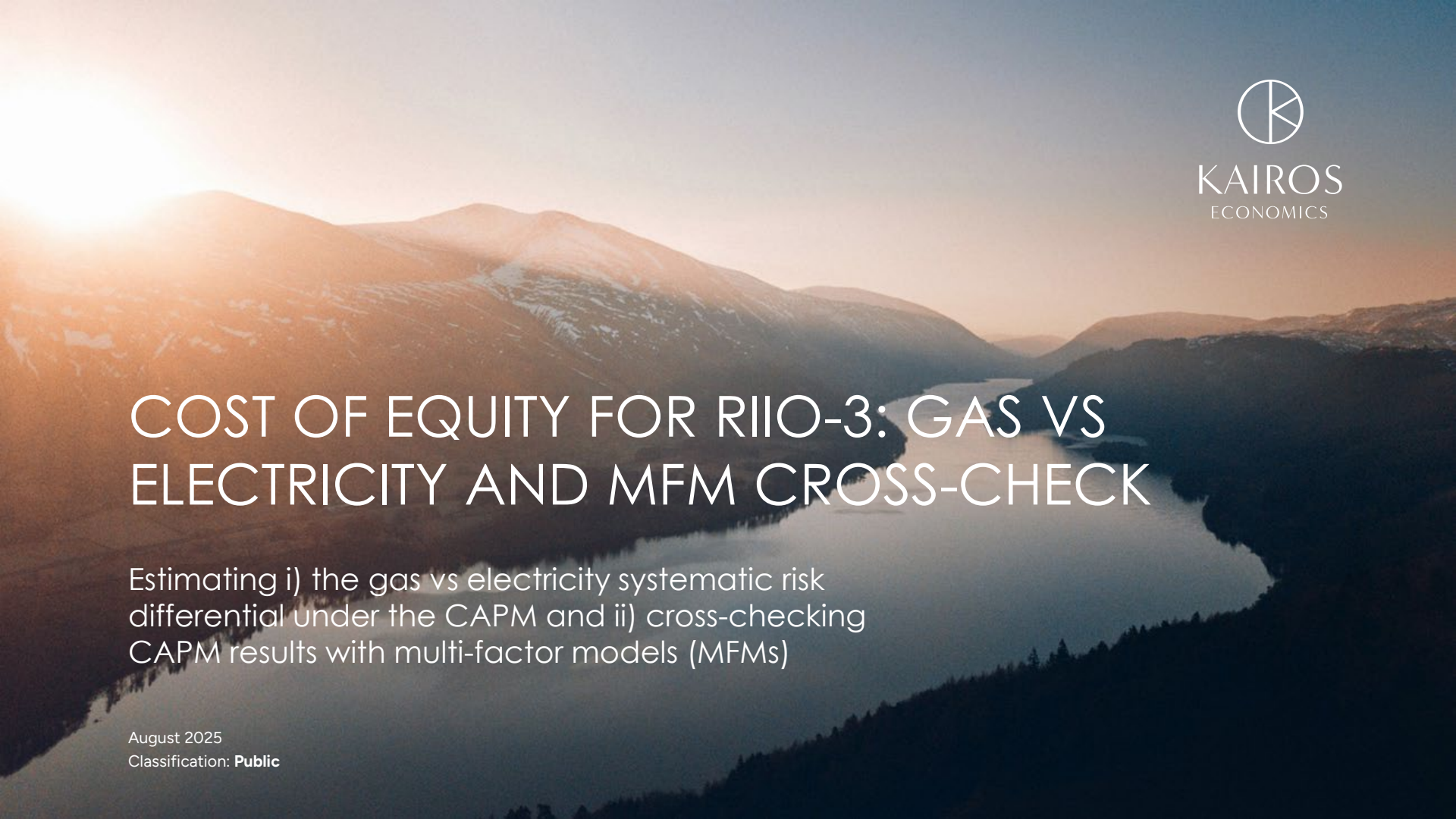

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COST OF EQUITY FOR RIIO-3: GAS VS ELECTRICITY AND MFM CROSS-CHECK

Estimating i) the gas vs electricity systematic risk differential under the CAPM and ii) cross-checking CAPM results with multi-factor models (MFMs)

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Classification: **Public**

PLEASE NOTE

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Key findings

To inform their responses to Ofgem's RIIO-3 Draft Determination (DD), we have undertaken analysis for the members of IGEM Future Energy Networks (FEN) on: i) the difference in systematic risk between regulated gas and electricity networks under the capital asset pricing model (CAPM); and ii) whether the CAPM is structurally underestimating the market cost of equity (Market-CoE) for regulated UK utilities, based on estimates under a multi-factor model (MFM). Our key findings are:

1. **Gas vs electricity:** We find evidence that supports a material differential between market pricing of systematic risk of European gas and electricity networks under the CAPM, as evidenced by a differential in the betas for portfolios of gas and electricity companies that persists on a country-specific basis. The value-weighted effect is c.0.03 (equal-weighted c.0.02) on the asset beta which translates to c.37bp (equal-weighted c.24bp) on the CAPM-CoE.
2. **MFM cross-check on the CAPM:** Given the known flaws with the CAPM, MFMs provide one important cross check when moving from the CAPM-estimated cost of equity to the allowed return on equity (Allowed-RoE). We have assessed the evidence provided by a MFM cross check and find that:
    a) The q-factor MFM should be applied when deriving a UK CoE estimate, given its superior performance compared to alternatives such as the Fama-French Five Factor (FF5F) model. Factor returns for the q-factor model are not readily available for the European comparators, hence the MFM cross check is applied to Ofgem's UK comparators only.
    b) For the UK comparators, the difference between a CAPM-CoE and MFM-CoE is 30bp on average (using Ofgem's approach of a 10-year historical estimation period of data with no adjustments for exceptional events).
    c) The finding that the MFM-CoE for the UK comparator set is above the CAPM-CoE is as expected, given the omitted variables in the CAPM, and particularly poor performance of the CAPM for low beta stocks (like utilities).
3. **Suggested impact on gas networks' Allowed-RoE:** Our analysis of the CAPM- and MFM-based estimates summarised above shows that:
    a) There is likely to be a higher cost of equity for regulated gas networks than regulated electricity networks under the CAPM; and
    b) That the CAPM is likely to be underestimating the cost of systematic risk of regulated UK utilities, generally.

This could be captured in gas networks' Allowed-RoE by: i) placing more weight on the beta estimates of the comparator European gas networks and in turn setting a CAPM beta estimate for gas networks above the mid-point of Ofgem's DD comparator set (assuming this is retained), to reflect Finding 1 above that there is likely to be a higher cost of equity for regulated gas networks than regulated electricity networks under the CAPM, and ii) separately, aiming-up above the gas-specific CAPM-CoE to reflect Finding 2 above that the CAPM underprices the systematic risk of regulated UK utilities, generally.

Introduction

On 1 July 2025, Ofgem published its Draft Determination for Electricity Transmission (ET), Gas Transmission (GT) and Gas Distribution (GD) for the next price control period, which runs from 1 April 2026 to 31 March 2031 (RIIO-3).[1]

Consistent with regulatory precedent to date, Ofgem's DD relies upon the Capital Asset Pricing Model (CAPM) to provide a framework for the estimation for the market cost of equity[2]. The CAPM captures systematic risk through a single factor, referred to as beta. In the DD, Ofgem analyses estimates of the equity beta for UK-listed companies National Grid, United Utilities, Severn Trent and Pennon. Ofgem also analyses estimates of the equity beta for Enagas (Spain), Red Electrica (Spain), Terna (Italy) and Snam (Italy). Ofgem places most weight on longer term 10-year timeframes when picking point estimates, with its 0.375 asset beta being the approximate mid-point of its 10-year betas.[3]

In its DD, Ofgem does not consider that there is sufficient evidence to justify an explicit beta premium for gas networks over ET in RIIO-3 and in particular, Ofgem does not consider that the additional risks facing gas investors, such as asset stranding risks, are systematic in nature.[4] Ofgem does not discuss or implement a cross-check based on Multi-Factor Models (MFMs) but does consider other cross checks when forming its overall view on the Allowed-RoE.[5]

Kairos Economic Consulting Limited (Kairos) has been asked by IGEM Future Energy Networks (FEN) to:

- Examine whether there is evidence of a differential between the compensation required by investors for systematic risk in regulated gas versus electricity assets under the CAPM;
- Investigate whether there is evidence to suggest that the CAPM is structurally underestimating the CoE for UK utilities, based on estimates under a MFM; and
- Summarise the findings from our analysis in these slides.

It should be noted that the scope of this analysis is purely focussed upon the parameters within the CAPM and relevant MFMs that capture systematic risk, for the purposes of setting the allowed return on equity for RIIO-3. Whilst it is necessary to adopt other parameters and assumptions at points to provide an illustrative impact on the Market-CoE, these slides should not be interpreted as representing Kairos' assessment or view of the allowed return on equity for RIIO-3, the Market-CoE, the CAPM-based CoE, or MFM-based CoE for the companies in question, or their component parameters (other than those capturing systematic risk within the scope of the analysis). Where possible, we have adopted Ofgem's assumptions within its DD on other parameters, for comparability.

[1] Ofgem, 'Draft Determination – Overview Document' (1 July 2025).
[2] Ofgem, 'Draft Determination – Finance Annex' (1 July 2025) (Ofgem DD), para. 3.3.
[3] Ofgem DD, Finance Annex, para 3.61.
[4] Ofgem DD, Finance Annex, paras 3.62 to 3.64.
[5] Ofgem DD, Finance Annex, paras 3.91 to 3.112 and Table 19.

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I) GAS VS ELECTRICITY
RISK DIFFERENTIAL UNDER THE CAPM

Examining the gas vs electricity systematic risk differential

It was submitted to the CMA as part of the RIIO-2 appeals that gas networks faced higher systematic risk than electricity due to the transition to Net Zero. The CMA acknowledged *'the uncertainty that arose from the Net Zero agenda and the potential for a disproportionately large impact on investors in the gas networks'* [6]. However, the CMA considered that, at the time of the RIIO-2 appeals, there was insufficient market evidence that investors were pricing in a higher risk for gas[7] and that the questions of whether and to what extent gas risk is higher due to the Net Zero and how this should be addressed, could be dealt with in future, when there was more clarity on the role of gas[8].

In its Sector Specific Methodology Decision (SSMD), Ofgem noted that the evidence for a gas premium in European betas was not conclusive, largely because the trend of gas betas being above electricity betas was not supported by the (now excluded) comparator Italgas over a 5-year timeframe.[9] Ofgem has since stated the following updated position in its DD, with regards to whether it considered that there was different systematic risk exposure between gas and electricity:

"...the future of gas networks is less certain [than electricity] with the expectation that customers move away from gas over time...

...we did not think any additional risks identified were systematic, non-diversifiable, and therefore something that consumers should compensate investors in energy networks for. We also did not see that the European comparator evidence gave an unambiguous signal that the market awards gas companies higher betas than electric companies.

We do not propose to adjust the GD and GT betas for asset stranding risk. As we argued in the appeal before the CMA for RIIO-2, we continue to believe that asset stranding risk is non-systematic and therefore diversifiable by investors." [10]

It is noteworthy, in the context of whether investors in gas networks are exposed to higher risk than investors in electricity networks, that under its assessment of the cost of new debt, Ofgem proposes adding a benchmark adjustment for gas of 25 bps to the average of the iBoxx A and BBB non-financial 10+ corporate index, but does not propose an adjustment for ET[11]. This was on the basis that over the 2023-2024 period, analysis of nine issuances from six different issuers across the ET and ED sectors, indicates that, on a simple average basis, the yield at issuance was broadly in line with the benchmark[12]. Yet, during the same period, analysis of 14 issuances from five issuers across the GD and GT sectors shows a yield at issuance that exceeded the benchmark by approximately 23 basis points on a simple average basis[13].

Given that Ofgem has not reflected a difference in systematic risk between gas and electricity networks in the cost of *equity*, we investigate **whether there is evidence to support a difference in systematic risk between regulated gas and electricity networks under the CAPM.**

[6] CMA, Energy Licence Modification Appeals 2021, 'Final Determination: Volume 2A: Joined grounds: Cost of equity' (28 October 2021). (CMA RIIO-2 appeals), para. 5.866.
[7] CMA RIIO-2 appeals, paras. 5.870 and 5.886.
[8] CMA RIIO-2 appeals, paras. 5.867 and 5.888.
[9] Ofgem SSMD, Finance Annex, para 3.200.
[10] Ofgem DD, Finance Annex, paras 1.6, 3.62 to 3.64.
[11] Ofgem DD, Finance Annex, para. 2.20.
[12] Ofgem DD, Finance Annex, para. 2.24.
[13] Ofgem DD, Finance Annex, para. 2.25.

Differences in beta between gas and electricity

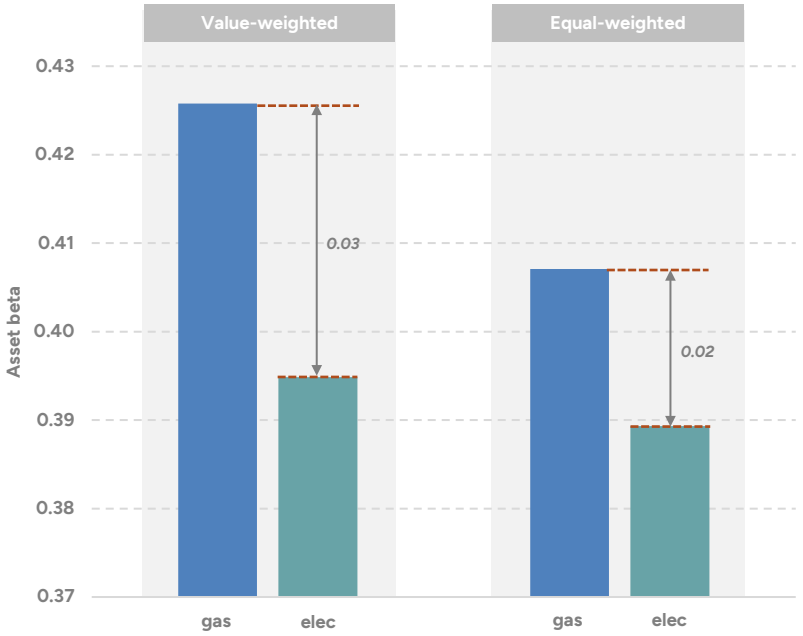
We investigate whether there is a difference in systematic risk between gas and electricity networks under the CAPM by considering beta estimates of European gas and electricity companies in Ofgem's DD comparator set, which are Enagas (ENAG), Red Electrica (REE), Terna (TRN) and Snam (SRG), using returns at a daily frequency over a 10-year estimation period (ending on 31 March 2025). This is consistent with the approach taken by Ofgem in its DD (Ofgem DD, Finance Annex, para 3.53). As the purpose of the analysis is to investigate sector-specific differences between regulated gas and electricity industries, UK comparators within Ofgem's DD comparator set are excluded from the analysis. This is because UU, SVT and PNN are regulated water companies, and NG may not be considered as sufficiently 'pure play' due to significant investments in network businesses overseas.

To investigate the differences in beta between regulated gas and electricity networks, we consider asset beta estimates for two portfolios of gas and electricity companies contained in the comparator set. Focusing on asset betas accounts for differences in gearing between the companies in the portfolios.

The figure opposite shows the range of asset beta estimates for the two portfolios of European gas and electricity companies contained in the comparator set. Importantly, we observe **a difference in the estimates of the asset betas of gas and electricity portfolios of c.0.03 (on a value-weighted basis) and c.0.02 (on an equal-weighted basis)**. We also observe similar differences in the asset betas of gas and electricity comparators in Spain and Italy separately. These intra-country differences in the estimates of beta indicate that there is a difference in systematic risk between gas and electricity networks under the CAPM, which is not the product of potential differences in country-wide regulatory regimes.

Under Ofgem's assessment of the parameters of the CAPM at DD (i.e. using a RFR of 2.01%, TMR of 6.90%, asset beta of 0.375, debt beta of 0.075, and notional gearing level of 60%; Ofgem DD Finance Annex, Table 17), differences of 0.02 and 0.03 in the asset beta amounts to a **24bp and 37bp impact on the CAPM-CoE,** respectively.

Figure: Differences between 10-year daily asset betas of European gas and electricity comparators



Source: LSEG Data and Analytics, Kairos analysis. Notes: 'Gas' represents the portfolio of listed European gas companies in the comparator set (Enagas and Snam) and 'Elec' represents the portfolio of listed European electricity companies in the comparator set (Red Electrica and Terna). Asset betas of the portfolios have been calculated on value-weighted and equal-weighted bases.

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II) MULTI-FACTOR MODEL CROSS CHECK

Introducing MFMs: Shortcomings of the CAPM

Whilst the CAPM is the primary model used for estimating the Market-CoE in UK regulation, it is estimated with considerable uncertainty and has known flaws. Cross checks from alternative models and wider market evidence should therefore be used to test the results. As Fama and French (2004) conclude:

"The version of the CAPM developed by Sharpe (1964) and Lintner (1965) has never been an empirical success. In the early empirical work, the Black (1972) version of the model, which can accommodate a flatter trade-off of average return for market beta, has some success. But in the late 1970s, research begins to uncover variables like size, various price ratios, and momentum that add to the explanation of average returns provided by beta. ***The problems are serious enough to invalidate most applications of the CAPM****." [page 27]*

Importantly, the CAPM is likely to suffer from omitted variables bias and has been proven to perform particularly poorly for low beta stocks:

- **Omitted variables bias:** Under the CAPM, the expected return of any marketable security over the risk-free rate can be determined as a function of the expected return on the market portfolio over the risk-free rate, where the 'loading' on the market portfolio is determined by a single factor – beta. Under the CAPM, investors are only compensated for risk that is correlated with the market portfolio. The underlying rationale is that the market portfolio is the efficient portfolio (i.e. the portfolio that optimises the risk/return trade-off and therefore maximises return for a given level of risk). However, it is likely that the market portfolio is not the efficient portfolio, and investors require compensation for accepting different sources of risk (i.e. not just the risk that is correlated with the market portfolio). In such a world, the CAPM has omitted variables and will not accurately capture expected returns. In academic and investment practitioner circles it has long been established that simply holding the market portfolio does not yield the greatest return for a given level of risk, and that models based on alternative portfolios representing different sources of risk are likely to capture expected returns more accurately. Where this is the case, we would expect such multi-factor models to: i) better explain historical returns and ii) be used by investment practitioners on a forward-looking basis.
- **Poor performance for low beta stocks:** Empirical tests of the CAPM also find that the relationship between beta and returns is flatter than the CAPM would predict. The Brennan model is one solution for this, whereby the flattening is partially corrected by setting the RFR above an appropriate gilt yield. This feature of the CAPM has been further explored by Frazzini and Pedersen (2014), who find that investing in low beta assets compared to high beta assets (i.e. adopting an investment strategy that is long low beta assets and short high beta assets), generates excess returns.[14]

The above shortcomings of the CAPM are particularly important for regulated utilities given that the beta is likely to be less than 1. Given the issues with the CAPM, we consider that cross-checking the CAPM-CoE with an MFM-CoE is an essential cross-check that has, to date, been underutilised in economic regulation. Accordingly, we investigate **whether there is evidence to suggest that the CAPM is structurally underestimating the Market-CoE for regulated UK utilities, based on estimates under a MFM.**

[14]Frazzini, A. and Pedersen, Lasse H., Betting against Beta, Journal of Financial Economics, Volume 111, Issue 1, January 2014, pages 1-25 (Frazzini and Pedersen 2014).

MFM vs CAPM-based CoE estimates

MFMs describe the expected return on an asset with respect to a number of factor portfolios. Tharyan et al. (January 2025)[15] investigate the performance of well-known MFMs by testing the CAPM, Fama-French 5 factor (FF5F), and Hou et al. (2015)[16] q-factor models, in a UK setting. The authors find that testing the models over a 44-year period (from 1980-2024) suggests that the q-factor model has better explanatory power when pricing the cross section of larger UK stock returns than the CAPM and the FF5F. Given these findings, we apply the q-factor to the UK comparators. Factor returns under the q-factor model are not readily available for the European stocks, hence we focus our assessment on the UK comparators only.

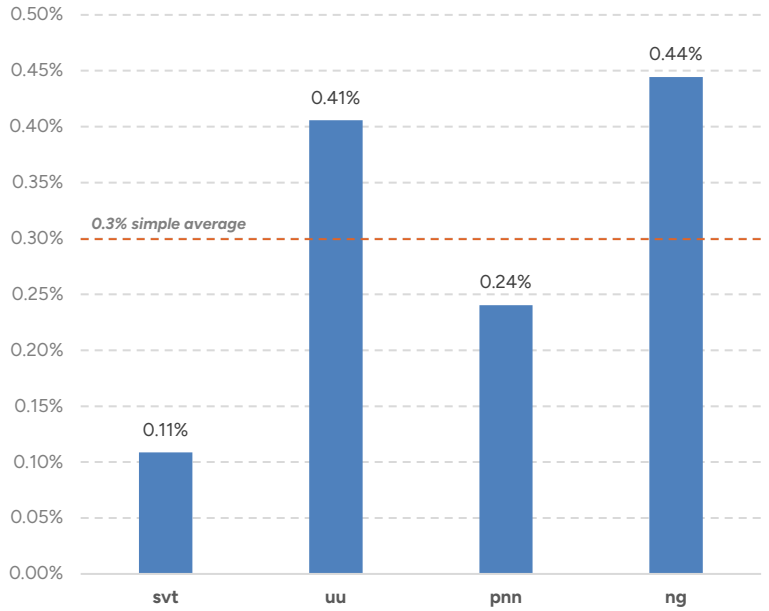
Under the q-factor model, the expected return of an asset in excess of the risk-free rate is described by the sensitivities of its returns to four factors: the market excess return, and the differences between the returns on portfolios of small and large stocks, low and high investment stocks, and high and low profitability stocks. It is important to note that the factor portfolios themselves are not risk factors, but diversified portfolios that provide different combinations of exposures to unknown macroeconomic variables[17].

For each UK comparator, factor loadings are estimated under a regression of excess stock returns against excess market returns and factor returns (which are provided by Northumbria University[15]), using a 10-year period of historical data. Factor premia are estimated under 1-year ex post arithmetic average estimators (with returns on the market portfolio taken to be 6.9%, which is consistent with the estimate proposed by Ofgem in its DD; Ofgem DD Finance Annex, Table 17).

The figure opposite shows the differences between the cost of equity under the q-factor model and CAPM-based approaches at actual levels of gearing for each UK comparator. The materially positive differential across all comparators (0.3% on average) suggests that the CAPM is systematically underestimating the cost of equity for regulated networks in the UK.

N.b.: Kairos consider that the historical period during which the Covid-19 restrictions were in place in the UK was an exceptional event that had a statistically significant impact on the betas of UK water stocks, which should be adjusted for in CoE analysis. Accounting for the effects of Covid on comparators is beyond the scope of our analysis, so the results presented here make no adjustment for the impact of the Covid-19 restrictions, which enables a like for like comparison with Ofgem's DD.

Figure: Differences between MFM- and CAPM-based CoE estimates across listed UK comparators under the q-factor model



Source: LSEG Data and Analytics, Northumbria University, Kairos analysis. Notes: The UK MFM and CAPM-based CoE estimates across comparators use a RFR of 2.01%, a TMR of 6.90%, a debt beta of 0.075, and notional gearing of 60% for consistency with Ofgem's estimates in its DD (Ofgem DD Finance Annex, Table 17).

[15] Northumbria University, 'Risk Factors for the UK' (https://www.northumbria.ac.uk/about-us/academic-departments/newcastle-business-school/nbs-research/responsible-business/risk-factors-for-the-uk)
[16] Hou, K., Xue, C., and Zhang, L. (2015): Digesting anomalies: an investment approach, Review of Financial Studies 28, 650–705.
[17] Fama, French (2015): A five-factor asset pricing model, page 3.

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