Estimating debt beta for regulated entities

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Contents

Figures and tables

Executive summary

In December 2019 and shortly before the appeals of the PR19 Final Determinations to the CMA, the UK Regulators Network (UKRN) published a report authored by CEPA, which discussed four approaches that could be used to estimate debt beta.[1] These four approaches included two regression-based methods, namely 'direct' and 'indirect', as well as the 'structural' method, and the 'decomposition' method.[2]

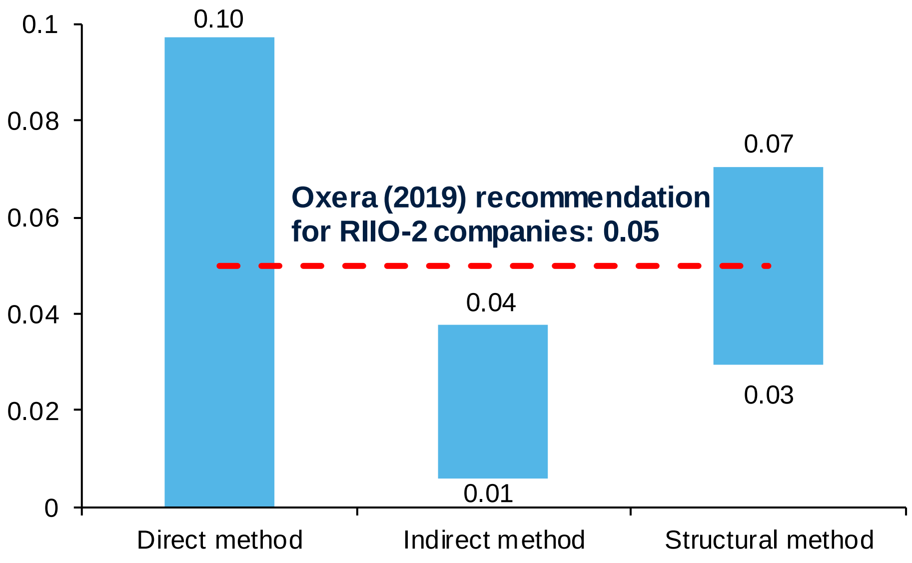
The ENA has commissioned Oxera to review and develop the work undertaken by CEPA. This report has four conclusions, as follows.

- First, methods based on regressions (the direct and indirect methods) and structural models have the advantage of measuring the systematic exposure of debt to market risk. In contrast, the spread decomposition method lacks robust theoretical support and depends on multiple uncertain parameters. The degree of uncertainty over the assumptions required by the spread decomposition approach suggest that it provides little or no incremental evidential value relative to the other approaches. Therefore, regulators should rely on regression-based and structural methods when setting debt beta for a price control.
- Second, methods based on regressions must follow best econometric practice in terms of data inspection and cleaning, model specification, diagnostic testing, and interpretation of results. This is particularly important when working with bond return data, which presents additional challenges compared to equity return data (e.g. heterogenous securities and infrequent trading).
- Third, controlling for interest rate risk is important when estimating debt beta using a regression-based method. Otherwise, the resulting debt beta estimate will capture risks over and above credit risk, resulting in a biased estimate. This was not reflected by CEPA when they compared the methodology used by Schaefer and Strebulaev (2008) i.e. the indirect regression-based approach to the direct regression-based methodology used by PwC and Europe Economics.[3]
- Finally, based on the estimates from the direct and indirect regressions with the corrected version of CEPA's structural method a debt beta assumption of 0.05 for regulated industries would be appropriate.

Estimates of debt beta using the direct and indirect regression-based methods, as well as the structural method, as presented in this report, are summarised in Figure 1 below.[4]

[1] CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December.
[2] CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, p. 7.
[3] CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, pp.7-10.
[4] The direct method involves regressing bond returns on market returns, but this can be extended to include government bond returns. The indirect method involves regressing an issuer's bond returns on (i) the respective issuer's equity returns and (ii) the returns on government bonds. The coefficient on equity returns is subsequently multiplied by the issuer's equity beta to obtain the debt beta estimate. The structural method involves using option-pricing models to estimate a debt beta consistent with the market data.

Figure 1 Summary of evidence on debt beta



Note: The ranges of estimates for the direct method and the indirect method are set out in Figure 2.1 and Figure 2.2. Those for the structured method are set out in Figure 2.4. The red dashed line represents our estimate of the appropriate debt beta assumption for RIIO-2 (0.05), which was set out in our 2019 reports on (i) asset risk premium, debt risk premium and debt betas dated 23 January 2019 and (ii) beta and gearing dated 20 March 2019. The lower bound of the direct method is set to 0, excluding one marginally negative estimate from United Utilities. For completeness, see Figure 2.1.

Source: Oxera analysis

Based on the above evidence we reaffirm that our recommended debt beta assumption of 0.05 remains appropriate for RIIO-2 and for PR19.

Lastly, we respond to the following remarks made by Ofgem with respect to the effect of debt beta on the cost of capital:[5]

> We refer the CMA to the UKRN study on debt beta as published in December 2019, noting also that the CMA may wish to consider the MM [Modigliani and Miller] cross-check as per the NATS reference. If notional gearing and actual gearing are aligned then this could render debt beta moot.

It is important to note that the MM cross-check does not necessarily lead to the correct estimation of the cost of capital parameters. In particular, previous submissions to the CMA have demonstrated the challenges of applying the MM cross-check in the context of regulated utilities (e.g. the treatment of the cost of embedded debt) and the risks that such an approach will lead to misleading conclusions about the cost of equity and the WACC. Therefore, the MM cross-check cannot be considered a replacement for robust estimates of the cost of capital parameters, including the debt beta and the risk-free rate.[6]

[5] Ofgem (2020), ‘Ofwat Price Determinations: Comments on the issues raised in the References’, 11 May, p. 2.
[6] For details, see Oxera (2020), ‘Are sovereign yields the risk-free rate for the CAPM?’, 20 May.

1 Introduction

Historically, regulators such as Ofgem and Ofwat have tended to assume a debt beta of zero when estimating the cost of capital for a regulated entity. In their proposals for the upcoming price controls, both Ofgem and Ofwat have assumed a non-zero debt beta with the working assumption set at 0.125.[7] In a previous report for the ENA, we have shown that Ofgem has misinterpreted some of the underlying evidence when arriving at this working assumption.[8] Therefore, having reviewed Ofgem's evidence we maintained the recommended debt beta of 0.05 for the upcoming RIIO-2 price controls, as initially proposed in our first report on the cost of equity for RIIO-2.[9]

In December 2019 and shortly before the appeal of PR19 Final Determinations to the CMA, CEPA published a report for the UK Regulators Network (UKRN) outlining the four possible approaches that could be used by regulators when estimating a debt beta for price controls.[10] These four approaches are the direct, indirect, structural and decomposition methods.[11]

The ENA have commissioned Oxera to review and develop the work undertaken by CEPA. In this report we examine the relative merits of the four approaches, respond to CEPA's proposals and reaffirm that our recommended debt beta assumption of 0.05 remains appropriate for RIIO-2 and for PR19.

This report is structured as follows:

- Section 1 explores the theoretical relationship between debt beta and cost of capital (section 1.1), how this relationship is applied in practice through equity beta in the context of PR19 and RIIO-2 (section 1.2), and the role of regulatory precedents in determining the debt beta allowance (section 1.3);
- Section 2 examines the different methods of debt beta estimation;
- Section 3 concludes.

1.1 Theory

Debt beta measures the systematic risk of debt returns and, assuming all else equal, increases as the level of gearing increases.

According to Modigliani and Miller (1958), as a company gears up, the asset beta and the WACC will remain constant, as they are each subjected to two opposing effects that offset each other. [12]

- All else equal, an increased proportion of debt financing would reduce the WACC, since the cost of debt is lower than the cost of equity.

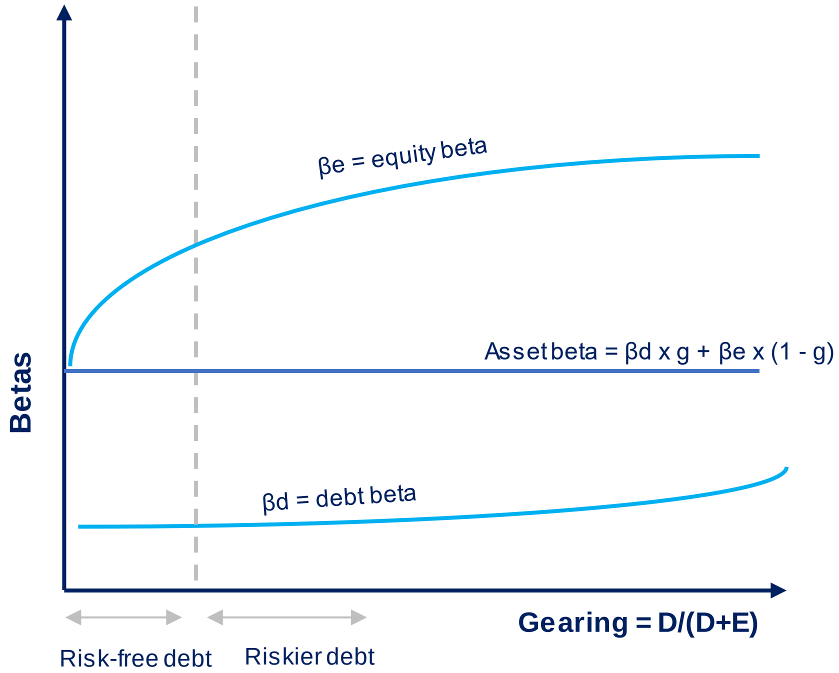
[7] Ofwat (2019), 'PR19 final determinations: Allow return on capital appendix', 16 December, Table 1.1, p.4; and Ofgem (2019), 'RIIO-2 Sector Specific Methodology Decision- Finance Annex', 24 May, Table 8, p.57.
[8] Oxera (2019), 'Review of RIIO-2 finance issues: The estimation of beta and gearing', 20 March, p. 34, section 3.2.5.
[9] Oxera (2018), 'The cost of equity for RIIO-2. A review of the evidence', 28 February.
[10] CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December.
[11] CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, p.7.
[12] Modigliani, F. and Miller, M. H. (1958), 'The Cost of Capital, Corporation Finance and the Theory of Investment', *The American Economic Review*, **48**:3, June, pp. 261–97.

- However, as gearing increases, the firm's equity and debt become riskier, resulting in higher required return on debt and equity and consequently, higher WACC.

Modigliani–Miller (MM) Proposition II predicts that the two effects above will always offset each other.

This is visually depicted in Figure 1.1 below.

Figure 1.1 Relationship between betas and gearing under the MM framework



Note: β_d—the debt beta, β_e—the equity beta. Gearing is defined as D/(D+E), where D is the market value of debt and E is the market value of equity.

Source: Oxera, based on Brealey, R. and Myers, S. (2013), *Principles of Corporate Finance*, 11th edition, McGraw-Hill, Figure 17.2, p. 429.

In the recent NATS appeal, the CMA relied on the MM cross-check to assess the validity of the WACC parameters.[13] It is important to note that the MM cross-check does not necessarily lead to the correct estimation of the cost of capital parameters. In particular, previous submissions to the CMA have demonstrated the challenges of applying the MM cross-check in the context of regulated utilities (e.g. the treatment of the cost of embedded debt) and the risks that such an approach will lead to misleading conclusions about the cost of equity and the WACC. Therefore, the MM cross-check cannot be considered a replacement for robust estimates of the cost of capital parameters, including the debt beta and the risk-free rate.[14]

Academic research has shown how debt beta varies with credit rating.[15] A credit rating is a composite measure of creditworthiness and is affected by

[13] CMA (2020), 'NATS (En Route) Plc/CAA Regulatory Appeal: Provisional findings report', Appendix D, para. 4.
[14] For details, see Oxera (2020), 'Are sovereign yields the risk-free rate for the CAPM?', 20 May.
[15] Schaefer and Strebulaev (2008) showed that debt beta and credit rating are negatively correlated, i.e. on average, all else equal, the lower the credit rating, the higher the debt beta. Note, however, that this is not a precise one-to-one relationship—two individual bonds with the same credit rating can have different debt

gearing and asset risk. Therefore, one would expect companies of a similar or the same credit rating to have similar debt betas.

1.2 How debt beta affects the cost of capital

When setting the cost of capital allowance for a regulated entity, regulators typically set the allowed cost of debt using the yield on a company's debt, or the yield on an index of debt issued by comparable companies. Therefore, debt beta does not directly enter the equation in assessing the allowed cost of debt for a regulated entity.

The assumed debt beta has an impact on the estimation of the cost of capital through the allowed cost of equity. This is because the debt beta affects the calculation of the asset and equity betas for the regulated entity (as shown in below).

The impact on the cost of equity is driven by the difference between the market gearing of the comparators used to estimate the raw equity beta, and the notional gearing ratio assumed by the regulator. Specifically, the debt beta assumption affects both the de-levering and re-levering calculations. If the notional gearing ratio assumed by the regulator is higher than the observed market gearing of the comparators, then any increase in the debt beta assumption will decrease the notional (i.e. allowed) equity beta, and hence the company's cost of equity. On the other hand, if the notional gearing ratio assumed by the regulator is lower than the observed market gearing of the comparators, an increase in the debt beta assumption will increase the cost of equity. The proof of this is shown in Box 1.1 below.

betas. Equally, two individual bonds with the same debt beta can have different credit ratings. See Schaefer, S. M. and Strebulaev, I. A. (2008), 'Structural models of credit risk are useful: Evidence from hedge ratios on corporate bonds', *Journal of Financial Economics*, *90:*1, pp.1–19.

Box 1.1 Impact of debt beta on equity beta

How debt beta relates to asset beta is shown below:

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

$\boldsymbol{g}$ gearing; $\boldsymbol{\beta_d}$ debt beta; $\boldsymbol{\beta_e}$ equity beta; $\boldsymbol{\beta_a}$ asset beta.

From this equation we can see that the debt beta and asset beta are positively related to each other (assuming gearing is greater than zero).

When we re-lever the asset beta to derive the equity beta, we use the following equation:

$$\beta_e = \frac{\beta_a - g \cdot \beta_d}{1 - g}$$

Regulators derive the asset beta using market comparators, and the resulting asset beta is then re-levered at the notional gearing. This can be expressed mathematically as follows:

$$\beta_e^n = \frac{g_m \cdot \beta_d + (1 - g_m) \cdot \beta_e^a - g_n \cdot \beta_d}{1 - g_n}$$

$\boldsymbol{g_m}$ market gearing; $\boldsymbol{g_n}$ notional gearing; $\boldsymbol{\beta_d}$ debt beta; $\boldsymbol{\beta_e^n}$ notional equity beta; $\boldsymbol{\beta_e^a}$ actual or raw equity beta

Differentiating the notional equity beta with respect to debt beta, we obtain:

$$\frac{d\beta_e^n}{d\beta_d} = \frac{g_m - g_n}{1 - g_n}$$

From this, it is possible to see that the impact of debt beta on the notional equity beta depends on whether market gearing is greater (or less) than the notional gearing assumed by the regulator. If the two equal each other than the notional equity beta is not affected by the debt beta assumed by the regulator. The impact that debt beta has on the notional equity beta is independent of the raw equity beta estimated (as can be inferred from the absence of the equity beta in the equation above).

Table 1.1 shows the impact of the debt beta assumed by the regulators on the notional equity beta for both PR19 and RIIO-2. Under both regulatory regimes, the notional gearing ratios assumed by the regulators are higher than the observed market gearing ratios of the comparators, implying that any overestimation of debt beta would underestimate the allowed equity beta and cost of equity.

Table 1.1 Impact of varying levels of debt beta on the notional equity beta

		PR19 (debt beta = 0.05)	PR19 (debt beta = 0.125)	RIIO-2 (debt beta = 0.05)[1]	RIIO-2 (debt beta = 0.125)[1]
Raw equity beta	[A]	0.63	0.63	0.63	0.63
Market gearing	[B]	54.2%	54.2%	43.4%	43.4%
Debt beta	[C]	0.05	0.125	0.05	0.125
Asset beta	[D] = [A] × (1 - [B]) + [C] × [B]	0.32	0.36	0.38	0.41
Notional gearing	[E]	60%	60%	60%	60%
Notional equity beta	[F] = ([D] - [C] × [E]) / (1-[E])	0.71	0.70	0.87	0.84

Note: [1] For RIIO-2, we have not included the EV / RAV and Market Value Factor (MVF) adjustments adopted by Ofgem. We set out the reasons for this in section 3.2.3 and section 3.2.4 of our cost of equity update dated 29 November 2019.

Source: Oxera analysis based on Ofwat (2019), 'PR19 final determinations: Allow return on capital appendix', 16 December, Table 1.1, p.5; Ofgem (2019), 'RIIO-2 Sector Specific Methodology Decision- Finance Annex', Table 8, p. 57; Oxera (2019), 'The cost of equity for RIIO-2: Q4 2019 update', pp. 37–38.

For example, in the context of RIIO-2, assuming that the true debt beta equals 0.05, as suggested by the empirical evidence set out in section 2 of this report and our 2019 report on beta and gearing,[16] a raw equity beta of 0.63 yields a re-levered equity beta of 0.87. If the debt beta is overestimated at 0.125 then the re-levered equity beta would be set at 0.84, implying a potential error of -0.03. This would result in an error of c. -0.23% on the allowed cost of equity and subsequently c. -0.09% on the allowed WACC.[17] Such a discrepancy would translate to a c. £60m yearly impact on the regulated energy sector in the UK, assuming a total RAV of £66bn.[18]

1.3 Regulatory precedents

In its report, CEPA states that given the empirical issues in determining debt beta, it is important to account for past regulatory decisions.[19]

Before using regulatory precedents to set an allowance for debt beta, one should carefully assess the evidence behind these precedents. This includes the robustness of the underlying methodology, the evidence base itself, and the extent to which the conclusions in past regulatory decisions would be supported by current market data.

1.3.1 Approaches used by regulators

Historically, regulators in the UK have used various approaches for estimating the debt beta. These include the following:

- using the debt beta set by the Competition Commission or the CMA in its most recent regulatory determination;
- assuming the same debt beta as in the preceding price control;
- adjusting the debt beta to reflect changes in credit spreads;

[16] Oxera (2019), 'Review of RIIO-2 finance issues: The estimation of beta and gearing', 20 March.
[17] Assuming Ofgem's estimate of the equity risk premium (7.25%) and notional gearing of 60%, as set out in Table 1.1.
[18] £66bn is an approximation of the total RAV of all the regulated energy networks in the UK, based on data from UK regulators, company financial accounts, and the Office for National Statistics.
[19] CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, p.13.

- employing empirical (e.g. regression-based) methods;
- employing the decomposition approach.

We briefly discuss some of the regulatory precedents that have relied on these methods in Box 1.2 and Box 1.3 below.

Box 1.2 Competition Commission and CMA precedents

In the 2007 determination for Heathrow and 2010 determination for Bristol Water, the Competition Commission (CC) used the decomposition approach to estimate the debt beta.[1]

In the 2014 determination for Northern Ireland Electricity (NIE), the CC used the debt beta from the 2010 determination for Bristol Water as a starting point and reduced it to reflect the differences between NIE and Bristol Water. This was to reflect the lower gearing assumed for NIE compared to the CC's previous decision on Bristol Water.[2] As noted previously, debt beta will also vary with factors other than gearing (such as asset risk), which the CC did not consider in its analysis of debt beta.

In the 2020 provisional findings on the NATS-CAA regulatory appeal, the CMA has reconsidered the use of the decomposition approach, choosing not to place any weight on it because the estimates carry significant uncertainties:[3]

> 'NERL's evidence, in our view, illustrated that there was **significant uncertainty** over the ability to measure debt betas using the CAA's approach.' [emphasis added]

Instead, The CMA used the regression estimates produced by NATS's advisors.

The CC or the CMA's decisions on the cost of capital are often given weight in other regulatory determinations by sectoral regulators. For example, in reaching its decision on a debt beta of 0.1 in the RIIO-ED1 price control, Ofgem relied on the 2014 NIE decision by the CC.[4]

Notes: [1] For more detail, see Competition Commission (2007), 'Reference of Heathrow Airport to the Competition Commission', 3 October, Appendix F, p. 24; (2010), 'Bristol Water plc price determination', Appendix N, p. 54. We have also reviewed other Competition Commission or CMA precedents, such as the 2015 determination for Bristol Water. In this determination, the CMA did not undertake a detailed analysis on debt beta. See CMA (2015), 'Bristol Water plc A reference under section 12(3)(a) of the Water Industry Act 1991 Report', March. [2] Competition Commission (2014), 'Northern Ireland Electricity Limited price determination', pp. 13–36. [3] CMA (2020), 'NATS (En Route) Plc/CAA Regulatory Appeal: Provisional findings report', paras 12.114–12.116. [4] Ofgem (2014), 'RIIO-ED1: Draft determinations for the slow-track electricity distribution companies Financial Issues', 30 July, pp.7–8.

Box 1.3 Ofcom precedents

Ofcom has assumed a non-zero debt beta since 2011. Ofcom typically assumes a debt beta estimate of 0.10.[1] This is informed by its previous decisions. Ofcom's initial debt beta assumption of 0.10 was informed by the CC's 2010 Bristol Water determination.[2]

Ofcom's decision to adjust the debt beta is often influenced by analysing two factors—gearing and the prevailing debt premium or credit spread. For example, in 2013, Ofcom increased its debt beta estimate from 0.10 to 0.15 to reflect an increase in the observed debt premium.[3] It then subsequently decreased its debt beta estimate in 2014 due to a fall in the debt premium.[4]

It should be noted that changes in the debt premium do not necessarily result in a change in debt beta; an increase in the debt premium could be driven by other factors such as an increase in the equity risk premium. Ofcom did not consider such factors in its analysis of the debt beta.

Notes: [1] Our research suggests that Ofcom only diverted from this assumption in 2013 for the LLCC Statement. See Ofcom (2016), 'Business Connectivity Market Review', Annex 30, p. 85. [2] Ofcom (2011), 'Wholesale mobile voice call termination', 15 March, para. A8.96. [3] Ofcom (2016), 'Business Connectivity Market Review', Appendix 30. [4] Ofcom (2016), 'Business Connectivity Market Review', Appendix 30.

The precedents from the Competition Commission, the CMA and Ofcom show that caution should be exercised when using regulatory precedents to inform the debt beta assumption for a price control. Therefore, the assumptions underlying each determination may have been derived from a previous determination, and may not be applicable to the case in hand.

2 Methods for estimating debt beta

In its report, CEPA outlines four methods for estimating debt beta. In this section, we discuss each method in turn and provide our response.

2.1 Regression-based methods

CEPA has presented two methods that use regression analysis to estimate debt beta. CEPA terms these methods the 'direct method' and the 'indirect method'.[20]

2.1.1 Direct method

The direct method, as described by CEPA, involves regressing bond returns directly on equity market returns to obtain the debt beta estimate. This method has been mentioned in the determination of allowed debt beta for H7 and RP3 by the CAA and for PR19 by Ofwat.[21] We describe this methodology in Box 2.1 below.

Box 2.1 Direct method

The direct method estimates the coefficients of the following equation:

$$R_d = \alpha + \beta_d \cdot R_m + \varepsilon$$

$\boldsymbol{R_d}$ return on debt; $\boldsymbol{\alpha}$ constant; $\boldsymbol{\beta_d}$ debt beta; $\boldsymbol{R_m}$market returns; $\boldsymbol{\varepsilon}$ error term

This approach is akin to how equity betas are estimated by regulators.

As described by CEPA, there are various methodological considerations when estimating debt beta using the direct method. These include comparators, market index, frequency, estimation window and estimation method.[1]

Ideally, the debt beta estimation methodology would be consistent with the approach adopted when estimating equity beta, i.e. the same estimation window, estimation method and comparators.

However, this may not always be possible due to limitations in the data. For example, bonds are not as liquid and frequently traded as listed shares; therefore, the quality of bond returns data could be lower than that of share price data. As a result, debt beta estimates based on daily returns may be insignificant and/or counterintuitive. Consequently, the debt beta regressions may be improved by using lower frequency data.

Note: [1] CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, p. 8.

CEPA claims that debt beta estimates obtained from the direct method have poor statistical properties, which include low statistical significance, volatility over time, implausible values, and/or low explanatory power of the underlying regression model.[22]

Low statistical significance and/or low explanatory power of the underlying model, as we found in some observations within our sample under the direct

[20] CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, p.7.
[21] Europe Economics (2019), 'The Cost of Capital for the Water Sector at PR19', 17 July and PwC (2019), 'Estimating the cost of capital for H7 and RP3 – Response to stakeholder views on total market return and debt beta', August.
[22] CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, p.7.

method, implies that the standard errors of the estimates are so high that the estimates are not statistically distinguishable from zero. While there is a risk that the regression model has been incorrectly specified or that the underlying data contains some noise, this lack of statistical significance could also be a result of the possibility that debt betas are in fact close to zero. Therefore, an estimation method should not be discarded just because the resulting estimates are statistically insignificant. Indeed, the direct method could be used productively in combination with the other estimation approaches.

Moreover, volatility by itself is not a reason for discarding an estimation method, as the true values of debt betas may be volatile over time. It is unclear if CEPA is of the view that the debt beta should be stable over time.

Finally, with respect to the allegedly 'implausible' estimates produced by the direct method, it is unclear which criteria were used to reach such conclusions. If the criteria were dictated by past regulatory decisions, it is important to examine the robustness of the underlying methods and evidence base, as discussed in section 1.3.

2.1.2 Indirect method

The indirect method described by CEPA is the two-step approach derived from Schaefer and Strebulaev (2008).[23] This is the same method as the one adopted in Oxera's earlier report for the ENA on estimating the appropriate equity and debt betas for the forthcoming RIIO-2 price control.[24]

The first step in this approach is to regress the returns of a company's bond (or portfolio of bonds) against the returns on an index of government bonds (a duration similar to the bond or the portfolio of bonds should be chosen) and the returns on the shares of the same company.[25] The second step is to multiply the coefficient on the company's equity returns (this is the elasticity of debt with respect to equity) obtained from the regression in the first step, by the company's equity beta. This provides an estimate of the debt beta for the company in question.[26] Box 2.2 summarises the indirect method.

[23] CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, p.10 and 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), pp.1-19.
[24] Oxera (2019), 'Review of RIIO-2 finance issues: The estimation of beta and gearing', 20 March
[25] Note that if a company is privately-held i.e. it does not have listed shares, then indirect method cannot be used.
[26] The coefficient on equity returns obtained in the first regression is the elasticity of debt with respect to equity. This is not a debt beta and has to be scaled by the equity beta in order to obtain the debt beta.

Box 2.2 Indirect method from Schaefer and Strebulaev (2008)

The indirect method can be characterised by the following equations:

1. $R_d = \alpha + h_r \cdot R_{sov} + E_e^d \cdot R_e + \varepsilon$
2. $\beta_d = E_e^d \cdot \beta_e$

$\boldsymbol{R_d}$ return on debt; $\boldsymbol{\alpha}$ constant; $\boldsymbol{h_r}$ hedge ratio with respect to interest rate risk; $\boldsymbol{E_e^d}$ elasticity of debt returns with respect to equity returns; $\boldsymbol{R_e}$stock returns; $\boldsymbol{\varepsilon}$ error term; $\boldsymbol{\beta_d}$ debt beta; $\boldsymbol{\beta_e}$ equity beta.

As with the direct method, there are several methodological considerations when using the indirect method. These include frequency and estimation window.

CEPA appears to have misunderstood the Schaefer and Strebulaev (2008) paper, as illustrated by two inaccurate statements.

First, CEPA claims that the authors used simulations of structural models, [27] while in fact the authors calculated the theoretical sensitivities directly using structural methods;

Second, CEPA claims that the authors used bond indices in their regressions.[28] This is incorrect. The authors used a large sample of bonds, and reported the average level of the estimated debt betas grouped by credit rating.

The second statement conceals an important difference between the indirect and direct methods. As described in Box 2.2 above, the regressors used in the indirect method include the equity returns and equity beta of the bond issuer, which will differ across issuers. The indirect method therefore always controls for differences in systematic risk across issuers. In contrast, the direct method, when using the returns on bond indices as the dependent variable, implicitly assumes that all issuers have the same systematic risk. The CEPA report in effect claims that there is no benefit to applying the indirect method instead of the simpler direct method. This is not necessarily correct, as the simpler direct method that uses returns on bond indices (instead of individual bonds) as the dependent variable makes more restrictive assumptions relative to the indirect method, where the debt beta can vary across issuers. This claim belies a fundamental misunderstanding of the indirect method.

With the assistance of Professor Stephen Schaefer, we used the indirect method (replicating the approach from Schaefer and Strebulaev (2008)) when estimating the debt beta for the upcoming RIIO-2 price controls.[29] We estimated the debt beta using bonds from National Grid, United Utilities, Severn Trent and Pennon Group.[30] We concluded that the evidence supported a debt beta assumption no higher than 0.05 for RIIO-2.

The relative merits of the indirect method are discussed below.

First, an advantage of using the direct method over the indirect method is that the direct method can be applied when the issuer does not have listed equity, and therefore where the elasticity of debt returns with respect to equity returns cannot be estimated directly.

[27] CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, p.8.
[28] CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, p.10.
[29] Oxera (2019), 'Review of RIIO-2 finance issues: The estimation of beta and gearing', March.
[30] Oxera (2019), 'Review of RIIO-2 finance issues: The estimation of beta and gearing', March.

Second, the direct method allows the use of an index of bond returns to estimate debt beta. As bond indices effectively increase the sample size, using a bond index could help to improve the statistical robustness of the debt beta estimate. However, as discussed above, the use of a bond index imposes a restrictive assumption that all issuers have the same or similar exposure to systematic risk.

A further difference between the indirect and direct method is controlling for interest rate risk in the estimation of debt beta.[31] The absence of control for interest rate risk is an important limitation of the single variable regression specification assumed by CEPA. Failing to control for interest rate risk in the context of debt beta estimation can lead to omitted variable bias.

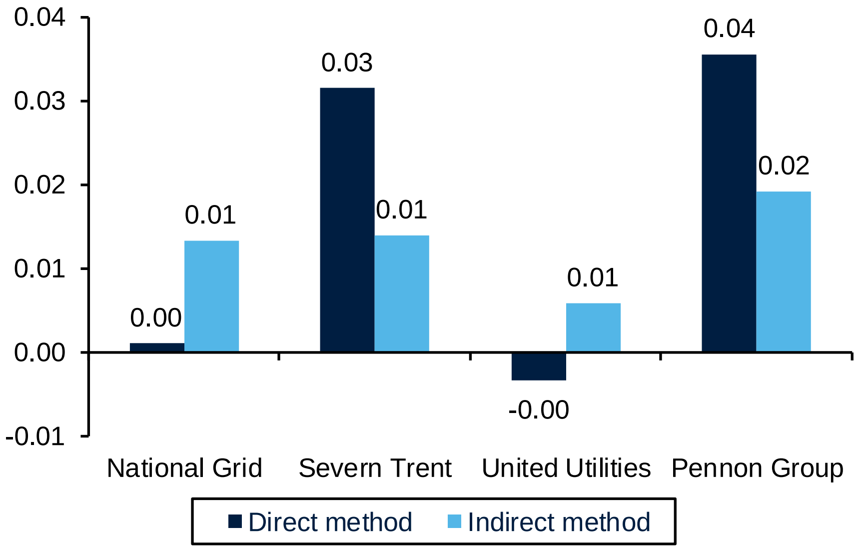
An omitted variable bias arises due to an exclusion of a relevant control variable (in this case, return on government bonds) that is also correlated with one or more of the included explanatory variables (in this case, return on equity market). Because of this correlation, the coefficient does not reflect solely the responsiveness of the dependent variable (in this case, cost of debt) to the respective explanatory variable (in this case, equity market return), but also part of the responsiveness to the omitted variable. Therefore, the estimated coefficient is likely to state a relationship that is different from the true relationship between the dependent variable and the explanatory variable.[32]

However, this does not have to be a fundamental difference between the two methods, since the direct method can be modified to include government bond returns as an additional regressor.

We have expanded our original analysis for the ENA by presenting a sensitivity for the direct method, where we do not control for interest rate risk. We have compared this new sensitivity against the results we presented previously using the indirect method, which controls for interest rate risk.[33] We present the results of our analysis in Figure 2.1 below.

[31] When estimating debt beta, one is looking to isolate the credit risk of the debt instrument from the interest rate risk.
[32] Omitted variable bias is a well-established statistical phenomenon. See, for example Barreto, H. and Howland, F., M. (2006), '*Introductory econometrics using Monte Carlo simulation with Microsoft Excel*', Cambridge University Press, p. 490, Angrist, J., D. and Pischke, J., S. (2008), '*Mostly harmless econometrics: An empiricist's companion*', Princeton University Press, Wooldridge, J., M., (2016), '*Introductory econometrics: A modern approach*', Nelson Education; Greene, W., (2018), '*Econometric analysis*', Pearson.
[33] We analysed the returns on 38 corporate bonds issued by National Grid (22), Severn Trent (9), United Utilities (6) and Pennon Group (1), from 1998 to 2018. For more details, see Oxera (2019), 'Review of RIIO-2 finance issues: Asset risk premium, debt risk premium and debt betas', 23 January.

Figure 2.1 Comparison of direct and indirect methods for debt beta estimates



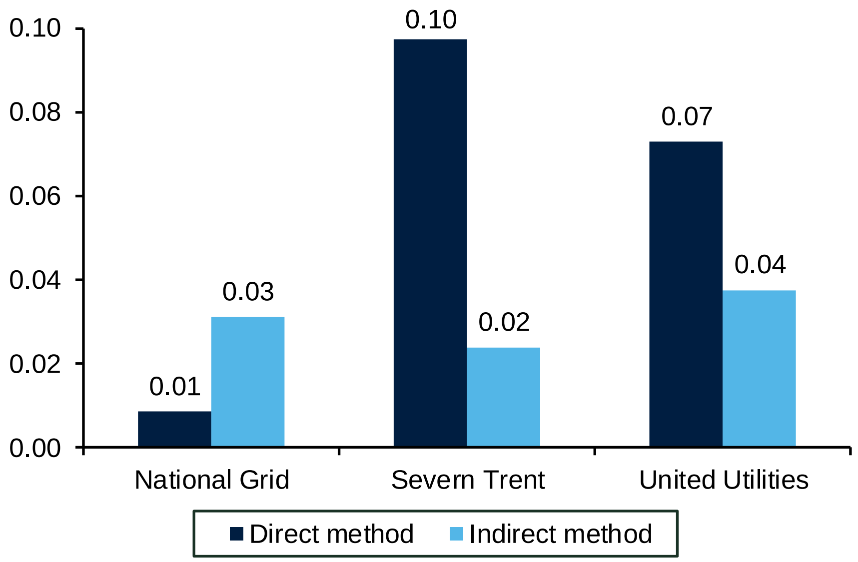
Note: The estimates presented above correspond to averages of debt betas for individual bonds. The analysis is based on 38 bonds, namely 22 for National Grid, nine for Severn Trent, six for United Utilities and one for Pennon Group. Refer to 4.2 section of Oxera report on debt beta dated 23 January 2019 for detailed results.
Source: Oxera analysis, based on Oxera (2019), 'Review of RIIO-2 finance issues: Asset risk premium, debt risk premium and debt betas', 23 January.

It can be seen that the estimates obtained under the direct method can be either higher or lower than those obtained under the indirect method, depending on the underlying company. However, in all cases, the average debt beta estimate across different bonds remains below 0.05, i.e. Oxera's recommended estimate. The relative variability of the debt beta estimates obtained under the direct method is consistent with the possibility that these estimates embed some of the company-specific exposure to interest rate risk. The relative consistency of the indirect debt beta estimates, on the other hand, suggests that once the interest rate risk is controlled for, the sensitivity of debt returns to equity returns appears to be fairly similar across companies.[34]

As highlighted in our previous analysis, a material number of debt beta estimates are statistically indistinguishable from zero.[35] In order to understand the magnitude of debt betas in cases where they are statistically different from zero, we also present the results exclusively for the bonds that exhibit positive and statistically significant debt betas. This is illustrated in Figure 2.2 below.

[34] This does not imply that the systematic risk exposure is similar across the companies. In order to compare the level of systematic risk, one has to examine the whole capital structure by looking at asset betas rather than debt or equity betas in isolation. See Oxera (2019), 'The cost of equity for RIIO-2: Q4 2019 update'.
[35] In particular, out of a total sample size of 38, 14 bonds exhibit a statistically insignificant debt beta.

Figure 2.2 Comparison of direct and indirect methods for debt beta estimates, statistically significant observations only



Note: The estimates presented above correspond to averages of debt betas for individual bonds. The analysis is based on 24 bonds with statistically significant debt betas, namely 13 for National Grid, nine for Severn Trent and two for United Utilities. Refer to 4.2 section of Oxera report on debt beta dated 23 January 2019 for detailed results.
Source: Oxera analysis, based on Oxera (2019), 'Review of RIIO-2 finance issues: Asset risk premium, debt risk premium and debt betas', 23 January.

It can be seen that even within the sample of statistically significant debt betas, the average beta remains below 0.05. Similarly, just like for the whole sample, controlling for interest rate risk makes a non-negligible impact on the debt beta estimates. This implies that regardless of whether a debt beta appears to be statistically significant or not, it is prudent to control for interest rate risk in the regression. Therefore, as discussed above, the direct method should be modified to include government bond returns as an additional regressor.

2.2 Structural methods

CEPA also discusses structural methods.[36] The structural methods rely on the theoretical option pricing models derived by Merton (1974) and Black and Cox (1976).[37] These models can be used to calculate a debt beta based on assumptions about parameters such as gearing, equity volatility and equity beta.

[36] CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, section 2.1.3.
[37] Structural methods developed by Merton (1974) and Black and Cox (1976) and others view debt as a put option on a firm's assets while equity—a call option. The main difference between the Black–Cox model and the Merton model is that the Black-Cox model allows for the possibility of default before the debt matures.

Box 2.3 Structural model methodology

The Merton model can be arranged to obtain debt beta:

$$\beta_d = \frac{(1 - N(d_1))}{g} \cdot \beta_a$$

Where:

$$d_1 = \frac{-\ln(g) - \left(y - \frac{\sigma_a^2}{2}\right) \cdot T}{\sigma_a \cdot \sqrt{T}}$$

$\boldsymbol{g}$ gearing; $\boldsymbol{\beta_d}$ debt beta; $\boldsymbol{\beta_a}$ asset beta; $\boldsymbol{N}$ is the cumulative normal distribution; $\boldsymbol{\sigma_a^2}$ asset variance, $\boldsymbol{T}$ time to maturity of the bond; $\boldsymbol{y}$ credit spread

Asset variance needs to be estimated as it is not directly observable. Schaefer and Strebulaev (2008) have presented ways to estimate the volatility and variance of assets.[1]

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

As described by CEPA, there are two advantages of using structural methods to estimate the debt beta. First, the model has strong theoretical foundations.[38] Second, the model allows for the consistent de-levering and re-levering of debt beta as it specifies the relationship between gearing and debt beta.[39]

CEPA cites three disadvantages of using structural methods.

First, CEPA states that regulators are unfamiliar with using the method.[40] However, regulators have not been averse to introducing new methods and data, and through their actions they have demonstrated that unfamiliarity is not a barrier in practice.

The second disadvantage cited by CEPA is that structural methods do not offer a complete account of credit spreads.[41] However, a complete account of credit spreads is not directly relevant to the evaluation of structural methods for the purpose of estimating debt betas. Instead, CEPA should be assessing whether structural methods capture debt betas well. This was the purpose of the paper by Schaefer and Strebulaev (2008), cited by CEPA.[42] Schaefer and Strebulaev (2008) found that structural models, on average, capture debt betas well.[43] Therefore, this criticism from CEPA is not directed at the issue at hand (i.e. estimation of debt beta).

The final disadvantage cited by CEPA is that structural methods require several assumptions. This is true, however, one can measure directly most of

[38] CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, p.11.
[39] Debt beta and equity beta are both positively correlated with gearing. However, when de-levering and re-levering equity beta for differences in gearing between the target company and comparators used to estimate asset beta, debt beta is typically held constant. This can result in the use of the incorrect debt beta when undertaking this process. CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, p.11.
[40] CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, p.11.
[41] CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, p.11.
[42] Schaefer, S. M. and Strebulaev, I. A. (2008), 'Structural models of credit risk are useful: Evidence from hedge ratios on corporate bonds', *Journal of Financial Economics*, *90*:1, pp.1–19.
[43] Schaefer and Strebulaev (2008) analysed the precision of structural methods by comparing the debt beta obtained by structural methods for various credit ratings and maturities to those obtained using empirical methods. They found that, on average, structural methods did approximate the debt beta obtained empirically through regressions.

the parameters required to estimate debt beta using structural methods. Additionally, another method cited by CEPA, the decomposition approach, requires just as many assumptions as the structural method but has weaker theoretical underpinnings, for the reasons set out in section 2.3. Therefore, it would appear that the structural method is a more robust approach to estimating debt beta than the decomposition approach.

With regard to CEPA's application of the structural method, we have identified two errors in its calculation.

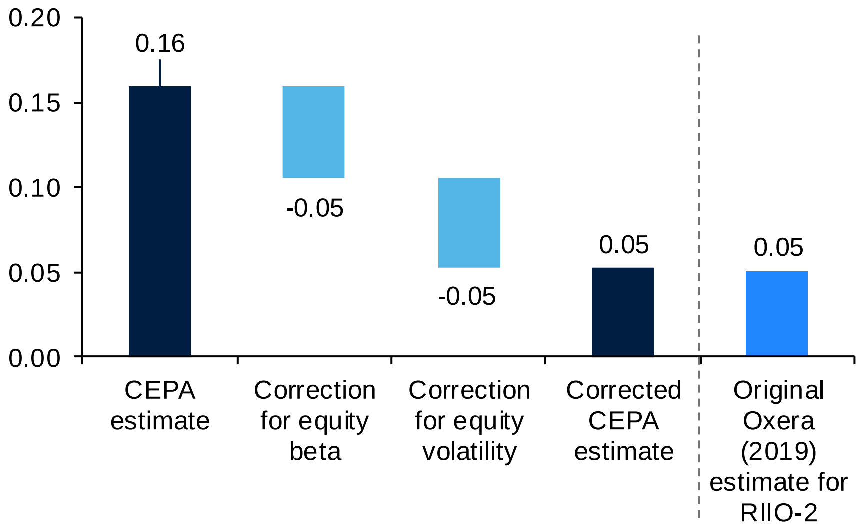
First, as a proxy for the volatility parameter, CEPA has used the volatility of equity returns, not that of asset returns. However, since the model proxies equity as a call on the company's assets, the volatility parameter needs to be set to that of asset returns. Correcting this error decreases CEPA's estimate of debt beta from 0.16 to 0.11.

Second, CEPA has not applied the conversion from asset beta to debt beta correctly. According to Berk and DeMarzo, the asset beta is converted to debt beta using the following equation:[44]

$$\beta_d = \frac{(1 - N(d_1))}{g} \beta_a$$

However, as can be seen from Appendix A of the CEPA report, instead of using the asset beta in the last term, CEPA has used an equity beta estimate.[45] Correcting this mistake further reduces CEPA's debt beta estimate from 0.11 to 0.05, which is in line with Oxera's recommendation for RIIO-2. This is illustrated in Figure 2.3 below.

Figure 2.3 Correcting CEPA's structural debt beta estimate



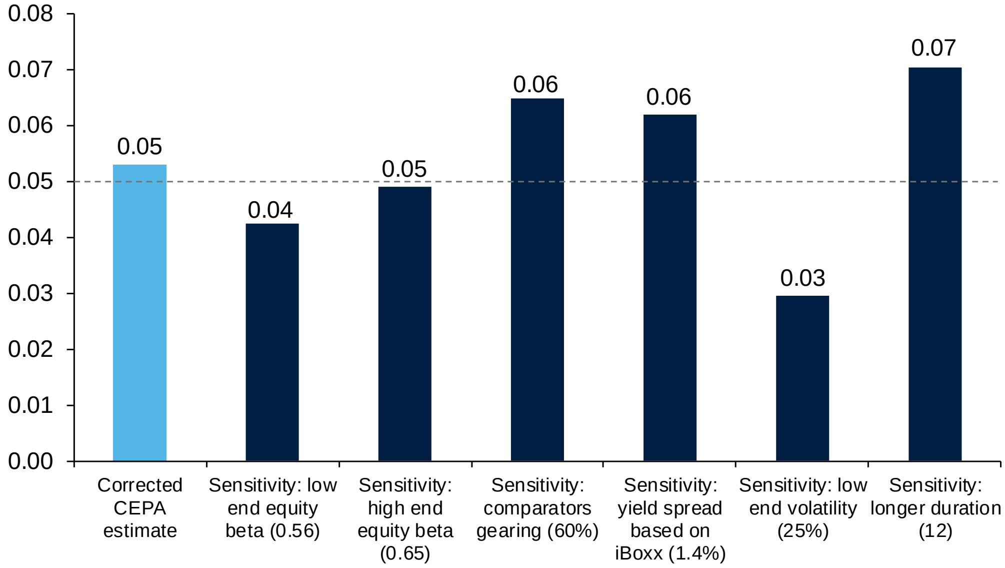
Note: CEPA's original and corrected estimate both assume a gearing of 40%, yield spread of 1%, a time horizon of 10 years, equity volatility of 30% and equity beta of 0.7. We note that CEPA does not disclose how it arrived at the yield spread of 1%.

Source: Oxera analysis based on CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, Appendix A, p. 26.

[44] Berk, J. and DeMarzo, P. (2014), '*Corporate finance. Third edition*', p. 768, equation 21.20.
[45] Oxera analysis based on CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, Appendix A, p. 26.

We have also conducted sensitivity analysis to examine how the structural debt beta estimate varies with key input parameters—this is presented in Figure 2.4.

Figure 2.4 Sensitivity analysis of structural debt beta



Note: CEPA's corrected estimate assumes a gearing of 40%, a yield spread of 1%, a time horizon of 10 years, equity volatility of 30% and equity beta of 0.7. The high end and low end of raw equity betas are based on the two-year and five-year daily betas of the Oxera UK comparator set, which includes National Grid, Pennon Group, United Utilities and Severn Trent. The cut-off date is 30 August 2019. The gearing sensitivity is based on the highest gearing among the Oxera UK comparator set (61% from United Utilities) as of 30 August 2019, rounded to the nearest 5%. The yield spread sensitivity (1.4%) is based on the average spread between iBoxx 10–15 year non-financial A & BBB indices and the average yield on 10–15 year gilts in 2015–20. The equity volatility sensitivity (25%) is based on the annual standard deviation of National Grid's equity returns in 1998–2018 (26.0%). The time horizon sensitivity (12 years) is based on the duration of a comparable generic bond issued by UK water companies, assuming a time to maturity of 15 years, a coupon rate of 4.47% (Ofwat's allowance for nominal cost of embedded debt), and a nominal yield of 1.97% (the average yield on iBoxx 10-15 year non-financial A & BBB indices as of 30 August 2019).

Source: Oxera analysis based on CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, Appendix A, p. 26.

It can be seen that the debt beta estimate is relatively insensitive to most of the sensitivities we have considered, apart from the equity volatility and time horizon. CEPA has not reported their assumed time horizon, but we were able to replicate their results using an assumption of 10 years.

As part of its financial resilience monitoring report from earlier this year, Ofwat notes that '[t]he average debt term across the sector at 31 March 2019 has reduced slightly to 13.8 years compared to 15.1 years in 2018'.[46] However, the term of 13.8 to 15.1 years needs to be adjusted to be used in the structural model. This is because the structural model assumes zero-coupon debt. Therefore, the time horizon in the structural models relates to bond duration and not the bond's term (or maturity).[47]

Since a 13.8-year term is approximately equivalent to a 10-year duration, CEPA's assumption appears to be consistent with Ofwat's evidence.

[46] Ofwat (2020), 'Monitoring financial resilience', January.
[47] In this context, 'duration' stands for Macaulay duration and is defined as the weighted average term to maturity of the cash flows from a bond. The weight of each cash flow is determined by dividing the present value of that cash flow by the bond's price. Since zero-coupon bonds assumed by the structured models only have one repayment at the end of maturity, their maturity is equivalent to their duration.

Note that the values of debt beta presented in Figure 2.4 can only be viewed as sensitivities to the mechanics of the structural model, rather than the debt beta estimates in their own right. This is because some of the input parameters are interrelated, e.g. a change in a company's gearing will likely affect the spread as well. Therefore, using a consistent set of inputs is critical when using a structural model to estimate debt beta.

2.3 Decomposition method

CEPA's final approach is the decomposition approach. This method was used in the Competition Commission's (CC) review of the Heathrow Q5 price control in 2007.[48] The method involves decomposing the debt spread (i.e. the spread between yields on corporate and government bonds) into three components—default premium, default risk premium and liquidity premium. The decomposition method was the main method relied on to derive the debt beta for the recent price controls for PR19 and RP3.[49]

Box 2.4 Decomposition method

When decomposing credit spreads, the Competition Commission used the following formula in its 2007 determination for Heathrow:[50]

$$(LGD + RfR + DP) \cdot p_d + \beta_d \cdot ERP + LP = DP$$

$\boldsymbol{\beta_d}$ debt beta; $\boldsymbol{p_d}$ probability of default; $\boldsymbol{DP}$ debt premium or credit spread; $\boldsymbol{LP}$ liquidity premium; $\boldsymbol{RfR}$ risk-free rate; $\boldsymbol{LGD}$ loss given default; $\boldsymbol{ERP}$ equity risk premium.

This can be rearranged into the following formula:

$$\beta_d = \frac{(1 - p_d) \cdot DP - LP - p_d \cdot (RfR + LGD)}{ERP}$$

We note that Europe Economics used a slightly different formula when implementing the decomposition approach in their reports advising Ofwat on the allowed return for PR19:[51]

$$\beta_d = \frac{(1 - p_d) \cdot (DP - LP) - p_d \cdot (RfR + LGD)}{ERP}$$

The Competition Commission used another variant of the decomposition approach in its 2010 determination for Bristol Water:[52]

$$\beta_d = \frac{DP - LP - Expected\ loss}{ERP}$$

CEPA quotes several advantages of the decomposition method. First, CEPA notes when the CC introduced the debt beta to UK regulation in 2007, the CC observed that the decomposition approach was used by leading academic

[48] Competition Commission (2007), 'Reference of Heathrow Airport to the Competition Commission', 3 October, Appendix F, p.24.
[49] Ofwat (2019), 'PR19 final determinations: Allow return on capital appendix', 16 December, p.55 and Europe Economics (2019), 'Comments on NERA/NERL critiques of Europe Economics' WACC analysis', 6 June, pp.16-20.
[50] Competition Commission (2007), 'Reference of Heathrow Airport to the Competition Commission', 3 October, Appendix F, p.24.
[51] Europe Economics (2019), 'The Allowed Return on Capital for the Water Sector at PR19 – Final Advice', December, p.38.
[52] Competition Commission (2010), 'Bristol Water plc price determination', Appendix N, p.54.

researchers and recommended by Berk and DeMarzo (2007).[53] However, Berk and DeMarzo have since updated their textbook and no longer recommend this method for estimating debt beta. Instead, the authors refer to structural method for estimating company-specific betas and to a mapping between a credit rating and debt beta,[54] as estimated by Schaefer and Strebulaev (2009).[55]

The second advantage cited by CEPA is that the estimates produced by the decomposition approach are less volatile.[56] However, having less volatile estimates is not necessarily an advantage. First, the reduced volatility could be driven by the misspecification of inputs when decomposing the credit spreads. Second, less volatility does not necessarily imply a better estimate, as the underlying debt beta may be changing over time. Therefore, whether stability is a sign of a good approach should be considered when evaluating the merits of the decomposition approach.

CEPA cites three disadvantages with the decomposition approach.

First, CEPA acknowledges that it can be hard to calibrate the parameters.[57] This is not surprising given the number of parameters that need to be estimated, and particularly given the uncertainty associated with measuring these parameters.[58]

The uncertainty associated with the decomposition approach was noted by the CMA in their preliminary decision in the NATS appeal:[59]

> We [CMA] considered that the evidence to support the debt beta was largely speculative. The CAA's analysis was based on regulatory precedent, and an attempt to deconstruct the debt premium [i.e. the decomposition approach]. The reasons for [the] current level of the debt premium, in particular why it is much higher than the premia implied by the debt beta and risk of default, are largely unexplained. NERL's evidence, in our view, illustrated that there was **significant uncertainty over the ability to measure debt betas using the CAA's approach**. [emphasis added]

This led to the CMA putting more weight on the regression estimates provided by NATS's advisors in reaching their draft decision.[60]

The second disadvantage noted by CEPA is that there are conceptual challenges associated with the decomposition approach.[61] This relates to the fact that some of the components used in the decomposition approach may be both systematic and idiosyncratic in nature and the components may be correlated with each other.[62]

The third disadvantage noted by CEPA is that the decomposition approach does not allow one to assess the statistical significance of the debt betas

[53] Competition Commission (2007), 'Reference of Heathrow Airport to the Competition Commission', 3 October, Appendix F, p.24.
[54] Berk, J. and DeMarzo, P. (2014), 'Corporate finance. Third edition', p. 413 and p. 765, example 21.10.
[55] Schaefer, S. M., & Strebulaev, I. A. (2009), 'Risk in capital structure arbitrage. Stanford GSB working paper', as referenced by Berk and DeMarzo.
[56] CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, p.12.
[57] CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, p.12-13.
[58] For example, the liquidity premium estimates reported by CEPA ranges from 0.01bps to 250bps. CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, p.13.
[59] CMA (2020), NATS (En Route) Plc/CAA Regulatory Appeal: Provisional findings report, para 12.115.
[60] CMA (2020), NATS (En Route) Plc/CAA Regulatory Appeal: Provisional findings report, para 12.116.
[61] CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, p.13.
[62] CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, p.13.

obtained.[63] This criticism applies to any approach that does not use statistical methods (i.e. regression analysis) for estimating the debt beta.

Another disadvantage that could be added to those noted by CEPA is that as demonstrated in Box 2.4, there is no agreement between market practitioners on how to implement the decomposition approach. For example, the formula cited by CEPA that is used by Europe Economics differs from the formula used by the CC in 2007 and by the CC in 2010.[64]

As a result of these disadvantages, the decomposition approach could be viewed as an inferior version of the structural methods cited by CEPA. This is because, unlike the decomposition method, structural methods have strong theoretical foundations, have been shown to approximate the regression estimates correctly, and can account for the relationship between gearing and debt beta. Additionally, both approaches require a similar number of parameters to be specified. Therefore, we would recommend that regulators place more weight on the structural method and the regression-based methods than the decomposition approach.

[63] CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, p.13.
[64] The two approaches differ with how one treats the liquidity premium. See CEPA (2019), 'Considerations for UK regulators setting the value of debt beta', 2 December, p.1 and CC F24.

3 Conclusion

In this report we have analysed CEPA's report on estimating debt beta for the UKRN.

When estimating debt beta, we have considered the four methods described by CEPA; direct, indirect, structural and decomposition. We recommend that regulators should place less weight on the decomposition approach due to:

- the lack of robust theoretical underpinnings; and
- the uncertainty associated with the input parameters.

As a result we recommend that regulators focus on using regression-based methods and structural methods for estimating the debt beta for regulated entities.

When applying regression-based methods, it is important to control for interest rate risk. Otherwise, the resulting debt beta estimate would capture risks over and above credit risk, resulting in a biased estimate. Our empirical analysis based on a sample of securities issues by regulated utilities in the UK shows that controlling for interest rate risk has a non-negligible impact on debt betas.

Based on the estimates from the direct and indirect regressions with the corrected version of CEPA's structural method a debt beta assumption of 0.05 for regulated industries would be appropriate.

Lastly, we respond to the following remarks made by Ofgem with respect to the effect of debt beta on the cost of capital:[65]

> We refer the CMA to the UKRN study on debt beta as published in December 2019, noting also that the CMA may wish to consider the MM [Modigliani and Miller] cross-check as per the NATS reference. If notional gearing and actual gearing are aligned then this could render debt beta moot.

It is important to note that the MM cross-check does not necessarily lead to the correct estimation of the cost of capital parameters. In particular, previous submissions to the CMA have demonstrated the challenges of applying the MM cross-check in the context of regulated utilities (e.g. the treatment of the cost of embedded debt) and the risks that such an approach will lead to misleading conclusions about the cost of equity and the WACC. Therefore, the MM cross-check cannot be considered a replacement for robust estimates of the cost of capital parameters, including the debt beta and the risk-free rate.[66]

[65] Ofgem (2020), 'Ofwat Price Determinations: Comments on the issues raised in the References', 11 May, p. 2.
[66] For details, see Oxera (2020), 'Are sovereign yields the risk-free rate for the CAPM?', 20 May.

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