
Are sovereign yields the risk-free rate for the CAPM?

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Executive summary

In the provisional findings for the NATS/CAA regulatory appeal, the Competition and Markets Authority (CMA) states that it has ‘some concerns with the consequences of the standard regulatory approach to ‘re-gearing’’. In particular, the CMA is concerned that:¹

[...] the cost of capital increases by around 0.5% as a result of the assumed higher gearing of NERL (60%) relative to gearing assumption based on the gearing of comparators (30%), which is not consistent with either finance theory or with our [CMA’s] understanding of how actual financing models work.

We will show in this report that the violation of the finance theory cited by the CMA is considerably reduced or eliminated if the risk-free rate is set at more plausible levels than the current underestimates assumed in recent regulatory decisions. Specifically, we show that all else equal, the lower the risk-free rate, the more the WACC exhibits instability with reference to the level of gearing (see section 2). We also examine evidence from academia, finding that the literature suggests that the risk-free rate to be used in the capital asset pricing model (CAPM) should be higher than the yields on sovereign bonds with a high credit rating.

Setting the risk-free rate based on sovereign yields did not lead to underestimation in the previous price controls, as the regulatory allowance for the risk-free rate was consistently set above the spot yields on government bonds (see section 1).

In the latest price controls, regulators have departed materially from regulatory precedent by following UKRN’s recommendation to ‘use the (zero coupon) yield on inflation-indexed gilts at their chosen horizon to derive an estimate of the risk-free rate’.² The CMA’s concern in the NATS/CAA appeal has drawn attention to the consequences of this change in regulatory methodology, and prompted consideration of what is the correct risk-free rate to be used in the CAPM framework.

The CAPM requires the yield on a risk-free asset as an input, but no asset exists that is a perfect estimator of the risk-free rate. Government bonds with high credit ratings are often used as a proxy for the risk-free rate, given the low or negligible default risk for these securities. However, even for highly rated sovereign debt, the academic literature provides two reasons for why the unadjusted spot yields on government bonds cannot be used as a proxy for the risk-free rate in the CAPM framework.

1. A substantial convenience premium for government bonds. Empirical studies show that government bonds possess special safety and liquidity characteristics compared to other securities. This pushes the yields on government bonds below the required rate of return for a zero-beta asset (which is the definition of the risk-free rate in the CAPM setting). Therefore, to be used as a proxy for the risk-free rate, the yields on bonds issued by governments with a high sovereign credit rating would need to be adjusted upwards to remove the impact of the convenience premium. Krishnamurthy and Vissing-Jorgensen (2012) write:³

¹ Competition and Markets Authority (2020) ‘Provisional Findings Report’, Appendix D, para. 4.

² Wright, S., Burns, P., Mason, R. and Pickford, D. (2018), ‘Estimating the cost of capital for implementation of price controls by UK regulators’, (referred to in this report as ‘the UKRN report’), pp. 31–32.

³ Krishnamurthy, A. and Vissing-Jorgensen, A (2012), ‘The Aggregate Demand for Treasury Debt’, *Journal of Political Economy*, **120**:2, April, pp. 233–67.

Treasury interest rates are not an appropriate benchmark for “riskless” rates. **Cost of capital computations using the capital asset pricing model should use a higher riskless rate than the Treasury rate**; a company with a beta of zero cannot raise funds at the Treasury rate. [emphasis added]

According to Feldhütter and Lando (2008), the magnitude of the convenience yield varies over time and can range from 30–90bp.⁴ Similarly, Krishnamurthy and Vissing-Jorgensen (2012) estimated the average of the liquidity component of the convenience yield to be 46bp from 1926 to 2008.⁵

2. The gap between corporate and sovereign risk-free financing rates.

The CAPM assumes that all investors can borrow and lend at the same risk-free rate. However, in reality, even the non-sovereign investors with the highest creditworthiness face higher borrowing rates than those faced by governments.

Berk and DeMarzo have observed that due to the issues above, **‘practitioners sometimes use rates from the highest quality corporate bonds in place of Treasury rates’** [emphasis added].⁶

Empirical analysis shows that between 1998 and 2005,⁷ spreads of AAA-rated corporate bonds relative to government bonds range from 52–176bp. More recently, over the past three to six months, this spread averaged at 75bp and 86bp respectively.

We also note that both considerations apply regardless of whether the cost of equity is estimated for the whole price control or for a particular point in time.⁸

The findings above are also consistent with the approach taken by investment banking analysts. In particular, the majority of equity analysts covering the regulated utilities in the UK have assumed a risk-free rate that exceeds the spot yield on government bonds by 69–214bp, averaging at 102bp.

On balance, based on the assessment of the academic literature and market evidence it is recommended that the risk-free rate is adjusted upwards by **50–100bp**. This upward adjustment should be applied before accounting for ‘the expected risk-free rate increases to mid-RP3.’⁹

Finally, and importantly, any adjustments to the risk-free rate must be applied consistently to all aspects of the regulatory framework. In particular, in the context of RII0-2, the initial risk-free rate used in the cost of equity indexation mechanism has to be adjusted upward by 50–100bp. In contrast, since the cost of debt allowance is based on the trailing average of the iBoxx indices, no adjustments need to be made.

⁴ Feldhütter, P. and Lando, D. (2008), ‘Decomposing swap spreads’, *Journal of Financial Economics*, **88**:2, pp. 375–405.

⁵ Krishnamurthy, A. and Vissing-Jorgensen, A. (2012), ‘The Aggregate Demand for Treasury Debt’, *Journal of Political Economy*, **120**:2, April, pp. 233–67.

⁶ Berk and DeMarzo (2014), ‘Corporate Finance. Third Edition’, p. 404.

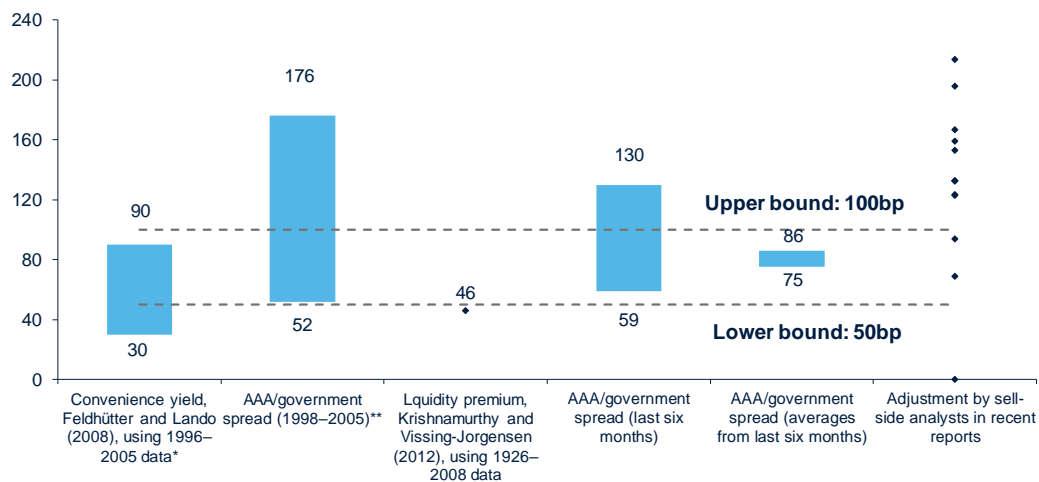
⁷ Feldhütter and Lando (2008) covered the period of 1996 to 2005. However, the data for iBoxx GBP Corporate AAA 15+ index became available on 1 January 1998.

⁸ Feldhütter and Lando (2008) analysed US Treasuries with maturities of 1, 2, 3, 5, 7 and 10 years, and swaps with maturities of 2, 3, 5, 7 and 10 years. The 30–90bp range for convenience yield is based on a 10-year horizon, as this is the only investment horizon for which Feldhütter and Lando report the value of convenience yield over time. However, the average value of convenience yield is consistent across different horizons and ranges from 50 to 57bp. See Feldhütter, P. and Lando, D. (2008), ‘Decomposing swap spreads’, *Journal of Financial Economics*, **88**:2, pp. 375–405, Figure 1 and Table 5.

⁹ The CMA estimates this uplift to be 0.15%. See Competition and Markets Authority (2020) ‘Provisional Findings Report’, para. 12.155 (c).

Figure 1 below summarises the evidence on the adjustment required for the risk-free rate.

Figure 1 Adjustment to government bond yields based on various sources (bp)



Note: The bands represent the low end and high end of the overall range recommended on the basis of all sources. * Feldhütter and Lando (2008) does not fully account for the gap between the risk-free financing rates faced by investors relative to the government, hence the lower bound of this range is not adopted as the lower bound of the overall recommended adjustment to the risk-free rate. ** The iBoxx GBP Corporate AAA 15+ index became available on 1 January 1998. The historical series from 1998 to 2005 are used as a cross-check for the gap between the financing rates faced by investors relative to the government for the time period analysed by Feldhütter and Lando (2008).

Source: Oxera, based on various sources cited throughout the report.

1 Introduction

In the provisional findings for the NATS/CAA regulatory appeal, the Competition and Markets Authority (CMA) states that it has ‘some concerns with the consequences of the standard regulatory approach to ‘re-gearing’’. In particular, the CMA is concerned that:¹⁰

[...] the cost of capital increases by around 0.5% as a result of the assumed higher gearing of NERL (60%) relative to gearing assumption based on the gearing of comparators (30%), which is not consistent with either finance theory or with our [CMA’s] understanding of how actual financing models work

The finance theory that the CMA is referring to is the Modigliani–Miller (MM) proposition that vanilla WACC should be invariant with respect to the level of gearing.

To remedy the issue, the CMA uses an ‘alternative model consistent with MM’¹¹ to solve for the cost of equity, which produces a WACC independent of gearing. The resulting cost of equity is different to the result of a standard calculation involving ‘re-gearing’ of the equity beta, because the CMA’s assumed relationship between gearing and the cost of equity is shallower than in the standard ‘re-gearing’ of the equity beta.

One of the causes of the CMA’s finding that the WACC increases with gearing is the incorrect application of the MM framework. While the CMA’s estimate of the cost of debt includes embedded debt, the MM test should be performed based on the cost of new debt alone. However, even with the correct cost of debt estimate, the issue of the positive relationship between the WACC and gearing persists.

The CMA observes that the violation of the MM proposition is driven by the fact that the market cost of debt includes a certain risk premium that ‘appears to be a systematic or market risk factor and is not therefore diversifiable’¹² and is not accounted for in the CAPM parameters.

The CMA further hypothesises that said premium could be driven by an increase in the liquidity premium or an increase in the debt premium due to ‘the ultra-low returns on government bonds by comparison to historical averages.’¹³

The UKRN report previously acknowledged this issue, recommending to rely on the so-called ‘pure’ CAPM–WACC as a remedy.¹⁴ In the ‘pure’ CAPM–WACC approach, both the cost of debt and cost of equity are estimated using the CAPM.

However, as this analysis shows, simply relying on ‘pure’ CAPM–WACC with no further adjustments fails to account for the risk premia required by investors who hold non-sovereign securities. Thus, the WACC would be underestimated, even if the invariance of WACC to gearing is restored. Therefore, even if pure CAPM–WACC is adopted, **spot** yields on government bonds have to be adjusted when used as a proxy for the risk-free rate in the CAPM.

This report is structured as follows.

¹⁰ CMA (2020) ‘Provisional Findings Report’, Appendix D, para.4.

¹¹ CMA (2020) ‘Provisional Findings Report’, Appendix D, p. 16.

¹² Competition and Markets Authority (2020), ‘NATS (En Route) Plc /CAA Regulatory Appeal: Provisional findings report’, 24 March, Appendix D, para. 13.

¹³ Ibid.

¹⁴ Wright, S., Burns, P., Mason, R. and Pickford, D. (2018), ‘Estimating the cost of capital for implementation of price controls by UK Regulators’, herein referred to as ‘the UKRN report’, p. 23.

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- Section 2 explores the possible causes behind the CMA's observation that WACC increases with gearing, and explains why the underestimation of the risk-free rate is likely to be a main cause.
 - Section 3 explains why the way to resolve CMA's concern about 're-gearing' is to adopt an estimate of the risk-free rate that is higher than the spot yields on government bonds.
 - Section 4 outlines the evidence on the levels of the risk-free rate historically adopted by practitioners and examines how those compare to spot yields on government bonds.
 - Section 5 explains why the issue of the risk-free rate underestimation has not emerged during previous price controls.
 - Section 6 presents evidence on spreads between government bond yields and corporate bonds with low default risk, namely AAA- and AA-rated bonds.
 - Section 7 concludes.
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2 The violation of the Modigliani–Miller proposition highlights an underestimated risk-free rate

In the provisional findings for the NATS/CAA regulatory appeal, the CMA observed that the violation of the MM proposition was caused by '[the] difference between the implied CAPM cost of debt and the actual cost of debt [used in the WACC calculation]'.¹⁵

This said difference was also identified in a report by the UKRN, which observed that the actual cost of debt is typically higher than the CAPM-implied cost of debt due to 'the observed premium element in the cost of debt that is unexplained by the CAPM'.¹⁶ While acknowledging that the regulators in the past have typically calculated the WACC using a combination of the CAPM-implied cost of equity and the market cost of debt (the 'CAPM(E)–WACC' approach), the UKRN paper recommends that the regulators calculate both cost of equity and cost of debt directly using the CAPM framework (the 'CAPM–WACC' approach).¹⁷

In addition to the differences between the actual cost of debt and CAPM-implied cost of debt, the violation of the MM proposition is exacerbated by the CMA's incorrect application of the MM framework. Specifically, the CMA 'weight embedded debt by 54% and new debt by 46% to give a pre-issuance and liquidity cost weighted cost of total debt (real, pre-tax) of 1.06%'.¹⁸

While the CMA's estimate of the cost of debt includes embedded debt, the MM test should be performed based on the cost of new debt alone—the cost of debt raised in the past is irrelevant to the proposition.

This is because the MM analysis assumes that 'the firm borrows at the market rate of interest'.¹⁹ Ofwat also observed this incompatibility between the MM test and embedded debt, noting:²⁰

[...] embedded debt is outside the Modigliani-Miller framework; its inclusion could be expected to result in an upwards-sloping WACC function as gearing increases.

This means that the positive relationship between WACC and gearing observed by the CMA does not in itself violate the second MM proposition.

Figure 2.1 shows that with the weight of new debt set to 100%, the variation of WACC with gearing becomes less pronounced, compared to that under the CMA's original approach.

¹⁵ Competition and Markets Authority (2020), 'NATS (En Route) Plc /CAA Regulatory Appeal: Provisional findings report', 24 March, Appendix D, para. 14.

¹⁶ Wright, S., Burns, P., Mason, R. and Pickford, D. (2018), 'Estimating the cost of capital for implementation of price controls by UK Regulators', herein referred to as 'the UKRN report', p.77.

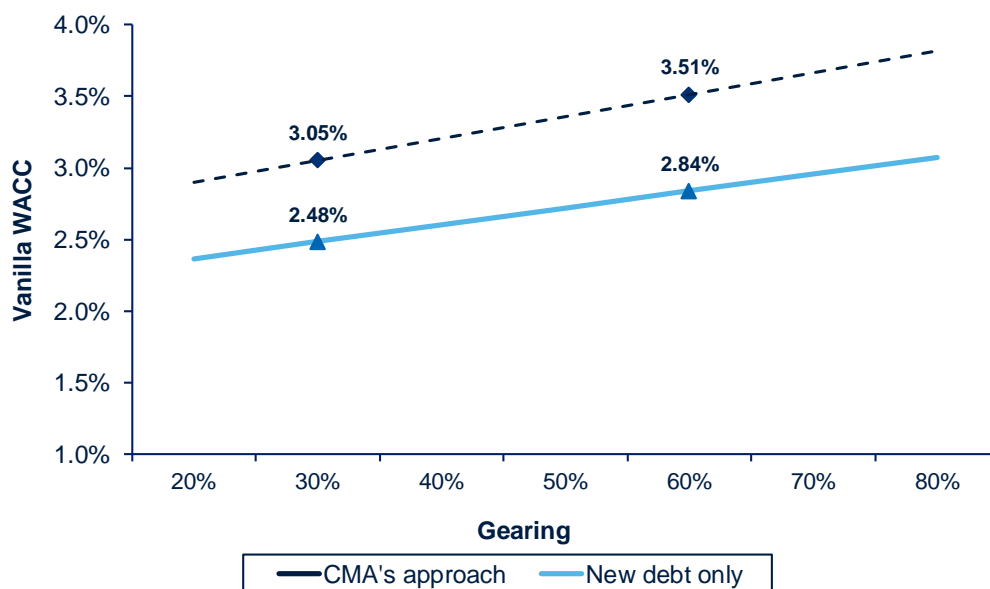
¹⁷ The UKRN report, p. 24.

¹⁸ CMA(2020), NATS (En Route) Plc /CAA Regulatory Appeal - Provisional findings report, 24 March, para. 12.160.

¹⁹ 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. 289, footnote 48.

²⁰ Ofwat (2020), 'Reference of the PR19 final determinations: Risk and return – response to common issues in companies' statements of case', May, para. 3.81.

Figure 2.1 The relationship between the midpoint WACC and gearing for different levels of new debt



Note: The dark blue dots show the WACC under different levels of notional gearing, with other parameter values equal to those adopted by the CMA—including a weight to embedded debt within the cost of debt estimation. The dotted line represents a linear interpolation between the WACC points disclosed by the CMA. The light blue line instead assumes a 100% weight on new debt, with all other parameters remaining the same. The CMA's assumptions are: a risk-free rate of -2.25%, a debt beta of 0.05, a total market return of 5.00% and 6.00% for the low and high scenario respectively, and an asset beta of 0.515 and 0.615 for the low and high scenario respectively. All WACC estimates presented in the chart above are calculated using the midpoint of the CMA's total market return (i.e. 5.50%) and asset beta (i.e. 0.565).

Source: Oxera, based on the CMA's assumptions as set out in Competition and Markets Authority (2020), 'NATS (En Route) Plc /CAA Regulatory Appeal: Provisional findings report', 24 March.

Similar to Figure 2.1, Table 2.1 compares the CMA's approach to the cost of debt with the MM approach, and illustrates the resulting effect on the WACC for different levels of gearing.

Table 2.1 Comparison of the CMA's approach and the MM approach to cost of debt and the resulting effect on WACC

		CMA's approach		MM approach (new debt only)	
Cost of debt		Gearing = 30%	Gearing = 60%	Gearing = 30%	Gearing = 60%
Cost of new debt	[A]			-0.68%	
Cost of embedded debt	[B]			2.55%	
Proportion of new debt	[C]	46.00%	70.00%	100.00%	100.00%
Issuance costs	[D]	0.15%	0.15%	0.00%	0.00%
Cost of debt	CMA: [E]= [A] x [C] + [B] x (1-[C]) + [D] MM: [E]=[A]	1.21%	0.44%	-0.68%	-0.68%
Gearing					
Gearing	[F]	30.00%	60.00%	30.00%	60.00%
Cost of equity					
Cost of equity (CMA high end)	[G]	4.82%	9.82%	4.82%	9.82%
Cost of equity (CMA low end)	[H]	2.93%	6.54%	2.93%	6.54%
Cost of equity (CMA midpoint) ¹	[I]	3.84%	8.12%	3.84%	8.12%
WACC estimates (high)	[J]= [E] x [F]+[G] x (1-[F])	3.74%	4.19%	3.17%	3.52%
WACC estimates (low)	[K]= [E] x [F]+[H] x (1-[F])	2.41%	2.88%	1.85%	2.21%
WACC estimates (midpoint) ²	[L]= [E] x [F]+[I] x (1-[F])	3.05%	3.51%	2.48%	2.84%
% Change in WACC with respect to changes in gearing from 30% to 60%					
High end		+0.45%		+0.35%	
Low end		+0.47%		+0.36%	
Midpoint		+0.46%		+0.35%	

Note: ¹ The midpoint cost of equity estimates are calculated using the midpoint of the CMA's total market return (i.e. 5.50%) and asset beta (i.e. 0.565). ² These figures are presented in Figure 2.1 above. Numbers presented in this table are subject to rounding.

Source: Oxera, based on the CMA's assumptions set out in Competition and Markets Authority (2020), 'NATS (En Route) Plc /CAA Regulatory Appeal: Provisional findings report', 24 March.

It can be observed that the positive relationship between the WACC and gearing still persists, even when the WACC calculation relies on the market cost of new debt only. This suggests that the market cost of debt includes an element that is not accounted for in the CAPM parameters.

The UKRN report acknowledges that the unexplained debt premium, despite being an actual cost that companies face, is omitted under the CAPM-WACC approach:²¹

The "pure" CAPM-WACC does not include the observed premium element in the cost of debt that is unexplained by the CAPM. As a result, it is typically

²¹ Wright, S., Burns, P., Mason, R. and Pickford, D. (2018), 'Estimating the cost of capital for implementation of price controls by UK Regulators', herein referred to as 'the UKRN report', p. 77.

lower than the CAPM(E)-WACC, that uses CAPM to estimate the cost of equity, but uses bond yields to estimate the cost of debt (although in practice for most of the time the two estimates have moved broadly in line). We acknowledge that the unexplained premium component of the cost of debt is a cost companies do face when issuing debt.

The CMA, in turn, acknowledges that ‘the additional [debt] risk premium appears to be a systematic or market risk factor and is not therefore diversifiable’.²²

The CMA further hypothesises that the said premium could be driven by an increase in the liquidity premium or an increase in the debt premium due to ‘the ultra-low returns on government bonds by comparison to historical averages’.²³

As explained in sections 3–6, theoretical and empirical evidence suggests that, after correcting for the CMA’s mistake of using embedded debt when testing the MM proposition, what the CMA considers to be a systematic risk premium is largely, if not wholly, attributable to the risk-free rate parameter being underestimated.

- First, the CAPM assumes that investors can borrow at the risk-free rate. However, even with the best credit ratings, non-government investors cannot access debt at the rate of ILGs.²⁴ In that respect, evidence from academic research shows that to be used as a proxy for the risk-free rate, the spot yields on government bonds need to be adjusted for the following.
 1. A convenience (‘money-like’) premium attached to government bonds that pushes down government yields relative to the risk-free rate (see section 3.1).
 2. The gap between corporate and sovereign risk-free financing rates (see section 3.2).
- Second, the risk-free rates assumed by sell-side analysts covering utilities in the UK are currently almost always higher than the spot yields on government bonds (see section 4).
- Third, empirical evidence shows a sizeable spread between the yields on government bonds and those on bonds with low default risk, namely AAA- and AA-rated corporate bonds (see section 6).

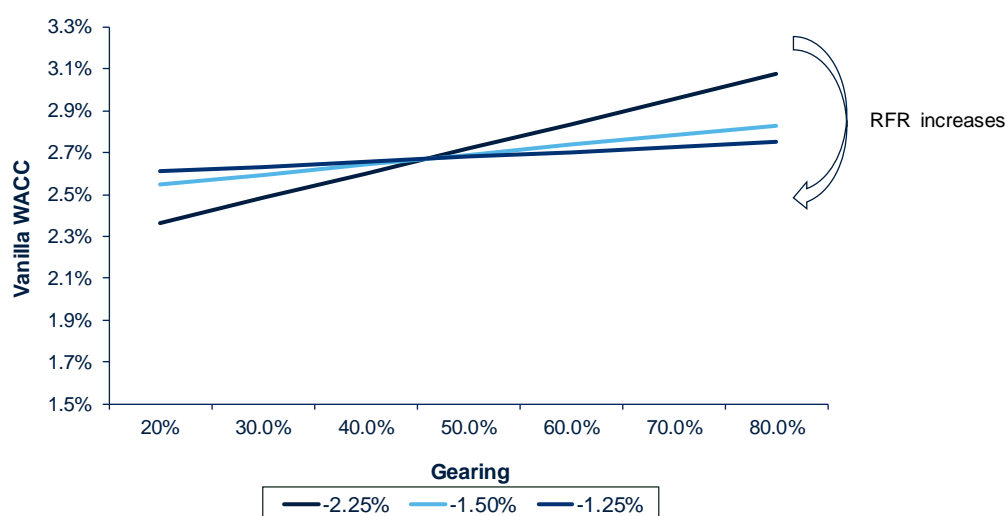
Figure 2.2 shows how the relationship between the WACC (RPI-real) and gearing changes with the risk-free rate assumption. The dark blue line, which adopts the CMA’s risk-free rate of -2.25%, is equivalent to the ‘new debt only’ line in Figure 2.1.

²² Competition and Markets Authority (2020), ‘NATS (En Route) Plc /CAA Regulatory Appeal: Provisional findings report’, 24 March, Appendix D, para. 13.

²³ Competition and Markets Authority (2020), ‘NATS (En Route) Plc /CAA Regulatory Appeal: Provisional findings report’, 24 March, Appendix D, para. 13.

²⁴ Berk and DeMarzo (2014), ‘Corporate Finance. Third Edition’, p. 404.

Figure 2.2 Impact of gearing and risk-free rate on WACC



Note: The graph is based on a real total market return of 5.5%, an asset beta of 0.565, and a constant debt beta of 0.05, and the actual real cost of new debt of -0.68% (as per the CMA preliminary findings). Each line represents the variation of WACC with gearing for different risk-free rate assumptions. Calculations are performed using cost of new debt only. As gearing increases, equity beta also increases as a result of de-levering of the asset beta.

Source: Oxera’s analysis, based on Competition and Markets Authority (2020), ‘NATS (En Route) Plc /CAA Regulatory Appeal: Provisional findings report’, 24 March.

It can be seen that at the low levels of the risk-free rate, the WACC increases with gearing. Moreover, the lower the risk-free rate, the more the WACC will increase with gearing.

This shows that the deviation from the MM proposition would be reduced or eliminated if the risk-free rate were adjusted upwards by an appropriate amount.

For completeness, we have also carefully examined whether the violation of the MM proposition could be resolved by making reasonable adjustments to other CAPM parameters. The details can be found in Appendix A2. In sum, we conclude that, after correcting for the CMA’s mistake of using embedded debt when testing the MM proposition, the underestimation of risk-free rate is likely to be the major, if not the only, factor that has caused the violation of the MM proposition. This conclusion is supported by a combination of theoretical and empirical evidence, as explained in sections 3–5.

In the next section, we explain how the risk-free rate affects the relationship between the WACC and gearing and outline the academic and industry evidence on the appropriate magnitude of the adjustment to the risk-free rate.

3 Adopting a higher risk-free rate: theoretical explanation

As mentioned in section 2, academic literature offers two explanations for why the yields on default-free government bonds would be downward biased estimates of the risk-free rate.

- First, empirical research has found that some government bonds provide additional benefits, referred to by some scholars as the 'convenience yield', over and above their low default probability. Therefore, when purchasing these securities, investors are paying not only for a risk-free asset, but also for the additional benefits associated with these securities.
- Second, the CAPM assumes that all investors can borrow and lend at the same risk-free rate.²⁵ This implies that the risk-free rate proxy in the CAPM has to be adjusted to account for the gap between the risk-free financing rates accessible to corporates and those (lower rates) accessible to governments with a high credit rating.

The next two subsections outline the academic evidence for each of the two points above.

3.1 Convenience premium embedded in government bonds

Feldhütter and Lando (2008) highlight potential drawbacks of using treasury yields as a proxy for the risk-free rate.²⁶ The authors observe that while both Treasury securities and interest rate swaps are the primary instruments for hedging interest rate risk in the mortgage-backed securities (MBS) and corporate bond markets, the difference between swap rates and comparable Treasury yields ('the swap spread') had widened since 1998, implying that there are important differences between the Treasury and swap markets. To understand this difference, the authors deconstruct the swap spread into various components and find a sizeable convenience premium embedded in the price of US treasuries.

Put differently, since investors in Treasuries receive additional benefits relative to equivalent investments in swaps, required returns on Treasuries are reduced relative to the required returns on swaps by the amount that is equal to these additional benefits (i.e. the convenience yield). Feldhütter and Lando (2008) explain the convenience yield as follows:²⁷

The premium is a convenience yield on holding Treasury securities arising from, among other things, (a) repo specialness due to the ability to borrow money at less than the GC repo rates, (b) that Treasuries are an important instrument for hedging interest rate risk, (c) that Treasury securities must be purchased by financial institutions to fulfil regulatory requirements, (d) that the amount of capital required to be held by a bank is significantly smaller to support an investment in Treasury securities relative to other securities with negligible default risk, and to a lesser extent (e) the ability to absorb a larger number of transactions without dramatically affecting the price. [emphasis added]

²⁵ Fama and French (2004), 'The Capital Asset Pricing Model: Theory and Evidence', *Journal of Economic Perspectives*, 18:3, Summer, p. 27.

²⁶ Feldhütter, P. and Lando, D. (2008), 'Decomposing swap spreads', *Journal of Financial Economics*, 88:2, pp. 375–405.

²⁷ Feldhütter, P. and Lando, D. (2008), 'Decomposing swap spreads', *Journal of Financial Economics*, 88:2, pp. 378,

In essence, the convenience premium reflects the money-like convenience services offered by government bonds, which have special safety and liquidity characteristics. For example, government bonds can be used as collateral to raise finance, can be readily exchanged for other assets and securities, and are widely recognised as a store of value among all investors. Investors value these attributes of government bonds and are thus willing to forgo some financial returns in exchange for them. In equilibrium, the willingness of investors to pay for the special safety and liquidity characteristics gives rise to a wedge between the return on safe assets on one hand and that on securities with the same financial payoffs, but no such special attributes, on the other.²⁸ It is also worth noting that in the aftermath of the global financial crisis that began in 2008, central banks around the world purchased large amount of government bonds (as part of the monetary policy referred to as ‘quantitative easing’), significantly reducing the yields on these bonds. As noted in a survey by Fernandez et. al. (2020):²⁹

Due to Quantitative Easing many respondents [finance practitioners] use for European countries a RF [risk-free rate] higher than the yield of the 10-year Government bonds [...]

Feldhütter and Lando (2008) paper provides two important implications for choosing a risk-free rate in the WACC calculation:

- yields on government bonds embed a material convenience yield, ranging from approximately 30–90bp for US Treasuries between 1996 and 2005;
- the convenience yield can materially change over time.

Krishnamurthy and Vissing-Jorgensen (2012) stated that ‘Treasuries in important respects are similar to money’.³⁰ Similarly to money, Treasuries have high liquidity, high security of nominal repayment and are widely accepted as collateral in financial transactions. The authors conclude that:³¹

Treasury interest rates are not an appropriate benchmark for “riskless” rates. **Cost of capital computations using the capital asset pricing model should use a higher riskless rate than the Treasury rate;** a company with a beta of zero cannot raise funds at the Treasury rate. [emphasis added]

In summary, the above evidence suggests that the yields on government bonds are likely to be below the risk-free rate, due to factors such as convenience yield. Therefore, it follows that the risk-free rate appropriate for the calculation of the WACC is likely to be above the yield on government bonds.

3.2 Gap between the corporate and sovereign risk-free financing rates

As mentioned above, the CAPM assumes that all investors can borrow at the same rate risk-free rate. However, in reality, even the non-sovereign investors with the highest credit-worthiness face higher borrowing rates than those faced by the governments with high credit ratings.

²⁸ See Del Negro et. al (2018), ‘Global Trends in Interest Rates’, Federal Reserve Bank of New York Staff Reports, September.

²⁹ Fernandez, P., Apellániz, E. and Acín, J. (2020), ‘Survey: Market Risk Premium and Risk-Free Rate used for 81 countries in 2020’, IESE Business School, 25 March.

³⁰ Krishnamurthy, A. and Vissing-Jorgensen, A (2012), ‘The Aggregate Demand for Treasury Debt’, *Journal of Political Economy*, **120**:2, April, pp. 233–67.

³¹ Krishnamurthy, A. and Vissing-Jorgensen, A (2012), ‘The Aggregate Demand for Treasury Debt’, *Journal of Political Economy*, **120**:2, April, pp. 233–67.

Berk and DeMarzo (2013) also comment on the issue in a section on 'Determining the risk-free rate' in their book *Corporate Finance: Third Edition*. The authors state the following:³²

The risk-free interest rate in the CAPM model corresponds to the risk-free rate at which investors can both borrow and save. We generally determine the risk-free saving rate using the yields on U.S. Treasury securities. Most **investors, however, must pay a substantially higher rate to borrow funds**. In mid-2012, for example, even the highest credit quality borrowers had to pay almost 0.30% over U.S. Treasury rates on short-term loans. Even if a loan is essentially risk-free, this premium compensates lenders for the difference in liquidity compared with an investment in Treasuries. [emphasis added]

Berk and DeMarzo also give the following examples:³³

[...] short-term margin loans from a broker are often **1–2%** higher than the rates paid on short-term Treasury securities. Banks, pension funds, and other investors with large amounts of collateral can borrow at rates that are generally within **1%** of the rate on risk-free securities. [emphasis added]

The authors conclude that:³⁴

As a result, practitioners sometimes use rates from the highest quality corporate bonds in place of Treasury rates. [emphasis added]

In line with Berk and DeMarzo's recommendation, in section 6 we present spreads between the yields on highest quality (i.e. AAA- and AA-rated) corporate bonds and the yields on the UK gilts. We believe that these spreads help to inform the size of the premium that should be added to gilt yields to arrive at the risk-free rate that is appropriate for calculation of the WACC.

³² Berk, J. and DeMarzo, P. (2013), *Corporate Finance: Third Edition*, Pearson, p. 404.

³³ *Ibid.*, p. 398.

³⁴ *Ibid.*, p. 404.

4 The risk-free rate assumed by practitioners

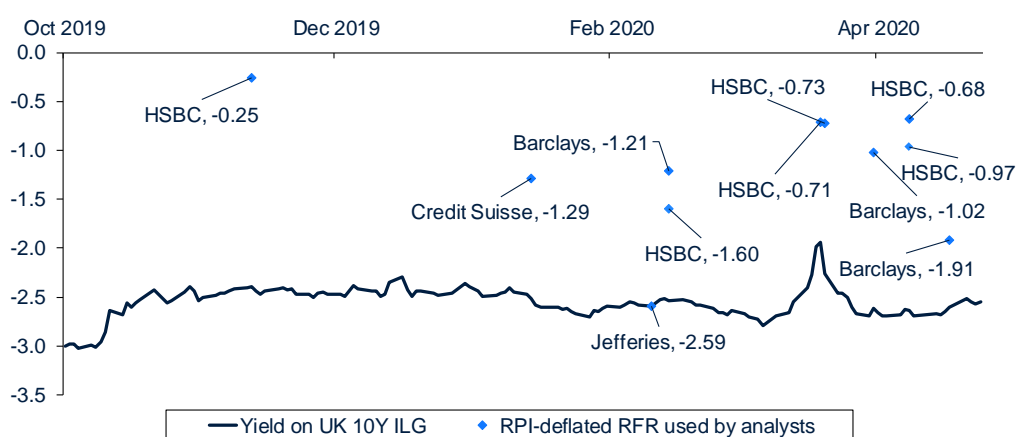
This section presents the evidence on the difference between the risk-free rate assumed by practitioners and the spot yields on government bonds.

Specifically, we consider the assumptions on the risk-free rates featured in sell-side analyst reports on the listed UK comparator companies identified in our report on cost of equity for RIIO-2 dated 29 November 2019.³⁵

Figure 4.1 compares the RPI-deflated risk-free rates adopted by sell-side analysts in their valuation of listed UK regulated businesses against the yields on 10Y ILGs.

We have limited our consideration to publications focused on the UK comparator set that we used to analyse RIIO-2 cost of equity,³⁶ issued over the last six months.³⁷

Figure 4.1 Daily yields on 10Y ILGs and RPI-deflated risk-free rates adopted by sell-side analysts on the Oxera UK comparators



Note: Oxera UK comparators include National Grid, Pennon, United Utilities, Severn Trent and SSE. We used the 10-year tenor of the ILGs as Jefferies and HSBC explicitly disclose using this maturity in their analysis. Barclays and Credit Suisse do not disclose the maturity for the risk-free rate assumed in their analysis.

Source: Jefferies (2020), 'Utilities. When the Facts Change...Upgrade UU to Buy', 10 February; HSBC (2019), 'Pennon Group. Buy: Capital allocation – a point of inflection', 12 November; (2020), 'Pennon Group. Buy: FD accepted, waste purchasers queue up', 14 February; (2020), 'National Grid. Upgrade to Buy: A truly defensive play', 19 March; (2020), 'Pennon Group. Pure play company with Viridor sale', 20 March; (2020), 'SSE. Dividend disruption premium', 8 April; (2020), 'United Utilities. Upgrade to Buy: Financial prudence, high visibility', 8 April; Credit Suisse (2020), 'National Grid. Risk discount dissipating', 14 January; Barclays (2020), 'Pennon Group / Severn Trent. Happy Valentine's Day Ofwat – and could CMA referrals be a match for Ofgem?', 14 February; (2020), 'Severn Trent. Severn Trent in line for 2020 but 2021 may see some downgrades', 31 March; (2020), 'Severn Trent / United Utilities. Ofwat consults on providing temporary liquidity', 17 April.

With one exception (Jefferies), the RPI-deflated risk-free rates adopted by the analysts are consistently and significantly higher than the yields on 10-year ILGs. The difference ranges between 0bp and 214bp and averages at 102bp.³⁸ If a Jefferies report that added no premium to the yield on 10-year government

³⁵ Oxera (2019), 'The cost of equity for RIIO-2'.

³⁶ These include National Grid, Pennon Group, United Utilities, Severn Trent, and SSE.

³⁷ I.e. we have considered reports published between 20 October 2019 and 30 April 2020.

³⁸ The average is calculated as follows: first, the risk-free rates are averaged for each broker (i.e. HSBC, Barclays, Jefferies and Credit Suisse). The resulting estimates are then averaged across all brokers.

bonds were to be excluded from consideration, the risk-free rates adopted by the analysts range between 69bp and 214bp and average at 136bp.

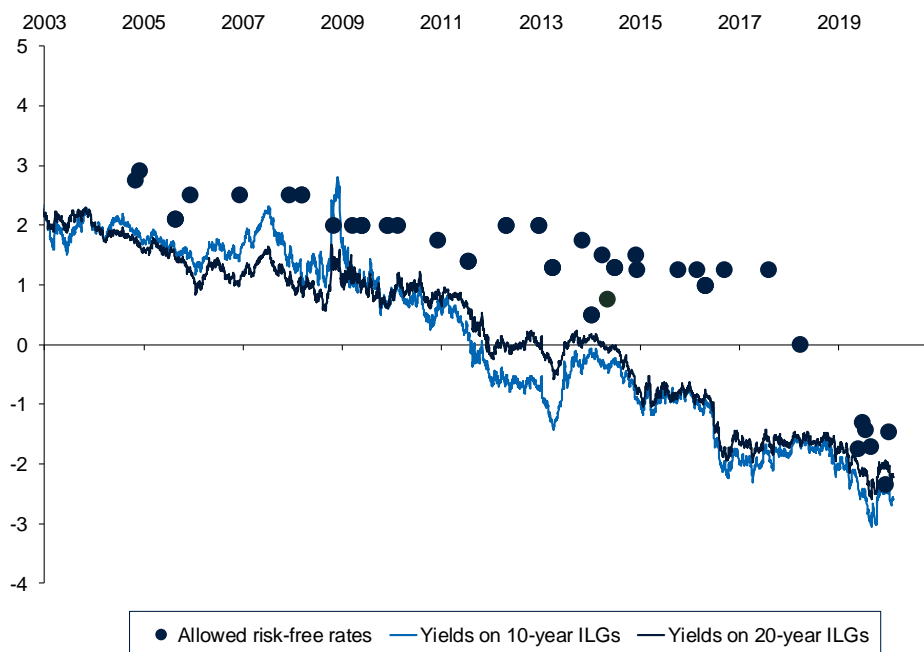
Separately, HSBC explicitly states that to arrive at the risk-free rates used in its cost of capital calculations, it uplifts the yield on 10-year government bonds by 150bp for SSE and the average yield on 10-year and 30-year government bonds by 100bp for Pennon Group.³⁹

³⁹ HSBC (2020), 'Pennon Group. Pure play company with Viridor sale', 20 March; (2020), 'SSE. Dividend disruption premium', 8 April.

5 The risk-free rate in previous determinations

To understand why the issue of underestimation of the risk-free rate was not raised in the past, it is helpful to examine the difference between historical regulatory risk-free rate allowances in the UK and the spot yields on government bonds. This is illustrated in Figure 5.1.

Figure 5.1 Regulatory precedents on the risk-free rate



Source: Oxera analysis based on past regulatory determinations.

It can be seen that prior to 2019, the issue of an underestimated risk-free rate in the CAPM framework did not occur, as the regulatory allowance for the risk-free rate was set above the spot yields on government bonds. The average gap was 149bp over 10Y ILGs and 131bp over 20Y ILGs. The gap, created by what has sometimes been described as the dragging anchor approach, had previously masked the underestimation of risk-free rate.

These allowances were not explicitly set to compensate for the convenience yield and the gap between the corporate and sovereign risk-free financing rates. However, they happened to ensure that the imperfection of the spot sovereign yields as a proxy for the risk-free rate was mitigated.

Absent this dragging anchor approach, the spot rates of the ILGs need to be explicitly adjusted to mitigate the understatement of the risk-free rate under the CAPM framework.

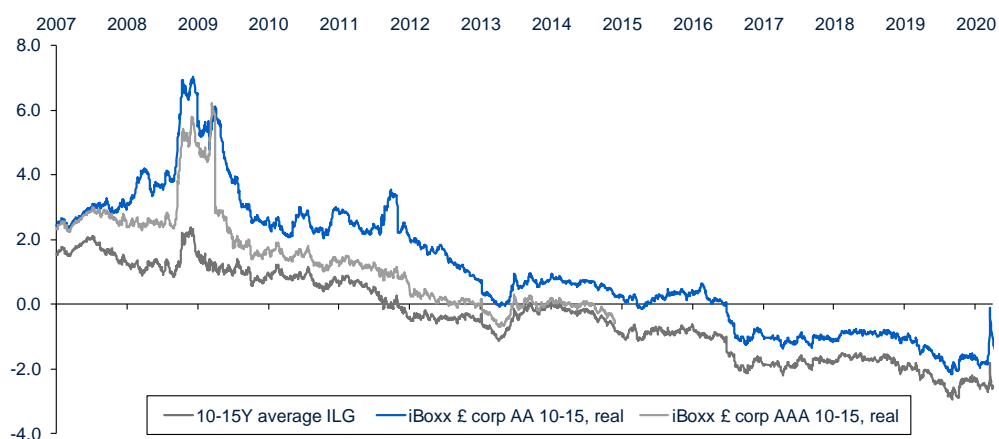
6 Comparison of yields on high-quality corporate bonds with those on government bonds

In line with the recommendation in Berk and DeMarzo (2013), in this section we provide market evidence on the yields of 'highest quality corporate bonds'. In particular, we present the yields on AAA-rated corporate bonds, as well as their spreads over UK ILGs.

We also consider the yields on AA-rated bonds as a cross-check.

Figure 6.1 and Figure 6.2 below show the historical yields of ILGs and iBoxx GBP corporate AA and AAA indices from 2007 to 2020.

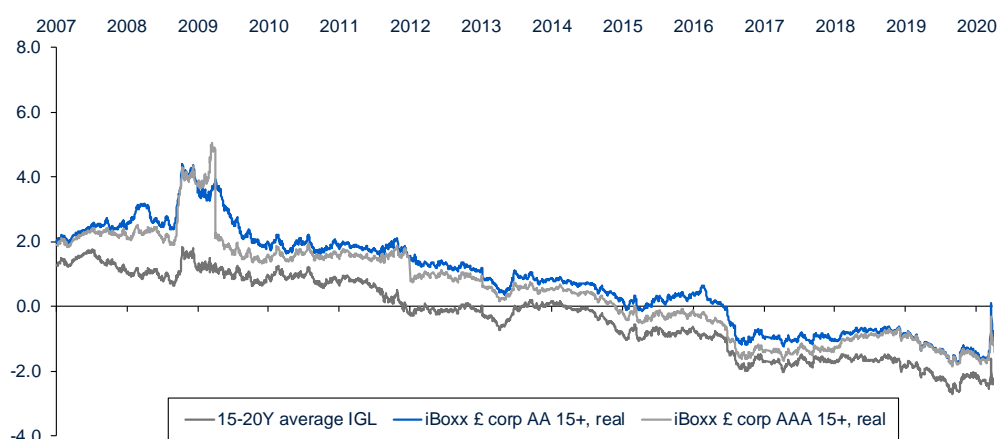
Figure 6.1 Yields on corporate bonds and ILGs: 10–15 year maturities



Note: The yields of iBoxx corporate bond indices are deflated using the average of 10-year and 15-year ILG-implied inflations from the Bank of England. IHS Markit stopped updating the iBoxx AAA 10-15 index in Dec 2014.

Source: Oxera analysis based on data from IHS Markit and Bank of England.

Figure 6.2 Yields on corporate bonds and ILGs: 15–20 year maturities



Note: The yields of iBoxx corporate bond indices are deflated using the average of 15-year and 20-year ILG-implied inflations from the Bank of England.

Source: Oxera analysis based on data from IHS Markit and Bank of England.

To summarise the above findings, we follow the CMA’s approach on the choice of horizon and consider spot yields, a three-month average and a six-month average. The results are presented in Table 6.1 and Table 6.2.

The spreads of iBoxx AAA over government bonds suggest that an appropriate adjustment to the risk-free rate amounts to 75–86bp.

The spreads of iBoxx AA in turn suggest a range of 88–112bp. Since the yields on AA securities could potentially embed a non-negligible default premium, we do not explicitly include this range in our overall assessment and only consider it as a cross-check.

It is also worth noting that due to the impact of the COVID-19 pandemic, the spreads of the spot yields and the three-month averages are generally higher than those of the six-month averages.

Table 6.1 Relevant spot and average yields with maturity of 10–15 years

	Spot	Three-month average	Six-month average
10-15Y ILG average	-2.54%	-2.49%	-2.43%
iBoxx £ corp AAA 10-15, real ¹	n.a.	n.a.	n.a.
Cross-check: iBoxx £ corp AA 10-15, real	-1.42%	-1.42%	-1.55%

	Spread (bp)	Spread (bp)	Spread (bp)
10-15Y ILG average	0	0	0
iBoxx £ corp AAA 10-15, real	n.a.	n.a.	n.a.
Cross-check: iBoxx £ corp AA 10-15, real	112	107	88

Note: The yields of iBoxx corporate bond indices are deflated using the average of 10-year and 15-year ILG-implied inflations from the Bank of England. ¹ IHS Markit stopped updating the iBoxx AAA 10-15 index in Dec 2014. A cut-off date of 30 April 2020 is assumed.

Source: Oxera analysis based on data from IHS Markit and Bank of England.

Table 6.2 Relevant spot and average yields with maturity of 15+ years

	Spot	Three-month average	Six-month average
15-20Y IGL average	-2.38%	-2.31%	-2.24%
iBoxx £ corp AAA 15+, real	-1.63%	-1.44%	-1.47%
Cross-check: iBoxx £ corp AA 15+, real	-1.38%	-1.26%	-1.33%

	Spread (bp)	Spread (bp)	Spread (bp)
15-20Y average IGL	0	0	0
iBoxx £ corp AAA 15+, real	75	86	77
Cross-check: iBoxx £ corp AA 15+, real	100	105	91

Note: The yields of iBoxx corporate bond indices are deflated using the average of 15-year and 20-year ILG-implied inflations from the Bank of England. A cut-off date of 30 April 2020 is assumed.

Source: Oxera analysis based on data from IHS Markit and Bank of England.

7 Recommendations

In its provisional findings on the NATS/CAA regulatory appeal, the CMA states its concern that the model used by regulators for the estimation of the WACC is inconsistent with the MM prediction that the WACC should be invariant to gearing. Specifically, the CMA observed that the estimated WACC would be higher if it used 60% gearing instead of 30% gearing. To remedy the issue, the CMA has proposed to estimate the WACC using the average gearing of comparators (i.e. 30%).

The analysis above demonstrates that, after correcting for the CMA's mistake of using embedded debt when testing the MM proposition, the observed relationship between the WACC and gearing can in large part be explained by an underestimation of the risk-free rate.

The issue of an underestimated risk-free rate in the CAPM framework did not occur in the previous price controls, as the regulatory allowance for the risk-free rate was set above the spot yields on government bonds.

In the latest price controls, regulators have departed materially from regulatory precedent by following UKRN's recommendation to 'use the (zero coupon) yield on inflation-indexed gilts at their chosen horizon to derive an estimate of the risk-free rate'.⁴⁰ The CMA's concern in the NATS/CAA appeal has drawn attention to the consequences of this change in regulatory methodology, and prompted consideration of what is the correct risk-free rate to be used in the CAPM framework.

Evidence suggests that the risk-free rate used in the calculation of the WACC should be adjusted upwards by **50–100bp** to control for the yield impact of the convenience premium embedded in the price of government bonds, as well as any incremental gap between the corporate and sovereign risk-free financing rates more broadly.

This adjustment is derived based on the examination of various sources (see Figure 7.1), including the following.

- According to Feldhütter and Lando (2008), the risk-free rate used in the calculation of the WACC should be adjusted upwards by approximately 30–90bp to control for the convenience yield embedded in the government bonds.⁴¹ Similarly, Krishnamurthy and Vissing-Jorgensen (2012) estimated the average of the liquidity component of the convenience yield to be 46bp from 1926 to 2008. Since these estimates do not account for other factors contributing to the gap between the corporate and sovereign risk-free financing rates, it could be considered conservative.
- Evidence from Berk and DeMarzo (2013) suggests that a practical adjustment to account for the convenience yield as well as the gap between the corporate and sovereign risk-free financing rates is to use market evidence from the highest-quality corporate bonds. In that respect, the spread of AAA-rated corporate bonds relative to ILGs provides a reasonable benchmark.

⁴⁰ The UKRN report, pp. 31–32.

⁴¹ See Feldhütter, P. and Lando, D. (2008), 'Decomposing swap spreads', *Journal of Financial Economics*, **88**:2, pp. 375–405; and Krishnamurthy, A. and Vissing-Jorgensen, A. (2012), 'The Aggregate Demand for Treasury Debt', *Journal of Political Economy*, **120**:2, April, pp. 233–67.

Empirical analysis suggests that between 1998 and 2005,⁴² spreads of AAA-rated corporate bonds relative to government bonds range from 52 to 176bp. More recently, over the past three to six months, this spread averaged to 75 to 86bp respectively.

- Evidence on the difference between the risk-free rate assumed by most sell-side analysts and the yields on government bonds suggests an adjustment ranging from 69–214bp, averaging at 102 bp.⁴³

The upper bound of the recommended range for the risk-free rate adjustment is based on the average difference between the risk-free rates adopted by sell-side analysts covering regulated utilities in the UK and the spot yields on UK gilts (rounded to the closest five basis points).

The high end of historical AAA-rated corporate bond spreads (i.e. 176bp) is not taken into account in the proposed range, because this datapoint is significantly impacted by the dot-com crisis.

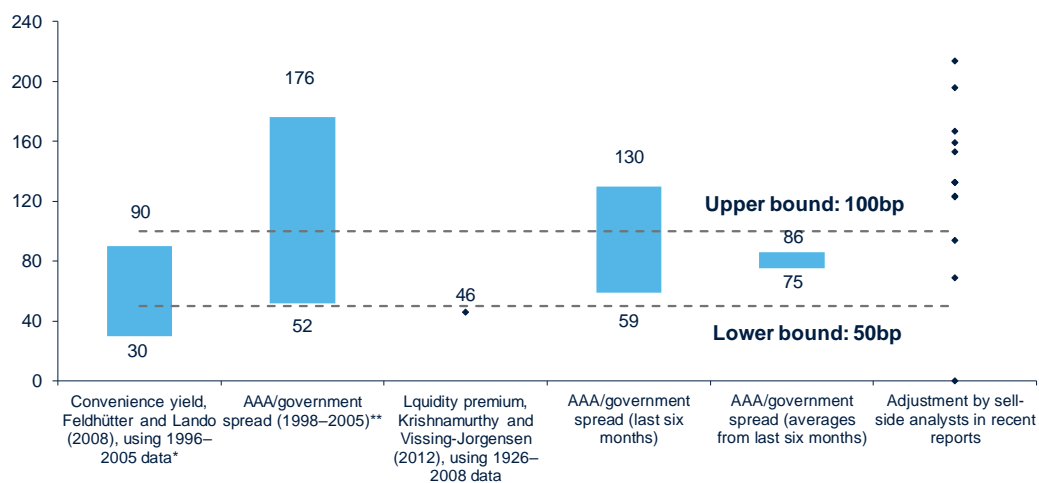
The bottom end of the proposed range is based on the minimum AAA-rated corporate bond spread observed over 1998–2005. The bottom end of the recommended range is set above the low estimate of convenience yield, i.e. 30bp, as the convenience yield does not fully account for the gap between the risk-free financing rates faced by investors and those faced by the government.

Finally, and importantly, any adjustments to the risk-free rate must be applied consistently to all aspects of the regulatory framework. In particular, in the context of RIIO-2, the initial risk-free rate used in the cost of equity mechanism has to be adjusted upward by 50–100bp. In contrast, since the cost of debt allowance is based on the trailing average of the iBoxx indices, no adjustments need to be made.

⁴² Feldhütter and Lando (2008) covered the period of 1996 to 2005. However, the data for iBoxx GBP Corporate AAA 15+ index became available on 1 January 1998.

⁴³ The upper bound of the range represents the average uplift over the spot yields on government bonds applied by sell-side analysts covering regulated utilities in the UK.

Figure 7.1 Adjustment to government bond yields based on various sources (bp)



Note: The bands represent the low end and high end of the overall range recommended on the basis of all sources. * Feldhütter and Lando (2008) does not fully account for the gap between the risk-free financing rates faced by investors relative to the government, hence the lower bound of this range is not adopted as the lower bound of the overall recommended adjustment to the risk-free rate. ** The iBoxx GBP Corporate AAA 15+ index became available on 1 January 1998. The historical series from 1998 to 2005 are used as a cross-check for the gap between the risk-free financing rates faced by investors relative to the government for the time period analysed by Feldhütter and Lando (2008).

Source: Oxera, based on various sources cited throughout this report.

A1 Mathematical proof of WACC invariance to gearing

According to Modigliani and Miller (1958), the WACC remains constant at all levels of gearing under the assumption of perfect capital markets and the absence of corporate and personal taxation.⁴⁴

The rationale is that as a company gears up, the WACC is subjected to two opposing effects that offset each other:

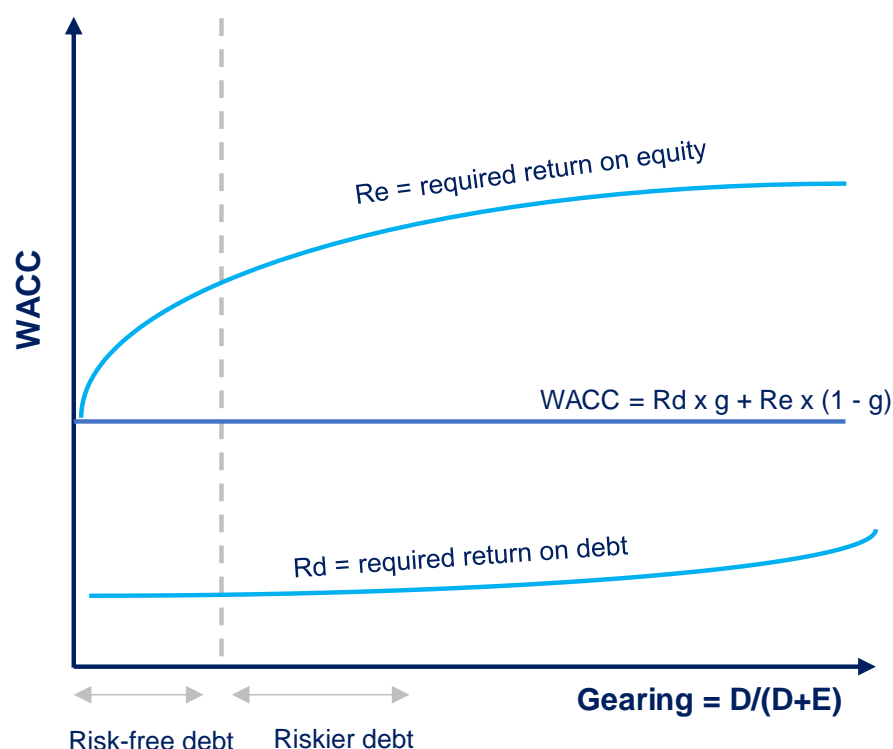
- all else equal, an increased proportion of debt financing decreases the WACC, as debt is cheaper than equity;
- however, as gearing increases, the firm's equity and debt become riskier, which in turn increases the required return on debt and equity.

MM Proposition II predicts that the two effects above will always offset each other. In other words, the savings in WACC made from increasing the proportion of debt financing will be exactly offset by an increase in the required return on debt and equity.

This is visually depicted in Figure A1.1 below.

⁴⁴ 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.

Figure A1.1 Relationship between the WACC and gearing under the MM framework



Note: R_d —cost of debt, R_e —cost of equity. 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.

Mathematically, MM WACC is represented by the following formula:⁴⁵

$$WACC = g \times R_d + (1 - g) \times R_e$$

where g is the level of gearing, R_d is cost of debt, and R_e is cost of equity.

This implies the following relationship between change in gearing and change in WACC:⁴⁶

$$\frac{dWACC}{dg} = R_d - \left(R_f + \beta_d \times (R_m - R_f) \right), \text{ where}$$

β_d is the firm's debt beta, R_m is the total market return and R_f is the risk-free rate, and $R_f + \beta_d \times (R_m - R_f)$ is the CAPM-implied cost of debt.

Therefore, the invariance of WACC to gearing is achieved when the cost of debt equals the CAPM-implied cost of debt.

⁴⁵ Note that throughout this report we use the term 'WACC' to refer to vanilla WACC.

⁴⁶ See appendix A1 for detailed derivation.

The rest of this appendix demonstrates the algebraic and numerical proof of the WACC's invariance to gearing.

$$\text{Vanilla WACC} = g \times R_d + (1 - g) \times R_e$$

Substituting the CAPM model into the required return on equity, we get:

$$\text{Vanilla WACC} = g \times R_d + (1 - g)(R_f + \beta_e \times (R_m - R_f))$$

Since $\beta_e = \frac{\beta_a - g \times \beta_d}{1 - g}$, it follows that:

$$\text{Vanilla WACC} = g \times R_d + (1 - g) \times (R_f + \frac{\beta_a - g \times \beta_d}{1 - g} \times (R_m - R_f))$$

$$\text{Vanilla WACC} = g \times R_d + (1 - g) \times R_f + (\beta_a - g \times \beta_d) \times (R_m - R_f)$$

Differentiating the WACC with respect to gearing:

$$\frac{dWACC}{dg} = R_d - R_f - (\beta_d + \frac{d\beta_d}{dg}) \times (R_m - R_f)$$

It is standard practice to assume that the debt beta is fixed, hence we arrive at:

$$\frac{dWACC}{dg} = R_d - (R_f + \beta_d \times (R_m - R_f))$$

The equation above shows that the WACC is invariant to changes in gearing if the cost of debt equals the required return on debt, as defined by the CAPM.

Table A1.1 demonstrates how using the CAPM-implied cost of debt, while setting the calculations up with a 100% weight on new debt (as indicated by the MM theory), restores the invariance of the WACC to gearing. Specifically, the correct application of the MM test, where the cost of debt is based on the CAPM-implied cost of new debt only, generates the same WACC at 60% gearing as at 30% gearing. However, based on the CMA's risk-free rate assumption, this implies using a CAPM-based cost of debt that is 120bp lower than the actual cost of debt. To address this shortcoming, the risk-free rate assumption needs to be adjusted up in the CAPM-based cost of equity.

Table A1.1 Comparing the variation of the WACC to gearing when using the CAPM-implied cost of new debt

Cost of debt		CAPM-implied cost of new debt	
		Gearing = 30%	Gearing = 60%
Cost of new debt (CAPM-based high)	[A]	-1.84%	-1.84%
Cost of new debt (CAPM-based low)	[B]	-1.89%	-1.89%
Cost of embedded debt	[C]	2.55%	2.55%
Proportion of new debt	[D]	100.0%	100.0%
Issuance costs	[E]	0.00%	0.00%
Cost of debt (high)	[F]= [B] x [D] + [C] x (1-[D]) + [E]	-1.84%	-1.84%
Cost of debt (low)	[G]= [A] x [D] + [C] x (1-[D]) + [E]	-1.89%	-1.89%
Gearing			
Gearing	[H]	30.0%	60.0%
Cost of equity			
Cost of equity (CMA high range)	[I]	4.82%	9.82%
Cost of equity (CMA low range)	[J]	2.93%	6.54%
WACC estimates (high)	[L]= [F] x [H]+[I] x (1-[H])	2.82%	2.82%
WACC estimates (low)	[M]= [G] x [H]+[J] x (1-[H])	1.48%	1.48%

Note: The WACC estimates are calculated using the CAPM-implied cost of new debt. We observe that MM is restored when using the CAPM-based cost of new debt. The assumptions of the CAPM model are based on CMA's inputs in the 'Provisional Findings Report'. Specifically, the CAPM-implied cost of debt is estimated based on the CMA's assumptions of: a risk-free rate of -2.25%, a debt beta of 0.05, and total market return between 5.00% and 6.00% for the low and high scenario respectively.

Source: Oxera, based on the CMA's assumptions as set out in Competition and Markets Authority (2020), 'NATS (En Route) Plc /CAA Regulatory Appeal: Provisional findings report', 24 March.

A2 Why the MM proposition is violated

This section shows that the violation of the MM proposition cannot be resolved by making reasonable adjustments to CAPM parameters other than the risk-free rate. Below, we examine each of these parameters in turn.

A2.1 Total market return

The increase in total market return required to close the gap between the actual and the CAPM-implied cost of new debt appears excessively high. In particular, with debt beta equal to 0.05, it would take a 24-percentage-point increase in total market return to increase the CAPM-implied cost of debt by 121bp.⁴⁷

A2.2 Debt beta

Similarly, empirical analysis shows that the current positive difference between NERL's actual and the CAPM-implied cost of debt is unlikely to be caused by underestimation of debt beta.

As examined in Oxera's multiple reports on RIIO-2 cost of equity,⁴⁸ a debt beta of 0.05 appears to be an appropriate assumption for regulated utilities based on empirical research.

In its provisional findings on the NATS appeal, the CMA also adopted a debt beta of 0.05. However, the MM violation persists even when using a higher debt beta—for example, a debt beta of 0.15, as per Ofgem's high end of the range in RIIO-2.⁴⁹ In this case, the estimated CAPM cost of debt is still 48bp lower than the market cost of new debt, and the WACC increases by 10-14bp as a result of the assumed higher gearing of 60% relative to a gearing assumption of 30%.

Both the CAA and the CMA note that the debt beta required to close the gap between the market cost of debt and the CAPM-implied cost of debt would have to be 'implausibly high'.⁵⁰

A2.3 Conclusion

In sum, a combination of theoretical and empirical evidence suggests that the unexpected positive relationship between gearing and the WACC is likely a result of the low risk-free rate assumption.

⁴⁷ In the CMA's estimation, the CAPM-implied cost of debt for NERL amounts up to -1.89%, while the market cost of new debt amounts to -0.68%. With a debt beta of 0.05, it would therefore take an approximately 24 percentage points (121bp/0.05) increase in the total market return to close this gap.

⁴⁸ See Oxera (2019), 'The cost of equity for RIIO-2 – Q4 2019 update', p. 40; (2019), 'Review of RIIO-2 finance issues. Asset risk premium, debt risk premium and debt betas', 23 January.

⁴⁹ Ofgem proposed a debt beta range of 0.10 to 0.15, and relied on the midpoint of this range, 0.125, as its working assumption for the allowed equity returns in RIIO-2. Ofgem (2019), 'RIIO-2 Sector Specific Methodology Decision- Finance Annex', p. 57.

⁵⁰ CAA (2019), 'UK RP3 CAA Decision Document: Appendices', para. E138.

