KPMG

Inference analysis as a cross-check on allowed returns at ET3

PREPARED FOR NATIONAL GRID

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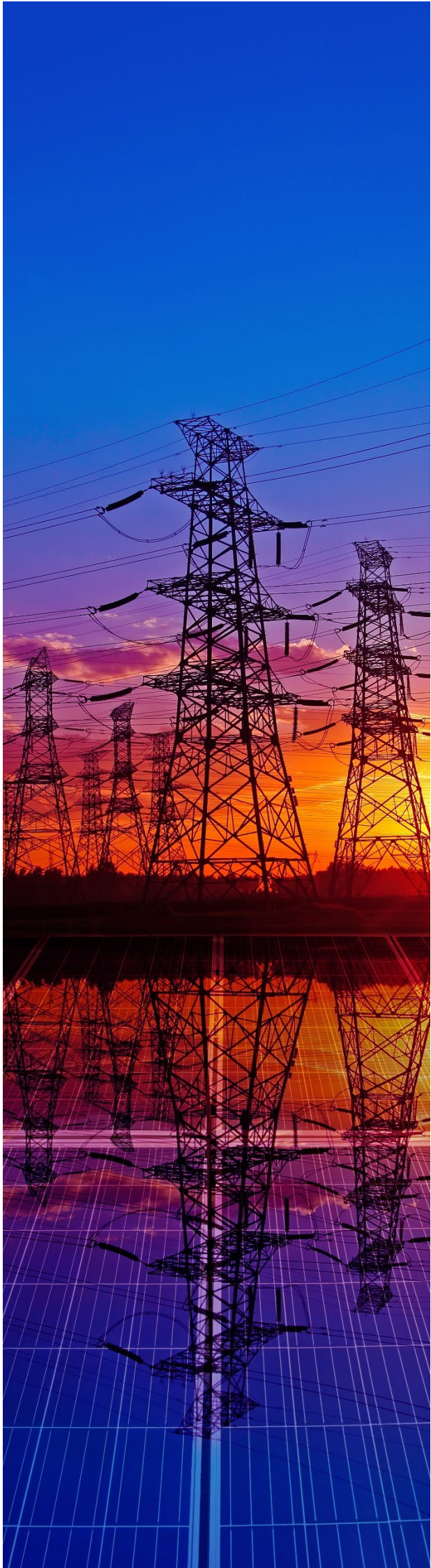
Contents



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NGET commissioned this work to aid in its considerations regarding the Office of Gas and Electricity Markets' (Ofgem) proposals relating to cost of equity cross-checks in the Sector Specific Methodology Consultation (SSMC) for the ET3 price control published on 13 December 2023. The agreed scope of work is included in section 3.2 of this Report. NGET should note that our findings do not constitute recommendations as to whether or not NGET should proceed with any particular course of action.

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2 Executive summary

On 13 December 2023 Ofgem published the Sector Specific Methodology Consultation (SSMC) for the next price control in the electricity transmission sector (ET3) which will start in April 2026. In the SSMC Ofgem outlined its proposed approach to cross-checking the cost of equity (CoE) implied by its estimate based on the Capital Asset Pricing Model (CAPM).

The regulatory allowance for CoE will be particularly significant for ET3 and beyond in the context of the unprecedented step change in the scale of required capital investment, a significant shift in the macroeconomic landscape marked by rising interest rates, high inflation, and heightened volatility.

Setting an appropriate, evidence-based, allowance for CoE is essential to retain and attract equity capital in the sector. An appropriate allowance for the CoE is one that reflects the return that investors can earn on investments of comparable risk (i.e. reflects the opportunity cost of capital) and remunerates investors for probability-weighted losses (or gains). Only where the CoE meets this criterion can the investment be deemed investable, i.e. be able to attract sufficient equity (and debt) capital on reasonable terms, consistent with what is priced into the allowance.

The potential consumer detriment from under-estimation of CoE would be particularly acute at ET3 given that it will be necessary for the notional firm to attract significant new equity capital to fund the substantial new investment required for ET3 and beyond[1]. The SSMC acknowledges these challenges and that new or adjusted methodologies may be required to capture the step change in interest rates and investment[2].

This Report develops a methodology which uses observed debt pricing and the relationship between the costs of equity and debt to infer the CoE which can be applied as a sense-check to a CAPM-derived estimate.

This cross-check (1) reflects the principle that due to its higher risk profile, equity requires a substantially higher expected return compared to debt to attract investor interest and (2) estimates the required level of differential for ET3, based on an empirical approach grounded in Merton's (1974) framework[3] and its practical applications.

Debt and equity are both claims on the same underlying asset and their values are intrinsically related to the value of the asset[4]. All else equal, the expected returns on equity and debt exhibit a positive correlation, as both are sensitive to the underlying factors that affect the firm's asset value.

Equity inherently faces higher risks in relation to loss of capital and return compared to debt. This is due to, *inter alia*, the subordinated nature of equity claims in case of insolvency[5], more limited control rights in the event of financial difficulty or distress and differences between contractually obligated debt interest payments and more discretionary equity dividends.

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1 The SSMC estimates that tens of billions of pounds of new investment could be required during ET3. Ofgem (2023), RIIO-3 Sector Specific Methodology Consultation – ET Annex, para 1.10

2 See for example, Ofgem (2023), RIIO-3 Sector Specific Methodology Consultation – Finance Annex, para 1.4 and Ofgem (2023), RIIO-3 Sector Specific Methodology Consultation – Finance Annex, para 3.6

3 In Merton's (1974) framework – which was developed as part of his work on option and derivative pricing – debt and equity are considered contingent claims over a firm's assets and the values of debt and equity are intrinsically related to the value of the firm's assets.

4 When the firm's asset value rises, equity holders benefit from larger residual claims, and debt value benefits from the reduction in the firm's leverage and the lower likelihood of default. Conversely, a decline in asset value diminishes the residual claims of equity holders and heightens the risk of default.

5 In the event of an insolvency, debt holders have the priority claim over the firm's assets for debt repayment, while equity holders could receive the remaining assets only once all outstanding debt capital has been repaid and if the remaining value of the firm is non-negative.

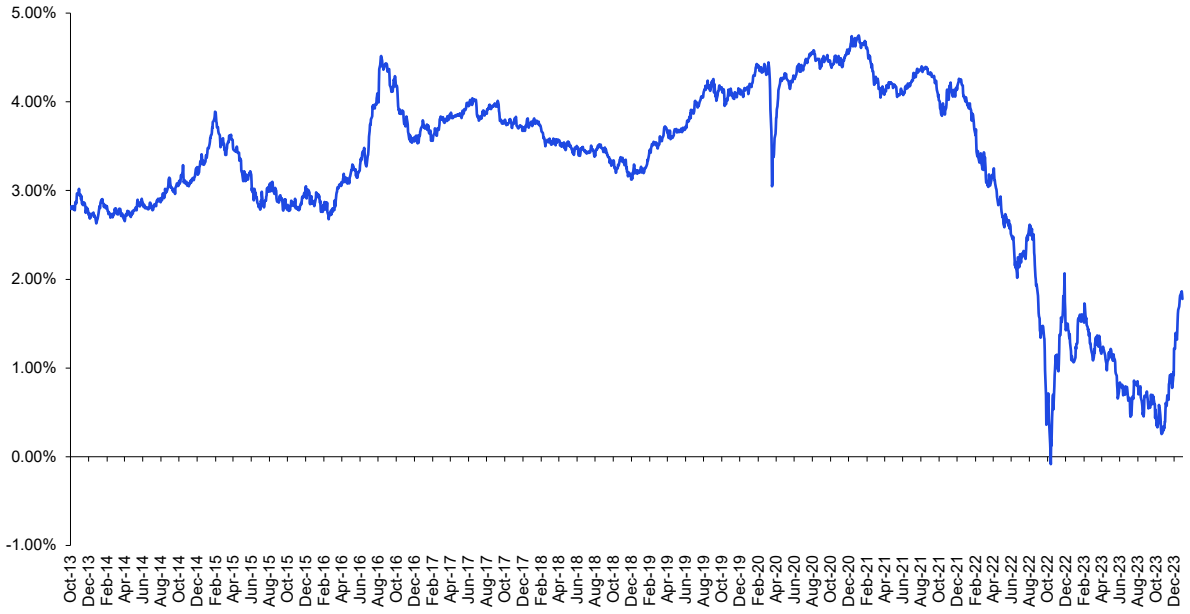
The expectation of a sufficient positive differential between expected returns for debt and equity has also been recognised by UKRN[6] and the CMA[7]. While these differentials may vary to some degree over time – as they can be affected by factors such as changes in risk exposure and leverage – a significant decrease in these differentials relative to recent historical periods could indicate mispricing of equity risk, warranting further investigation.

The CAPM-derived CoE reflected in this Report is based on an extrapolation of the ET2 methodology[8] across the full period (2013 – 2023) considered in the analysis, notwithstanding that Ofgem has signalled that it will consider how its methodology may need to evolve at ET3 to support investability.

The analysis of the differential between CoE and current CoD based on yields on the iBoxx Utilities 10+ index as a proxy for current borrowing costs indicates that the gap between the pricing of the capital sources has narrowed significantly. Yields on the iBoxx Utilities 10+ index are used for consistency with Ofgem's approach for pricing new debt issuance as part of setting the CoD allowance.

The differential between CoE and current CoD was relatively stable between 2013 and 2021. It reduced materially at the beginning of 2022 and has since remained at historically low levels, despite increasing somewhat during November – December 2023. The initial reduction from 2022 onwards was likely driven by a combination of step changes in interest rates and limited responsiveness of the regulatory CoE to these changes.

Figure 1 Evolution of the differential between allowed CoE (ET2 methodology) and yields on the benchmark index



Source: KPMG analysis of the ET methodology and Refinitiv Datastream data.
Note: (1) Compares nominal yield on the iBoxx index (default adjusted) to allowed CoE converted to nominal using long-term inflation assumptions from the WACC allowance model published as part of the 2023 Annual Iteration Process.
(2) For consistency allowed CoE estimates at the 55% notional gearing level have been converted from the 60% notional gearing level using the same approach as followed in the ET2 FD. The FD imputes CoE at the 55% notional gearing level based on the WACC estimate at the 60% notional gearing level and the allowed cost of debt, assuming that the WACC would not vary with gearing. This is illustrated in the WACC allowance model published alongside the ET2 FD.

In principle, significant reductions in the differential between the CoE and current CoD may be appropriate in case of a material reduction in risk borne by equity that is not accompanied by an

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6 In its cost of capital guidance, UKRN has recognised "*the principle that equity bears more risk than debt and so should normally receive a higher return*".

7 At PR19 the CMA recognised that "*for a regulated business with capped returns, the cost of equity used in the WACC should still be assumed to remain sufficiently above the current cost of debt to promote equity investment in the sector*".

8 It is assumed that ET2 estimates of asset beta (0.349), notional gearing (55%) and TMR (6.50% CPIH-real) remain constant; the risk-free rate and wedge estimates have been updated based on outturn data/ latest forecasts. Risk-free rate estimates are based on a rolling 1-month average at each cut-off date.

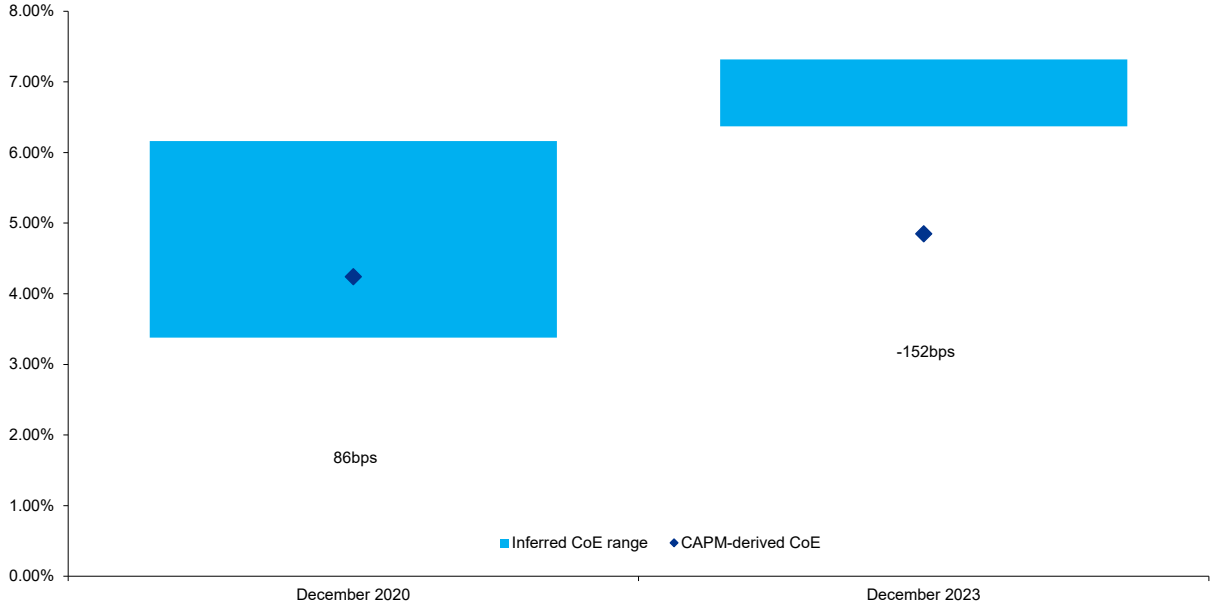
equivalent reduction in the risk borne by debt. This is unlikely to be the case for ET3 as there is a significant and unprecedented step change in the scale and complexity of capital programmes expected for ET3 and beyond, which increases the risk to equity holders. All else equal, a significantly larger differential between observed debt pricing and allowed equity returns would be expected.

To assess the implications of inference analysis evidence for the allowed CoE at ET3, the Report undertakes two comparisons, which consider (1) how the CAPM-derived CoE estimates compare to inferred CoE estimates and (2) how the differentials between CoE and current debt pricing implied by the CAPM-derived CoE compared to those implied by the inferred CoE (this represents the difference between implied equity and debt risk premia). This comparison is undertaken for the date of the ET2 Final Determination (FD), as well as the latest market data (December 2023 cut off).

In each of the charts below, the diamond represents either the CAPM-derived CoE or the CAPM-implied differential and the floating bar represents the range implied by the inference analysis. The data labels represent the difference between the CAPM-derived values and the lower bound of the range from inference analysis.[9]

Figure 2 and Table 1 below illustrate that the CAPM-derived CoE as at December 2023 based on the ET2 methodology and the resulting differential with current debt pricing are significantly below the range implied by inference analysis. The scale of the reduction indicates scope for material under-estimation of the allowed CoE based on CAPM. If the ET2 CAPM approach were to be applied for ET3, the inference analysis suggests that required returns could materially exceed allowed returns, making investment in ET3 less attractive compared to other opportunities with better risk-reward profiles. Investors could in turn be disincentivised to commit equity capital to the electricity transmission sector where CAPM-derived equity risk premia, which underpin allowed returns, do not reflect appropriate differentials to the pricing of lower-risk debt.

Figure 2 Comparison between inferred and CAPM-derived CoE[10]



Source: KPMG analysis

[9] The ranges for inferred CoE and inferred differentials between inferred CoE and current pricing of debt for each cut-off date are formed based on the (1) minimum and maximum CoE and (2) minimum maximum differentials implied by the 1-, 3-, 6- and 12-month averaging windows as at that date. Note that the height of range will not be the same for inferred CoE and differentials. The range for the CoE depends only how different 1-, 3-, 6- and 12-month averages of CoE are from each other. The range for the differentials is affected by both CoE and debt pricing. This means that for the two ranges to be consistent, the debt pricing being deducted to calculate differentials would need to be the same based on 1-, 3-, 6- and 12-month averaging windows. This is not the case as debt pricing varies depending on the averaging window.

[10] It is noted that the elasticity (and hence the CoE) derived based on the Merton (1974) framework and its practical applications based on market leverage can differ from the ET2 notional gearing assumption of 55%. Since the beginning of

Note: (1) CAPM-derived CoE is on a 55% notional gearing basis. For consistency CAPM-derived CoE estimates at the 55% notional gearing level have been converted from the 60% notional gearing level using the same approach as followed in the ET2 FD. The FD imputes CoE at the 55% notional gearing level based on the WACC estimate at the 60% notional gearing level and the allowed cost of debt, assuming that the WACC would not vary with gearing. This is illustrated in the WACC allowance model published alongside the ET2 FD.
(2) The use of inflation swaps to deflate the nominal inferred CoE is expected to yield conservative estimates of the real inferred CoE. All else equal, using OBR's 5-year ahead inflation forecasts consistent with the ET2 FD would increase the real inferred CoE values.

Table 1 Comparison of CoE and differentials between CoE and current debt pricing for inferred versus CAPM-derived CoE

Cut-off date	Inferred CoE	CAPM-derived CoE	Differential between inferred CoE and current debt pricing	Differential between CAPM-derived CoE and current debt pricing
December 2020	3.38 – 6.16%	4.24%	3.68 – 6.14%	4.54%
December 2023	6.37 – 7.32%	4.85%	2.56 – 3.21%	1.40%

Source: KPMG analysis
Note: (1) CAPM-derived CoE is on a 55% notional gearing basis. For consistency CAPM-derived CoE estimates at the 55% notional gearing level have been converted from the 60% notional gearing level using the same approach as followed in the ET2 FD. The FD imputes CoE at the 55% notional gearing level based on the WACC estimate at the 60% notional gearing level and the allowed cost of debt, assuming that the WACC would not vary with gearing. This is illustrated in the WACC allowance model published alongside the ET2 FD.
(2) The use of inflation swaps to deflate the nominal inferred CoE is expected to yield conservative estimates of the real inferred CoE. All else equal, using OBR's 5-year ahead inflation forecasts consistent with the ET2 FD would increase the real inferred CoE values.

The Report does not propose that inference analysis can yield a *precise* estimate of the required CoE. This is due to the presence of some noise in the estimation of equity risk premia from debt risk premia, driven by the different nature and risk exposures of each type of capital. Instead, the Report considers that observed debt pricing and the expected differential between debt and equity pricing can represent a useful cross-check on CAPM-derived returns.

Overall, the magnitude of the differential between the inferred CoE and CAPM-implied CoE based on a roll-forward of the ET2 regulatory CAPM implies a substantial reduction in the equity risk premium. This effect may be driven in particular by an assumption that the Total Market Return (TMR) is relatively constant within the regulatory CAPM[11], which limits the responsiveness of the regulatory CoE to the significant recent step change in interest rates.

Ofgem recognises that CoE calculated based on a stable TMR might result at any given point in time in a higher or lower equity premium relative to debt when compared to the through-the-cycle average. In consequence, Ofgem considers that adjusting for a low premium in one price control period without considering the through-the-cycle impact of the stable TMR approach could structurally over-reward investors.[12]

It is not clear from SSMC how Ofgem is defining an economic cycle. Assuming that an economic cycle broadly corresponds to the typical investment horizon for the sector of 20Y, a key question which will underpin the investability of the ET3 capital programme is whether investors can reasonably expect to recover required returns across the investment horizon. A through-the-cycle approach implicitly assumes that peaks and troughs in market rates will 'average out' over any given investment horizon, with current underestimations of returns offsetting future overestimations.

Such an approach could result in a long-term mismatch between (1) returns implied by current market conditions – which could persist across the investment horizon – and (2) returns implied by a relatively constant TMR. This implicit asymmetry could in turn deter commitment of new equity capital required to support investment required to facilitate the energy transition.

Overall, the variance between inferred and CAPM-derived CoE suggests that an approach to estimation of TMR that balances maintenance of broad stability and the responsiveness of the

2022, market leverage has remained below assumed notional gearing of 55%, meaning that expected elasticity based on market leverage will yield inferred CoE estimates that somewhat *understate* the required returns at the notional gearing level. The inferred CoE estimates for ET3 in this Report are based on market leverage and can thus be considered to be conservative.

[11] Regulators estimate the equity risk premium within the CAPM as the difference between TMR and the risk-free rate, instead of estimating the risk premium directly. Where TMR is assumed to be stable over time in the context of increasing interest rates the equity risk premium will reduce and constrain the degree to which increased rates translate into the CoE estimate.

[12] Ofgem (2023), RIIO-3 Sector Specific Methodology Consultation – Finance Annex, para 3.84

regulatory CoE to changes in interest rates should be pursued to enable the electricity transmission sector to successfully compete with other investment opportunities to attract capital.

In practice, this means that careful re-examination of the methodology for CAPM-implied CoE is likely to be required at ET3 to ensure that allowed returns and equity risk premia are sufficient to attract equity capital relative to current levels of observed debt pricing, which has responded to the recent step change increases in interest rates. In particular, it will be important to consider whether targeted adjustments to the current methodology for the estimation of regulatory CoE are warranted to secure investment in the new macroeconomic reality.

3 Context and scope

3.1 Context

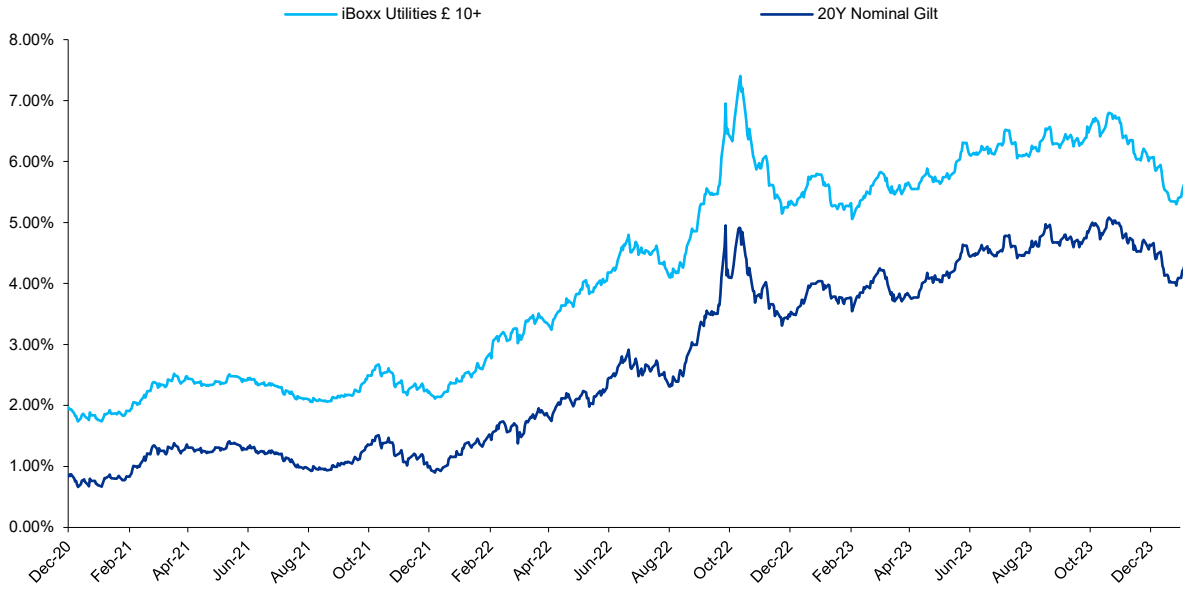
On 13 December 2023 Ofgem published the Sector Specific Methodology Consultation (SSMC) for the next price control in the electricity transmission sector (ET3) which will start in April 2026. In the SSMC Ofgem outlined its proposed approach to cross-checking the cost of equity (CoE) implied by its estimate based on the Capital Asset Pricing Model (CAPM).

Key factors relevant to the estimation of allowed returns at ET3

Setting an appropriate, evidence-based, allowance for CoE is essential to attract and retain equity capital in the sector. An appropriate allowance for the CoE is one that reflects the return that investors can earn on investments of comparable risk (i.e. reflects the opportunity cost of capital) and remunerates investors for probability-weighted losses (or gains). Only where the CoE meets this criterion can the investment be deemed investable, i.e. be able to attract sufficient equity (and debt) capital on reasonable terms, consistent with what is priced into the allowance.

There has been a significant shift in the macroeconomic landscape, marked by rising interest rates, high inflation, and heightened volatility. Forward curves[13] imply that long-term rates (15-20Y) are likely to increase marginally relative to current levels until the end of ET3. Bank of England projections imply that while the bank rate may decrease between December 2023 and end of Q2 of 2027[14], it is expected to remain significantly above the 2010-2021 average.

Figure 3 Evolution of interest rates since ET2



Source: Refinitiv Datastream

The regulatory allowance for CoE will be particularly significant for ET3 and beyond in the context of the unprecedented step change in the scale of required capital investment. The SSMC estimates that tens of billions of pounds of new investment could be required during ET3[15]. It will be necessary for the notional firm to attract significant new equity capital as well as retain existing equity capital deployed in the sector to fund this investment, which will in turn be contingent on allowed returns that

[13] Based on average rates during January 2024
[14] Bank Of England (February 2024), Monetary Policy Report, supporting file <Market profiles>
[15] Ofgem (2023), RIIO-3 Sector Specific Methodology Consultation – ET Annex, para 1.10

adequately compensate for forward-looking risk exposure and the opportunity cost of capital in current market conditions.

The SSMC recognises that "***attracting equity capital is a key factor*** *in securing the step-change increase in investment in infrastructure that underpins key government policy objectives in areas such as the transition to net zero, climate resilience and energy security*"[16]. Given scale of investment, the issue of investability will become increasingly important as "***companies will need to seek 'fresh' equity from their investors over and above what they would be able to fund via retained earnings****, and at a time where there is greater competition for investment and capital in the UK water and global regulated infrastructure sectors"*[17].

Regulatory methodologies for estimation of allowed returns that were developed and applied during a low interest rate environment and where networks did not need to attract new equity capital may no longer be appropriate in the new market reality with significantly higher capital intensity. There is inherent uncertainty in estimating CoE and greater potential harm from under-estimation of returns compared to over-estimation[18]. This is amplified in the context of macroeconomic uncertainty and investments of strategic significance. The SSMC acknowledges these challenges and that new or adjusted methodologies may be required to capture the step change in interest rates and investment:

- *"appropriate evolution, particularly* ***to deal with macro developments*** *that create new challenges or where* ***updates to best practice can be identified****, is likely to underpin regulatory credibility and support the ongoing attractiveness of investment in the sector… For ET, there is a step-change in infrastructure investment needs across GB to build out a zero carbon, more flexible and more secure energy system at pace"*[19].
- *"we plan to* ***develop the notion of 'investability', alongside our existing financeability assessment****, to better understand* ***whether the allowed return on equity is sufficient to retain and attract the equity capital that the sector requires****. This may involve pulling a combination of levers such…* ***it may also require new tools*** *to be developed"*[20].

Regulatory CoE needs to be sufficient to provide incentives for firms to meet investment requirements. The SSMC recognises the importance of investment incentives and in particular the requirement to set a fair allowance that contributes to an overall regulatory model that provides certainty and assurance to investors that projects are viable, investible, and deliverable.[21]

The role and principles for the use of cross-checks in setting allowed returns

In the context of (1) a step change increase in interest rates; and (2) a requirement to attract capital to invest in substantial capital programmes at T3 and beyond, the role of cross checks to ensure that the allowed CoE can attract and retain equity capital will be critical. Cross checks that are transparent, targeted, objective, incentive compatible, and consistent with regulatory precedent and academic literature, can be effective in increasing the reliability and robustness of the CoE estimate derived based on the CAPM.

Recent regulatory determinations have recognised that to develop a robust CoE estimate, CAPM-derived returns should be cross- or sense-checked with reference to alternative market benchmarks. Ofgem, Ofwat, UKRN and the CMA have positioned the role of cross-checks as follows:

- In the SSMC Ofgem reaffirmed that it would be prudent to use cross-checks based on market data and other estimation methodologies to provide assurance that a CAPM-derived CoE estimate is neither too low nor too high. It proposed to follow the Recommendation 7 of UKRN

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16 Ofgem (2023), RIIO-3 Sector Specific Methodology Consultation – Finance Annex, para 3.4
17 Ofgem (2023), RIIO-3 Sector Specific Methodology Consultation – Finance Annex, para 5.9
18 The welfare loss arising from under-estimation of the CoE is greater than that from over-estimation of the cost of capital. If the allowed return is set too high, customers end up paying more in their bills than they would have had the allowance been based on the true cost of capital. On the other hand, if the allowed return is set too low, companies are discouraged from making new investments or adequately maintaining existing ones, resulting in suboptimal levels of investment and a significant loss in consumer welfare. As the demand for most regulated services is driven by the essential nature of the services provided, the welfare loss from under-investment is substantial. Consequently, the detrimental impact on consumers is not symmetric when the allowed return deviates significantly from the true cost of capital.
19 Ofgem (2023), RIIO-3 Sector Specific Methodology Consultation – Finance Annex, para 1.4
20 Ofgem (2023), RIIO-3 Sector Specific Methodology Consultation – Finance Annex, para 3.6
21 Ofgem (2023), RIIO-3 Sector Specific Methodology Consultation – Finance Annex, para 3.4

Guidance to sense check the CAPM derived point estimates and use a range of cross checks to "*assess whether its CAPM-based estimated is materially out of line relative to estimates suggested by relevant market data and other estimation methodologies*"[22].

- Ofwat in its PR24 DM stated that: *"Our proposed implementation of the CAPM…is reliant on significantly backwards-looking data, particularly on TMR, where we propose to capture over 120 years of historical evidence. One implication of this approach may be an allowed return which is slow to adapt to changing market conditions. Because our objective is to set an allowed return aligned with investors' expectations over 2025-30, it is therefore important to cross-check our CAPM-derived estimates against estimates from alternative approaches underpinned by more recent and forward-looking data"*[23]. However, the PR24 FM noted that "*there should be a high evidential bar for moving away from this central estimate, limited to evidence from market-based cross checks*"[24].
- UKRN in its guidance for regulators on the methodology for setting the cost of capital noted that: "*Since the CAPM is just one model of expected returns, market benchmarks…provide a sense-check on the CAPM point estimate when such market data are available"* and *"as available cross-checks themselves may be uncertain and reliant on assumptions, there should be a high evidential bar to deviating from the mid-point of the* [CAPM] *cost of equity range"*[25].
- The CMA in its PR19 re-determination noted that cross-checks of the point estimate for CoE – in particular, financeability – are valuable given that CAPM could be used to derive a wide range of potential estimates for the CoE[26]. Further, the CMA considered that *"arguments for picking a point estimate higher than the midpoint include…to take into account a cross-check on market data and financeability ratios"*[27].
- As part of the RIIO GD&T2 appeals the CMA considered that the role of cross-checks is to assess whether the CAPM-implied returns appear materially miscalibrated relative to market-based evidence[28]. The CMA commented that: *"the ultimate requirement should be to ensure that the overall cost of equity allowance is sufficient to attract investors and allow companies to finance their activities"* and *"market-based cross-checks can help with this process"*[29].

At RIIO2 the suite of cross-checks applied by Ofgem included Modigliani–Miller (MM) CoE inference, market-to-asset ratio (MARs) implied CoE, Offshore Transmission Ownerships (OFTOs) investors' bids, investment managers' CoE and infrastructure fund implied internal rate of return.

In the SSMC Ofgem highlighted that its RIIO2 suite of cross-checks generally pointed to a lower CoE relative to the CAPM-based estimate but that it had chosen not to make any downward adjustments for this as "*the overall pattern did not suggest that any of the cross-checks were more reliable indicators of the cost of capital than that provided by the long-term approach used in the CAPM*"[30]. Ofgem proposed a similar approach for ET3 unless there was evidence to justify changing it.

Both Ofgem and the CMA have recognised the shortcomings of RIIO2 cross-checks[31]. These shortcomings may limit their capacity to offer additional insights to the CAPM and hence the ability to robustly cross-check whether allowed returns will attract and retain equity capital. As a result, for ET3,

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22 Ofgem (2023), RIIO-3 Sector Specific Methodology Consultation – Finance Annex, para 3.82
23 Ofwat (2022), PR24 Draft Methodology, Appendix 11 – Allowed return on capital, p. 24
24 Ofwat (2022), PR24 Final Methodology, Appendix 11 – Allowed return on capital, p. 49
25 UKRN (2023), Guidance for regulators on the methodology for setting the cost of capital
26 CMA (2021), PR19 Final Determination, para. 9.1378
27 Ibid., para. 9.1240
28 CMA (2021), RIIO2 Final Determination, Volume 2A: Joined Grounds: Cost of equity, para. 5.718
29 Ibid., para. 5.723
30 Ofgem (2023), RIIO-3 Sector Specific Methodology Consultation – Finance Annex, para 3.82
31 For example, in the GD&T2 FDs, Ofgem noted that "*the cross-checks…each have benefits and drawbacks. For example, some of these crosschecks will involve assets that are exposed to different risk profiles or gearing levels*." Ofgem ultimately reflected stakeholder representations that its "*market cross-checks were not as strong as we [Ofgem] believed*" in its GD&T2 decision. During GD&T2 appeals, the CMA recognised that there are challenges with relying on and interpreting these cross-checks and that it was important to avoid unduly relying on a small number of specific methodologies and / or attaching undue weight to methodologies which are not robust. However, the CMA concluded that collectively the suite of cross-checks provided useful evidence and the presence of cross-checks that implied returns above and below Ofgem's CAPM-implied CoE went some way to mitigate concerns that the regulator had deployed a materially skewed body of cross-checks.

the consideration of more robust alternative cross-checks is important to refine the CAPM-derived CoE range and/or inform the selection of the point estimate for the CoE.

Relationship between debt and equity pricing as a potential cross-check

The following principles have informed the exploration of the relationship between debt and equity pricing for more detailed consideration in this Report:

- In its guidance for setting the cost of capital (WACC), the UK Regulators' Network (UKRN) highlights that returns should be "*risk reflective*"[32] such that "*the reward will reflect the allocation of risk in the regulatory framework and sectors*"[33]. The allowance for the cost of capital set by regulators should be commensurate with the risks faced by debt and equity investors.
- In its guidance, UKRN has similarly recognised "*the principle that equity bears more risk than debt and so should normally receive a higher return*"[34].
- At PR19 the CMA recognised that "*for a regulated business with capped returns, the cost of equity used in the WACC should still be assumed to remain sufficiently above the current cost of debt to promote equity investment in the sector*"[35].

These regulatory principles suggest that a cross-check based on the relationship between current pricing of new debt in the sector and equity pricing in allowed returns would be relevant. This is because (1) debt and equity are both claims on the same underlying asset, and there should be a relationship between them and (2) the CoE cannot be observed whereas cost of debt can be observed. This is in line with Damodaran (2023) which considers that "*there should be a relationship across the risk premiums in these asset classes that reflect their fundamental risk differences*"[36]. As a result, observed debt pricing and the relationship between the CoE and the cost of debt could be used to infer the CoE which can be applied as a sense-check to the CAPM-derived estimate.

It is a core principle of corporate finance that equity is inherently riskier than debt. Both security classes represent contingent claims over a firm's assets. In the event of an insolvency, debt holders have the priority claim over the firm's assets for debt repayment, while equity holders could receive the remaining assets only once all outstanding debt capital has been repaid and if the remaining value of the firm is non-negative. This suggests that equity holders face higher risks in relation to loss of capital and return.

Similarly, as the payment terms of debt are fixed, debt is known as fixed income. If the company fails to make the required interest or principal payments, it is in default and debt holders can take control of the business. By contrast any dividends can only be paid to equity holders once fixed payments have been made to debtholders. Debtholders are senior and equity holders are junior – they can only be paid *after* all debtholders are paid.

Given the inherently riskier nature of equity, the expected return on equity needs to be substantively above the expected return on debt of the same company. If the allowed WACC does not consistently reflect the subordinated nature of equity relative to debt, equity investors may seek alternative investments that appropriately reflect these factors, such as projects with similar risks or lower-risk assets like debt that provide equivalent or higher returns.

However, equity investors often have multiple investment options, each with varying risk and return profiles. When making capital allocation decisions, investors will need to carefully consider the risk-return profile of each opportunity. In the context of the choice between investing in a single firm's debt or equity, absent an appropriate differential between the returns available from these investments, an investor is unlikely to be incentivised to invest in equity given its higher risk exposure.

This Report will consider whether significantly reduced headroom between allowed CoE and CoD is consistent with corporate finance principles and may be indicative of under-estimation of the CoE

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[32] UKRN cost of capital principles
[33] Ibid.
[34] UKRN (2023), Guidance for regulators on the methodology for setting the cost of capital, Appendix A: Guidance Consultation Issues and Taskforce Response
[35] CMA (2021), PR19 Final Determination, para. 9.1386
[36] Damodaran A., Equity Risk Premiums (ERP): Determinants, Estimation, and Implications – The 2023 Edition

based on CAPM which warrants further investigation, taking into account whether investors might look through a reduction in the differential on the basis that it is expected to 'average out' across a long-run economic cycle.

3.2 Scope and structure of the Report

This Report develops a cross-check for the regulatory CoE based on the market pricing of debt and relationship between debt and equity based on following steps:

- First, it considers the evolution of observed differentials between allowed CoE and market pricing of debt and its implications for the calibration of ET3 CoE (section 4).
- Second, it establishes the conceptual framework for inferring CoE from CoD based on established corporate finance theories and sets out the approach and methodology for empirical analysis (section 5 and 6).
- Third, it comments on the implications of the empirical analysis for the calibration of the ET3 CoE (section 7).

3.3 Authors

This Report has been written in conjunction with Professor Alex Edmans, who is a sub-contractor of KPMG LLP.

Professor Edmans is Professor of Finance at London Business School. Professor Edmans' research interests are in corporate finance and behavioural finance. He is a Director of the American Finance Association and a Fellow of the Financial Management Association. From 2017-2022 he was Managing Editor of the Review of Finance, the leading academic finance journal in Europe. Professor Edmans has spoken at the World Economic Forum in Davos, testified in the UK Parliament, presented to the World Bank Board of Directors as part of the Distinguished Speaker Series, and given the TED talk What to Trust in a Post-Truth World and the TEDx talks The Pie-Growing Mindset and The Social Responsibility of Business. Alex was named Professor of the Year by Poets & Quants in 2021 and has won 25 teaching awards at Wharton and LBS.

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

4 Analysis of observed differentials between allowed CoE and market pricing of debt

This section explores the pricing dynamics between allowed CoE and yields on the benchmark index between October 2013 and December 2023. It comments on the evolution on the differential between allowed CoE and prevailing market pricing of debt and its implications for investability and financeability during ET3.

The CoE reflected in the analysis in this Report is based on an extrapolation of the ET2 methodology across the full period (2013 – 2023) considered. It is assumed that ET2 estimates of asset beta (0.349), notional gearing (55%)[37] and total market return (TMR, 6.50% CPIH-real) remain constant; the risk-free rate[38] and wedge estimates have been updated based on outturn data/ latest forecasts. In other words, at this early stage of ET3 the potential implications of debt pricing are assessed relative to the ET2 CoE – notwithstanding that Ofgem has signalled that it will consider how its methodology may need to evolve at ET3 to support investability.

Corporate finance theory implies that equity bears more risk that debt and hence that allowed CoE should be assumed to remain sufficiently above the current CoD to promote equity investment in the sector and price in risk differentials for different claims on the same asset. This has been recognised by the UKRN and the CMA (section 3.1).

While these differentials may vary to some degree over time – as they can be affected by factors such as changes in risk exposure and leverage – a significant decrease in these differentials relative to recent historical periods could indicate mispricing of equity risk, warranting further investigation. Furthermore, the observed differential from previous price controls would not reflect any changes in forward-looking risk exposure – to the extent that equity risk is increasing and is not accompanied by an equivalent increase in the risk borne by debt, the differential between the pricing of CoE and current CoD would be expected to widen.

To this end, the figure below shows the evolution of the differential between allowed CoE (based on the ET2 methodology) and yields on the benchmark index as a proxy for current borrowing costs. Yields on the iBoxx Utilities 10+ index are used for consistency with Ofgem's approach for pricing new debt issuance as part of setting the CoD allowance. The effective maturity of the iBoxx Utilities £ 10+ index is close to 20 years such that the investment horizons implied in CoE and debt pricing are broadly consistent.

The differential between CoE and current CoD was relatively stable between 2013 and 2021. It reduced materially at the beginning of 2022 and has since remained at historically low levels. The reduction from 2022 onwards appears to have been driven by a combination of step changes in market rates and limited responsiveness of the regulatory CoE to these changes. The differential has increased during November – December 2023, however it continues to remain materially below historical levels.

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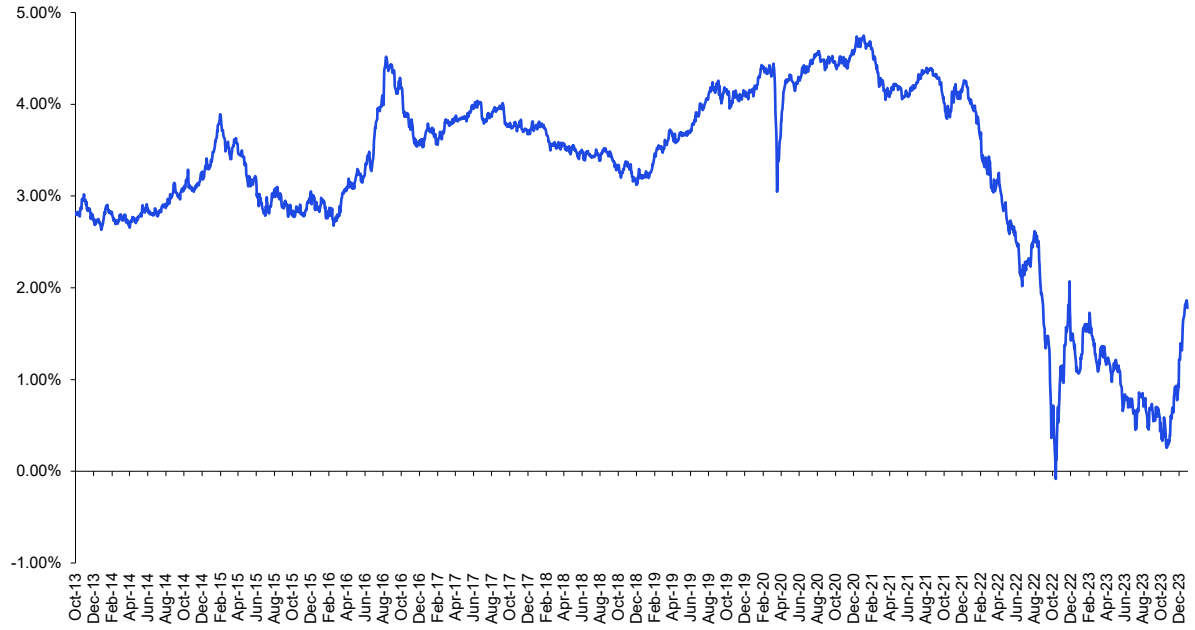
[37] These estimates are based on a rolling 1-month average at each cut-off date.

[38] For consistency CAPM-derived CoE estimates at the 55% notional gearing level presented in this Report have been converted from the 60% notional gearing level using the same approach as followed in the ET2 FD. The FD imputes CoE at the 55% notional gearing level based on the WACC estimate at the 60% notional gearing level and the allowed cost of debt, assuming that the WACC would not vary with gearing. This is illustrated in the WACC allowance model published alongside the ET2 FD.

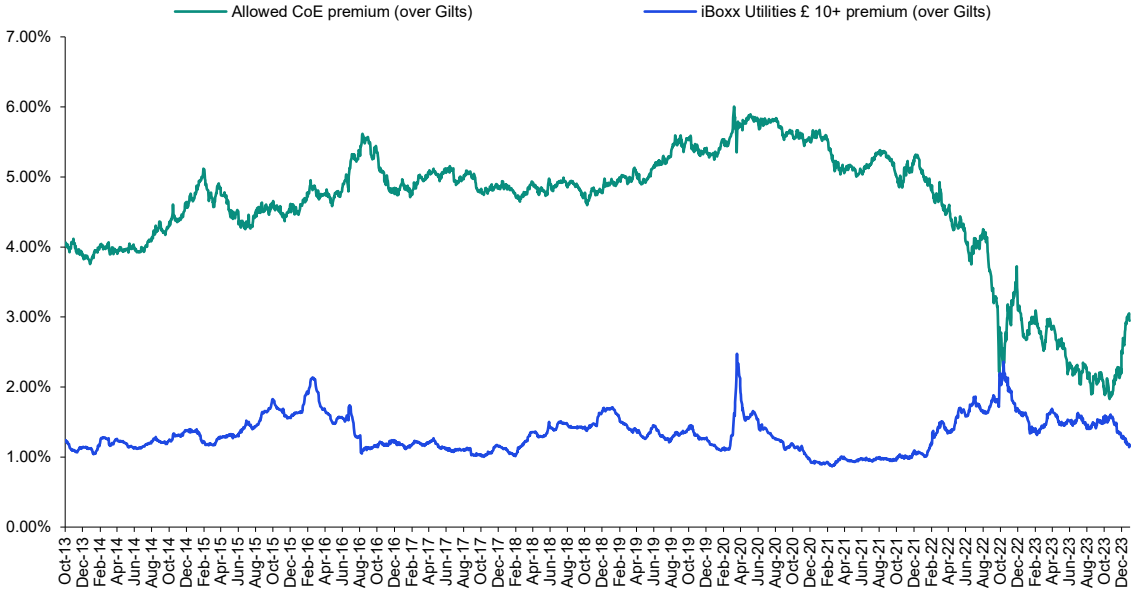
Figure 4 Evolution of the differential between allowed CoE (ET2 methodology) and yields on the benchmark index



Source: KPMG analysis of the ET methodology and Refinitiv Datastream data.
Note: (1) Compares nominal yield on the iBoxx index (default adjusted) to allowed CoE converted to nominal using long-term inflation assumptions from the WACC allowance model published as part of the 2023 Annual Iteration Process.
(2) For consistency allowed CoE estimates at the 55% notional gearing level have been converted from the 60% notional gearing level using the same approach as followed in the ET2 FD. The FD imputes CoE at the 55% notional gearing level based on the WACC estimate at the 60% notional gearing level and the allowed cost of debt, assuming that the WACC would not vary with gearing. This is illustrated in the WACC allowance model published alongside the ET2 FD.

Figure 5 illustrates that the implied premium (over Gilts) for CoE has decreased materially from the beginning of 2022 whereas debt premia have remained relatively stable. This suggests that the observed reduction in the differential between allowed CoE and yields on the benchmark index is driven by calibration of the allowed CoE.

Figure 5 Evolution of CoE (ET2 methodology) and benchmark index premia (over Gilts)



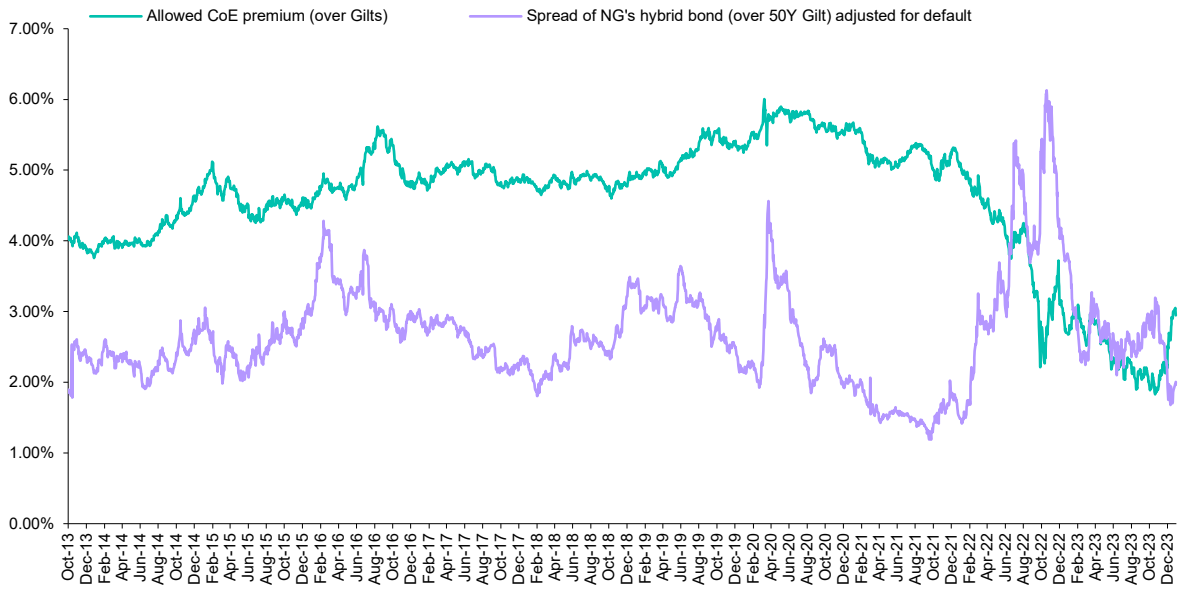
Source: KPMG analysis of the ET methodology and Refinitiv Datastream data.
Note: (1) Compares nominal yield on the iBoxx index (default adjusted) to allowed CoE converted to nominal using long-term inflation assumptions from the WACC allowance model published as part of the 2023 Annual Iteration Process. Premium calculated relative to the 20Y nominal gilt yield.
(2) For consistency allowed CoE estimates at the 55% notional gearing level have been converted from the 60% notional gearing level using the same approach as followed in the ET2 FD. The FD imputes CoE at the 55% notional gearing level based on the WACC estimate at the 60% notional gearing level and the allowed cost of debt, assuming that the WACC would not vary with gearing. This is illustrated in the WACC allowance model published alongside the ET2 FD.

Whilst the analysis in this section focuses on differentials between allowed CoE and debt costs at the investment grade credit rating level, one would also expect to observe a positive but smaller gap between allowed CoE and debt issued by HoldCos. Although the latter can be viewed as more equity-like than debt found within the regulatory ringfence, it nonetheless is senior to equity in bankruptcy, and this remains true irrespective of whether the debt is investment grade or sub-investment grade. Even though HoldCo debt sits outside the regulatory ring fence, it can still provide valuable insights on the extent to which allowed CoE reflects the greater exposure of equity relative to debt given that from a lender perspective the risk exposure of this debt is linked to the same regulatory assets and cash flows as OpCo equity.

The figure below sets out the evolution of the differential between the allowed CoE and the yield on National Grid plc's (NG) GBP-denominated hybrid debt instrument, which is held at HoldCo level. The hybrid bonds have certain equity characteristics. For example, the hybrid bond ranks senior only to NG's ordinary share capital and, therefore, is relatively highly subordinated with increased loss severity and risks of non-performance. Its rating is also currently two notches below NG's Long-term Issuer Default Rating. There is also full discretion to defer coupons which results in 50% equity treatment and 50% debt treatment of the hybrid notes by Fitch[39].

Historically, there has been a positive differential between observed spreads on the hybrid bond and allowed CoE which is consistent with the subordinated nature of equity claims relative to the hybrid debt. Since 2022, this differential has become negative and appears to indicate under-estimation of allowed CoE based on the ET2 CAPM methodology.

Figure 6 Differential between allowed CoE and yields on NG's hybrid instrument



Note: (1) Compares nominal yields on NG's GBP hybrid instrument to allowed CoE converted to nominal using long-term inflation assumptions from the WACC allowance model published as part of the 2023 Annual Iteration Process. CoE premium calculated relative to the 20Y nominal gilt yield.
(2) For consistency allowed CoE estimates at the 55% notional gearing level have been converted from the 60% notional gearing level using the same approach as followed in the ET2 FD. The FD imputes CoE at the 55% notional gearing level based on the WACC estimate at the 60% notional gearing level and the allowed cost of debt, assuming that the WACC would not vary with gearing. This is illustrated in the WACC allowance model published alongside the ET2 FD.

In principle, significant reductions in the differential between the CoE and current CoD may be appropriate where a material reduction in risk borne by equity that is not accompanied by an equivalent reduction in the risk borne by debt. However, this is unlikely to be the case for ET3 as there is a significant and unprecedented step change in the scale and complexity of capital programmes expected for ET3 and beyond, which increases the risk to equity holders. Moreover, the differential should never be negative, as equity is always riskier than debt due to its lower priority in bankruptcy.

[39] Fitch (2013), Fitch Assigns NGG Finance Plc's Hybrid Notes Final 'BBB-'Rating

The observed reduction in the differential, and in particular it sometimes turning negative, indicates that the ET2 CAPM may under-estimate the CoE and if applied at ET3 may result in equity investment being deemed less attractive than other available opportunities with better risk-reward profiles. In the most recent period, the returns available for equity investment in ET have been below BB-rated debt (as proxied by NG's hybrid instrument) which does not recognise the additional risks that equity faces due to its subordinated nature of equity and so is inconsistent with corporate finance theory. In this context, it is important to consider the appropriate level of differential for ET3.

The subsequent sections of this Report undertake more detailed analysis of the appropriate differential based on debt pricing and the relationship between equity and debt outlined in corporate finance theory.

5 Framework for inferring CoE based on the relationship between debt and equity pricing

This section sets out an overall framework for inferring the CoE based on debt pricing and specification of the key drivers of the relationship between debt and equity pricing as outlined in corporate finance theory. The purpose of this analysis is to inform the assessment of the appropriate differential in current market conditions.

Merton's (1974)[40] contingent claim framework – developed as part of his work on option and derivative pricing – and its modern applications represent a potential basis for estimation of CoE based on the interrelationship between equity and debt pricing.

In Merton's framework, debt and equity are considered contingent claims over a firm's assets[41]. This framework views equity as a European call option, exercised when firm assets exceed debt value, granting shareholders the right to acquire assets. When assets fall below debt value (signifying default), shareholders forgo this option, leaving assets for debtholders. Debt is akin to risk-free debt and shorting a European put option on assets. If assets surpass debt value, equity holders repay the debt, granting debtholders the debt's value instead of firm assets.

The values of debt and equity are intrinsically related to the value of the firm's assets. When the firm's asset value rises, equity holders benefit from larger residual claims, and debt value benefits from the reduction in the firm's leverage and the lower likelihood of default. Conversely, a decline in asset value diminishes the residual claims of equity holders and heightens the risk of default. Consequently, all else equal, the expected returns on equity and debt exhibit a positive correlation, as both are sensitive to the underlying factors that affect the firm's asset value.

Campello, Chen and Zhang (2008)[42] have developed an analytical formula (see Equation (1) below) to estimate the expected equity return based on the relationship between equity and debt inferred from Merton's framework. Their research is published in the top-ranking Review of Financial Studies.

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[40] Merton, R. C. (1974). On the pricing of corporate debt: The risk structure of interest rates. *The Journal of Finance*, 29(2), 449-470.

[41] The framework views equity as a European call option, while debt is considered as a European put option.

- Equity holders are effectively holding a European call option on the firm's assets, which means that they have the right, but not the obligation, to obtain the firm's assets by paying off the debt. Their net payoff is the residual value of the firm, the difference between the asset value and the debt value. They will thus exercise the option when the residual value if positive, i.e., when the firm's asset value exceeds the value of debt.
    - When the value of a firm's assets is lower than the value of debt (i.e., the company is in default), then the payoff from exercising the option is negative – shareholders would lose money by paying off the debt to obtain assets of lower value. They will thus allow the option to expire worthless, leaving debtholders with all of the firm's assets.
    - When the value of a firm's assets is higher than the value of debt, shareholders can exercise their call option to buy the assets, retaining the residual claim on the firm's assets.
- Debt holders are effectively holding risk-free debt and shorting a European put option on the firm's assets. the risk-free debt reflects the money they have lent and expect to be repaid Unlike the buyer of an option which has the right, but not the obligation to exercise his option, the option seller, in this case the debtholder, gets what the option holder chooses to leave them with. When the value of the firm's assets is lower than the value of debt (i.e., the company is in default), equity holders choose not to exercise their option to buy the firm's assets; instead, they leave the firm's assets to the debtholders and do not repay the debt.
    - When the value of the firm's assets exceeds the value of debt, equity holders choose to repay the debt. Thus, debtholders receive the value of the debt rather than the firm's assets.

[42] Campello, M., Chen, L., & Zhang, L. (2008). Expected returns, yield spreads, and asset pricing tests. *The Review of Financial Studies*, *21*(3), 1297-1338.

The inputs into this formula are the elasticity of the equity value with respect to debt value ($\frac{\partial E/E}{\partial D/D}$) and the expected cost of debt which is the company's weighted-average bond yield adjusted for default risk.[43]

Equation (1)

$$E[r_E] - r_f = \frac{\partial E/E}{\partial D/D} (E[r_D] - r_f)$$

Elasticity ($\frac{\partial E/E}{\partial D/D}$) reflects the percentage change in the value of equity relative to the percentage change in the value of debt, which is equivalent to the ratio of return on equity to the return on debt. If elasticity is high (i.e. a small change in the value of debt leads to a large change in the value of equity), then equity is much riskier than debt and so the equity risk premium $E[r_E] - r_f$ will be much larger than the debt risk premium $E[r_D] - r_f$.

This Report uses Equation (1) to infer CoE based on the elasticity of debt to equity and debt pricing. Academic literature suggests two ways of decomposing elasticity into key drivers. One approach is based on Schaefer and Strebulaev (2008)[44] and the Black-Scholes-Merton option pricing model[45] and the other on Friewald, Wagner and Zechner (2013)[46].

These approaches are described in Appendix 1. They suggest that risk-free rate, asset volatility, market leverage and time to maturity of the firm's debt[47] represent the key drivers for elasticity. The analysis undertaken in this Report follows the methodology put forward by Campello et al., in which the key drivers considered are the risk-free rate, market leverage, and equity volatility[48] as the latter is more straightforward to measure than asset volatility.

The relevance of the drivers used in the Campello et al. methodology to the estimation of elasticity and the theoretical basis for inclusion of these drivers in the Campello et al. methodology is as follows:

- Equity volatility: Equity is more sensitive to changes in firm value than debt, since the payoffs of debt are capped. Thus, greater volatility increases the sensitivity of equity more than the sensitivity of debt, and so shareholders require a higher compensation for volatility.
- Market leverage: As is well known from Modigliani-Miller, higher leverage increases the risk of equity as it is the residual claim, thus increasing the return required by equity holders.
- Risk-free rate: The rationale for the inclusion of risk-free rate as a key driver of elasticity stems from the linkage between Merton's framework – which views equity as a European call option – and the Black-Scholes-Merton framework for option pricing which incorporates risk-free rate as one of the inputs.

In practice, in the real world there are other drivers and complexities which could also affect elasticity and its derivation. This underpins the role of inference analysis as a cross-check, rather than a primary methodology for estimation of the CoE.

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[43] Campello et al. (2008) explain why bond yield data could be used to represent investors' expected return on debt. Bond yields are computed in the spirit of forward-looking internal return, capturing factors such as probability of default and yield spreads that incorporate the expected risk premiums associated with default risks. Controlling for default risks, bonds with higher systematic risk should have higher yield spreads.

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

[45] Black-Scholes-Merton model is an option pricing model that determine the fair value of a stock option based on the price of the underlying asset, the strike price of the option, risk-free rate, time to maturity of an option, and the volatility of an asset.

[46] Friewald, N., Wagner, C., & Zechner, J. (2014). The cross-section of credit risk premia and equity returns. *The Journal of Finance*, *69*(6), 2419-2469.

[47] This Reports estimates the inferred CoE for a 20Y investment horizon based on yields on the benchmark index with similar maturity. As the horizons of CoE and CoD are aligned, time to maturity is not included as an independent variable in the regression.

[48] The methodology used by Campello et al. focuses on equity volatility which is measured as the standard deviation of daily stock returns. As asset volatility is not considered directly in the empirical analysis in subsequent sections, this Report does not comment on its relationship with elasticity.

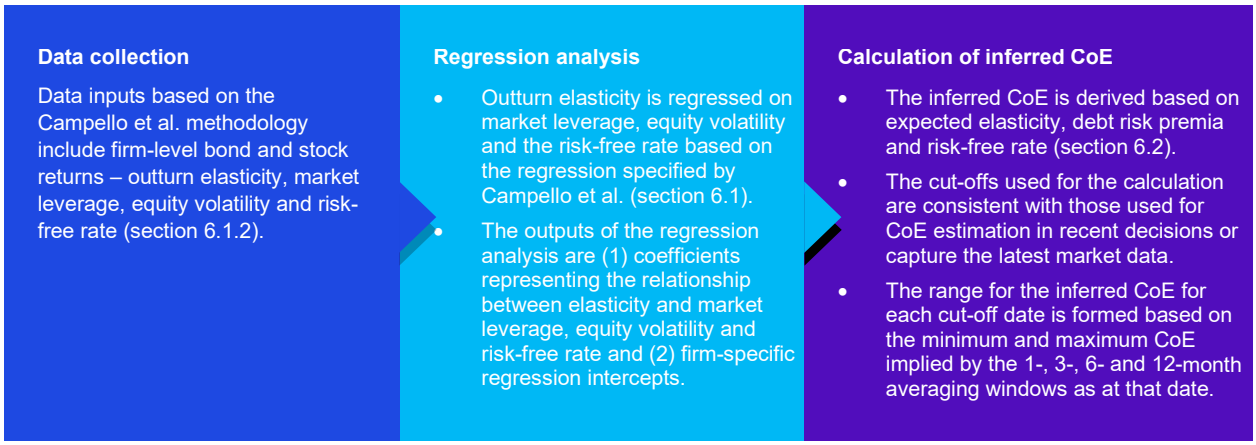
6 Methodology for inference analysis to estimate CoE based on debt pricing

This section sets out the approach and data used for the estimation of inferred CoE using the analytical formula developed by Campello, Chen and Zhang (2008) (Equation (1)).

The calculation of inferred CoE based on this formula requires an estimate of the expected elasticity for NGET as well as estimates of debt risk premia and risk-free rate.

The section first comments on the methodology for estimating the expected elasticity, including the specification of the regression, data collection, and the calculation of the expected elasticity based on regression outputs. It then comments on how the expected elasticity is combined with debt risk premia and risk-free rate to generate a range for the inferred CoE.

Figure 7 Overview of the methodology for the estimation of inferred CoE



6.1 Outline of the methodology for the estimation of expected elasticity

The elasticity used for estimating the expected CoE is the expected elasticity, which reflects the expected relationship between equity and debt returns based on the drivers suggested by Merton's framework, including market leverage, equity volatility and risk-free rate. The relationships between elasticity and its drivers are established through a regression analysis conducted over an extended timeframe. This approach ensures that the derived elasticity reflects the underlying fundamental relationships, free from distortions caused by transient factors.

These relationships (represented by regression coefficients) in conjunction with the values of drivers based on most up-to-date market data are used to calculate current expected elasticity (expected elasticity).

6.1.1 Regression framework specification based on outturn elasticity

To derive expected elasticity, Campello et al. (2008) regress outturn elasticity ($\frac{\partial E/E}{\partial D/D}$) on historical market leverage, equity volatility and the risk-free rate based on monthly frequency bond and stock data[49].

Equation (2)

$$\frac{\partial E/E}{\partial D/D}_{it} = \alpha + \beta_{lev}\ Leverage_{it} + \beta_{vol}\ Volatility_{it} + \beta_{rf}\ r_{f_t} + \varepsilon_{it}$$

where

- $\frac{\partial E/E}{\partial D/D}_{it}$ is the outturn elasticity, measured as the change in the market value of equity divided by the change in the market value of debt. The market value of debt is calculated by scaling the book value of debt using the weighted average bond market price
- α is the intercept term
- $Leverage_{it}$ is the market leverage, measured by the ratio of market value of debt to market value of equity
- $Volatility_{it}$ is the equity volatility, measured by the standard deviation of daily stock returns, based on a rolling window of 180 days
- r_{f_t} is the 30-day Treasury bill rate
- ε_{it} is the error term, representing the difference between the actual elasticity based on market data and the expected elasticity based on the regression
- i and t refer to each firm i at each time t. The data used in the regression has both a cross-sectional component (different firms at a given time t) and a time-series component (each firm i over different time t). As the regression contains multiple firms over time, it is a panel regression[50]

6.1.2 Approach to data collection

The Report relies on the period from October 2013 to December 2023 informed by the following considerations.

First, the earliest start date to draw a robust sample size based on bond returns available from Bloomberg is October 2013[51][52].

Second, no structural break is identified in the regression model on elasticity at the 5% significance level, which indicates that the entire period between October 2013 to December 2023 should be considered.[53]

The collection of data for the analysis is undertaken in three steps:

- Step 1: Obtain the list of all stocks listed in the London Stock Exchange for each year

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[49] Campello et al. conduct the regression based on 1205 nonfinancial firms listed in the U.S. from January 1973 to March 1998.

[50] Panel regression is a type of regression that contains data with both cross-sectional and time-series dimensions. Panel data sets consist of observations on multiple firm over time.

[51] Campello et al. use data collected from Lehman Brothers Fixed Income Database, which provides bond-specific data in the US from January 1973 to December 1997. This source is not available in the UK.

[52] Relative to the later years, the number of companies with bond data available before 2013 decreases significantly to be less than 50 companies. This could be because Bloomberg does not have the bond data for stocks listed in the earlier years which subsequently de-listed and could result in the results being affected by survivorship bias should these periods be included in the analysis.
Survivorship bias results from the use of a dataset that consists of survivors over a period, not the full set of companies that were listed. As the characteristics of survivors are likely to differ systematically from those who have delisted, the results will be biased. Therefore, the report uses the period from 2010 onwards to reduce the likelihood of survivorship bias.

[53] Based on all the three structural break tests - Supremum Wald test, Average Wald test and Average LR test. The null hypothesis of no structural break cannot be rejected at 5% significance level. Therefore, no structural break is identified.

- Step 2: Apply the filtration criteria to exclude financial companies and Alternative Investment Market (AIM) listed companies
- Step 3: Download firm-level bond and stock data required for the regression

Step 1

The London Share Price Database (LSPD)[54] is used to obtain a list of all the stocks listed on the London Stock Exchange from 2013 to 2023. LSPD provides a comprehensive list of stocks from 1955 to date, including companies that have since de-listed and / or gone bankrupt. De-listed stocks are included in the dataset to avoid survivorship bias.

Step 2

The list of stocks obtained from LSPD is filtered as outlined in the table below.

Table 2 Filtration criteria and rationale

Criterion	Treatment	Rationale
Financial firms[55]	Exclude	The implications of high leverage are different across financial and non-financial firms (consistent with Campello et al.). Whilst high leverage is common for financial firms and not indicative of financial distress, in non-financial firms, high leverage may indicate financial distress or difficulty.
AIM listed firms[56]	Exclude	AIM-listed firms are excluded to capture the tradable and investable universe for institutional investors. AIM-listings include many small and illiquid stocks. AIM stocks have not historically been viewed as investible by many fund managers due to their high failure rates and poorer standards of reporting. Therefore, the UK studies focus on the Main Market of the London Stock Exchange and exclude AIMs.

Stocks that are not excluded based on the filtration criteria above are then taken forward to the next step for data collection.

Step 3

The dependent and independent variables used in the regression include firm-level bond and stock returns, outturn elasticity, market leverage, equity volatility and risk-free rate. The methodology for deriving these variables is broadly consistent with Campello et al. with targeted exceptions as set out below.

- Leverage is measured on the same basis as in Campello et al., i.e. as the ratio of market value of debt to market value of equity, where market value of debt is obtained by scaling the book value of debt by the weighted-average bond market price.
- Stock volatility is measured in the same manner as in Campello et al. i.e. based on the 180-day daily stock return volatility. The daily stock return is calculated as the daily percentage change in the Total Return Index (TRI).
- Risk-free rate is measured based on the yields on the 20-year nominal gilt whereas Campello et al. use the 30-day treasury bill rate. As shown in equation (4) in Appendix 1, risk-free rate is used to calculate the delta (Δ) of the call option, which in this case is the value of equity. Consequently, a long-term measure of risk-free rate is used to reflect the long-term horizon of equity investors.
- Outturn elasticity ($(\frac{\partial E/E}{\partial D/D})$) is calculated based on the ratio of month-on-month total return on equity to total return on debt, whereas Campello et al. use the ratio of month-on-month changes in the market value of equity to market value of debt.

Merton (1974) – upon which Campello et al's analysis is based – uses a simplified model that assumes that there are no coupon payments on bonds, no cash dividends, no share repurchase or

[54] London Share Price Database | Finance | London Business School
[55] Sector information as of each year is obtained using Bloomberg and DataStream based on Global Industry Classification Standard (GICS) definition of sectors.
[56] The classification of AIM-listed stocks is obtained from LSPD.

new equity or debt issuance[57]. Under these simplified assumptions, the changes in the market value of debt and equity could be used to capture investors' returns, as the only driver of returns would be the movement of market price.

These simplified assumptions do not hold in practice meaning that changes in market values of debt and equity are a poor proxy for total returns received by equity and debt investors. In contrast, total returns capture returns arising from capital gains and the coupons and dividends received by investors. The total return is used to measure elasticity as follows:

- The total return on equity ($\partial E/E$) is measured as the month-on-month % change in TRI of equity. TRI reflects both the market price movement and dividend distributions, assuming the dividend distributions will be re-invested.
- The total return on debt ($\partial D/D$) is measured as the month-on-month weighted average total return on bonds[58] which includes 1) price movement, 2) accrued interest, 3) coupon actually paid out during the month, and 4) interest on interest (i.e. the interest that is earned by re-investing the coupon).

The table below summarises the data sources used for independent and dependent variables.

Table 3 Sources of data for independent and dependent variables

Variable	Underlying data	Data source
Outturn elasticity; Equity volatility	Total Return Index (TRI) on equity	Refinitiv Datastream
Outturn elasticity	Weighted average total return of fixed-rate bonds[59]	Bloomberg
Leverage	• Weighted average fixed-rate bond price[60] • Book value of total debt • Market value of equity	Bloomberg
Risk-free rate	20-year nominal gilt rates	Refinitiv Datastream

6.1.3 Refinement and specification of the panel regression model

Campello et al. use a pooled Ordinary Least Square (OLS) regression (see Equation (2)), which assumes that the average elasticity is the same across different firms. Under this assumption, the intercept term (α) of the regression is a constant term and does not vary across firms.

However, it is reasonable to expect that the average elasticity could vary across firms, due to influence of differentiated factors such as sectors, business risks, management styles etc. This suggests that a firm fixed effect regression – which incorporates a firm-specific intercept (α_i) instead of the constant intercept (α) – would be appropriate. Indeed, firm fixed effects are used in the vast majority of corporate finance analysis and research.

Equation (3)

$$\left(\frac{\partial E/E}{\partial D/D}\right)_{it} = \alpha_i + \beta_{lev}\, Leverage_{it} + \beta_{vol}\, Volatility_{it} + \beta_{rf}\, r_{f_t} + \varepsilon_{it}$$

To test whether individual-specific intercept is needed, the Breusch-Pagan Lagrange multiplier test is conducted. The null hypothesis is that (α_i) does not differ significantly across firms, in which case the pooled OLS would be the appropriate specification. The results of the test shows that the p-value is equal to 0.0%, which unambiguously rejects the null hypothesis. There are significant differences across firms, and so the firm fixed effect regression is used.

[57] See page 452 to 453 of Merton, R. C. (1974). On the pricing of corporate debt: The risk structure of interest rates. *The Journal of finance*, *29*(2), 449-470.

[58] i.e. the weighted average total return of all the fixed-rate bonds issued by each company. For comparability (across sampled companies) and simplicity the analysis focuses on fixed-rate bonds.

[59] Weighted by amount outstanding of all fixed rate bonds issued by a firm.

[60] Weighted by amount outstanding of all fixed rate bonds issued by a firm.

6.1.4 Calculation of elasticity

NG is used as a proxy for risks and required returns for equity investment in NGET. The expected elasticity is calculated as the sum of:

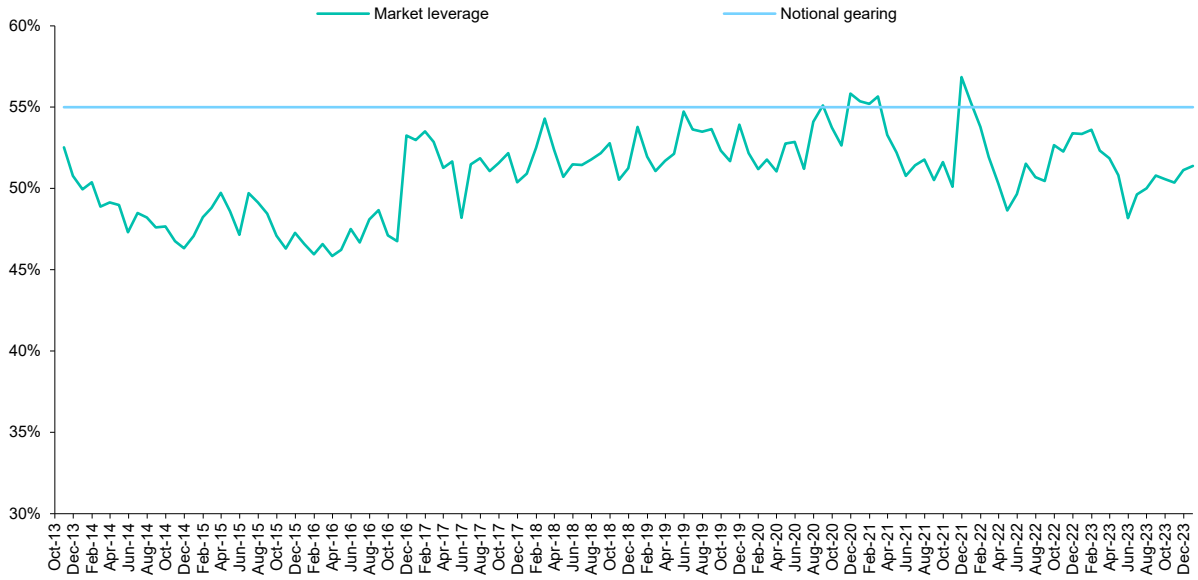
- The regression coefficients (β_{lev}, β_{vol} and β_{rf}) multiplied by the historical time series of NG's market leverage and equity volatility and risk-free rate (the 20Y nominal gilt rate used in the regression).
- The intercept value ($\alpha_{NG,i}$)

$$\frac{\partial E/E}{\partial D/D}_{NG,t} = \alpha_{NG,i} + \beta_{lev}\ Leverage_{NG,t} + \beta_{vol}\ Volatility_{NG,t} + \beta_{rf}\ r_{f_t}$$

It is noted that the elasticity derived from the regression based on market leverage can differ from the 55% notional gearing assumption applied to NGET at ET2.

The figure below sets out the evolution of market leverage[61] for NG relative to the ET2 notional gearing assumption. Market leverage has consistently remained below assumed notional gearing with the exception of a few observations, meaning that expected elasticity based on market leverage will yield inferred CoE estimates that somewhat *understate* the required returns at the notional gearing level of 55%. The inferred CoE estimates in this Report are based on market leverage and can thus be considered to be conservative. The sensitivity of the results to the differences between market leverage and notional gearing is considered in section 7.

Figure 8 Evolution of NG's market leverage relative to the ET2 notional gearing assumption



Source: KPMG analysis

The Report does not suggest that the market leverage used for the inference analysis is the right market benchmark to inform the notional gearing assumption for the electricity transmission sector. As is widely acknowledged – including by rating agencies[62] – RAV represents the invested capital on which the energy utility will earn a return over time, so the relevant measure of leverage is Net Debt to RAV. It is appropriate to consider the book value of Net Debt for consistency with the regulatory

[61] Market leverage is calculated as the ratio of market value of debt to the market value of equity. Consistent with Campello et al., the market value of debt is derived by scaling the book value of debt by the weighted average fixed rate bond price. For example, if the book value of debt is equal to 60, and the weighted average fixed rate bond price is 120, then market value of debt is equal to 60 x (120/100) = 72. The market value of equity is market capitalisation of the firm.

[62] Moody's (April 2022), Rating Methodology, Regulated Electric and Gas Networks

commitment to allow for the recovery of efficient costs[63]. Separately, in practice, there are significant challenges associated with obtaining up-to-date market values given the prevalence of private debt on companies' books.

6.2 Approach and methodology for estimation of the inferred CoE

The inferred CoE is derived based on expected elasticity, debt risk premia and risk-free rate. The table below sets out a comparison between the CAPM and inference analysis in terms of estimation approaches and underlying intuition.

Table 4 Comparison between CAPM and inference analysis

	CAPM	Inference analysis (based on Campello et al approach)
Intuitive interpretation	Investors require higher returns for holding stocks that exhibit greater sensitivity to market movements, with the magnitude of this premium contingent upon the asset's systematic risk	Investors require higher returns for assuming the higher risk associated with holding equity – the lowest priority claim against a firm's assets and returns – compared to debt which has a higher priority. This premium is contingent upon the firm's security structure, equity volatility, and the underlying macroeconomic conditions
Formula for estimating returns	$E[r_E] = r_f + \beta_{equity}\,(E[r_M] - r_f)$	$E[r_E] = r_f + \frac{\partial E/E}{\partial D/D}\,(E[r_D] - r_f)$ Where: $(\frac{\partial E/E}{\partial D/D})$ represents the elasticity of equity to debt and reflects the % change in the value of equity relative to the % change in the value of debt (elasticity). It measures the sensitivity of equity value to debt value
Reference for pricing required equity returns	Relative to the risk and return of the wider market	Relative to the risk and return of a specific company's debt or a debt benchmark
Estimation of a company's equity risk premium	A product of equity beta and market risk premium	A product of elasticity and debt risk premium
Risk factor	Equity beta (β), a systematic risk factor, measures the sensitivity of a company's equity return to the changes in the overall market return. Higher sensitivity indicates higher compensation required by the investors	Elasticity $(\frac{\partial E/E}{\partial D/D})$, a relative risk factor, measures the sensitivity of a company's equity return to its debt return. Higher sensitivity implies higher compensation required by equity investors compared to the debt investors of the same company
Determinant of the risk factor	Equity beta (β) is determined by: 1) the covariance between a stock's return and the market return, which can be positive,	Elasticity $(\frac{\partial E/E}{\partial D/D})$ is determined by several factors such as risk-free rate, asset volatility, and market leverage

[63] Regulated assets are financed with historic debt as a result of which substantive portions of embedded debt is carried through on balance sheets. Given that the regulatory contract is intended to allow 'recovery of efficient costs' – including those of efficiently incurred historic debt – the CoD allowance is based on historic yields at issuance. The allowance assumes that the yield at issuance is the cost that is payable by a regulated firm that holds debt to maturity and for consistency with this assumption considers the book value of debt. Reflecting current market prices in gearing and current yields in the cost of debt allowance, will not only reflect the change in the market price of debt given the reduction in tenor of the debt as it approaches maturity, but will also mark down (or up) costs based on the observed prevailing level of interest rates. This would effectively penalise companies for efficiently incurred debt costs, with the benefit of hindsight. In general, it is a long-established UK regulatory policy to allow the efficient cost of embedded debt, and not to penalise an otherwise efficient company for market movements which are outside of its control.

	negative or zero; 2) the volatility of the stock's return relative to the market return	
Regression model	Regress a stock's realised equity return on realised market return	Regress realised elasticity on risk-free rate, volatility, and market leverage which are the determinants of elasticity commonly cited in academic research Realised elasticity = α + β_{lev} leverage + β_{vol} volatility + β_{rf} risk-free rate
Regression output	Equity beta (β_{equity})	Betas for realised risk-free rate, volatility, and market leverage ($\beta_{lev}, \beta_{vol}, \beta_{rf}$) To derive expected elasticity, betas from the regression are multiplied by the outturn leverage, volatility, and risk-free rate, plus α Expected elasticity = α + β_{lev} company's outturn leverage + β_{vol} company's outturn volatility + β_{rf} risk free rate

The table above underscores the clear parallels between CAPM and inference analysis, both of which adopt market-based approaches to CoE estimation by estimating a factor that reflects risks of a specific company. The key difference is that CAPM estimates required returns based on the sensitivity of a company's equity returns to market returns, whilst inference analysis considers the sensitivity of a company's equity returns to debt returns of the same company.

The table below provides the specification of methodology and assumptions underpinning the calculation of inferred CoE in the Report along with associated rationale.

Table 5 Methodology and assumptions underpinning the estimation of inferred CoE

	Approach	Rationale
Cut-off date	31 December 2020 and 31 December 2023.	Consistent with the publication of the ET2 FD and the ET3 SSMC.
Averaging window	1-, 3-, 6-, 12-month averages used.	Consistent with averaging windows typically considered for estimation of risk-free rate and cost of debt.
Debt risk premium	Market pricing of debt is derived based on outturn yields on the benchmark index, adjusted for default risk by subtracting an expected default loss rate. It is assumed that the effective rating of iBoxx Utilities £ 10+ is A/BBB. The expected default loss rate of 0.15% is calculated based on a 0.24% annualised default rate (the average of highlighted values in Table 6 below) and a 37.7%[64] recovery rate for senior unsecured bonds sourced from Moody's 2023 default study.	Consistent with the regulatory approach for setting the allowance for debt. Campello et al. apply a similar default loss rate adjustment based on Moody's data in their analysis.
Treatment of inflation	Inferred CoE is derived in CPIH-deflated terms in three steps: First, an equity risk premium is calculated by multiplying expected elasticity by a debt risk premium derived from a comparison of default-adjusted nominal yields on the benchmark index and the yields on the 20Y nominal gilt. Then an inferred CoE is calculated as the sum of the yields on the 20Y nominal gilt and the equity risk premium. Lastly, the nominal inferred CoE is converted into a CPIH-deflated value based on the 20Y CPI swap rate[65].	Consistent with the approach for estimating the regulatory CoE which does not reflect compensation for the inflation risk premium (given that it is estimated using index-linked gilts and a real TMR). The use of inflation swaps to deflate the nominal inferred CoE is expected to yield conservative estimates of the real inferred CoE. All else equal, using OBR's 5-year ahead inflation forecasts consistent with the ET2 FD would increase the real inferred CoE values.

Source: KPMG analysis

Table 6 Cumulative and annualised default rates for A/BBB corporate issuers

Rating category	Time period	Time horizon	Cumulative default rate	Annualised default rate	Source
A3	1983 - 2022	10Y	2.00%	0.20%	[1]
		20Y	5.30%	0.27%	[1]
Baa1	1983 - 2022	10Y	2.20%	0.22%	[1]
		20Y	6.00%	0.30%	[1]
A/BBB	1983 - 2022	10Y	2.10%	0.21%	[1]
		20Y	5.65%	0.28%	[1]
A3	1998 - 2022	10Y	2.20%	0.22%	[2]
Baa1	1998 - 2022	10Y	2.20%	0.22%	[2]
A/BBB	1998 - 2022	10Y	2.20%	0.22%	[2]

Notes: Cumulative default rates are issuer-weighted; (2) Annualised default rate = cumulative default rate / time horizon
Source: KPMG analysis of Moody's 2023 Annual default study: Corporate default rate will rise in 2023 and peak in early 2024.
[1]: Moody's 2023 Annual default study Exhibit 41; and [2] Moody's 2023 Annual default study Exhibit 42

[64] Moody's (2023), Annual default study: Corporate default rate will rise in 2023 and peak in early 2024, Exhibit 7
[65] Sourced from Bloomberg.

The range for the inferred CoE for each cut-off date is formed based on the minimum and maximum CoE implied by the 1-, 3-, 6- and 12-month averaging windows as at that date.

Differentials between the inferred CoE and debt pricing for comparison with the CAPM-implied differentials are calculated as follows:

- The inferred CoE is converted into CPIH-real terms using CPI swaps. This is consistent with the regulatory approach that strips out both market-based inflation expectation and the inflation risk premium from the estimation of CoE (by using index-linked gilts as a benchmark).
- iBoxx yields are converted to CPIH-real values using long-term inflation values sourced from the WACC Allowance Model from the 2023 Annual Iteration Process.
- The real iBoxx yields are deducted from the real inferred CoE for each averaging window at each cut-off date.

7 Inference analysis results and implications for CAPM-implied returns at ET3

This section sets out the results of the inference analysis and comments on its implications for the allowed CoE at ET3.

The role of the inference analysis cross-check in the estimation of the ET3 CoE

A cross-check based on Merton's (1974) framework and its practical applications aligns with the principles described in section 3.1.

- Unlike traditional asset pricing models, Merton's framework is not dependent on a specific model for asset valuation, meaning that the resulting cross-check would be derived from outside the CAPM framework.
- Merton's framework acknowledges the impact of a firm's risk exposure on both debt and equity returns, whilst recognising that equity inherently carries higher risk than debt. Consequently, it can be utilised to derive a cross-check for the CoE, incorporating the risk differentials between equity and debt capital. The framework further allows for the fact that the differential between debt and equity will depend on various factors, such as leverage, which may vary over time.
- This cross-check would also reflect the prevailing market conditions and the risk environment, both in terms of the level of return and the interrelationship between the equity and debt.

This is in line with Damodaran who states that "*there should be a relationship across the risk premiums in these asset classes* [corporate bonds, stocks, and real estate] *that reflect their fundamental risk differences… there is enough of a relationship here that we would suggest using this approach as a secondary one to test to see whether the equity risk premiums that we are using in practice make sense, given how risky assets are being priced in other markets*"[66].

As a result, this section explores a cross-check based on Merton's framework to sense-check CAPM-derived CoE for ET3 based on current debt pricing.

The Report does not propose that an approach based on Merton's framework and its practical applications can yield a precise estimate of the required CoE. As recognised by Damodaran, there may be some noise in the estimation of equity risk premia from debt risk premia, driven by the different nature and risk exposures of each type of capital.

Estimation of CoE is inherently complex, necessitating the consideration of multiple available estimation techniques, data sources, and additional factors such as policy objectives. This is particularly the case where there has been a step change in macroeconomic conditions and firms need to attract equity capital to support unprecedented levels of investment in ET3 and beyond.

This Report considers that the Merton framework and its practical applications can provide valuable insights into the relationship between required returns on equity and debt for the same firm. The remainder of this section comments on the results and implications of the inference analysis for ET3 CoE.

Expected elasticity estimates

The starting point for the derivation of inferred CoE is the estimation of expected elasticity based on regression analysis described in section 6.1.

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[66] Damodaran A., Edition Equity Risk Premiums (ERP): Determinants, Estimation, and Implications – The 2023 Edition

The firm fixed effect regression, excluding outliers[67], results in the following coefficients for α and β.

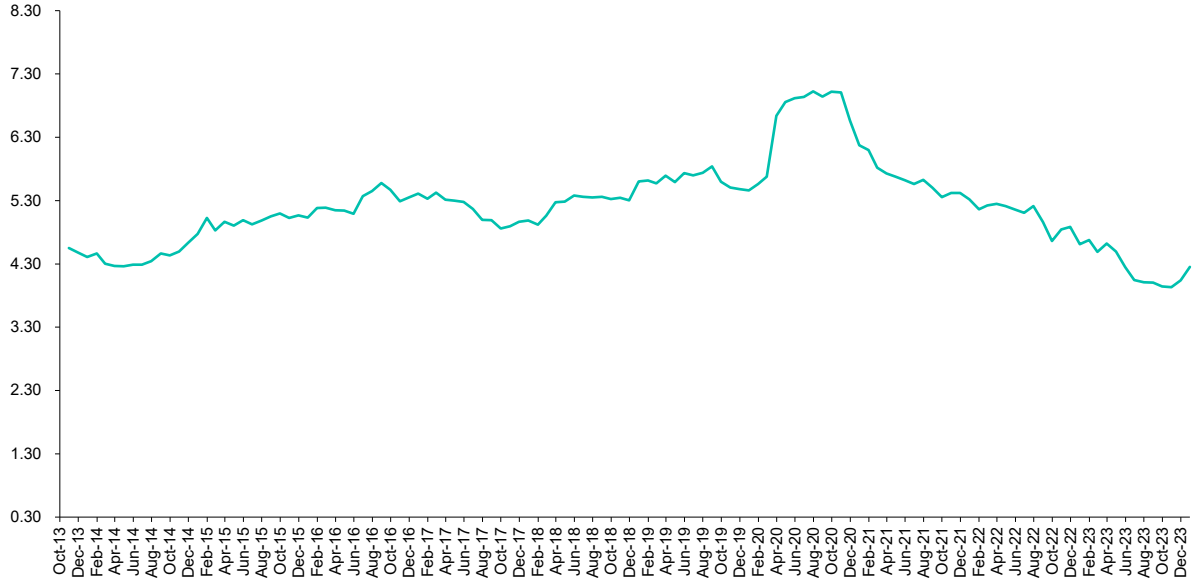
$$\frac{\partial E/E}{\partial D/D}_{it} = \alpha_i + 0.01\ Leverage_{it} + 106.51\ Volatility_{it} - 0.42\ r_{f_t} + \varepsilon_{it}$$

α_i is equal to 4.88.

Market leverage and stock volatility are positively correlated with elasticity, while the risk-free rate is negatively correlated. All three independent variables are jointly statistically significant at a 1% significance level, which suggests that they jointly explain the outturn elasticity. Additionally, stock volatility is statistically significant at a 10% level.

As illustrated in in Figure 9, apart from a temporary spike during the height of the Covid19 pandemic in 2020, elasticity remained broadly stable until 2022 where it experienced a modest decrease. All else equal, the level and trend of expected elasticity suggest that there should continue to be a significant differential between debt and equity pricing at ET3, albeit with a modest reduction relative to observed differentials at the beginning of ET2.

Figure 9 Expected elasticity for National Grid



Source: KPMG analysis

A comparative analysis of inferred and CAPM-derived CoE estimates

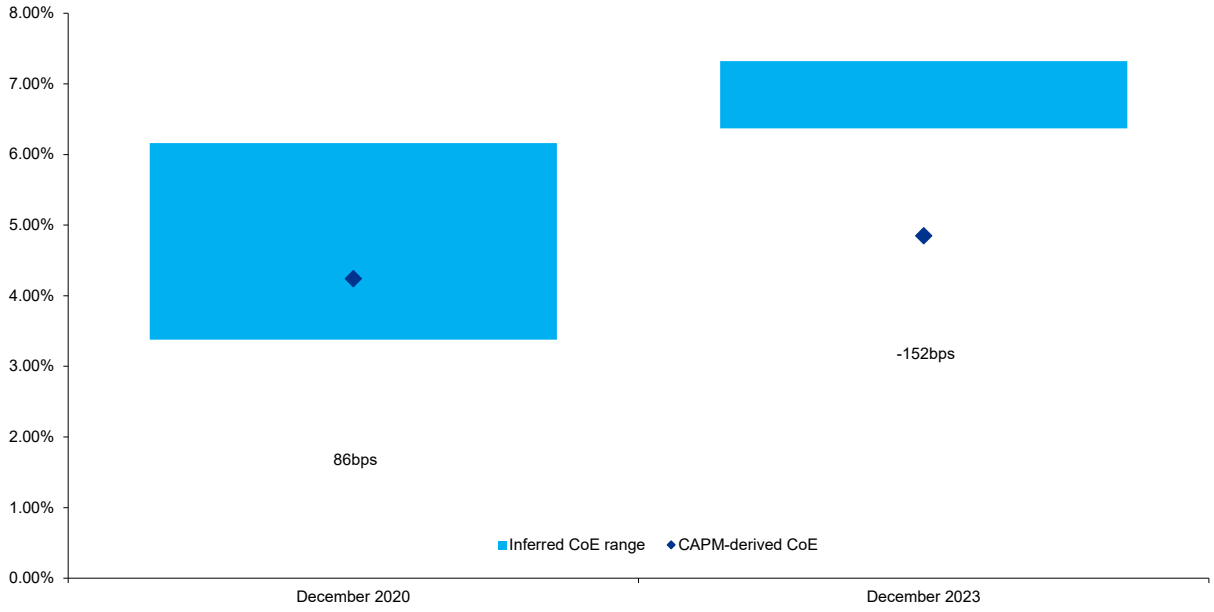
To assess the impact and implications of the inference analysis for the allowed CoE at ET3, the Report undertakes two comparisons, which consider (1) how the CAPM-derived CoE estimates compare to inferred CoE estimates and (2) how the differentials between CoE and current debt pricing implied by the CAPM-derived CoE compare to those implied by the inferred CoE (this effectively represents the difference between implied equity and debt risk premia). In each of the charts below, the diamond represents either the CAPM-derived CoE or the CAPM-implied differential and the floating bar represents the range implied by the inference analysis. The data labels represent

[67] This is done by winsorisation, a data cleaning technique commonly adopted in statistics to mitigate the impact of extreme values (outliers) on the coefficient estimates of the regression, which reduces estimation bias and provides more accurate regression outputs. In this Report outliers are 'capped' meaning that they are replaced with the nearest non-outlying values within a specified range. A 5% winsorisation is applied to elasticity ($\frac{\partial E/E}{\partial D/D}_{it}$), which means that all observations greater than the 97.5th percentile are set to be equal to the 97.5th percentile, and all observations lower than 2.5th percentile are set to be equal to 2.5th percentile.

the difference between the CAPM-derived values and the lower bound of the range from inference analysis[68].

As set out in Figure 10, the CAPM-derived CoE (ET2 methodology) based on a December 2023 cut off is c.152bps below the lower bound of the inferred CoE range. In contrast, at the time of ET2 FD allowed CoE was within the range implied by inference analysis. All else equal, this suggests that the ET2 methodology based on current market data is not consistent with current market pricing of debt and the relationship between debt and equity pricing expected based on corporate finance theory.

Figure 10 Comparison between inferred and CAPM-derived CoE

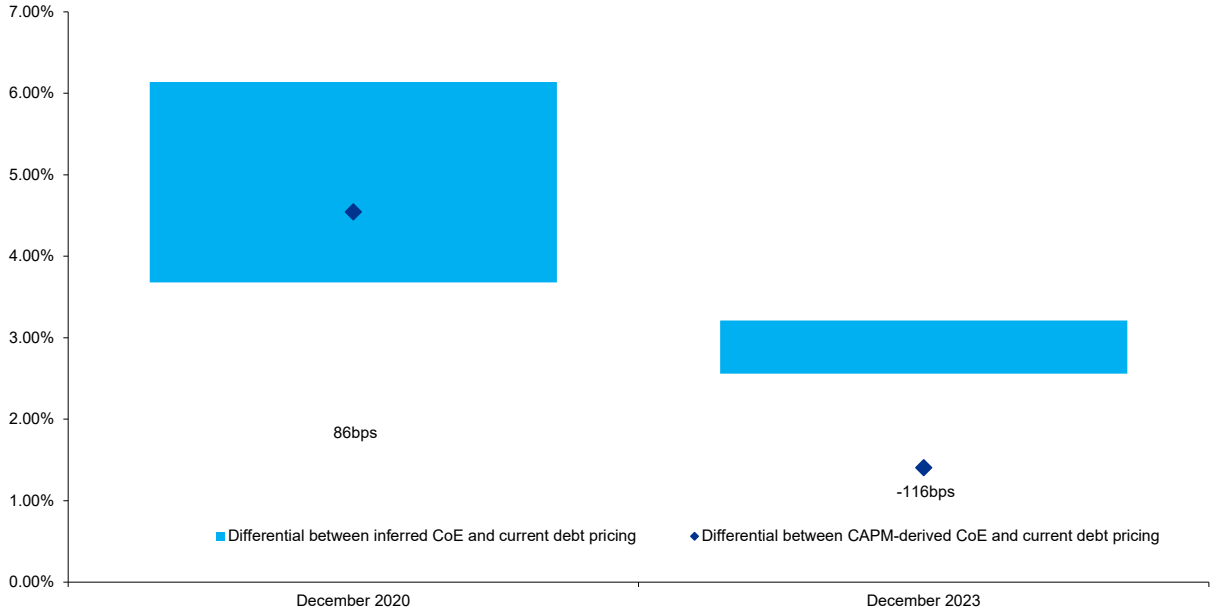


Source: KPMG analysis
Note: (1) CAPM-derived CoE is on a 55% notional gearing basis. For consistency CAPM-derived CoE estimates at the 55% notional gearing level have been converted from the 60% notional gearing level using the same approach as followed in the ET2 FD. The FD imputes CoE at the 55% notional gearing level based on the WACC estimate at the 60% notional gearing level and the allowed cost of debt, assuming that the WACC would not vary with gearing. This is illustrated in the WACC allowance model published alongside the ET2 FD.
(2) The use of inflation swaps to deflate the nominal inferred CoE is expected to yield conservative estimates of the real inferred CoE. All else equal, using OBR's 5-year ahead inflation forecasts consistent with the ET2 FD would increase the real inferred CoE values.

Figure 11 below further illustrates that the differential between CoE and current debt pricing implied by the CAPM-derived CoE is significantly below that implied by the inferred CoE. The differential for based on latest market data is also substantively below the differential implied by past regulatory precedent (section 4).

[68] The ranges for inferred CoE and inferred differentials between inferred CoE and current pricing of debt for each cut-off date are formed based on the (1) minimum and maximum CoE and (2) minimum maximum differentials implied by the 1-, 3-, 6- and 12-month averaging windows as at that date. Note that the height of range will not be the same for inferred CoE and differentials. The range for the CoE depends only how different 1-, 3-, 6- and 12-month averages of CoE are from each other. The range for the differentials is affected by both CoE and debt pricing. This means that for the two ranges to be consistent, the debt pricing being deducted to calculate differentials would need to be the same based on 1-, 3-, 6- and 12-month averaging windows. This is not the case as debt pricing varies depending on the averaging window.

Figure 11 Comparison of differentials between CoE and current debt pricing implied by inferred versus CAPM-derived CoE



Source: KPMG analysis
Note: (1) CAPM-derived CoE is on a 55% notional gearing basis. For consistency CAPM-derived CoE estimates at the 55% notional gearing level have been converted from the 60% notional gearing level using the same approach as followed in the ET2 FD. The FD imputes CoE at the 55% notional gearing level based on the WACC estimate at the 60% notional gearing level and the allowed cost of debt, assuming that the WACC would not vary with gearing. This is illustrated in the WACC allowance model published alongside the ET2 FD.
(2) The use of inflation swaps to deflate the nominal inferred CoE is expected to yield conservative estimates of the real inferred CoE. All else equal, using OBR's 5-year ahead inflation forecasts consistent with the ET2 FD would increase the real inferred CoE values.

The gaps illustrated in Figure 10 and Figure 11 are conservative estimates given that the inferred CoE is derived based on market leverage that is below notional gearing.

As illustrated in the figures above and the table below, the CAPM-derived CoE is materially below the lower bound of the inferred CoE range based on a December 2023 cut off. The magnitude of the differential between the inferred CoE and CAPM-implied CoE implies a substantial reduction in the equity risk premium.

Table 7 Comparison of CoE and differentials between CoE and current debt pricing for inferred versus CAPM-derived CoE

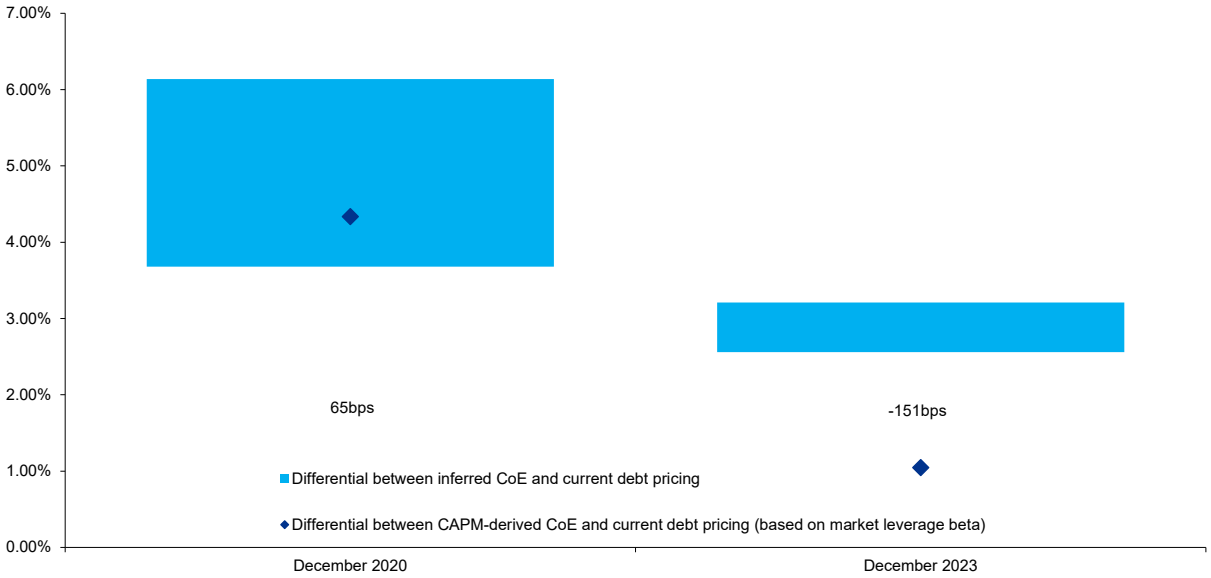
Cut-off date	Inferred CoE	CAPM-derived CoE	Differential between inferred CoE and current debt pricing	Differential between CAPM-derived CoE and current debt pricing
December 2020	3.38 – 6.16%	4.24%	3.68 – 6.14%	4.54%
December 2023	6.37 – 7.32%	4.85%	2.56 – 3.21%	1.40%

Source: KPMG analysis
Note: (1) CAPM-derived CoE is on a 55% notional gearing basis. For consistency CAPM-derived CoE estimates at the 55% notional gearing level have been converted from the 60% notional gearing level using the same approach as followed in the ET2 FD. The FD imputes CoE at the 55% notional gearing level based on the WACC estimate at the 60% notional gearing level and the allowed cost of debt, assuming that the WACC would not vary with gearing. This is illustrated in the WACC allowance model published alongside the ET2 FD.
(2) The use of inflation swaps to deflate the nominal inferred CoE is expected to yield conservative estimates of the real inferred CoE. All else equal, using OBR's 5-year ahead inflation forecasts consistent with the ET2 FD would increase the real inferred CoE values.

Figure 12 below presents the comparison of the differentials between CoE and current debt pricing where both inferred and CAPM-based differentials reflect market leverage for better comparability. As of December 2020, market leverage was marginally above notional gearing, whereas as of December 2023 it was below notional gearing. Where market leverage is below notional gearing – as is the case with a few exceptions – inference analysis yields conservative estimates of CoE. This is corroborated by the figure which shows that the gap widens from 116bps to 151bps where both inferred and CAPM-based CoE have been derived using the same market leverage.

This differential is also likely to be conservative as it may not capture all relevant changes in forward looking risk for networks at ET3.

Figure 12 Comparison of differentials between CoE and current debt pricing implied by inferred versus CAPM-derived CoE



Source: KPMG analysis
Note: (1) CAPM-derived CoE is on a 55% notional gearing basis. For consistency CAPM-derived CoE estimates at the 55% notional gearing level have been converted from the 60% notional gearing level using the same approach as followed in the ET2 FD. The FD imputes CoE at the 55% notional gearing level based on the WACC estimate at the 60% notional gearing level and the allowed cost of debt, assuming that the WACC would not vary with gearing. This is illustrated in the WACC allowance model published alongside the ET2 FD.
(2) The use of inflation swaps to deflate the nominal inferred CoE is expected to yield conservative estimates of the real inferred CoE. All else equal, using OBR's 5-year ahead inflation forecasts consistent with the ET2 FD would increase the real inferred CoE values.

Potential implications for the estimation of ET3 allowed CoE

Energy networks expect to face heightened risks in ET3 and beyond, driven by the significant expansion and greater complexity of capital programmes, and corresponding increases in delivery risk. Exposure to equity is expected to increase as more value is put at risk, with limited corresponding impact on debt. All else equal, the differential between observed debt and equity pricing based on regulatory CAPM would be expected to *increase* at ET3. This expected dynamic may not be reflected in full in the evolution of debt and allowed equity pricing since ET2 FD.

The size of the discrepancy between the inferred CoE and CAPM-derived CoE could indicate a material under-estimation of the allowed CoE. If the ET2 CAPM approach were to be applied for ET3, the inference analysis suggests that the CoE could materially exceed allowed returns, making investment in ET3 less attractive compared to other opportunities with better risk-reward profiles. Investors could in turn be disincentivised to invest in electricity transmission sector equity where CAPM-derived equity risk premia, which underpin allowed returns, do not align practically with and reflect appropriate differentials to lower-risk debt pricing.

Potential consumer detriment arising from under-estimation of CoE would be particularly acute for ET3 given that it will be necessary to attract significant new equity capital to fund the substantial new investment required for ET3 and beyond, which will in turn be contingent on allowed returns that adequately compensate for forward-looking risk exposure and the opportunity cost of capital in current market conditions.

Overall, the magnitude of the differential between the inferred CoE and CAPM-implied CoE based on a roll-forward of the ET2 regulatory CAPM implies a substantial reduction in the equity risk premium. This effect may be driven *inter alia* by an assumption that the TMR is relatively constant within the regulatory CAPM[69], which limits the responsiveness of the regulatory CoE to the significant recent step change in interest rates.

[69] Regulators estimate the equity risk premium within the CAPM as the difference between TMR and the risk-free rate, instead of estimating the risk premium directly. Where TMR is assumed to be stable over time in the context of increasing interest rates the equity risk premium will reduce and constrain the degree to which increased rates translate into the CoE estimate.

Ofgem recognises that CoE calculated based on a stable TMR might result at any given point in time in a higher or lower equity premium relative to debt when compared to the through-the-cycle average. In consequence, Ofgem considers that adjusting for a low premium in one price control period without considering the through-the-cycle impact of the stable TMR approach could structurally over-reward equity investors.[70]

While Ofgem's approach of using a relatively constant TMR assumption may indeed contribute to overall stability in the allowed return on equity, it is important to recognise that investors in practice may not align their pricing of assets and return expectations with this assumption.

When the risk-free rate rises, the returns on gilts rise, as do the yields on corporate debt as they are typically linked to gilt yields. If the TMR is held relatively constant, both gilts and corporate bonds become relatively more attractive than equities for their level of risk, potentially leading to a reallocation of investments away from equities.

Reducing the equity risk premium significantly as a result of adopting a relatively constant TMR assumption over time may diminish the attractiveness of investment in electricity transmission compared to alternative opportunities with more favourable risk-reward profiles.

Adopting a through-the-cycle approach – as Ofgem acknowledges – can inherently result in periods of unspecified duration during which returns might be excessively low, particularly in cases of significant shifts in interest rates.

It is not clear from SSMC how Ofgem is defining an economic cycle. Assuming that an economic cycle broadly corresponds to the typical investment horizon for the sector of 20Y, a key question which will underpin the investability of the ET3 capital programme is whether investors can reasonably expect to recover required returns across the investment horizon. A through-the-cycle approach implicitly assumes that peaks and troughs in market rates will ‘average out’ over any given investment horizon, with current underestimations of returns offsetting future overestimations.

Such an approach could result in a long-term mismatch between (1) returns implied by current market conditions – which could persist across the investment horizon – and (2) returns implied by a relatively constant TMR. This implicit asymmetry could in turn deter commitment of new equity capital required to support investment required to facilitate the energy transition. In other words, an investor’s decision to finance a company will likely depend on the long-term returns available now, rather than through-the-cycle.

Overall, the variance between inferred and CAPM-derived CoE suggests that an approach to estimation of TMR that balances maintenance of broad stability and the responsiveness of the regulatory CoE to changes in interest rates should be pursued to enable the electricity transmission sector to successfully compete with other investment opportunities to attract capital.

In practice, this means that careful re-examination of the methodology for CAPM-implied CoE is likely to be required at ET3 to ensure that allowed returns and equity risk premia are sufficient to attract equity capital relative to current levels of observed debt pricing, which has responded to the recent step change increases in interest rates. In particular, it will be important to consider whether targeted adjustments to the current methodology for the estimation of regulatory CoE are warranted to secure investment in the new macroeconomic reality.

[70] Ofgem (2023), RIIO-3 Sector Specific Methodology Consultation – Finance Annex, para 3.84

8 Appendix 1: Decomposing elasticity into underlying drivers

Academic literature suggests two ways of decomposing elasticity into key drivers.

Approach 1: Decomposing elasticity into delta (Δ) and market leverage (L)

This approach is based on Schaefer and Strebulaev (2008)[71] and the Black-Scholes-Merton option pricing model[72].

Schaefer and Strebulaev (2008)[73] derive the elasticity of debt to equity – which is the inverse of elasticity of equity to debt shown in Equation (1) – as follows:

Equation (4)

$$\frac{\partial D/D}{\partial E/E} = \left(\frac{\partial E/E}{\partial D/D}\right)^{-1} = \left(\frac{1}{\Delta} - 1\right)\left(\frac{1}{L} - 1\right)$$

Where:

- Δ is the change in the equity value with respect to the change in the value of the asset[74].
- L is the market leverage, calculated as the ratio of market value of debt to the market value of firm.

Further, the Black-Scholes-Merton model implies that the call option delta (Δ) is equal to:

Equation (5)

$$\Delta = N(d_1), \text{ where } d_1 = \frac{\ln(A/D) + \left(r + \sigma_A{}^2/2\right)T}{\sigma_A \sqrt{T}}$$

Where:

- r is the risk-free rate,
- A is the value of the firm's asset,
- D is the value of the firm's debt,
- T is the time to maturity of firms' debt, and
- σ_A is the volatility of the return on firm's assets.

Equation (4) and (5) imply that the underlying drivers of elasticity include the market leverage (L), risk-free rate (r), asset volatility (σ_A) and time to maturity of the firm's debt (T).

Approach 2: Decomposing elasticity into the volatility of equity (σ_E) and debt (σ_D)

Friewald, Wagner and Zechner (2013)[75] derive the following equation, where elasticity is equal to the ratio of the volatility of equity to the volatility of debt.

Equation (6)

$$\frac{\partial E/E}{\partial D/D} = \frac{\sigma_E}{\sigma_D}$$

Therefore, Equation (6) implies that the underlying drivers of elasticity include asset and equity volatility.

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

[72] Black-Scholes-Merton model is an option pricing model that determine the fair value of a stock option based on the price of the underlying asset, the strike price of the option, risk-free rate, time to maturity of an option, and the volatility of an asset.

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

[74] Δ is the delta of the European call option on the firm's asset and given Merton's (1974) framework views equity as a European call option, Δ is the change in the equity value in response to the change in the asset value.

[75] Friewald, N., Wagner, C., & Zechner, J. (2014). The cross-section of credit risk premia and equity returns. *The Journal of Finance*, *69*(6), 2419-2469.

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