on issues relating to the estimation of the allowed CoE for regulated networks.

The CoE is the rate required by equity investors to invest in a particular company or asset, and can be estimated in several ways. The UKRN report recommends that regulators primarily rely on CAPM, which computes the CoE as the sum of the RFR and a risk premium that investors require as compensation for the risk exposure of the investment. The risk premium is based on the equity risk premium (ERP) and the equity beta (β_e), the latter being a parameter that captures a company's exposure to systematic risk. Mathematically, the CAPM representation of the CoE is as follows.

$$CoE = RFR + \beta_e * ERP$$

In this report, we provide a review of the methodology proposed in the UKRN paper to estimate each of the CAPM parameters. We then present an overview of alternative methodologies that can be used to cross-check the CoE implied by the CAPM.

We conclude this report with a review of the trade-offs associated with choosing a point estimate within the cost of capital range. The report is structured as follows.

- Section 2 presents a review of the UKRN position on the RFR estimation and our response to issues such as the convenience premium and the use of SONIA swaps as cross-checks.
- Section 3 presents a review of the UKRN position on the beta estimation. This section also presents our commentary on raw beta estimation and beta de-levering and re-levering.
- Section 4 presents a review of the UKRN position on the total market return (TMR). This section presents our responses covering the ex post approach, the ex ante approach, and the forward-looking approach.
- Section 5 presents a review of alternative measures that can be used to cross-check the CAPM-implied CoE. This section covers the market-to-asset ratios (MARs) and the asset risk premium (ARP)–debt risk premium (DRP) framework.
- Section 6 presents a review of the UKRN position on the choice of a point estimate. This section also presents our commentary on the welfare impacts of potential underinvestment in networks, as well as the implications for setting the point estimate of the CoE based on other price control considerations—such as any asymmetry of the control package, parameter estimation uncertainty and financeability.
- Section 7 concludes the report.

2 Risk-free rate

The RFR measures the expected return on an asset that is free of risk—i.e. where the realised return on the investment will be equal to the expected return. In the CAPM framework, this notional riskless asset is also referred to as a 'zero-beta asset' (i.e. an asset with zero sensitivity to overall market risk). The CAPM model assumes that all investors can borrow and lend an unlimited amount at the RFR. This is an important assumption because it informs the set of instruments that can be used to estimate the RFR.

In economies with low sovereign default risk, regulators have typically estimated the RFR with reference to the yield to maturity on government-issued bonds (also known as gilts in the UK). These bonds are assumed to be notionally free of default and systematic risk.[2] Indeed, the UKRN paper recommends regulators in the UK estimate the RFR with reference to inflation-linked government bonds (ILGs).

However, more recently, there has been a debate in the UK and in Europe as to whether government bonds provide the best estimate of the RFR. It has been argued that not all market participants can borrow at the same rate as the government—e.g. the yield on the highest rated corporate bonds (i.e. AAA) is usually above the yield on government bonds of the same maturity. It has also been argued that government bond yields are below the return on a zero-beta asset because they have special properties that give rise to a price premium (which we refer to as a 'convenience premium' in this report) that lowers their yields below the RFR.

In the following subsections, we investigate the characteristics of government bonds which give rise to the convenience premium, and the viability of the SONIA swap rate as a proxy and cross-check for RFR estimation.

2.1 Special properties of government bonds and the convenience premium

In 2020, Oxera published a paper that investigated the relationship between sovereign yields and the CAPM.[3] In that paper, we explain that using the yield on government bonds as the RFR in the CAPM model can lead to a violation of the Modigliani-Miller (MM) theorem.[4] We explain that this is caused by a convenience premium, which pushes down yields on government bonds relative to the RFR.

In essence, the convenience premium is caused by excess demand for highly rated government bonds driven by regulatory requirements and the use of government bonds in hedging strategies—e.g. interest rate

[2] Note that, in the past, regulators have typically followed this approach while allowing for a certain amount of additional headroom.
[3] Oxera (2020), 'Are sovereign yields the risk-free rate for the CAPM?', prepared for the Energy Networks Association, 20 May, https://www.oxera.com/wp-content/uploads/2020/08/2020.05.20-RFR-and-gearing-1.pdf (accessed 14 October 2022)
[4] Ibid., p. 6.

hedging. Hence, the convenience premium reflects the money-like safety and liquidity characteristics of government bonds.

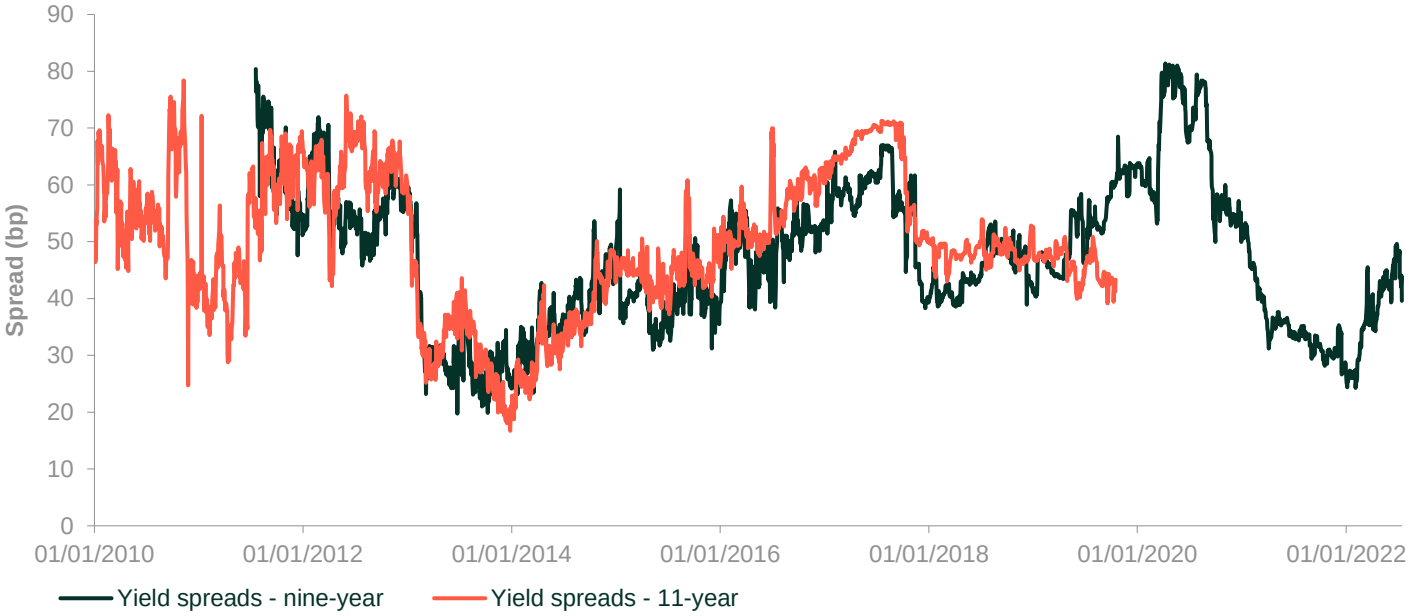
Therefore, when deriving the RFR for use as an input to the CAPM from government bond yields, adjustments are required to account for the convenience premium. This is also supported by the academic literature, which has attempted to quantify this convenience premium.

According to Feldhütter and Lando (2008), the magnitude of the convenience premium varies over time and can range from 30 to 90bp.[5] Similarly, Krishnamurthy and Vissing-Jorgensen (2012) estimate the average of the liquidity component of the convenience premium to be 46bp from 1926–2008,[6] while van Binsbergen et al. (2020) estimate a convenience premium of around 40bp on US government bonds over 2004–18.[7]

Using a methodology that is broadly consistent with that set out in Longstaff (2004),[8] we have previously estimated the size of the premium since 2010.[9] Figure 2.1 below shows that the long-term convenience premiums implied by the spreads of nine- and 11-year REFCORP bonds from 2010 to date are on average 47bp and 50bp respectively. It can be seen that the 11-year spreads reduced significantly in early 2020 when the COVID-19 pandemic began, but at the start of January 2022 this reversed and the spreads have trended upwards. These estimates are consistent with the upward adjustment of 50–100bp that we recommended in our September 2020 CoE report,[10] which should be added to the yield of 20-year ILGs to estimate the 'true' RFR for the CAPM.

[5] Feldhütter, P. and Lando, D. (2008), 'Decomposing swap spreads', *Journal of Financial Economics*, **88**:2, pp. 375–405.
[6] Krishnamurthy, A. and Vissing-Jorgensen, A. (2012), 'The Aggregate Demand for Treasury Debt', *Journal of Political Economy*, **120**:2, pp. 233–67.
[7] van Binsbergen, J. H., Diamond, W. F. and Grotteria, M. (2022), 'Risk-free interest rates' *Journal of Financial Economics*, **143**:1, pp. 1–29.
[8] Longstaff, F.A. (2002), 'The flight-to-liquidity premium in US Treasury bond prices', No. w9312, National Bureau of Economic Research.
[9] Oxera (2022), 'Cost of equity in RIIO-ED2 Draft Determinations', August.
[10] Oxera (2020), 'The cost of equity for RIIO-2', prepared for the Energy Network Association, 4 September, https://www.northerngasnetworks.co.uk/wp-content/uploads/2020/09/CoE-Oxera.pdf (accessed 14 October 2022).

Figure 2.1 Evolution of yield spreads of nine- and 11-year zero-coupon REFCORP bonds strips since 2010



Note: Assumes a cut-off date of 1 July 2022. The yield spreads at a given point in time, are calculated by averaging the daily spreads across all outstanding REFCORP bond strips that have maturities equal to the target maturities at that time (i.e. nine- and 11-year). The spreads are calculated based on the USD US Treasury bonds/notes (FMC 82) zero-coupon yield curve, which has maturities available at yearly intervals between one and ten years, and also at 15 years, 20 years and 30 years. The gaps between these maturities are linearly interpolated.
The nine-year spreads series are not available until 20 July 2011, as before that date no REFCORP bond strips have maturities shorter than or equal to nine years. The 11-year spreads series are not available after 17 October 2019, as after that date no REFCORP bond strips have maturities longer than or equal to 11 years. Due to data limitations, it is not possible to reconstruct the time series of spreads for maturities longer than 11 years. For example, as of 1 January 2010, only six out of 34 outstanding REFCORP bond strips had maturities greater than or equal to 20 years. As of 19 October 2010, all outstanding REFCORP bond strips had maturities less than 20 years.
Source: Oxera analysis using Bloomberg data.

In sum, evidence from academic literature and empirical analysis suggests that there is a positive convenience premium embedded in government bonds. This convenience premium pushes down the yield on government bonds below the level of the 'true' RFR. The evidence also suggests that this premium changes over time. Therefore, to estimate the RFR using the yields on government bonds, it is necessary to adjust the benchmark yield upwards to account for the convenience premium.

2.2 SONIA swaps

Recent regulatory consultations in the UK have proposed to use the SONIA swap rate as a proxy for the RFR in the CAPM.[11] Although the UKRN guidance is for regulators to primarily rely on ILGs to estimate the RFR, the authors do not rule out cross-checks against other benchmarks. The UKRN paper suggests that the SONIA swaps rates may be a useful cross-check, because they are available at maturities consistent with the recommended 10–20 year investment horizon.[12]

[11] Ofwat (2022), 'Creating tomorrow, together: Consulting on our methodology for PR24', Appendix 11, p. 5. (Henceforth 'PR24 consultation')
[12] UK Regulators Network (2022), 'UKRN guidance for regulators on the methodology for setting the cost of capital—consultation', September, p. 13

In this section, we explain why using SONIA swap rates as a cross-check for RFR only adds more noise and distortions to RFR estimation. To do that, we first explain how the yield curve is derived and how, in a theoretically frictionless world, the SONIA swap rates should equal the yield on government bonds. We then explain that, in practice, a variety of distortions and market frictions lead to significant and persistent differentials in swap rates relative to gilt yields. For instance, at the longer end of the yield curve, SONIA swap rates are distorted by, for example, the excess demand generated by the hedging operations of pension funds, relative to the limited supply due to stringent regulatory requirements (i.e. high capital requirements) for swap dealers. This tends to lead to in a premium within swap rates at this maturity and makes the SONIA swap rate an unreliable proxy of the RFR.

Thus, in the real world, as opposed to a theoretically frictionless world, SONIA swap rates provide a noisy proxy for the yield curve based on government bond yields.

2.2.1 The yield curve in a frictionless world and associated arbitrage

The yield curve can be obtained by bootstrapping the bond yields or the swap rates over the different maturities. Smith (2014), for example, illustrates how to infer the forward curve starting from swaps,[13] while Hull (2003) illustrates how to infer it from Treasury bonds.[14]

In a theoretically frictionless world, the two methods lead to the derivation of the same yield curve. In other words, SONIA swap rates and gilt yields should be perfectly aligned across the term structure. If this were not the case, any misalignments would be eliminated by profit-seeking arbitrageurs. It then follows that, in a frictionless world, SONIA swap rates do not provide additional information that is not already contained in the yield curve obtained from gilts.

What follows is a description of how an arbitrage strategy would eliminate any difference between the yield curve obtained from gilts, and that obtained from SONIA swaps.

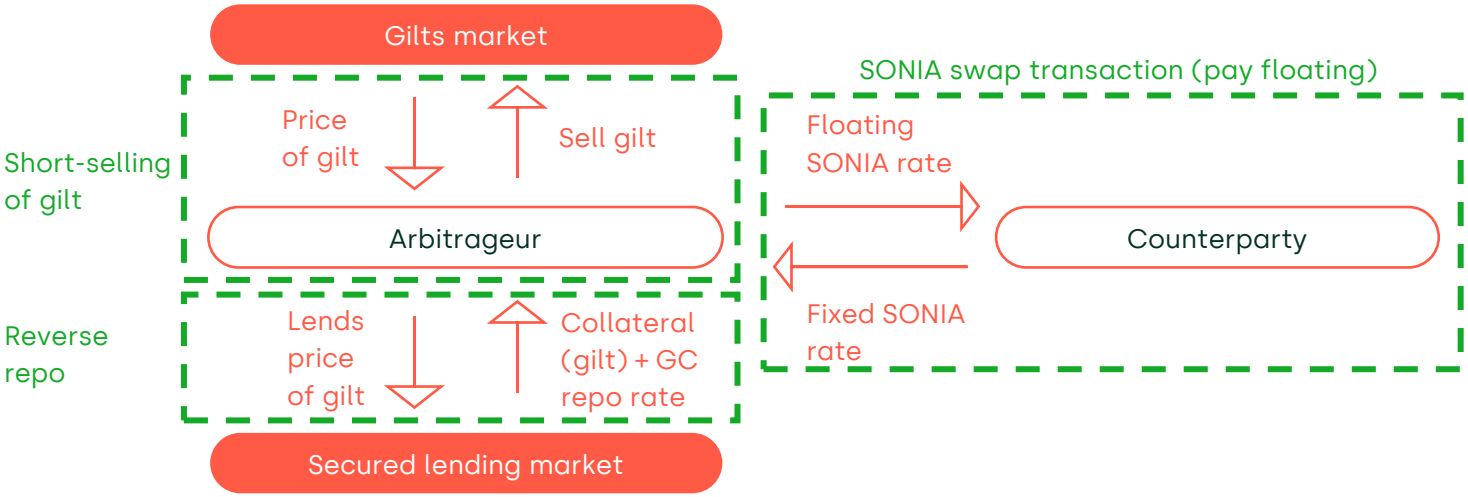
Consider first the case of a positive difference between the rate on the fixed leg of the SONIA swap and the corresponding yield on gilts. This case is known as 'positive swap spread'. In this case, investors can arbitrage this spread by going long on the SONIA swap and short on the gilt, then lending the proceeds raised from the short sale of the gilt to a third party.

More precisely, the long position on the swap implies that the investor pays the floating SONIA rate and receives the fixed rate. The short position on the gilt implies that the investor pays the fixed rate of the gilt. The arbitrage strategy is completed by lending the short-selling proceeds to a borrower in a reverse repurchase agreement (reverse repo) earning the general collateral (GC) repo rate, which is used to

[13] Smith, D.J. (2014), *Bond math: the theory behind the formulas*, John Wiley & Sons, p. 181.
[14] Hull, J.C. (2003), *Options, futures and other derivatives*, Pearson Education India, section 4.5.

cover the payments of the floating rate of the SONIA swap.[15] This strategy is depicted in Figure 2.2 below.

Figure 2.2 Illustration of arbitrage strategy if SONIA swap spreads are positive



Note: Oxera representation based on Duarte, J., Longstaff, F.A. and Yu, F. (2007), 'Risk and Return in Fixed-Income Arbitrage: Nickels in Front of a Steamroller?', The Review of Financial Studies, 20:3, pp. 769–811.

The total cash flows that the investor receives are equal to the difference between the fixed leg of the swap rate and the gilt yield (swap spread), plus the difference between the GC repo rate (interest on the reverse repo) and the floating SONIA rate (if positive). Absent market frictions, investors can adopt this arbitrage strategy and generate positive profits until the swap spread is zero and the GC repo rate equals the SONIA rate.

Conversely, if the swap rates are lower than the gilt yields (i.e. there is a negative swap spread), the arbitrage strategy can be reversed such that investors short the swap spread instead of going long on it. The arbitrage trades will repeat until the swap spreads are pushed to zero.

2.2.2 Limits to arbitrage

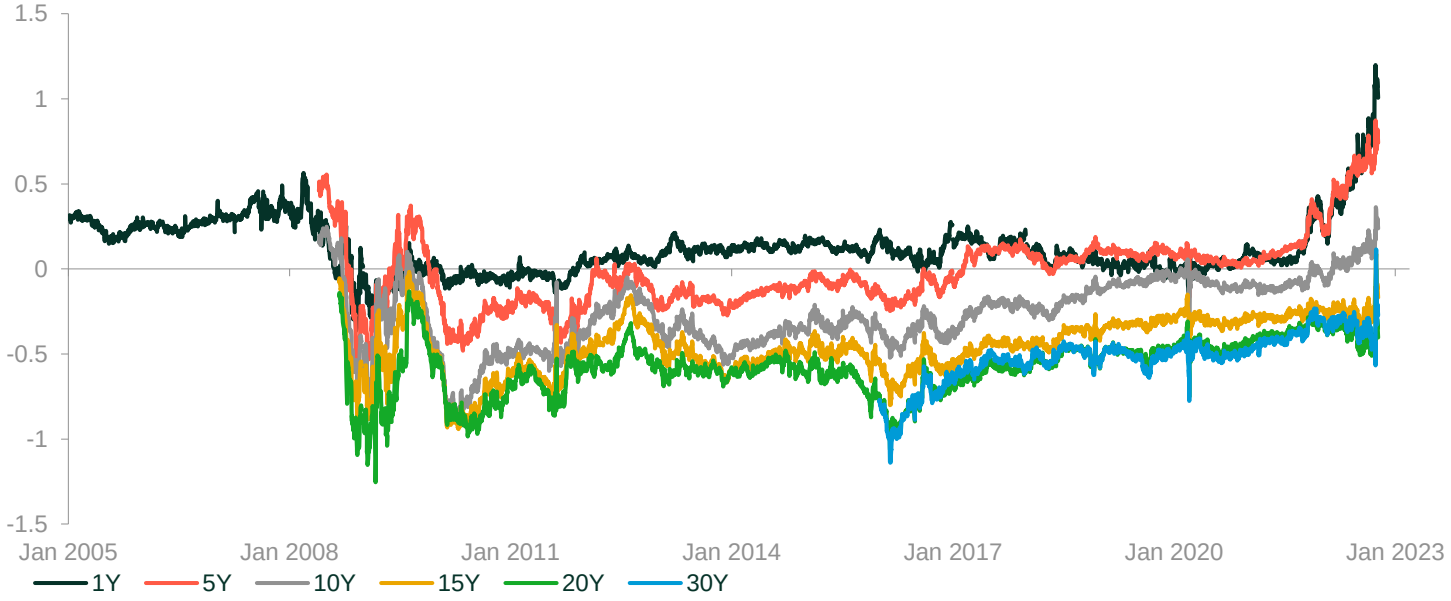
The above discussion explains why the SONIA swap spread would be zero in a frictionless world. In practice however, the swap spread is typically different from zero. Figure 2.3 presents the historical spreads of one-, five-, ten-, 15-, 20- and 30-year SONIA swap rates, and Figure 2.2 presents the spread of different maturities in the first six months of 2022.

The shorter maturities tend to have positive (or less negative) spreads. This has become more pronounced since the start of the COVID-19 pandemic, where the spread on the one-, five- and 10-year increased rapidly. On the other hand, the longer maturities (10Y+) have had consistently negative spreads since the 2007–8 financial crisis. We see

[15] In a reverse repo transaction, the borrower and lender agree to a short-term agreement, whereby the lender agrees to purchase securities in order to later sell them back to the borrower at a slightly higher price. In the present case, investors are lenders in the reverse repo transaction, lending to the borrowers by temporarily purchasing gilts from them. When the reverse repo agreement unwinds, investors receive the initial purchase price plus interest.

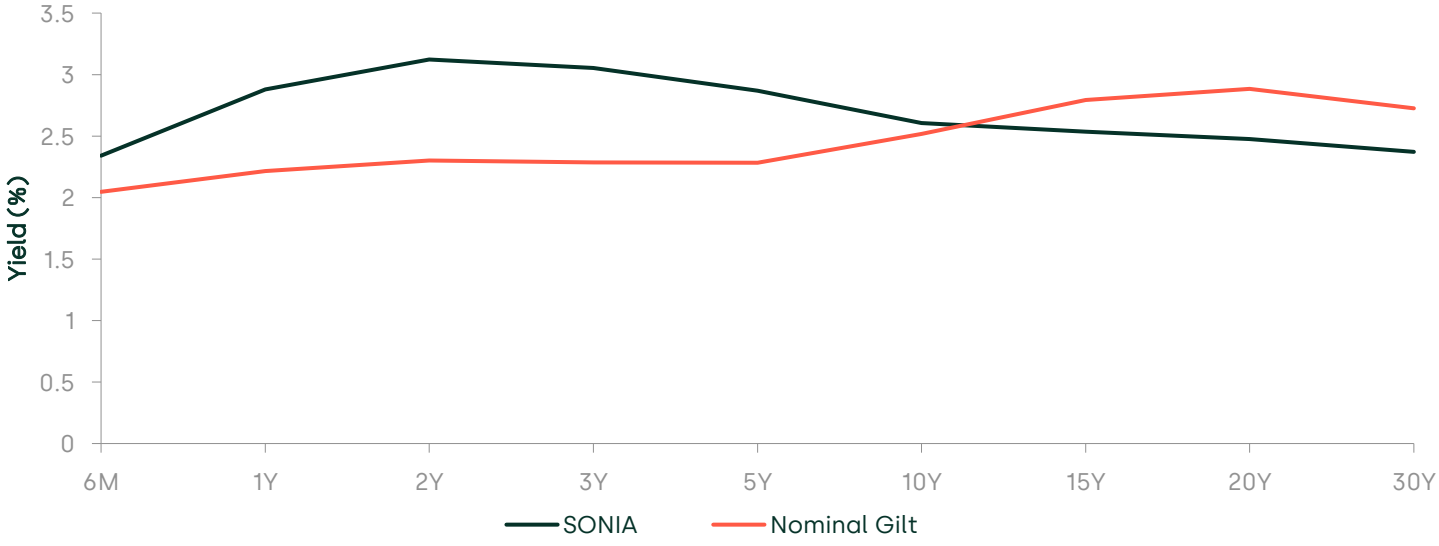
this represented also in Figure 2.4, where the SONIA swap rate is above corresponding gilts in the first section of the term structure (c. 10Y), but then is below corresponding gilts in the longer end of the term structure. Similar patterns are also observed in the USD market, as shown by Boyarchenko et al. (2018).[16] These discrepancies in spreads are driven by various factors, which we discuss below in more detail.

Figure 2.3 Historical data on SONIA swap spreads



Note: The spreads were calculated by subtracting gilts to SONIA swaps of matching maturities.
Source: Oxera analysis using Bloomberg data.

Figure 2.4 Yield curves of the SONIA swap rate and nominal gilts



Note: Assumes a cut-off date of 10 October 2022. Yields are calculated as 6-month averages of spot rates.
Source: Oxera analysis using Bloomberg data.

The starting point is to look at the persistence of positive spreads for shorter maturity swaps. As noted above, gilts carry a convenience

[16] Boyarchenko, N., Gupta, P., Steele, N. and Yen, J. (2018), 'Negative swap spreads', *Federal Reserve Bank of New York Economic Policy Review*.

premium due to their greater liquidity as well as other factors. Insofar as swap rates do not carry such a premium, a positive swap spread will tend to occur.

In theory, an arbitrage strategy like that discussed in the previous section and illustrated in Figure 2.2 should lead to the elimination of the spread. For the strategy to be profitable, the difference between the GC repo rate and the SONIA floating rate must be sufficiently non-negative. However, historical GC rates have often been significantly below SONIA rates, such that the reverse repo arbitrage is not profitable. The academic literature has attributed the existence of a negative spread primarily to 'excess' demand for hedging relative to supply (i.e. there is a convenience premium for swap rates). Since limits to arbitrage prevent the market from correcting these supply–demand imbalances, negative swap rates–as shown for longer-dated securities—persist.

More precisely, Klingler and Sundaresan (2019) develop a model in which underfunded pension plans' demand for duration hedging creates demand for the fixed rate leg in swaps with long maturities, and is a significant explanatory variable of long-date swap spreads in the USA. [17] In finding similar for the euro market, where the supply of interest rate swaps is lower than in the USA, Domanski et al. (2017) explain that the impact of demand-driven pressure on the swap spreads can be extremely significant.[18]

This 'excess demand' cannot be met with additional supply due to limits to arbitrage. Boyarchenko et al. (2018) focus on limits to arbitrage resulting from the more stringent regulatory requirements for swap dealers. Specifically, they argue that higher capital requirements reduce incentives for market participants to enter into the relevant arbitrage trades. The authors conclude that, given the balance sheet costs for the dealers, spreads must reach more negative levels to generate an adequate risk-adjusted return on equity for dealers.[19]

2.3 RFR conclusion

The evidence from academic, market and regulatory sources that gilt yields are likely to reflect a significant convenience yield supports an upwards adjustment of the gilt yields to derive the RFR. A pragmatic and simple approach to recognising the convenience yield in the estimate of the RFR is to take an average of the yields on the UK gilts and the iBoxx £ Non-Gilt AAA, converted into real terms using the relevant inflation metric. Alternatively, a 50-100bp convenience premium could be added to the UK ILG yields.

[17] See Klingler, S. and Sundaresan, S.M. (2019), 'An explanation of negative swap spreads: Demand for duration from underfunded pension plans', *The Journal of Finance*, 74:2, pp. 675–710.
[18] Domanski, D., Shin, H.S. and Sushko, V. (2017), 'The hunt for duration: not waving but drowning?', *IMF Economic Review*, pp. 113–53.
[19] See also Chowdhury, S. and Wurm, M.A. (2017), 'Modelling and Forecasting Interest Rate Swap Spreads', Moody's Analytics risk perspectives, https://www.moodysanalytics.com/risk-perspectives-magazine/managing-disruption/principles-and-practices/modeling-and-forecasting-interest-rate-swap-spreads (accessed 30 June 2021).

In relation to the use of SONIA swaps as a cross-check to the RFR, we demonstrate that SONIA swap rates should, in theory, be equal to the UK gilt yields in a theoretically frictionless world. However, in practice, a variety of distortions and market frictions lead to significant and persistent swap spreads. Therefore, in the real world, as opposed to a theoretically frictionless world, swap rates provide a poor proxy for the yield curve based on government bond yields.

In sum, using SONIA swap rates as a cross-check for RFR thus only adds more noise and distortions to RFR estimation. Therefore, we do not consider SONIA swap rates to be an appropriate proxy for the RFR.

3 Beta

The equity beta in the CAPM is a measure of how risky an equity investment is compared with the average of the market portfolio. The risk arising because of a company's general exposure to the market is known as 'systematic risk'. An equity beta of one means that the stock return moves in line with the average market return. An equity beta between zero and one means that it tends to move in the same direction as the market return, but to a lesser magnitude (or greater magnitude, for a beta above one).

For a company listed on the stock market, estimating the equity beta using simple regression analysis is straightforward because all required market data is publicly available. For companies that are not listed, listed comparator companies need to be identified that can be used as a proxy. Observable equity betas for these comparators need to be adjusted to the level of gearing for the company for which the CoE is being estimated, in order to be comparable (i.e. de-levering and re-levering needs to be consistently undertaken with reference to the capital structure of the target company).

In the next subsection we comment on the UKRN guidance on how to estimate raw equity betas and adjust for varying gearing levels to ensure comparability.

3.1 Raw equity beta estimation

The UKRN paper suggests that current regulatory practice in the UK—of estimating the raw betas of 'pure play' listed companies—is reasonable. The authors suggest that some regulatory judgement is required when 'pure play' comparators are not available. Furthermore, the UKRN paper suggests that regulators should estimate the raw equity beta using the standard OLS regression and that a range of estimation windows could be used (e.g. two, five and ten years). With regards to the frequency of estimation, the guidance is to rely on daily data for liquid stocks.

In principle, we agree with the UKRN guidance on the selection of comparator firms (i.e. that 'pure play' comparators should be used), the use of daily data for liquid stocks, and the length of the estimation windows. We also agree with the UKRN that the beta should be estimated using an OLS regression method, with reference to the most diversified available local index[20] in the relevant currency. Further, we reiterate the importance of undertaking appropriate de-levering and re-levering of raw comparator betas in estimating the CoE of the target company. This ensures like-for-like comparisons, i.e. it should not be assumed that the gearing of comparator firms is the same, or that raw equity betas are directly comparable across companies. With regards to the selection of comparator companies, we note that to select a sample of comparators for a specific activity, one needs to consider the following:

[20] In practice, this will be a national index, such as FTSE All Share in the UK.

- **The distribution of revenues per activity**: Revenues should be earned in relation to the activity of interest (i.e. the regulated activity in the case of WACC setting for regulated networks).
- **The geographical distribution of revenues**: the majority of the revenues should be in similar economies with comparable regulatory systems. For example, for energy networks in the UK, the sample of comparators should include companies that generate their revenues in regulated energy networks in the UK and in mainland Europe where regulatory regimes are comparable.

In the absence of companies that fit these criteria, the sample of comparators can be expanded to other jurisdictions or industries. A degree of judgement is required in assessing how cross-industry and cross-jurisdiction differences need to be accounted for.

Another important consideration in selecting a sample of comparators is data availability and quality. Specifically, it is important to ensure that the comparators used are sufficiently liquid to allow a robust estimation of the beta. Illiquid stocks could take more than one period to reflect market information, which leads to serial correlation of returns and a downward-biased estimation of the beta. We also note that empirical tests suggest that the CAPM tends to under-predict the CoE for firms with a beta below one. We explain that in the box below.

Box 3.1 Accuracy of the standard CAPM

Asness et all (2013) and Fama and French (2015) show that the standard CAPM model has many 'anomalies' which suggest that the accuracy of the CAPM model decreases the further away the equity beta is from unity.

The 'low beta anomaly' was empirically observed in a dataset of US firms, where it was demonstrated that stocks with a low beta (such as utility companies) consistently outperformed high-beta stocks over the period from January 1968 to December 2008. This runs counter to the CAPM prediction that there is a linear relationship between beta and returns. As the comparator companies used to determine the asset beta of regulated companies in the UK typically have equity betas lower than one when measured at market levels of gearing, adopting an asset beta estimate in the top half of the estimated asset beta range would provide some offset to this downward bias. This point is covered in section 6, where we explain that the asymmetry in estimation of the CAPM parameters is skewed to an underestimation of the CoE of regulated utilities.

Source: Asness, C., Moskowitz, T.J. and Pedersen, L.H. (2013), 'Value and momentum everywhere', The Journal of Finance, LXVIII: 3; Fama, E. and French, K. (2015), 'Dissecting Anomalies with a Five-Factor Model', The Review of Financial Studies, 29:1, 1 January 2016, pp. 69–103

With regards to data frequency and estimation window, we note that the statistical robustness of the beta estimates is directly proportional to the number of observations used in the regression

analysis. This would imply that greater data frequency (i.e. daily data) and a longer estimation window is preferable as it leads to a more robust estimation. However, where systematic risk is changing over time, appropriate selection of the estimation window is essential in seeking to assess the current (or 'forward-looking') market risk exposure of a company.

Finally, the UKRN paper suggests that a sector-specific investigation is necessary to estimate the betas. Specifically, the UKRN paper says:

> Interpreting beta regressions involves judgement and investigation of sector-specific issues. For instance, share prices of airports have been affected quite differently to the share prices of water companies by the COVID-19 pandemic, and therefore, **the weight given to the data during the pandemic may need to be different depending on the sector.** In addition, availability of data over long enough period [sic] may constrain the length of estimation window which can be used in some sectors. For these reasons a 'one-size-fits-all' approach is unlikely to be appropriate. Nonetheless, there is scope to adopt a more streamlined approach to estimating betas. [Emphasis added][21]

More generally, we consider that regulators should be consistent over time by taking a 'through the cycle' view and there should be a high threshold for methodology changes. However, we agree with the UKRN report that there is merit in assessing whether the risk exposure of a sector or a company has changed over time. For example, there could be changes in the business mix through acquisitions and disposals, or changes in market perceptions of the risk of certain business activities. There is also merit in assessing whether a dataset presents clear evidence of structural breaks that could affect the estimation of the beta.

Hence, in the context of setting the allowed regulatory return, where the objective of the regulator is to set the beta at the level of the forward-looking risk exposure of the companies, it is important to consider whether the data used for forecasting is representative of the future. In doing so, it is reasonable that regulators rely on daily data of sufficiently liquid comparator stocks. These methodology choices should also be provided with clear supporting evidence and justifications.

3.2 Beta de-levering and re-levering

Upon deriving comparators' raw equity betas, these should then be de-levered to produce each company's asset beta, which according to the MM theorem (Propositions I and II), is constant irrespective of the company's level of gearing.[22] This thus allows for comparison across companies to be unaffected by their respective financial capital structure choices. As addressed in the UKRN report, this de-levering is

[21] UK Regulators Network (2022), 'UKRN guidance for regulators on the methodology for setting the cost of capital — consultation', September, p. 20

[22] Proposition I states that when there are no transaction costs and no difference in the cost of borrowing across agents, a firm's cost of capital is constant regardless of the firm's capital structure. The theorem also applies to the asset beta – if a firm's weighted average cost of capital (WACC) is constant, the asset beta must also be constant.

performed by applying the Harris-Pringle formula,[23] and incorporating the respective company's debt beta and gearing. We briefly address the former in this section, and the latter in the following subsection.

In a previous Oxera report investigating contemporaneous estimations for RIIO-2, we demonstrated that OLS regression (both direct and indirect) and structural models are the optimal methods for robust estimation of the debt beta, ahead of the spread decomposition method.[24] We show that the indirect regression-based approach from Schaefer and Strebulaev (2008)[25] supported a debt beta assumption of no higher than 0.05, taking into account similar comparator credit risk profiles.[26] For comparison, in previous regulatory precedents, regulators have assumed debt betas typically ranging from 0 to 0.15. [27]

Once the asset beta is determined, this can then be re-levered using the notional company's gearing and debt beta, to arrive at the equity beta of the notional company for the determination of the regulatory package.

3.3 Gearing

Determination of the gearing parameter is central to correctly estimating beta, return components of the WACC, and ultimately allowed revenues and financeability.

We note that the UKRN report suggests that notional gearing should be set by the regulators based on their judgement of the average, efficiently-run company. The report further suggests that companies are free to deviate from the notional gearing, at their own risk of any incremental costs that may arise from the difference between notional and actual gearing.[28] Additionally, in performing past financeability assessments, regulators have used a notional gearing to determine the level of allowed revenues that would ensure a target credit rating.

In an Oxera report discussing the capital structure of UK water companies,[29] we investigated factors affecting the capital structure decision. These factors can be broadly categorised as tax effects, agency and informational issues, risk redistribution, and risk reduction.

[23] This formula states that the asset beta (also unlevered beta) of a company is equal to the weighted average of its equity beta (also levered beta) and debt beta. This is reflected in the following equation:

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

Where g represents the gearing ratio defined as net debt divided by the sum of net debt and equity.

[24] Oxera (2020), 'The cost of equity for RIIO-2', 4 September.

[25] Schaefer, S. M. and Strebulaev, I. A. (2008), 'Structural models of credit risk are useful: Evidence from hedge ratios on corporate bonds', *Journal of Financial Economics*, 90:1, pp. 1–19.

[26] Oxera (2020), 'The cost of equity for RIIO-2', 4 September.

[27] In our contemporaneous estimations, we apply a debt beta of 0.05, to improve comparability with previous regulatory precedents, and which is consistent with evidence on the appropriate level of the debt beta for regulated UK networks.

[28] UK Regulators Network (2022), 'UKRN guidance for regulators on the methodology for setting the cost of capital — consultation', p. 29.

[29] Oxera (2002), 'The capital structure of water companies', October.

Overall, based on the evidence including academic literature, we found that there are many parameters driving managers' financing decisions, and that a firm's capital structure will depend on managerial choice rather than a theoretical optimum-gearing level defined ex ante. Echoing Brealey, Myers and Allen,[30] we concluded that gearing is derived from and reflects, rather than determines, the underlying risks and performance of a firm.[31]

In sum, the optimal level of gearing of a regulated firm should ultimately be left for managers and investors to decide. This decision will reflect the characteristics of the firm's investment needs, financial performance, and regulatory package. Furthermore, the gearing factor should be derived with reference to market evidence and should not be used to generate financial ratios solely to pass a financeability assessment. This exercise would be erroneous and undermines the stability of the regulatory package.

3.4 Beta conclusions

Accurate determination of the asset beta and thus its components is imperative in setting the allowed regulatory package. We show that in estimating the equity beta, the comparator set should meet several appropriateness and data quality requirements. We agree with the estimation approach to raw equity betas and reiterate the importance of ensuring the data used for estimation is sufficiently representative and frequent. We note, however, that in the context of estimating the beta of regulated utilities which typically present an equity beta lower than one, empirical tests find that the CAPM tends to under-predict the CoE and therefore it is recommended to choose a point estimate at the top of the range.

In addition to this, we detail the de-levering and re-levering process in estimating beta in order to account for varying levels of gearing across comparators. Proceeding in step, we reiterate that estimation of the debt beta should be based on regressions and structural models, and according to our evidence around 0.05 is an appropriate level of the debt beta for regulated UK networks.

We also address the importance of gearing, and highlight that making assumptions about a notionally efficient financing structure should be informed by market evidence on actual gearing ratios.

[30] Brealey, R.A., Myers S.C. and Allen F., Principles of Corporate Finance, Chapter 18, How Much Should a Corporation Borrow?, Section 4.
[31] Oxera (2002), 'The capital structure of water companies', October.

4 Total market return

The ERP is a premium above the RFR that investors demand for investing in a market equity portfolio in 'normal' market conditions. The ERP is calculated as the difference between total market return (TMR) and the RFR. UK regulators and the Competition and Markets Authority (CMA) have tended to follow the view that expected real TMR is relatively stable over time, and that changes in the real RFR are largely offset by changes in the ERP.

The TMR can be estimated using a range of different methodologies. The UKRN suggests three approaches to estimate the TMR:

- historical ex post: based on the average of observable historical returns;
- historical ex ante: based on the average of adjusted historical returns, where the adjustment accounts for 'unexpected' events that generated a return lower/higher than the expected return;
- forward-looking: based on investor's expectations of future returns. Different methodologies can be used to estimate this, from survey evidence to dividend discount models.

The UKRN guidance is for regulators to rely primarily on the historical ex post and ex ante TMR estimations and to combine these with the RFR to derive the ERP. In the next subsections we discuss the two approaches proposed by the UKRN to derive the TMR. We also comment on the use of forward-looking approaches as an alternative to estimate the TMR.

4.1 Ex post TMR

The ex post TMR approach is based on the assumption that the average historical return provides an unbiased and reliable indicator of expected future returns.

This approach is adopted by many regulators in the UK. For instance, Ofgem, Ofwat, Ofcom, and the CAA used this methodology as the primary indicator to estimate the TMR in their last regulatory reviews.

To estimate the TMR using the ex post approach, one needs to average a series of historical returns. The Dimson-Marsh-Staunton (DMS) dataset[32] provides a useful starting point to calculate this historical average. However, as regulators in the UK are interested in real returns, it is necessary to combine the DMS data with a reliable measure of inflation to estimate the real historical returns. In addition, one needs to make a choice of which averaging method to use (i.e. geometric or arithmetic).

In the next subsections, we explain how to deflate the nominal return series and how to average the real returns to obtain an unbiased and reliable measure of the TMR.

[32] E. Dimson, P. Marsh, M. Staunton (2019), 'Credit Suisse Global Investment Returns Yearbook 2021'.

4.1.1 Treatment of inflation

Historical data on market returns is expressed in nominal terms. However, price controls in the UK are set in real terms, meaning that the TMR should also be in real terms.[33]

As real returns are unobservable, nominal returns must be adjusted by the inflation rate. The UKRN report suggests that regulators should deflate nominal historical returns using the CED series (for the period 1900-1947) and the CPI (or CPIH) backcast for the period 1947-1988.[34] We note also that some regulators require the TMR to be estimated in RPI-real terms. In previous submissions, we have expressed our concerns with the use of the ONS backcast CPI series as an input to estimating the real CoE allowance, due to issues with robustness of the series.[35]

In May 2022, superseding the previous backcast series, the ONS has published new backcast series for the CPI and the CPIH for the period 1950–88, which address the most concerning errors found in the previous release. The new CPIH backcast should therefore be used instead of the old CPI backcast when estimating historical returns in CPIH-real terms. At the same time, there is still merit in using the historical RPI series because it was compiled and published contemporaneously and it is therefore not subject to the same estimation uncertainty as a backcast series.

We now present the impact of using the new CPIH backcast on the CPIH-real equity return over the period 1900–2021.

Consistent with our previous submissions, we use UK nominal returns data published by DMS to calculate the CPIH-real returns. As shown in Table 4.1, the average CPIH-real equity return over this period is 0.24% higher than the original CPI-real equity return estimate. Using the new (lower) inflation series published by the ONS leads to a higher estimated average real equity return over the period 1900–2021.

[33] Note that some regulators require a RPI-real TMR and some require a CPI-real TMR.
[34] UK Regulators Network (2022), 'UKRN guidance for regulators on the methodology for setting the cost of capital — consultation', p. 18
[35] The initial release included ex post estimation of CPI and selective methodological changes, which upon our investigation suggested that estimates were materially upward-biased. The ONS was unable to locate the information used to construct those estimates, and was unable to replicate them. See Oxera (2020), 'The cost of equity for RIIO-2', prepared for the Energy Networks Association, 4 September.

Table 4.1 Impact of new ONS inflation series on real-equity returns

	Old CPI series	New CPI series	New CPIH series
1900–2021 arithmetic average inflation	3.98%	3.91%	3.74%
Difference from old CPI series		*-0.07%*	*-0.24%*
1900–2021 arithmetic average real equity returns[1]	6.85–6.94%	6.91–7.01%	7.09–7.18%
Difference from old CPI series		*0.07%*	*0.24%*

Note: The update from the ONS affects only the data points between 1950 and 1988. To cover the pre-1950 period, we use Consumption Expenditure Deflator (CED) data published by the Bank of England in its Millennium database. However, we note that this is an imperfect method as the CED is theoretically and empirically a closer proxy for RPI than CPI. For details, see Oxera (2022), 'Assessing the new ONS CPIH back-cast', 15 July.
[1] The range in real equity returns is driven by the range of potential values for the 2021 UK equity returns used by DMS. In particular, we have the yearly breakdown of the data used by DMS for the period 1900–2020, but not for 2021. We infer the estimates in the table from the 1900–2020 and 1900–2021 nominal average returns.
Source: Oxera analysis based on ONS and DMS data.

4.1.2 Averaging historical returns

There are two options to estimate the average TMR: to calculate the geometric mean or to calculate the arithmetic mean. The geometric mean of any set of numbers is always lower than the arithmetic mean unless all the numbers are equal (in which case the means are the same). For a series of returns, equality between the geometric and arithmetic means would occur only if there is no volatility at all (i.e. if returns are constant). While there is debate about which is the more appropriate averaging method in any given context, the academic literature is broadly supportive of placing more weight on the arithmetic averages for estimating the ERP to use when computing required equity returns for valuation and capital budgeting purposes.

The UKRN report suggests that regulators can either use the arithmetic average of historical returns over the corresponding holding periods, or the whole-period geometric average uplifted to reflect the volatility in returns. The UKRN paper notes that regulators have tended to apply a 1–2% uplift to the geometric mean in recent regulatory decisions. This uplift was previously presented in the UKRN 2018 CoE report, where the authors state that regulators can add a 1–2% uplift to the geometric mean to account for serial correlation of returns.

In previous submissions, we have explained that the unbiased estimator of the expected TMR can be derived using the arithmetic mean, and that uplifting the geometric mean by a factor lower than the one half of the variance of annual returns would result in a downward-biased TMR. Note that this holds irrespective of the holding period that is assumed. Below, we summarise the points raised in previous submissions and explain why the arithmetic mean should be used to estimate the expected TMR.

The issues with serial correlation and the correct methodology to average historical returns have been raised previously and were

explored at length in the NATS (2020) redetermination and the CMA PR19 and the RIIO-GD2/T2 appeals. Professor Stephen Schaefer's submission to the CMA for the NATS (2020) price control redetermination highlights that the observed relationship between the arithmetic and geometric averages suggests that serial correlation is itself insignificant, or that the impact of serial correlation on the relationship between arithmetic and geometric average returns is insignificant. Professor Schaefer states that:

> [...] the difference between the arithmetic and geometric mean return is given by one half of the variance. Bound up in the assumption of normality are further assumptions that both the expected return and the variance of returns are constant over time and that returns are not serially correlated.[36]

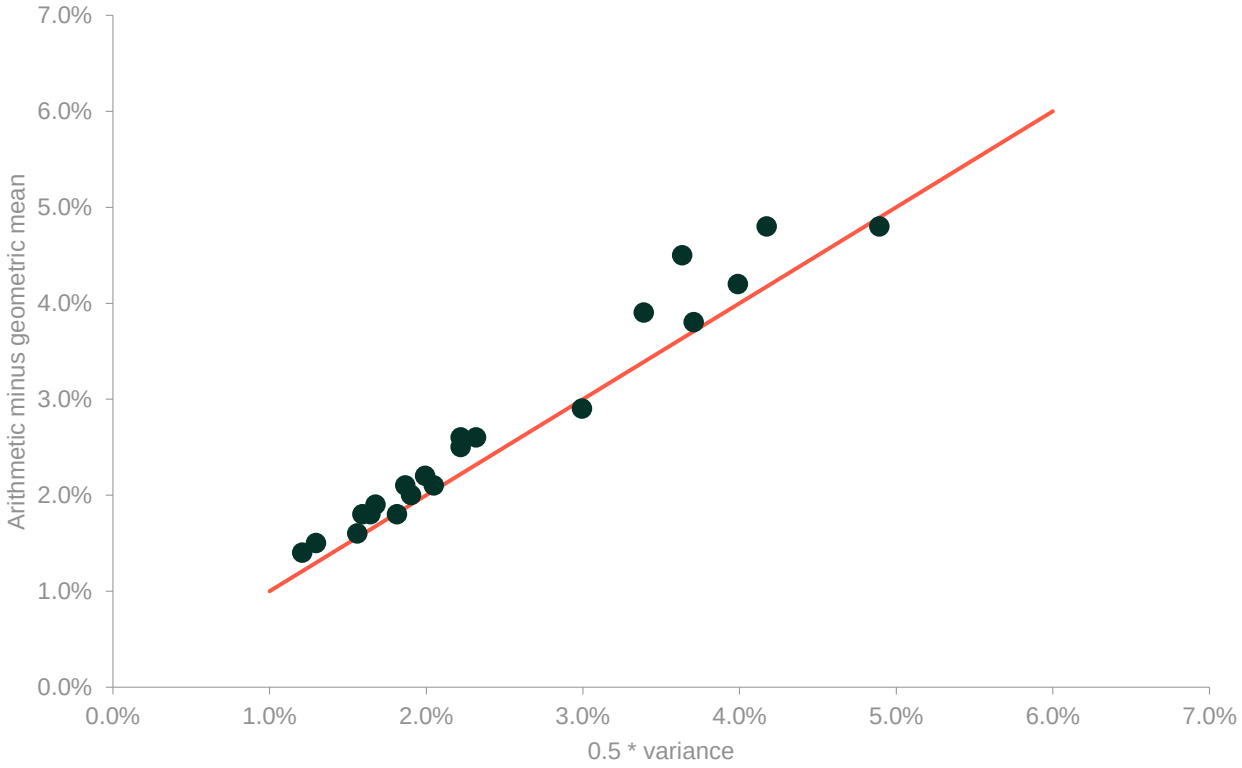
Professor Schaefer further shows, based on analysis of the DMS data, that:

> [...] despite this, the difference between the arithmetic and geometric means is indeed well approximated in the data by one half the variance.[37]

Figure 4.1 below reproduces Professor Schaefer's analysis, which plots the difference between the arithmetic and geometric mean returns in the vertical axis, against the variance of the annual returns divided by two (horizontal axis). The figure shows that the difference between the arithmetic and geometric mean is closely approximated by half of the realised variance.

[36] Appendix of Schaefer, S. (2020), 'Using Average Historical Rates of Return to set Discount Rates', contained within Oxera (2020), 'Deriving unbiased discount rates from historical returns', 14 February.
[37] Ibid.

Figure 4.1 Difference in mean returns plotted against variance



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

The implication is that applying the appropriate upward adjustment to the geometric mean of half the variance of annualised returns results in an estimate close to the arithmetic average.

The findings of Professor Schaefer are further supported by the serial correlations test we performed in the nominal and real return series. We apply the Ljung–Box test to the DMS series assuming different holding periods.[38] For the holding periods above one year, we run the test on non-overlapping samples. The results are summarised in Table 4.2 below and show that for each holding period (i.e. 1-year, 5-year, 10-year and 20-year) we do not observe a statistically significant finding of serial correlation in the returns. This is consistent with the findings of Professor Schaefer and supports the conclusion that adding an uplift to the geometric mean to account for the serial correlation of returns is not a robust approach. Instead, the arithmetic mean more appropriately accounts for the volatility of past returns, in deriving an average from a historical return's series.

[38] The Ljung–Box test is a quantitative method that tests for autocorrelation at multiple lags jointly. Ljung, G.M. and Box, G.E.P. (1978), 'On a Measure of a Lack of Fit in Time Series Models'. Biometrika. 65:2, pp. 297–303.

Table 4.2 Ljung–Box serial correlation test

Holding period	Returns	P-value	Significant
1Y	Nominal	0.2954	No
	CPIH-real	0.3653	No
5Y (non-overlapping)	Nominal	0.1658	No
	CPIH-real	0.6133	No
10Y (non-overlapping)	Nominal	0.0802	No
	CPIH-real	0.6224	No
20Y (non-overlapping)	Nominal	0.8526	No
	CPIH-real	0.4268	No

Note: The significance test is performed at a 10% significance level. The null hypothesis associated with the Ljung-Box test is H_0: the residuals are independently distributed.
Source: Ljung, G.M. and Box, G.E.P. (1978), 'On a Measure of a Lack of Fit in Time Series Models'. Biometrika. 65:2, pp. 297–303.

In sum, the empirical evidence does not justify deviating from the arithmetic mean based on arguments concerning serial correlation. This conclusion is supported by the CMA decision in the PR19 redetermination,[39] where the CMA stated that:[40]

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

4.2 Ex ante TMR

The ex ante approach attempts to identify investors' reasonable expectations of returns by adjusting the historical series of returns. These adjustments attempt to identify one-off periods of good or bad 'luck', i.e. those that investors might not expect to be repeated in the future.

The ex ante approach was discussed in the CMA PR19 appeals, where two approaches were used to derive the ex ante TMR: a generalisation of the constant growth model (Fama–French method) and the DMS decomposition method. The former requires an assumption that the market dividend yield (D/P) and/ or the earnings yield (EP) is stationary. Elsewhere, the DMS decomposition approach involves decomposing the ERP into the mean dividend yield, the growth rate of real dividends, the expansion of the price/dividend ratio, and change in real exchange rate. The adjustment to the estimated TMR then arises

[39] It is important to note that the judicial review of the PR19 is different from the RIIO-2. In the latter, the CMA found that Ofgem was not wrong in applying the subjective uplift to the geometric mean. However, the legal framework of RIIO-2 requires the appellants to demonstrate that an error was made, whereas the legal framework of PR19 requires the CMA to state which methodology is superior. Hence, we refer to the PR19 to illustrate the CMA's view on the topic.
[40] Competition and Markets Authority (2021), 'Anglian Water Services Limited, Bristol Water plc, Northumbrian Water Limited and Yorkshire Water Services Limited price determinations – Final report', 17 March, para. 9.329.

from subjective adjustments to the average value of one or more of these components. While not the same, the approach adopted by the Fama–French method has a similar character, in that they decompose total returns into the dividend yield and capital gain.

Before explaining how these models work and the advantages and disadvantages of using them, a clarification is necessary regarding the use of the term 'ex ante approach'. An estimate of the TMR *today*, i.e. the expected *future* return obtained using either the decomposition methods (or even the simple historical mean return), can be described as 'ex ante' in the sense that the estimate applies to future returns.

However, the question that both the Fama-French and DMS decomposition methods address is somewhat different; it is whether the returns that investors were expecting in the *past* are well approximated by the historical mean.

As Fama–French point out,[41] a secular decline in the TMR in the past could lead to ex post returns exceeding true ex ante returns. While there appears to be no way to definitively resolve this, [42] research by Martin shows that under certain reasonable conditions, the size of the ERP is at least equal to a particular measure of its variance.[43]

4.2.1 Decomposing the TMR

We consider the 'ex ante approach' described in the UKRN paper to be more appropriately labelled as an *adjusted* ex post approach, since it uses an adjusted historical data series to estimate the TMR. In the next paragraphs we explain the principles underpinning this adjusted ex post model and how it relates to the ex post model described in the previous sub-section.

The gross return, R_t, from time (t–1) to t on a stock or an index with price P_t can be written as:

Equation 1

$$R_t = \frac{P_t}{P_{t-1}}$$

Now consider a related variable, x_t, such as the level of dividends or earnings. The same gross return can now be written as:

Equation 2

$$R_t = \frac{P_t}{P_{t-1}} = \frac{\frac{P_t}{x_t}}{\frac{P_{t-1}}{x_{t-1}}} * \left(\frac{x_t}{x_{t-1}}\right) = G_t\left(\frac{P}{x}\right) * G_t(x)$$

where $G_t\left(\frac{P}{x}\right)$ is the growth rate of $\left(\frac{P}{x}\right)$, and $G_t(x)$ is the growth rate of x. This equation shows that the gross return can be expressed as the

[41] Fama, E., French, K. (2002), 'The equity premium', The Journal of Finance, December.
[42] See, for example, the debate between Welch and Goyal (2008) and Campbell and Shiller (1998) on the prediction of stock market returns. Welch, I., Goyal, A. (2008), 'A comprehensive look at the empirical performance of equity premium prediction', July. Campbell, J., Shiller, R. (1998), 'Valuation ratios and the long-run stock market outlook', January.
[43] Martin, I. (2017). What is the expected return on the market? Quarterly Journal of Economics 132 (1), 367–433. See also Knox, B., Vissing-Jorgensen, A. (2022), 'A stock return decomposition using observables'. Finance and Economics Discussion Series 2022-014.

product of a series of growth rates in, for our example, the price dividend ratio and dividends. We now take logs of this relation:

$$r_t = g_t\left(\frac{P}{x}\right) + g_t(x)$$

where $r_t = \ln(R_t)$, $g_t\left(\frac{P}{x}\right) = \ln\left(G_t\left(\frac{P}{x}\right)\right)$, $and\ g_t(x) = \ln(G_t(x))$.

This equation implies that, for our example, the log-return can be expressed as the sum of a log-growth rate in the price dividend ratio and the log-growth rate of dividends. We now take the average of this equation over time to give:

$$\bar{r} = \overline{g\left(\frac{P}{x}\right)} + \overline{g(x)} \text{ and } \bar{r} = \frac{1}{T}\sum_{1}^{T} r_t \text{ , etc.}$$

Two observations should be made in relation to the formulas above:

- First, because the relation between the arithmetic return, R_t, and the various growth rates, $G\left(\frac{P}{x}\right)$ and $G(x)$ is multiplicative, the relation between average returns and average growth rates holds only in log. In other words, the mean return which is calculated from variables such as the average dividend growth rate is the geometric average return. To obtain an estimate of the arithmetic mean, the usual adjustment of one half the variance needs to be added.
- Second, other variables can be introduced to the formula to further decompose the TMR; this is exactly what is done in DMS decomposition, and is similar to the Fama–French approach.

Effectively, the returns defined in the so-called ex ante (decomposition) approach are equivalent to the returns defined in the ex post method. Therefore, there is no advantage in decomposing the ERP into several elements, in place of estimating the geometric average directly.

The UKRN paper suggests that the advantage might come from decomposing the ERP into elements that are likely to be repeatable and those that are not, e.g. the expansion of valuation ratios. However, as we demonstrate in the formula above, the decomposition of the price return can include many different variables and therefore, many different forms. Hence, it is a subjective exercise that requires one to choose which elements to include in the decomposition, and which to be classified as 'unlikely to be repeatable'. There is no guarantee that a variable, A, that exhibits 'unrepeatable' behaviour when included in the decomposition with variable B, would exhibit the same behaviour in conjunction with variable C.

In other words, the decomposition approach does not add any additional information to the ex post approach. Instead, it is its inherent subjectivity which makes the results of this approach different from the results of the ex post approach. While in particular periods raw returns may be classified as 'unrepeatable', the ad-hoc subjectivity of the approach would be all too evident. The decomposition method applies adjustments to components of the returns and so in this case the subjectivity is less obvious.

Considering the subjective nature of the adjustments made to derive the adjusted ex post TMR, we find that regulators should not place weight on this approach compared to the ex post approach.

4.3 Forward-looking measures

Although the UKRN guidance is for regulators to rely on the historical ex post and ex ante approaches to derive the TMR, the paper notes that the CMA recognised the value of forward-looking approaches in providing some insight into market expectations in the near term. Note that the CMA has expressed its reservations against forward-looking methods such as survey evidence.[44] The UKRN paper mentions three sources of evidence of the expected market return: dividend discount models (DDM), professional forecasts, and surveys of market practitioners.

The UKRN paper recognises the degree of judgement required to perform a DDM estimation saying that 'these estimates are heavily influenced by the choice of input assumptions'.[45]

We agree with the UKRN that DDMs are sensitive to the set of assumptions underpinning the model, in particular the long-term growth rate. We note, moreover, that the same set of assumptions that is required to estimate the DDM is also required to make adjustments to ex post returns when applying the 'ex ante' method. Therefore, it would have been internally consistent for the UKRN to also recognise the sensitivity of the 'choice of input assumptions' in de-emphasising the usefulness of the 'ex ante' method relative to the ex post TMR approach.

In relation to surveys, we note that they should be interpreted with caution because there is a tendency for respondents to extrapolate from recent realised returns, making the estimates less forward-looking and prone to be anchored on recent short-term market performance. In addition, the results are based purely on judgement, which may also be influenced by the respondent's own position or biases, reducing their reliability.

Similarly, many market practitioners' forecasts are based purely on their judgement and are produced with the primary purpose of providing cautious estimates of future returns to their clients. This conservatism is mainly a function of the regulatory framework—the FCA Conduct of Business Sourcebook—which stipulates the maximum rates of return that financial services companies must use in their calculations when providing retail customers with projections of future benefits.

Based on these collective issues, we consider it appropriate to place less weight on DDM, surveys and investment manager estimates when determining a TMR range and cross-checking the CoE.

[44] CMA (2022), 'Anglian Water Services Limited, Bristol Water plc, Northumbrian Water Limited and Yorkshire Water Services Limited price determinations. Final report', 17 March, para. 9.377-9.378.
[45] UK Regulators Network (2022), 'UKRN guidance for regulators on the methodology for setting the cost of capital — consultation', p. 17

4.4 TMR conclusions

In conclusion, the UKRN paper provides a useful starting point to estimate the TMR. However, the paper would benefit from more detailed consideration of important aspects of certain approaches.

We have explained that when estimating the (real) allowed TMR using the ex post approach, a reliable inflation measure should be used to deflate historical returns. The new CPIH backcast should be used instead of the old CPI backcast when estimating the TMR in CPIH-real terms. There is also merit in considering RPI-deflated estimates given that the RPI series was compiled and published contemporaneously. Moreover, the arithmetic average should be used to estimate the expected TMR, using a series of historical annual returns.

Based on the sensitivity of input assumptions and degree of subjectivity that may be involved in deriving the 'ex ante' and forward-looking TMR, we consider that less weight should be placed on those approaches.

5 Cross-checks to the CAPM

Regulators and economists in the UK have used multiple alternative approaches to cross-check the results of the CAPM.[46]

The UKRN paper reflects this and recommends that regulators sense-check the point estimate of the CAPM using alternative methodologies. Specifically, the UKRN paper suggests using market benchmarks as a cross-check. However, the paper notes that there should be a high evidence bar to deviate from the mid-point of the CAPM CoE.

In this section, we discuss two market-based methodologies that were used in the past to estimate the CoE. First, we explain why MARs cannot be relied upon as a robust cross-check for the CoE level. Second, we explain how a measure of the asset risk premium relative to the debt risk premium (ARP–DRP) is derived and why it offers a reliable measure of whether the allowed CoE is appropriately calibrated, as it is derived from market data on observed debt yields rather than built up from a theoretical asset pricing model. Finally, in section 6, we comment on the choice of a point estimate within the CAPM CoE range, a topic that covers cross-checks, total welfare, risk asymmetry, and the price control package.

5.1 Market-to-asset ratios

A MAR is a ratio of the market value of a utility network to its regulatory asset base (RAB). In its report the UKRN suggests that a MAR above 1x 'indicates the market is willing to pay a premium over the regulated asset value of the business'.[47] The UKRN report further suggests that 'the MAR premia could be indicative of expected outperformance against future price controls (including potential outperformance on the cost of capital)'.[48] Based on that consideration, some regulators use MARs as a cross-check to their CoE allowances, assuming that the CoE allowance is above the investors' required return on equity when they observe a MAR above 1x and cannot explain it with a reasonable level of expected operational outperformance.

However, many factors affect market valuations and can explain an observed level of MARs above 1x without assuming industry-wide expected outperformance (on the allowed return or other elements of the price control). Therefore, many adjustments are required before inferences can be made from the MARs evidence, and even after those adjustments, the evidence may not be sufficiently robust because many factors are qualitative and cannot be reliably adjusted for.

We discussed these factors in the related reports prepared for the CMA PR19 and RIIO-2 appeals and summarise them below.[49] We note

[46] [reference to Ofgem and other regulators to be added].
[47] PR24 consultation, p. 24.
[48] Ibid.
[49] See, for example, Oxera (2020), 'What explains the equity market valuations of listed water companies?', 20 May, https://www.northerngasnetworks.co.uk/wp-content/uploads/2020/09/Oxera-2020-%E2%80%98What-explains-the-equity-market-

that some factors are specific to transaction MARs. However, most of them apply to both transaction and traded MARs.

Error! Reference source not found. lists some of the factors that e xplain an observed level of MARs being above 1x.

Box 5.1 List of factors explaining an observed level of MARs to be above 1x

- company-specific outperformance on financing, tax and TOTEX, as well as rewards related to the quality of the provided services;
- expected RAB growth, which may be used by investors to extrapolate the impact of ambitions for company-specific outperformance to a larger future RAB;
- revenue and/or RAB adjustments as reconciliations from the preceding price control;
- the value of non-regulated business activities, which is additional to the value generated by the RAB;
- adjustments required due to the network transaction being a part of a wider exchange of assets;[1]
- accrued dividends, which are likely to be embedded into the market capitalisation of a company and need to be adjusted for;
- a RAB exit multiple as the terminal value, particularly when combined with expected RAB growth as noted above;
- the winner's curse (applicable to transaction MARs)—the winning bid on a transaction is the one with the highest valuation, which often happens to be above the intrinsic asset value;[2]
- a control premium—in a competitive process, investors are willing to pay a premium for a majority stake in a business;
- synergies that certain investors may expect to achieve in combination with other businesses in their portfolio;
- environmental, social and governance (ESG) factors and market sentiment.

Note: [1] For example, we observed that National Grid's acquisition of WPD from PPL Corporation was a part of a wider transaction that included the sale of Narragansett Electric Company (NECO) to PPL Corporation. Netting off the cash premium received for the sale of NECO significantly reduces the MAR estimate on the WPD acquisition. [2] See, for example, Andrade G., Mitchell M., and Stafford E. (2001), 'New Evidence and Perspectives on Mergers', *Journal of Economic Perspectives*, spring, **15**:2.
Source: Oxera.

Additionally, in summer 2022, we developed evidence in response to Ofgem's RIIO-ED2 Draft Determinations based on the UK water and energy networks. The evidence showed that there is no relationship between MARs and proxy measures for how challenging or lenient the regulatory CoE allowance is—the relationship typically assumed by regulators and relied upon when interpreting MARs. Instead, we observe that investors' expectations are sticky, i.e. that MARs

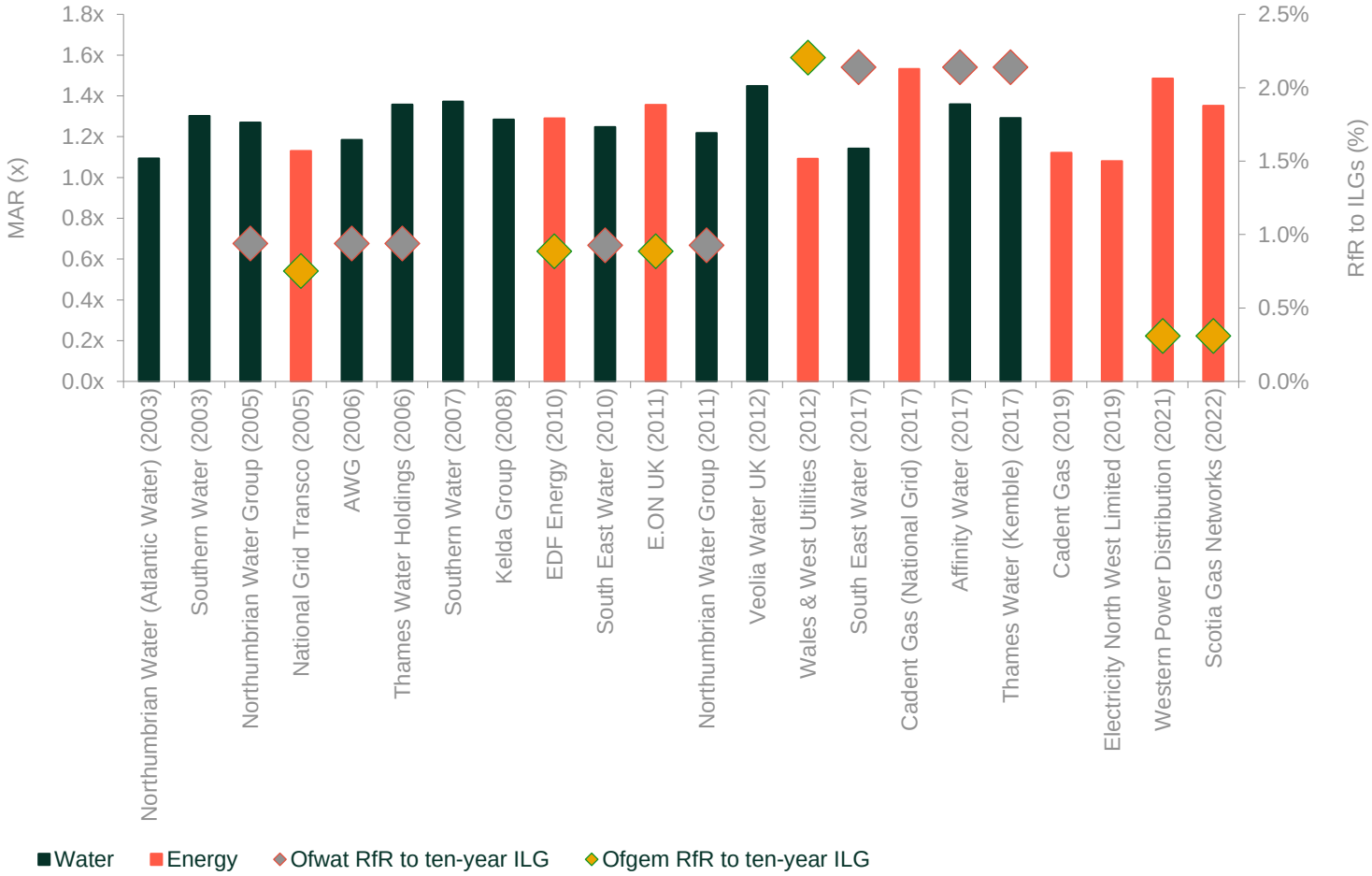
valuations-of-listed-water-companies%E2%80%99-20-May-1.pdf (accessed 14 October 2022).

fluctuate within and around the same range over an extended period of time.

As long as investors believe that MARs will stay approximately at the same level as when they invested, they could assume a terminal value aligned with the MAR at the time of the investment. MARs above 1x can therefore become self-perpetuating. An expected terminal value of above 1x can explain a significant proportion of the premium paid above RAB at the time of investment.

Figure 5.1 below shows that water and energy network transaction MARs have been fluctuating in a range of 1.1–1.5x at least since 2003. The figure also compares MARs with the 'headroom' between the allowed RFR and ILGs, as a proxy for whether the CoE allowance is set at a challenging level, and demonstrates no correlation between the two measures.[50]

Figure 5.1 Transaction MARs and the difference between ILGs and the allowed risk-free rate set within two years before the transaction



Note: Transaction MARs are estimated as ratios of enterprise values derived from transactions and networks' latest available actual RAB at the time of the transaction. This resulted in MAR estimates that were conservatively higher than estimates based on forecast RAB (at the end of the relevant year). The figure reflects only those determinations that were published within a two-year window before the transaction. Since the RFR allowance had not been set by Ofwat or Ofgem for all transactions within the last two years, we do not show the RFR headroom for all of them. The headroom between the allowed RFR and ten-year ILGs is estimated based on one-year averages of

[50] We have performed this analysis for both traded and transaction MARs and for two measures of how challenging or lenient the regulatory cost of equity allowance is: the headroom between the allowed RFR and ILGs and between the allowed CoE and ILGs.

ten-year ILGs. Three relevant CMA determinations are included under Ofwat—these are the Bristol Water price determination in 2010 (as Competition Commission), the Bristol Water price determination in 2015, and the PR19 appeal price determinations in 2021.
Source: Oxera analysis, based on data from Dealogic, Ofwat and Ofgem.

These results support our hypothesis that, instead of reacting instantly to regulatory determinations, investors anchor their willingness to (over-)pay on previous transaction prices, resulting in consistently high acquisition prices relative to RAB values.

The 'stickiness' of investors' expectations and other factors described above demonstrate that no strong inferences can be made based on the MARs evidence. This is the case even after some adjustments are made, as many of the factors driving valuations may not be quantifiable in a robust manner.

5.2 ARP–DRP

In March 2019, as part of the Energy Network Association's response to Ofgem's RIIO-2 Sector Specific Methodology, Oxera submitted evidence to Ofgem on how calculations of the CoE of regulated companies compared with their risk in the debt markets (the first 'Oxera ARP–DRP report').[51] We explained that the differential between the ARP and DRP can be used as a cross-check to the estimation of the allowed CoE.

In the next subsections, we explain the ARP–DRP framework and how it can be used to derive the CoE of regulated utilities.

5.2.1 Underpinnings of the framework

The ARP–DRP framework is founded upon the fundamental principle of risk aversion in finance, where holders of capital assets with higher risk demand a higher return. As debt-holders have priority claims ahead of equity investors over a company's assets, equity investors are thus subject to greater risks and demand a higher return. Where this principle is breached by CoE estimates being too low relative to the market pricing of debt, it suggests an error in the application of the CoE estimation.

In practice, this means that we estimate the differential between the asset and debt risk premiums as allowed by proposed regulatory determinations and observed from utilities bonds' traded yields.[52] We then compare this proposed differential against those implied by regulatory precedents and contemporary market evidence, to inform our view of the proposed regulatory determinations.

The ARP reflects the excess return required by investors in return for providing capital to risky assets compared with the risk-free rate, while the DRP reflects the excess return required by investors in return

[51] Oxera (2019), 'Risk premium on assets relative to debt', 25 March.
[52] In the first Oxera ARP–DRP report, this was formed of bonds issued by a utilities comparator set. This analysis was later updated with a refined comparator set, while robustness was improved by using contemporaneous daily traded yields, in line with Ofgem's comments in the Sector Specific Methodology Decision. See Oxera (2020), 'Asset risk premium relative to debt risk premium', 4 September.

for acquiring risky debt. As an asset (debt) becomes more risky, the ARP (DRP) also increases. With this understanding, we are able to determine several characteristics of the ARP–DRP differential. The first is that the differential will depend on gearing as implied under the MM Proposition 1,[53] i.e. as gearing and the cost of debt increases, the differential between the ARP and DRP narrows.

The second characteristic relates to how the ARP–DRP relationship changes according to a company's exposure to systematic risk. Given that debt is less risky than assets, in absolute terms any changes in the premium for exposure to systematic risk will be greater for assets rather than for debt. It follows then that the change in the ARP would be higher than the change in the DRP. As a result, a higher asset beta is consistent with a higher ARP–DRP differential.

5.2.2 Development and use case of the ARP–DRP framework

There are several advantages inherent within the ARP—DRP framework, which are altogether beneficial to improving the robustness of cost of capital estimates. The first is that the ARP—DRP framework relies on contemporaneous market data with regard to the market price of debt risk. Therefore, the framework provides a real-world market-based cross-check against the cost of capital estimated using theoretical asset pricing models.

Secondly, the ARP—DRP framework can be employed to correct bias in estimates of the WACC as its specification mitigates the attenuation bias apparent in the CAPM beta arising from measurement errors in the independent variable (i.e. market returns). By constructing the ARP–DRP delta, any measurement errors embedded within each of the asset and debt beta estimates will tend to offset, thus providing a more reliable estimate of the difference between the asset and debt risk premiums.

Thirdly, the ARP—DRP framework provides a method for the evaluation of financeability in a way that is neutral to the treatment of inflation. In other words, the differential derived from nominal parameter values will be the same as that derived from RPI-real or CPIH-real parameter values. This negates any confounding influence of the switch from RPI to CPIH indexation.

Following the first Oxera report, our evidence and methodology was updated in a later submission to Ofgem in September 2020 (the second Oxera ARP–DRP report),[54] where we set out further support for the ARP–DRP framework to be given greater weight and consideration in assessing the allowed CoE.

In reviewing Ofgem's assessment process for the setting of the allowed return on equity for RIIO-2, the CMA reiterated the role of cross-checks in ensuring that the CAPM-based allowance is

[53] This is because the asset beta, and therefore ARP, is constant irrespective of gearing given the MM propositions, and the cost of debt and the DRP increases with gearing as default risk increases. See Oxera (2019), 'Risk premium on assets relative to debt', 25 March.
[54] Oxera (2020), 'Asset risk premium relative to debt risk premium', 4 September.

appropriate 'in the round'. With specific reference to Oxera's ARP–DRP framework as an alternative cross-check, the CMA noted that 'the theoretical principles behind ARP–DRP may be valid',[55] and that it 'provides one useful perspective and is a check that may have suggested a higher CoE was justifiable'.[56]

[55] Competition and Markets Authority (2021), 'Cadent Gas Limited, National Grid Electricity Transmission plc, National Grid Gas plc, Northern Gas Networks Limited, Scottish Hydro Electric Transmission plc, Southern Gas Networks plc and Scotland Gas Networks plc, SP Transmission plc, Wales & West Utilities Limited vs the Gas and Electricity Markets Authority. Final determination Volume 2A: Joined Grounds: Cost of equity', 28 October, para. 5.717.
[56] Ibid., para. 5.692 (a).

6 Choice of a point estimate

Given that the parameters of the CAPM are uncertain, the application of the CAPM often results in a range of CoE estimates. Although a mid-point within the range is a natural starting point, in the context of regulatory price controls there are factors that can lead to the selection of a point estimate within the WACC range that is higher than the mid-point (also referred to as 'aiming up').

In the UKRN report, the following factors are considered:

- cross-checks from market evidence;
- the welfare impact from underinvestment;
- asymmetry in the package of incentives;
- asymmetry in the choice of parameters;
- financeability.

The report concludes that there are 'more targeted means of achieving the relevant objectives' than aiming up on the CoE, that cross-checks from market evidence are 'potentially useful', although need to be interpreted with caution, and that as a result 'regulators should only deviate from the mid-point of the CAPM CoE range if there are strong reasons to do so'.[57]

We discuss cross-checks from market evidence in section 5 above, and other factors supporting aiming up below.

6.1 Welfare impacts from underinvestment

Selecting the point estimate within the CoE range requires striking a balance between higher consumer prices in the short term and reducing the risk of underinvesting in assets that deliver the consumer benefits of network resilience and enhancement. For example, for energy networks, such underinvestment can result in supply problems (e.g. delayed connections or an increase in outages) and threaten the delivery of the energy transition—corresponding to significantly higher social costs and consumer bills in the future. A regulatory allowed CoE at the middle of the range of estimates risks being below the true CoE and hence risks undercompensating investors for the level of risk that they assume.

We have reviewed new academic research, by Romeijnders and Mulder (2022), who studied the relationship between WACC uplifts and consumer welfare under a theoretical model for energy networks.[58] They found that, under their model, the optimal solution was typically to target a percentile above the 50th of the WACC range. Box 6.1 provides the details of their approach.

[57] PR24 consultation, pp. 24–26.
[58] Romeijnders, W. and Mulder M. (2022), 'Optimal WACC in tariff regulation under uncertainty', *Journal of Regulatory Economics*, **61**, pp. 89–107.

Box 6.1 Academic research by Romeijnders and Mulder (2022) on the relationship between the allowed WACC uplifts and consumer welfare

To assess the welfare impact of potentially underestimating the regulatory WACC relative to investors' required returns, the authors use WACC standard deviation as a measure of uncertainty of whether the regulatory WACC allowance is set above or below the 'true' WACC. To assess the relationship between WACC uplifts and consumer welfare, the authors use a theoretical model where they assume that the grid operator replaces a certain percentage of the infrastructure in each year if the regulated WACC is set above the true WACC, and performs no investment if the regulated WACC is set below the true WACC. Subsequently, the model estimates the expected quantity of lost load in a given year, based on the age of the infrastructure (which is a function of the operator's investment decisions).

The authors find that the relationship between the WACC mark-up and the standard deviation of the WACC, i.e. the uncertainty behind the WACC parameters, exhibits an inverted u-shape relationship, whereby the recommended uplift on the WACC increases with the standard deviation when the standard deviation is low, and decreases with the WACC when the standard deviation is high.

The authors conclude that, under their model, the optimal solution is to typically target a percentile above the 50th percentile of the WACC range.

Source: Romeijnders, W. and Mulder M. (2022), 'Optimal WACC in tariff regulation under uncertainty', *Journal of Regulatory Economics*, **61**, pp. 89–107.

The UKRN report notes that alternative mechanisms of incentivising investment reduce or remove the need to explicitly uplift the allowed rate of return, and that aiming up for welfare reasons can be relevant only if there is uncertainty around cost recovery or no other investment incentives are present. We do not consider that these mechanisms, which the UKRN put forward remove the need for aiming up and discuss them in turn, below.

6.1.1 Statutory requirements

The UKRN notes that a significant proportion of investment is driven by statutory requirements, that the corresponding costs are allowed for recovery and that failure to fulfil statutory obligations can lead to withdrawal of the licence.

The UKRN acknowledges that the costs corresponding to these investments need to be recovered. If the costs are not covered sufficiently, the company is still able to invest but may incur losses in that regulatory period. In the same way, the allowed return needs to remunerate investors for their capital provided to undertake this investment. If the allowed return is below the true required return, this

position becomes unsustainable. Letting utilities reach that limit would not align with consumers' interests.

In addition, companies have discretion in relation to their investments, as long as they meet their statutory requirements—which is the main reason for output-based regulation. The companies' willingness to identify, develop, and undertake those discretionary investments is affected by the level of the allowed return, which we also discuss in the following subsection.

6.1.2 Service delivery incentives

Service delivery incentives may incentivise companies to undertake the discretionary investments discussed above but such incentives cannot be relied on to offset the risk of setting the allowed return too low.

The incentives may not be sufficient to incentivise companies to invest if the allowed return is below the required level. It depends on the calibration of the level of penalties and rewards—if the company loses from investing because it receives less than the required rate of return, then unless the expected incentive rewards are large enough to offset this the company will not go ahead with the investment.

6.1.3 Separate treatment of 'large one-off' projects

The UKRN further notes that it may be possible to treat some large investments separately from the rest of the price control, in which case the allowed rate of return determined by the regulator does not affect those investments.

If treated separately, large projects are indeed unaffected by the price control allowed rate of return, but not all investments qualify for separate treatment.

For example, in its PR19 guidance, Ofwat sets out the following factors that companies should consider when identifying discrete projects for the direct procurement for customers, i.e. for treatment outside of the price control:

- Limited economies of scale and scope with the rest of the appointees' network system (or where such economies could be maintained through contracts).
- Simple or limited, well understood and manageable physical and operational interactions with the appointees' network.
- Assets with capacity that is shared by multiple appointed companies.
- Assets that are more 'passive' and are not actively managed as part of the overall system.[59]

It may not be sensible to treat an investment separately if it is not large enough to justify separation (and the costs of running a competition for the project overweigh the benefits), if it is too integrated into an existing network (and integration costs between the incumbent's network and the separate project would mitigate the

[59] Ofwat (2017), 'Delivering Water 2020: Our methodology for the 2019 price review, Appendix 9: Direct procurement for customers', 13 December, p. 3.

benefits) or if there are significant benefits of delivering the project fast.

Overall, despite the option of treating some projects separately, there will be a significant amount of investment to which the price control allowed rate of return applies. Moreover, the bespoke risk profiles and regulatory and contractual arrangements for separated investments will be an obstacle for using their implied rates of return as benchmarks for the regulated rate of return on the RAB.

6.1.4 Pricing freedom for new investments when competing infrastructure and/or regulation legacy service constrains market power

The UKRN puts forward that sometimes regulators provide pricing freedom to new infrastructure (when market power is subject to commercial rather than regulatory constraints), and that in those cases, the company's actual returns may be higher or lower than the cost of capital and they offset each other over time.

We agree that in such circumstances companies will need to target returns that are higher than the cost of capital to offset the risk that returns may be below the cost of capital. This is required to give a probability-adjusted expected return that is at least as high as the cost of capital, and to provide sufficient incentive to invest.

6.2 Asymmetry in the package of incentives

The UKRN report considers asymmetry in the package of regulatory incentives as a potential reason for adjusting the point estimate of the allowed CoE. Given that in the case of a downward skew in the package of incentives (and where no adjustment is made to the allowed CoE), an efficiently-run company could expect to be penalised and hence earn less than the required return on equity, an upwards adjustment to the allowed CoE is one way to restore the balance.

In this context, the UKRN notes that the asymmetry should be considered in the overall package (rather than individual incentives) and that the distribution of expected performance should be accounted for.

We agree with both points in principle. While, in practice, it is challenging (or not possible) to know the exact distribution of the expected performance, it is usually possible to assess whether incentive thresholds (to receive a penalty or a reward) are challenging for the efficiently-run company or not. Regulators tend to re-set thresholds based on recent performance and future efficiency challenges, to keep incentivising companies to improve their quality of service. This creates a ratchet effect whereby even continual improvement in service performance may lead to penalties.

Note that the required uplift to the allowed CoE is not limited to the upper bound of the CAPM-based CoE range—instead, the uplift should be as high as required to restore the balance of the regulatory package.

Finally, the UKRN points out that any asymmetry in the package of incentives should where possible be addressed 'at source' by recalibrating that package—this is a sound principle and we agree with it.

6.3 Asymmetry in the choice of parameters

As discussed throughout this report, the estimation of each CAPM parameter is associated with uncertainties. Note that some regulators have mitigated the risk of a sub-category of estimation errors (i.e. forecast errors) by indexing some of the CAPM parameters—e.g. the benchmark yield of the RFR is indexed in the RIIO-2 control. However, if the regulator sets ranges for every parameter towards the lower end of what would be supported by a balanced review of the evidence, the overall CoE range would also end up being downward-biased and would require an upwards adjustment to the allowed CoE. In practice, there are two ways in which this asymmetry can arise.

First, we demonstrate in this report that several of the methodological proposals outlined by the UKRN would result in a downward-skewed CoE estimate (e.g. absence of a convenience premium in the RFR estimation, adoption of 'historical ex ante' approaches to the TMR). If this skew is not addressed at source (i.e. if parameters are set following those methodologies), then an overall upwards adjustment would be required to the CAPM-based CoE range.

Second, even if individual parameters are not set at a 'wrong' level, they could be set at the lower bound of an acceptable level, and the overall package would still tend to be skewed to the downside. In particular, in many sectors the appeals legal framework requires the CMA to identify the areas of the price control that are clearly 'wrong'. Here there is potential for a wide margin of discretion to be permitted to the regulator when determining each element of the price control. The nature of the appeals regime in those sectors therefore increases the potential for misalignment across the balance of risk and reward.

Similar to the potentially required CoE uplift in the case of the asymmetry in the package of incentives, the uplift required to compensate for the asymmetry in the choice of parameters cannot be limited by the upper bound of the CAPM-based CoE range, because the range itself may be biased. To avoid such downward bias, regulators should first adjust the CAPM parameters and then consider whether to aim up in (or above) the CAPM implied range. Note that, as discussed in section 3, even with the correct specifications of the RFR and TMR, the CAPM model would tend to underpredict the returns on stocks with beta below one.

6.4 Financeability

A CoE uplift would also support networks' financeability, i.e. ability to finance their operations with debt and equity capital. The UKRN paper suggests that there is no direct link between assumptions behind financial ratios that are used to assess financeability and the CAPM parameters. However, there is a clear link between the level of those ratios and the overall level of the CoE allowance—the higher the allowance, the stronger the ratios.

While regulators typically consider other financeability remedies to support financeability ratios, they often appear to be ineffective for improving financeability. As an example, in Box 6.2, we discuss Ofgem's proposed remedies.

Box 6.2 Are non-CoE-related financeability remedies effective?

In its latest price control review for RIIO-ED2, Ofgem outlined the following possible remedies:[1]

- reducing the dividend assumption, if appropriate;
- adjusting capitalisation and/or depreciation rates; and/or
- adjusting notional gearing (which implies notional equity injection).

Each of these remedies has its limitations.

- While dividends can be reduced for a limited time period, this measure is not sustainable in the long term, as it would reduce equity investors' willingness to invest. It is also recognised as being relatively ineffective by credit rating agencies. For example, Moody's notes the following:[2]

In some cases, however, this [cutting dividends] may not be enough to maintain credit quality. Dividend reductions alone may not suffice, particularly where companies are unable to improve against ever more stringent regulatory cost and performance targets.

- Adjusting capitalisation and/or depreciation rates (which would be referred to as run-off and pay-as-you-go rates under Ofwat's regulatory regime) increases revenue in the short term, but slows down RAB growth, reducing revenue in the long term. Due to this movement of cash flows over time, the measures face challenges. First, they are not recognised by two out of three major credit rating agencies (Moody's and Fitch make adjustments for those regulatory measures and as a result, they do not improve credit ratios). Second, they will tend to introduce intergenerational unfairness.
- Adjusting notional gearing to a lower level requires equity injection, which is not always possible and, even when it is, it might be limited to a certain amount. Furthermore, the equity injection is possible only if the CoE allowance is set at the appropriate level.

Source: Oxera. [1] Ofgem (2022), 'Consultation - RIIO-ED2 Draft Determinations – Finance Annex', para. 5.26. [2] Moody's (2020), 'Lower returns hit key ratios, but regulatory consistency still supports credit quality', 8 September, pp. 1 and 6. See p. 6 for indication that Moody's refers to GB networks.

Therefore, given the limitations of the alternative financeability remedies, and given that the CoE estimation is associated with a significant degree of uncertainty, choosing a point estimate above the mid-point of the CAPM-based range may be a more effective way of supporting financeability.

Indeed, in the PR19 redeterminations, the CMA concluded that a higher CoE allowance could be used to address financeability risks:

> We have also concluded that a decision to set a point estimate above the middle of the range will address the risks to financeability which would increase from setting the cost of equity at lower levels within the range.[60]

6.5 Point estimate conclusions

In sum, the considerations on the welfare impact from underinvestment, the asymmetry in the package of incentives, the asymmetry in the choice of parameters, and financeability support the choice of a point estimate above the mid-point of the CoE range. We consider that the UKRN report has understated the importance of these factors that may merit an uplift to the CoE in certain circumstances.

In relation to welfare impact, we note that companies have discretion in relation to their investments, notwithstanding statutory requirements—which is the main reason for output-based regulation. The companies' willingness to identify, develop and undertake those discretionary investments is affected by the level of the allowed return. We show that mechanisms such as service delivery incentives or the separate treatment of large one-off projects are not sufficient to mitigate the risk that the allowed return may be below the minimum rate of return demanded by investors.

In relation to the asymmetries in the package of incentives, we agree with the UKRN that these asymmetries should, where possible, be addressed 'at source' by recalibrating the package itself. If it is not possible to address the asymmetry at the source, the uplift in the CoE should be as high as required to restore the balance of the regulatory package.

Finally, in relation to the asymmetry in the parameter estimate and financeability, we note that regulators should first address the estimation issue at the parameter level—e.g. by considering a convenience premium on top of the yield on government bonds. Regulators should then perform financeability tests and consider whether the CAPM-implied CoE range is suitable. Given the limitations of the alternative financeability remedies, choosing a CoE above the mid-point of the correctly estimated CAPM CoE may be a more effective way of supporting financeability.

[60] CMA (2022), 'Anglian Water Services Limited, Bristol Water plc, Northumbrian Water Limited and Yorkshire Water Services Limited price determinations. Final report', 17 March, para. 9.1402.

7 Final remarks

The UKRN paper touches on other aspects of the regulatory package beyond the estimation of the CoE. It notes, for instance, the stability and predictability of the regulatory framework and the constant evolution of financial markets and states that the guidance should be revised to reflect those developments.

> [...] we recognise that material developments in market conditions, finance theory and the statutory frameworks regulators operate under could constitute a case for revising regulatory practice. There are also areas of this guidance where further work may be required to refine some of the recommendations. For these reasons, we propose that the recommendations on a common methodology are subject to a periodic review by the regulators.[61]

We agree with the UKRN that the guidance should evolve with changes in the macroeconomic and regulatory environment, as well as in response to developments in finance theory. The guidance should also reflect the investment needs of infrastructure operators to reach net zero and to provide the necessary levels of service quality that are required by consumers over time.

[61] UK Regulators Network (2022), 'UKRN guidance for regulators on the methodology for setting the cost of capital — consultation',

Contact

Peter Hope, CFA
peter.hope@oxera.com

Sahar Shamsi, CFA
sahar.shamsi@oxera.com