PRIVATE AND CONFIDENTIAL

Ofgem
10 South Colonnade
Canary Wharf
London
E14 4PU

Tuesday 26 August 2025

Dear Director,

Estimating the Risk-free Rate for RIIO-3

We attach a copy of the above confidential report dated August 2025 (the "Final Report") prepared by KPMG LLP ("KPMG"). The Final Report was solely prepared for IGEM future Energy Networks ltd.

KPMG has agreed that we may disclose the attached Final Report to you, on the basis set out in this letter, to enable you to verify that a report has been commissioned by us and issued by KPMG in connection with the cost of equity ("CoE") set out in the RIIO-3 Draft Determinations for the Electricity Transmission, Gas Distribution and Gas Transmission sectors ("RIIO-3 DDs"), and to facilitate the discharge by you of your regulatory functions subject to the remaining paragraphs of this letter to which your attention is drawn. KPMG has also agreed that you may publish the Final Report (in full only) on your website pages.

KPMG's work was designed to meet our agreed requirements and the engagement activities were determined by our needs at the time. The Final Report should not be regarded as suitable to be used or relied on by any party other than us for any purpose or in any context.

In consenting to the disclosure of the Final Report to you, KPMG does not assume any responsibility to you in respect of its work for us or for the Final Report. To the fullest extent permitted by law, KPMG accepts no liability in respect of any such matters to you.

If you rely on the Final Report or any part of any of them, you do so at your own risk.

Yours faithfully

James Earl

James Earl, CEO, IGEM future Energy Networks ltd

Estimating the risk-free rate for RIIO-3

Prepared for Future Energy Networks

August 2025

Contents

Important notice

This report has been prepared by KPMG LLP (‘KPMG’, ‘we’ or ‘our’) for IGEM Future Energy Networks Ltd (‘FEN’) on the basis of an engagement contract dated August 2025 between FEN and KPMG (the “Engagement Contract”). FEN commissioned the work to assist FEN in its considerations of the Office of Gas and Electricity Markets (‘Ofgem’) methodology for estimating the allowed cost of equity, as outlined in the RIIO-3 Draft Determination (‘DD’) for the Electricity Transmission, Gas Distribution and Gas Transmission sectors published on 1 July 2025. FEN commissioned the work on its own behalf and on behalf of its members Cadent Gas Ltd, Wales and West Utilities Ltd, Southern Gas Networks plc and National Gas Transmission plc.

The agreed scope of work is included in section 2 of this report. FEN should note that our findings do not constitute recommendations as to whether or not FEN should proceed with any particular course of action. For the avoidance of doubt, it is FEN’s sole responsibility to decide what should be included in their submission to Ofgem. KPMG has not made any decisions for FEN or assumed any responsibility in respect of what FEN decides, or has decided to, include in its submission.

This report is for the benefit of FEN only. It has not been designed to be of benefit to anyone except FEN. In preparing this report we have not taken into account the interests, needs or circumstances of anyone apart from FEN, even though we may have been aware that others might read this report. We have prepared this report for the benefit of FEN alone.

This report is not suitable to be relied on by any party wishing to acquire rights against KPMG (other than FEN) for any purpose or in any context. Any party other than FEN that obtains access to this report or a copy and chooses to rely on this report (or any part of it) does so at its own risk. To the fullest extent permitted by law, KPMG does not assume any responsibility or liability in respect of our work or this report to any party other than FEN.

In particular, and without limiting the general statement above, since we have prepared this report for the benefit of FEN alone, this report has not been prepared for the benefit of any other person or organisation who might have an interest in the matters discussed in this report, including for example other companies or regulatory bodies. Without prejudice to any rights that FEN may have, subject to and in accordance with the terms of engagement agreed between FEN and KPMG, no person is permitted to copy, reproduce, or disclose the whole or any part of this report unless required to do so by law or by a competent regulatory authority.

The market information in this report is based on financial information platforms, datasets, and publicly available sources. Our analysis is based on data available up to 31 March 2025. The analysis in the report reflects prevailing conditions as of this period, all of which are accordingly subject to change. We have not undertaken to update the report for events or circumstances arising after these periods. Although we endeavour to provide accurate and timely information, there can be no guarantee that such information is accurate as of the date it is received or that it will continue to be accurate in the future. Information sources and source limitations are set out in the report. We have satisfied ourselves, where possible, that the information presented in this report is consistent with the information sources used, but we have not sought to establish the reliability or accuracy of the information sources by reference to other evidence. We relied upon and assumed without independent verification, the accuracy and completeness of information available from these sources. KPMG does not accept any responsibility for the underlying data used in this report.

Where our report makes reference to ‘KPMG analysis’ this indicates only that we have (where specified) undertaken certain analytical activities on the underlying data to arrive at the information presented. We do not accept responsibility for the underlying data.

KPMG has not made any decisions for or assumed any responsibility in respect of what FEN, or any individual company within FEN, decides, or has decided to, include in its business plan submission. The findings expressed in this report are (subject to the foregoing) those of KPMG and do not necessarily align with those of FEN.

This engagement is not an assurance engagement conducted in accordance with any generally accepted assurance standards and consequently no assurance opinion is expressed.

1. Executive summary

Ofgem has set the risk-free rate based on 20Y index-linked gilts (ILGs). Modern academic research has found that the ILG yield should be adjusted for the convenience yield (CY) and the difference between investors' risk-free saving and borrowing rates to arrive at the risk-free rate. This report has estimated the risk-free rate in line with modern academic research.

In relation to CY, this reflects the additional benefits that ILGs provide to investors which depress the ILG yield. Diamond and Van Tassel (DVT, 2025) is a Journal of Finance forthcoming paper that bases the CY-free risk-free rate on the discount rate in the put-call parity relationship on stock options. It shows that 2Y UK CY is 29bps and the term structure is upward sloping for most tenors.

There is further evidence that CY should be higher for long-dated ILGs and under current market conditions: (1) there is strong demand from liability-driven investors for long-dated ILGs; (2) the collateral value of gilts vs other maturity-matched safe assets is higher at longer tenors; and (3) DVT observes that CY increases with interest rates and rates in the UK have increased significantly. Despite this evidence, this report conservatively estimates CY for 20Y ILGs of 15.5bps.

In relation to differing risk-free saving and borrowing rates, it is an empirical reality that the risk-free borrowing rate is higher than the risk-free saving rate. Academic research has found that the CAPM risk-free rate lies between these two rates. Ofgem has not considered an adjustment to the ILG yield for this factor, which is conceptually separate to CY. CY is to do with the additional benefits that ILGs provide for investors when investors *buy* ILGs; CY has nothing to do with the inability of investors to *borrow* at the ILG yield. Adjusting for both factors is required by modern academic research.

The CMA at PR19 made an explicit adjustment for differing risk-free saving and borrowing rates. It recognised the potential for CY but did not make an explicit adjustment for this. The approach in this report builds on the CMA's PR19 approach by including explicit adjustments for both; this brings the approach for estimating the risk-free rate closer to the modern academic research.

The CMA at PR19 based the risk-free saving rate on ILGs and the risk-free borrowing rate on AAA corporate bonds. This report bases the risk-free saving rate on ILGs plus CY(ILG). It bases the risk-free borrowing rate on AAA corporate bonds but expressed as ILG yield plus AAA-ILG spread.

The spread between RPI-linked AAA corporate bonds of 5Y duration and duration-matched ILGs over March 2025 is 69bps. Given the AAA-ILG spread is a quality spread, it is expected that the spread at 5Y duration would hold at 20Y duration. If anything, the spread could widen as AAA rated corporates are very unlikely to default in the next 5Y but may have a small chance of default in the next 20Y.

There is evidence that the AAA corporate borrowing rate is an underestimate of investors' risk-free borrowing rate: (1) corporates are backed by hard assets and thus can achieve lower borrowing costs than investors; (2) AAA corporate bonds may bear CY; and (3) Berk and DeMarzo (2020) notes that investor borrowing rates are percentage points (not basis points) higher than Treasury yields.

On this basis, this report estimates a risk-free saving rate of ILG yield plus CY of 15.5bps and a risk-free borrowing rate of ILG yield plus AAA-ILG spread of 69bps. The point estimate of 42bps is slightly below the midpoint of the two which is line with how the CMA estimated the risk-free rate at PR19. Adding 42bps to the 20Y ILG yield over March 2025 results in a risk-free rate of 2.33% in RPI terms.

The RPI-CPIH wedge should reflect a pure expectation of inflation as ILGs are in practice accreted by pure inflation. Official forecasts of inflation can provide such an estimate of the wedge. Ofgem has placed sole weight on official forecasts and estimated a wedge over RIIO-3 of 10bps. This report adopts Ofgem's estimate of the wedge.

Inflating the RPI-real risk-free rate over March 2025 of 2.33% with the RPI-CPIH wedge of 10bps produces a CPIH-real risk-free rate of 2.43%. The table below summarises the overall range and point estimate for the risk-free rate.

Table 1: Overall range and point estimate for the risk-free rate

Component		Index	Formula	Ofgem DD	KPMG		
					Lower	Upper	Point
1m average of 20Y ILG yield		RPI	A	1.91%	1.91%	1.91%	1.91%
Adjustments	CY				0.155%		
	AAA-ILG					0.69%	
	Point	RPI	B	0%			0.42%
Risk-free rate		RPI	C = A+B	1.91%	2.06%	2.60%	2.33%
RPI-CPIH wedge		n/a	D	0.10%	0.10%	0.10%	0.10%
Risk-free rate		CPIH	E = (1+C)*(1+D)-1	2.01%	2.17%	2.70%	2.43%

Notes: Based on a cut-off date of 31 March 2025
Source: KPMG analysis and data from Bank of England

2. Risk-free rate

In July 2025, Ofgem published its Draft Determination (DD) for the RIIO-3 price control for gas and transmission networks. Future Energy Networks has engaged KPMG to assess Ofgem's DD estimate of the risk-free rate and develop its own estimate of the risk-free rate.

The risk-free rate in the CAPM represents the rate of return expected by investors for holding a risk-free asset, i.e. an asset with zero risk. This report on the risk-free rate is structured as follows:

1) It evaluates Ofgem's approach to the risk-free rate.
2) It considers the impact of the convenience yield.
3) It considers the impact of differing risk-free saving and borrowing rates.
4) It evaluates Ofgem's approach to estimating the RPI-CPIH wedge.
5) It sets out the overall estimate for the risk-free rate.

This report has been written in conjunction with Professor Alex Edmans FBA FAcSS.

Professor Edmans is Professor of Finance at London Business School. He is a Fellow of the British Academy, Fellow of the Academy of Social Sciences, a Director of the American Finance Association, and Non-Executive Director of the Investor Forum. From 2017-2022 he was Managing Editor of the Review of Finance, the leading academic finance journal in Europe.

Professor Edmans is a co-author of Principles of Corporate Finance (with Brealey, Myers, and Allen). The UK government appointed him to conduct one study on the alleged misuse of share buybacks and a second one on the link between executive pay and investment.

2.1. Ofgem's approach to the risk-free rate

Ofgem has set the risk-free rate based on the 1m average of 20Y index-linked gilt (ILG) yields plus an RPI-CPIH wedge. Ofgem's estimate of the RPI-CPIH wedge is based on official forecasts of inflation. Ofgem will index the risk-free rate by annually updating it over the price control. Ofgem's estimate of the risk-free rate in the DD based on market data over March 2025 is 2.01%.

Ofgem's approach to the risk-free rate does not reflect modern academic research, such as the presence of the convenience yield and the difference between investors' risk-free saving and borrowing rates. The approach taken in this report to the risk-free rate is a reasonable approximation to that in modern academic research and is straightforward to implement.

2.2. Convenience yield

2.2.1. Relevance of the convenience yield

This section explains the relevance of the convenience yield for estimating the CAPM risk-free rate.

What is the convenience yield

The risk-free rate is used as a measure of the time value of money: the required return for receiving a riskless payoff in the future instead of today[1]. Government bonds like ILGs are commonly used for this benchmark because investors perceive them to be risk-free (i.e. zero chance of default).

However, government bonds provide additional benefits to investors when investors buy government bonds. These benefits create additional investor demand for government bonds and push their return below that implied by the time value of money alone. The difference is the convenience yield (CY).

The additional benefits that government bonds provide to investors include their superior liquidity (see Krishnamurthy and Vissing-Jørgensen, 2012[2]) and the ease with which they can be traded by agents,

1 Van Binsbergen, J., Diamond, W., and Grotteria, M. (2022), 'Risk-free interest rates'.
2 Krishnamurthy, A. and Vissing-Jørgensen, A. (2012), 'The Aggregate Demand for Treasury Debt'.

posted as collateral, satisfy regulatory capital requirements, or perform other roles similar to that of money (see van Binsbergen et al., 2022[3]).

It is not only government bonds that bear CY. For example, physical cash (notes and coins) and cash held in a bank account are both risk-free. However, physical cash earns no return whereas cash held in a bank account earns the deposit rate i.e. physical cash bears CY. This is because physical cash has a superior ability to perform money-like roles as it can be spent immediately. Rational investors are willing to pay for this convenience of using physical cash.

It follows that for ILGs, CY must be added to their return to obtain the estimate of the risk-free rate.

For clarity, adjusting for CY is consistent with the CAPM. The CAPM allows for the existence of a theoretical risk-free asset, but it does not specify that government bonds (which bear CY) must be that asset. The government bond yield, adjusted for CY, gives the CAPM's risk-free rate.

Return on the benchmark asset in the CAPM

There are two approaches for estimating the return on the benchmark asset in the CAPM. The first is to estimate the risk-free rate and the second is to estimate the zero-beta return.

An example of a zero-beta asset is a corporate bond (or stock) whose return is uncorrelated with the market. Corporate bonds typically do not have convenience properties and therefore do not benefit from CY. Thus, the zero-beta return does not require an adjustment for CY.

It is not possible to identify the risk-free rate either where there is no risk-free asset, or the risk-free asset bears CY which cannot be estimated. In either case, the risk-free rate should be replaced with the return on a zero-beta asset, as shown by Black (1972)[4].

The zero-beta asset bears no systematic risk whereas the risk-free asset bears no risk. Hence, the return on the zero-beta will be higher than the risk-free asset as the former bears idiosyncratic risk.

Di Tella et al. (2023) finds that in the US the real zero-beta return[5] is 7.6% higher than the real 1m Treasury bill return per year on average over 1973-2020[6]. The paper comments that *"the average level of the zero-beta rate may seem surprising. But it reflects a well-known fact, going back to Black et al. [1972], who pointed out, in the context of CAPM, that the expected return of an equity portfolio with zero covariance to the market was well in excess of Treasury bill yields"*.

This means that both approaches for estimating the return on the benchmark asset in the CAPM imply a rate that is higher than the gilt yield. In the first case, CY must be added to the gilt yield and in the second case, the zero-beta return is necessarily higher than the gilt yield.

2.2.2. Primary evidence for CY

This section explores primary evidence for CY.

Ofgem estimated the risk-free rate rather than the zero-beta return. Its risk-free rate proxy is the 20Y ILG yield. It considered making an adjustment for CY to its proxy to estimate the risk-free rate.

Ofgem has criticised analysis of CY in RIIO-3 which has based the CY-free risk-free rate on AAA corporate bonds. DVT (2025) is the leading academic research on CY[7]. DVT (2025) bases the CY-free risk-free rate on the discount rate in the put-call parity relationship on European stock options.

The primary approach for estimating CY in this report starts from DVT (2025). The focus on DVT (2025) as the primary approach for estimating CY addresses Ofgem's criticism of the use of AAA corporate bonds. Ofgem has already recognised estimates of CY in DVT (2025)[8]. AAA corporate bonds form a cross-check in this report as they were used in earlier academic research.

3 Van Binsbergen, J., Diamond, W., and Grotteria, M. (2022), 'Risk-free interest rates'.
4 Black, F. (1972), 'Capital Market Equilibrium with Restricted Borrowing'.
5 The zero-beta return is not tenor-specific because equities are assumed to have a flat term structure. The implication is that the zero-beta return can be used to set the allowed return at both short and long investment horizons.
6 Di Tella, S., Hebert, B., Kurlat, P., and Wang, Q. (2023), 'The Zero-Beta Interest Rate'.
7 DVT (2025) is a Journal of Finance forthcoming paper and is based on the methodology in van Binsbergen et al. (2022) which was a lead article in the Journal of Financial Economics.
8 Ofgem (2025), RIIO-3 Draft Determination - Finance Annex, para. 3.32.

DVT (2025) estimates CY for 2Y UK nominal gilts (NGs) of 29bps. To apply this CY to Ofgem's risk-free rate proxy of 20Y ILGs, it must be shown that:

1) CY(NG) is a good benchmark for CY(ILG) at shorter tenors; and
2) CY for shorter-dated safe assets, at least, holds for longer-dated safe assets.

On (1), the qualitative analysis shows that the majority of CY factors cited in academic research apply similarly to NGs/ILGs at shorter tenors. This suggests that CY(NG) is a good benchmark for CY(ILG) at short tenors. The qualitative analysis is set out in section 3.1.

The quantitative analysis shows that CY(ILG) could be lower than CY(NG) at shorter tenors. The quantitative analysis is based on inferring 2Y CY(NG) from the 2Y CY(NG) in DVT (2025) by applying a modified version of the formula in Liu et al. (2015)[9]. However, this formula has many omissions. The quantitative analysis and its omissions are set out in section 3.2.

The qualitative analysis implied that 2Y CY(ILG) is 29bps and the quantitative analysis implied that it is 2bps, which resulted in a range of 2-29bps. Given the many omissions in the quantitative analysis, it is not correct to place sole weight on the lower bound. It is reasonable to place as much weight on the upper bound as the lower bound. Accordingly, the midpoint of the range of 15.5bps has been selected as the point estimate for 2Y CY(ILG).

On (2), the qualitative and quantitative analysis shows that CY for longer-dated ILGs could be higher than for shorter-dated gilts. This analysis is set out in section 3.3. Despite this analysis, 20Y CY(ILG) has conservatively been assumed to equal 2Y CY(ILG) of 15.5bps.

First, there is strong demand from liability-driven investors (LDI) in the UK for long-dated ILGs. LDI demand is an important driver of CY and is widely recognised in academic research on CY. Second, the collateral value of gilts vs other safe assets increases at longer tenors. This means that the collateral value component of CY for gilts is higher at longer tenors than shorter tenors. Third, the term structure of CY in DVT (2025) is mostly upward sloping.

The data cut-off in DVT (2025) is in 2020. The UK's deep and persistent LDI demand for long-dated ILGs suggests continued scarcity value for these assets, even if market conditions change. The resilience of UK LDI has been recognised by BoE. If anything, CY may be higher under a more recent data cut-off. This is as DVT (2025) observes that CY has a positive relationship with interest rates and interest rates in the UK have risen significantly. These points are discussed more in section 3.4.

Ofgem may consider it is not possible to estimate CY and therefore identify the risk-free rate. In this case, it should use the zero-beta return in place of the risk-free rate in the CAPM. This will imply a significantly higher adjustment to the ILG yield than 15.5bps based on Di Tella et al. (2023).

2.2.3. Cross-check evidence for CY

This section explores cross-check evidence for CY.

Whilst the primary approach for estimating CY in this report starts from DVT (2025), this report adopts a cross-check for CY using AAA corporate bonds. In this context, the previous analysis of CY in RIIO-3 using AAA corporate bonds is still relevant.

Under the previous analysis, gilts are the risk-free asset with CY and AAA corporate bonds are the risk-free asset without CY. Ofgem suggests that AAA corporate bonds are a suitable proxy for the CY-free risk-free rate only after adjusting for default and illiquidity risks. This report considers whether adjustments for default and illiquidity risks are required.

On default risk, this report has estimated default risk in line with how the CMA looked at this in PR19. The analysis of default risk is set out in section 3.5. The range for the default risk embedded in AAA corporate bonds is 0-8bps. This range recognises that AAA corporate bonds are not risk-free but are very low risk which was the CMA's view at PR19. AAA corporate issuers have become slightly less risky since the CMA formed its view at PR19 based on the most recent default studies.

9 Liu, Z., Vangelista, E., Kaminska, I. and Relleen, J. (2015), 'The informational content of market-based measures of inflation expectations derived from government bonds and inflation swaps in the United Kingdom'.

On illiquidity risk, it is typically considered that assets with bid-ask spreads above 1% are illiquid. This threshold has strong regulatory precedent[10]: it been adopted by Ofcom and CEPA[11] on behalf of Ofwat in the UK, BNetzA in Germany, E-Control in Austria and CNMC in Spain. The AAA corporate bonds used in this report have bid-ask spreads over March 2025 well below 1%. Accordingly, the bonds are not illiquid and cannot carry an illiquidity premium[12].

In this vein, this report adopts a cross-check that bases the CY-free risk-free rate on AAA corporate bonds after adjusting for default risk. This addresses Ofgem's concerns.

This approach could underestimate CY according to van Binsbergen et al. (2022) and DVT (2025). This is because an AAA corporate bond is sufficiently safe, liquid, and collateralisable to be somewhat money-like and therefore may itself bear CY. In this case, the yield on AAA corporate bonds controlling for default risk may be lower than the CY-free risk-free rate.

The spread between RPI-linked AAA corporate bonds and duration-matched ILGs over March 2025 is 69bps which is set out in section 4.5. Reducing this spread by the default risk in AAA corporate bonds of up to 8bps results in an estimate of CY(ILG) of at least 61bps. This cross-check reaffirms that the estimate for 20Y CY(ILG) of 15.5bps from the primary approach is conservative.

Previous analysis of CY in RIIO-3 has focused on the spread between nominal AAA corporate bonds and NGs. The analysis of CY in this report builds on such previous analysis as it focuses on ILGs. ILGs, not NGs, are the starting point for Ofgem's risk-free rate.

2.2.4. Variation in CY over time

Ofgem has suggested that CY for gilts should only be present during times of market distress. This section considers the evidence on this point.

Under the primary approach for estimating CY, DVT (2025)'s estimate of CY is based on a long run of data (2004-2020). Thus, it already reflects the long-run average of CY.

Under the cross-check approach for estimating CY, the iBoxx AAA indices that formed the CMA's PR19 index, after adjusting for default risk, are used to proxy the CY-free risk-free rate[13]. This is because iBoxx indices start in 01/01/1998 which allows for a very long-run data to be taken.

The CMA's PR19 AAA index was formed of the iBoxx AAA 10Y+ and the iBoxx AAA 10-15Y+ indices. Over 01/01/1998 to 31/03/2025, the iBoxx AAA 10Y+ index has been 57bps higher and the iBoxx AAA 10-15Y+ index has been 72bps higher than duration-matched NGs. Reducing these spreads by the default risk in AAA corporate bonds of up to 8bps[14] results in CY of at least 49-64bps.

In conclusion, this evidence shows that CY is a persistent feature of gilts. It may increase or decrease at points in time but remains positive over time.

2.3. Differing risk-free saving and borrowing rates

This section explains the relevance of the difference between investors' risk-free saving and borrowing rates for estimating the CAPM risk-free rate.

2.3.1. Brennan (1971) and its application in regulatory precedent

This section explains the Brennan (1971) CAPM and regulatory precedent related to it.

The Sharpe-Lintner CAPM assumes that investors can borrow and save at the same risk-free rate. Where investors' risk-free borrowing rate is higher than their risk-free saving rate, the appropriate risk-free rate for the CAPM lies between the two rates as shown by Brennan (1971)[15].

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10 Frontier Economics (2020), Criteria to select peers for efficient beta estimation, p. 6.
11 CEPA (December 2024), PR24 Cost of Equity, p. 32.
12 In the primary approach for estimating CY, the inflation swaps used in the quantitative analysis of 2Y CY(ILG), which is set out in section 3.2, have bid-ask spreads significantly above 1%.
13 It has been shown that the RPI-linked AAA corporate bonds referred to in section 2.2.3 are not illiquid. As such, it is reasonable to expect that the publicly traded iBoxx AAA indices are also not illiquid.
14 This estimate of default risk is also based on a very long run of data.
15 Brennan, M. (1971), 'Capital Market Equilibrium with Divergent Borrowing and Lending Rates'.

The intuition behind the Brennan (1971) CAPM is set out in section 4.1. It is an empirical reality that investors' risk-free borrowing rate exceeds their risk-free saving rate as shown in section 4.2. As such, an adjustment for this factor must be made via use of the Brennan (1971) CAPM.

The adjustment for differing risk-free saving and borrowing rates is conceptually separate to that for CY. CY is to do with the additional benefits that ILGs provide for investors when investors *buy* ILGs; CY has nothing to do with *borrowing* ILGs. Indeed, the academic research on each factor is non-overlapping. Adjusting for both factors is required by modern academic research.

The CMA at PR19 explicitly adjusted for differing risk-free saving and borrowing rates: *"We consider that our interpretation of the CAPM in a situation of different borrowing and lending rates…is in principle in line with Brennan's (1971) often quoted finding that the market equivalent RFR is a weighted average of the RFR of all individual investors"*[16]. The CMA used ILGs as a proxy for the risk-free saving rate and AAA corporate bonds as a proxy for the risk-free borrowing rate.

The CMA recognised the potential for CY but stated that it did not explicitly adjust for it[17]. Previous analysis in RIIO-3 has focused solely on CY. The approach in this report builds on the CMA's PR19 approach as well as previous analysis in RIIO-3 by including explicit adjustments for both factors: CY and differing risk-free saving and borrowing rates. This brings the approach for estimating the risk-free rate closer to the modern academic research.

For reference, since the CMA at PR19 adjusted for differing risk-free saving and borrowing rates using the Brennan (1971) CAPM, other UK regulators have broadly done the same: CAA H7 FD[18], CAA NR23 FD[19], UREGNI GD23 FD[20] and UREGNI RP7 FD[21].

In Europe, regulators have implicitly adopted the Brennan (1971) CAPM. The German federal network agency, Bundesnetzagentur, estimates the risk-free rate using an index containing bank, corporate and public sector bonds from domestic issuers. It has adopted this approach in its determinations for energy networks since 2005[22]. The Italian regulatory authority, ARERA, estimates the risk-free rate in the allowed return for gas and electricity sectors using government bonds and AAA corporate bonds. It has adopted this approach in its latest determination for the gas and electricity sectors[23].

2.3.2. Interaction between Brennan (1971) and CY

The CAPM risk-free rate lies above the ILG yield as (1) investors cannot borrow at the ILG yield; and (2) ILGs benefit from CY. This section explains how these two factors interact.

The first factor applies where the risk-free borrowing rate exceeds the risk-free saving rate. The second factor applies even where these are the same.

a. Assume, as a simple benchmark, that investors can borrow and save at the same risk-free rate as in the standard Sharpe-Lintner CAPM.

The first factor does not apply as investors' risk-free borrowing rate is equal to their risk-free saving rate i.e. there is a common risk-free rate.

The second factor does apply. The return on government bonds is below the risk-free rate as these bear CY. It follows that CY(ILG) must be added to the ILG yield to obtain the risk-free rate.

b. Now consider the more realistic case that investors' risk-free borrowing rate exceeds their risk-free saving rate.

Specifically, investors' risk-free saving rate is equal to the common risk-free rate in the previous world but their risk-free borrowing rate increases.

16 CMA (2021), PR19 Final Determination, para. 9.263.
17 Ibid., paras. 9.235-9.236.
18 CAA (2022), H7 Final Proposals, Section 3: Financial issues and implementation, paras. 9.247-9.248.
19 CAA (2023), NR23 Final Decision, paras. 5.64 and 5.91-5.93.
20 UREGNI (2022), GD23 Final Determination, para. 10.17.
21 UREGNI (2024), RP7 Final Determination, para. 13.57.
22 https://www.bundesnetzagentur.de/DE/Beschlusskammern/BK04/BK4_74_EK_Zins/BK4_Beschl_EK_Zins.ht
23 https://www.arera.it/en/atti-e-provvedimenti/dettaglio/21/614-21

The risk-free saving rate remains the ILG yield plus CY(ILG). The risk-free borrowing rate now becomes the ILG yield plus CY(ILG) plus borrowing costs. These borrowing costs relate to e.g. the transaction costs and collateral requirements associated with borrowing.

The CMA's estimate of the risk-free borrowing rate is discussed in section 2.3.3. The CMA's estimate of the risk-free saving rate is the ILG yield. However, a more complete estimate is the ILG yield plus CY(ILG) as this explicitly takes into account the presence of CY.

2.3.3. AAA corporate bond yield as the risk-free borrowing rate

This section considers the CMA's estimate for the risk-free borrowing rate.

The CMA used the AAA corporate bond yield as the risk-free borrowing rate because: "*…the risk of loss resulting from default on these bonds is exceptionally low…*"[24] and "*…non-government bonds with the highest possible credit rating provide an input that is both very close to risk free (issuers with a higher credit rating than the UK government, but with some inflation and default risk) and is at least closer to representing a rate that is available to all (relevant) market participants*"[25].

This is supported by corporate finance textbooks. Brealey, Myers, Allen, and Edmans (2025) notes that: *"A common benchmark for rB, the borrowing rate, is the yield on high-quality (e.g., AAA- or AA-rated) corporate bonds"*[26]. Berk and DeMarzo (2014) notes that: *"…practitioners sometimes use rates from the highest quality corporate bonds in place of Treasury rates in Eq. 12.1* [CAPM]*"*[27].

The AAA corporate bond yield is not perfectly but is almost risk-free. This report estimates a default risk premium in AAA corporate bonds of just 0-8bps.

The AAA corporate bond yield is the lowest rate at which corporates can borrow in the real world. This is a lower bound for and likely underestimates the rates at which investors can borrow:

- Investors are backed by securities whose prices can significantly fluctuate. Corporates are backed by hard assets and thus can achieve lower borrowing costs[28].
- AAA corporate bonds may bear CY[29]. If a bank lends to an investor, its loan is not safe, liquid, or collateralisable and so investors do not benefit from CY when borrowing.

In this context, the AAA corporate bond yield is the best possible estimate of investors' risk-free borrowing rate for the real-world application of Brennan (1971). The CMA shared this view, noting that it "*…consider*[s] *that the yield on these* [AAA] *indices provides information on the lowest risk borrowing costs available to nongovernment market participants…*"[30].

Default and illiquidity premia should not be deducted from the AAA corporate bond yield to arrive at the risk-free borrowing rate. This is discussed in section 4.3.

Ofgem may consider it is not possible to identify the risk-free borrowing rate. In this case, Ofgem should use the zero-beta return plus shorting costs in place of the risk-free borrowing rate in the Brennan (1971) CAPM. This is explained in section 4.4.

2.3.4. Quantitative analysis of AAA-ILG spread

The risk-free saving rate is the ILG yield plus CY(ILG). The risk-free borrowing rate is the AAA corporate bond yield which can be expressed as the ILG yield plus AAA-ILG spread. This section estimates the spread between AAA corporate bonds and ILGs.

The CMA at PR19 estimated the AAA-ILG spread by deflating its AAA index of 20Y tenor by long-term CPIH of 2% and inflating 20Y ILGs by the 20Y RPI-CPIH wedge. The 20Y RPI-CPIH wedge estimated in this report is 10bps as set out in section 2.5. Applying the CMA's PR19 approach using this wedge results in an AAA-ILG spread of 103bps over March 2025.

24 CMA (2021), PR19 Final Determination, para. 9.146.
25 Ibid., para. 9.149.
26 Brealey, R., Myers, S., Allen, F. and Edmans, A. (2025), 'Principles of Corporate Finance', Chapter 8.
27 Berk, J. and DeMarzo, P. (2014), Corporate Finance, p. 404.
28 Brealey, R., Myers, S., Allen, F. and Edmans, A. (2025), 'Principles of Corporate Finance', Chapter 8.
29 See van Binsbergen et al. (2022) and DVT (2025).
30 CMA (2021), PR19 Final Determination, para. 9.150.

This report's approach to estimating the AAA-ILG spreads builds on the CMA's approach:

- The CMA compares the yield on AAA corporate bonds to tenor-matched ILGs. This report compares the yield on AAA corporate bonds to duration-matched ILGs. Duration matching limits differences in cashflow structure between coupon-paying AAA bonds and zero-coupon ILGs.
- The CMA compares the yield on nominal AAA corporate bonds to ILGs. This report directly compares the yield on RPI-linked AAA corporate bonds to ILGs. This avoids the need to make inflation assumptions to which the CMA's calculation is highly sensitive.
- The CMA compares the yield on the AAA index to ILGs. This report compares the yield on individual AAA corporate bonds, rather than the index as a whole, to ILGs i.e. bond-by-bond analysis. This is because the yield curve is non-linear and so an individual AAA corporate bond of the same duration as the index will have a different yield to the index.

The highest duration amongst the sample of RPI-linked AAA corporate bonds in this report was 5.2Y as at 31 March 2025. The analysis uses the five bonds in the sample with a duration above 4.75Y. These five bonds imply a spread against duration-matched ILGs of 69bps over March 2025. The full details of how the AAA-ILG spread of 69bps was estimated is set out in section 4.5.

Whilst these five bonds represent the best available data that exists to inform the AAA-ILG spread, their 5Y duration falls short of the duration of Ofgem's risk-free rate proxy of 20Y.

The AAA-ILG spread is a quality spread. It is expected that the spread at 5Y duration would hold at longer durations as ILGs remain higher quality than AAA corporate bonds. If anything, the spread could widen at longer durations: there is less investor appetite to take on the credit risk of AAA corporate bonds over the long-term. This is because AAA rated corporates are very unlikely to default in the next 5Y, but they may have a small chance of default in the next 20Y.

The AAA-ILG spread of 69bps in this report is already conservative as it is below the estimate of 103bps implied by the update of the CMA's PR19 approach. Furthermore, the AAA corporate borrowing rate is likely an underestimate of the investor borrowing rate for the reasons set out in section 2.3.3. In this context, Berk and DeMarzo (2020) notes that investor borrowing rates are percentage points (not basis points) higher than Treasury yields[31].

2.4. Overall adjustment to the ILG yield

This section sets out the range and point estimate for the adjustment required to the ILG yield to arrive at the risk-free rate in RPI terms.

The range adopted for the adjustment required to the ILG yield is 15.5-69bps. 15.5bps is the minimum adjustment required to derive the risk-free saving rate and 69bps is the same for the borrowing rate.

The adjustment for differing risk-free saving and borrowing rates, the upper end of the range, is based on the AAA-ILG spread. The adjustment for CY, the lower end of the range, starts from DVT (2025)'s estimate of CY. DVT (2025) bases the CY-free risk-free rate on the discount rate in the put-call parity relationship on European stock options.

Brennan (1971) states that the CAPM risk-free rate is a weighted average of the risk-free saving and borrowing rates; however the theoretical weights cannot be translated into empirical measures. The CMA in its application of Brennan (1971) at PR19 decided it was not necessary to assess the precise balance of borrowers and savers. The CMA ultimately determined the CAPM risk-free rate to be the midpoint of its estimates of the risk-free saving and borrowing rates.

These considerations imply a point estimate of 42bps for the adjustment to the ILG yield, which is slightly below the midpoint of 15.5bps and 69bps. This might be an underestimate as the estimates adopted for the risk-free saving and borrowing rates are themselves potentially biased down.

Ofgem may consider that it is not possible to identify the risk-free saving rate if it considers that either there is no risk-free asset, or the risk-free asset bears CY which cannot be estimated. In either case,

31 Berk, J. and DeMarzo, P. (2020), 'Corporate Finance', p. 440.

Ofgem should follow the zero-beta route in section 4.4. The zero-beta return option would imply a significantly higher adjustment to the ILG yield than 42bps based on Di Tella et al. (2023).

2.5. RPI-CPIH wedge

This section evaluates Ofgem's estimate of the RPI-CPIH wedge.

The RPI-CPIH wedge should reflect a pure expectation of inflation as ILGs are in practice accreted by pure inflation. This expectation should be at the 20Y horizon as Ofgem uses 20Y ILGs.

Official forecasts of inflation can provide such an estimate of the RPI-CPI wedge. Ofgem has placed sole weight on official forecasts. It has used OBR's forecasts of the annual wedge and assumed the annual wedge is zero post-2031 due to the UKSA RPI reform. It estimated that the official forecast of the 20Y RPI-CPI wedge over RIIO-3 is 0.10% in the DD. This report adopts Ofgem's estimate.

Ofgem assumes CPI can proxy CPIH because it considers that: *"The average difference between CPIH and CPI over a longer-term dataset is only 0.04%, and it is far from certain what the magnitude or direction of any difference between the measures would be over the price control horizon"*[32]. This is the same reason why Ofwat assumed the same in the PR24 FD[33]. This report agrees with this logic.

As such, this report adopts an RPI-CPIH wedge of 0.10%.

2.6. Derivation of the risk-free rate for RIIO-3

The table below summarises the overall range and point estimate for the risk-free rate.

Table 2: Overall range and point estimate for the risk-free rate

Component		Index	Formula	Ofgem DD	KPMG		
					Lower	Upper	Point
1m average of 20Y ILG yield		RPI	A	1.91%	1.91%	1.91%	1.91%
Adjustments	CY				0.155%		
	AAA-ILG					0.69%	
	Point	RPI	B	0%			0.42%
Risk-free rate		RPI	C = A+B	1.91%	2.06%	2.60%	2.33%
RPI-CPIH wedge		n/a	D	0.10%	0.10%	0.10%	0.10%
Risk-free rate		CPIH	E = (1+C)*(1+D)-1	2.01%	2.17%	2.70%	2.43%

Notes: Based on a cut-off date of 31 March 2025
Source: KPMG analysis and data from Bank of England

The 20Y ILG yield component of the risk-free rate will be indexed over RIIO-3[34] and the RPI-CPIH wedge component of the risk-free rate will remain fixed over RIIO-3[35]. It is expected that the adjustment to the 20Y ILG yield of 42bps will remain fixed over RIIO-3.

32 Ofgem (2024), RIIO-3 Sector Specific Methodology Decision – Finance Annex, para. 3.70.
33 Ofwat (2022), PR24 Final Methodology, Appendix 11 – Allowed return on capital, p. 22; and Ofwat (2024), PR24 Draft Determination, Aligning risk and return – Allowed return appendix, p. 108.
34 Ofgem (2025), RIIO-3 Draft Determination – Finance Annex, para. 3.16.
35 Ofgem (2024), RIIO-3 Sector Specific Methodology Decision – Finance Annex, para. 3.66.

3. Appendix 1: Convenience yield

3.1. Difference between CY(NG) and CY(ILG) at short tenors

This section analyses whether CY(NG) and CY(ILG) differ at short tenors based on CY factors cited in academic research. CY factors considered in the analysis are: (1) liquidity; (2) money-like roles; (3) collateral; (4) regulatory; and (5) safety.

1. Liquidity (ability to be traded without moving the market price)

- Both NGs and ILGs have narrow bid-ask spreads relative to other safe assets, though the spreads on ILGs may be wider than for NGs.
- As NGs and ILGs are both riskless assets, uninformed agents are not at an informational disadvantage and are thus willing to trade them, increasing market liquidity.
- NGs and ILGs are important instruments for hedging interest rate risk; for example, a buyer of a corporate bond can short gilts to remove such risk. However, ILGs also provide an inflation hedge, which may increase the trading of ILGs relative to NGs, and thus their liquidity.

2. Money-like roles (ability to store value and act as a medium of exchange)

- Both NGs and ILGs can be used as a medium of exchange as they are widely accepted. ILGs may serve as a better medium of exchange than NGs given the value of ILGs move in line with price inflation for goods.
- In the same vein, ILGs may serve as a better store of value as their purchasing power is not eroded by inflation like with NGs.

3. Collateral (ability to be used as security in financial transactions)

- Both NGs and ILGs are superior forms of collateral over other safe assets. This leads to additional demand for both types of gilt, in turn lowering their yields.
- Counterparties need to pledge collateral to banks in order to engage in a range of transactions such as borrowing money, trading derivatives, entering into security financing transactions with banks (for example, entering into repos[36]). Banks require collateral to mitigate the credit risk generated by undertaking these transactions.
- The collateral value of an asset is derived by applying a haircut to its current market value to account for valuation uncertainty[37]. The size of the haircut depends on the type and credit quality of the asset. Collateral in the form of NGs/ILGs face significantly lower haircuts than corporate bonds; for example, they are half the size of the haircuts applied to AAA corporate bonds[38]. There are also conditions under which their haircut is zero[39].

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36 A repo is a repurchase agreement that is generally short-term. In a repo, the ‘seller’ sells an asset to the ‘buyer’ for cash and agrees to repurchase the asset for a higher price at a later date, typically overnight. A repo is economically equivalent to a secured loan because (1) the difference between the asset’s initial price and its repurchase price is akin to the interest paid on a loan and is known as the repo rate; and (2) the asset effectively acts as collateral for the ‘buyer’. From the perspective of the ‘seller’ the transaction is a repo and for the ‘buyer’ it is a reverse repo.

37 The value of the non-cash asset may not be fixed. It may differ over time as a result of changes in market conditions or the perceived credit quality of the issuer of the bond/equity.

38 Article 224 illustrates the haircuts that have to be applied to the current market value of assets to derive their collateral value. NGs/ILGs fall in the category Article 197(1)(b) whereas AAA corporate bonds fall in the category Article 197(1)(c) and (d) based on Article 197. NGs/ILGs and AAA corporate bonds are both of credit quality step 1 based on the EBA mapping table. Hence, based on Article 224, for an NG/ILG of ⩽1 remaining maturity and used for a transaction with a 10-day liquidation period, its collateral value is 0.5% less than its current market value. In contrast, the haircut for an AAA corporate bond under equivalent conditions is 1%. This relationship whereby the haircut on NGs/ILGs are half that for AAA corporate bonds holds throughout Article 224, but the difference between the two in absolute terms becomes larger at higher residual maturities and liquidation periods. The liquidation periods that apply for different types of transactions are explained in Article 224(2). Articles can be found here and the EBA mapping table can be found here.

39 Article 227 sets out conditions under which a 0% haircut can be applied for collateral. NGs/ILGs may qualify for a 0% haircut because they satisfy the condition in 227(2)(a) that collateral must be *“cash or debt securities issued by central governments or central banks”* and *“eligible for a 0 % risk weight”* based on Article 197(1)(b) and Article 114. In the same vein, there are no conditions under which a 0% haircut can be applied for corporate bonds. Articles can be found here.

- Similarly, the superiority of NGs and ILGs as collateral means that they allow the owner to borrow money at lower rates than the general collateral repo rates. Feldhütter and Lando (2008)[40] states that this 'repo specialness' contributes to a convenience yield that *"…distinguishes the Treasury rate from the riskless rate"*.

4. Regulatory (ability to be used to satisfy regulatory requirements)

- Owning gilts (both NGs and ILGs) requires banks and insurance companies to hold less regulatory capital than owning other safe assets. As a result, banks and insurance companies may have additional demand for NGs/ILGs.
- Banks do not require capital to support an investment in NGs/ILGs but do to support an investment in corporate bonds due to their credit risk. For AAA corporate bonds, banks must hold capital equal to their current market value multiplied by either 0.25%, 1% or 1.25% depending on their remaining maturity (higher capital charge for longer maturities). For NGs/ILGs, the capital charge is nil regardless of their maturity because government bonds are risk-free[41].
- Banks are subject to the liquidity coverage ratio (LCR). This ratio imposes a hypothetical gap between a bank's cash inflows and outflows, in particular, that cash inflows are only 75% of cash outflows. The bank should at all times have a sufficient liquid asset buffer to meet this hypothetical gap. Banks are required to monitor their LCR on a daily basis. The value of assets in this liquid asset buffer depends on their liquidity and credit quality. NGs/ILGs are considered level 1 assets and therefore face no haircut to their current market value in the liquid asset buffer. In contrast, AAA corporate bonds are considered level 2A assets and thus face a 15% haircut. Further, there is a cap on the amount of level 2A assets that can contribute to the liquid asset buffer whereas the contribution of level 1 assets is unlimited[42].
- Banks are also subject to the Net Stable Funding Ratio (NSFR). The NSFR requires that at all times the bank's funding requirement can be met by stable funding sources. Banks monitor their NSFR on a daily basis, like LCR. Investments in NGs/ILGs and corporate bonds are considered assets that require stable funding. For the same reasons as under LCR, the funding required for unencumbered[43] NGs/ILGs is nil whereas it is 15% of the current market value for unencumbered AAA corporate bonds[44].
- Insurance companies are required to hold capital against investments in corporate bonds for spread risk, but not for investments in NGs/ILGs. Spread risk refers to the risk that the value of investments may fall with a widening of credit spreads. For an AAA corporate bond, the capital charge for spread risk is the current market value multiplied by 0.9% for a residual duration of 1Y[45], this increases to >12% for a residual duration of >20Y[46].

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40 Feldhütter, P. and Lando, D. (2008), 'Decomposing swap spreads'.

41 When a bank buys a bond, it is assumed that the bond is held in the bank's 'trading book'. The capital requirements relating to credit risk for a bank's trading book assets are governed by Article 336. This says that a bond with a 0% risk weight does not require capital to be held. It also says that a bond with a 20% risk weight requires capital to be held equal to the bond's current market value multiplied by 0.25% (residual maturity of < 6m), 1% (residual maturity of 6-24m) or 1.6% capital charge (residual maturity of >24m). NGs/ILGs have a 0% risk weight based on Article 114 and AAA corporate bonds have a 20% risk weight based on Article 122 and the EBA mapping table. Articles can be found here and the EBA mapping table can be found here.

42 https://www.prarulebook.co.uk/rulebook/Content/Part/392857/20-07-2023; https://www.bankofengland.co.uk/-/media/boe/files/prudential-regulation/regulatory-reporting/banking/corep-liquidity.xlsx

43 The PRA Rulebook defines unencumbered assets as assets which are not subject to any legal, contractual, regulatory, or other restriction preventing the institution from liquidating, selling, transferring, assigning or, generally, disposing of those assets via an outright sale or a repurchase agreement.

44 https://www.prarulebook.co.uk/rulebook/Content/Part/392857/20-07-2023

45 Residual duration here refers to modified duration. Modified duration is the weighted average time (by present value of cashflow) for a bondholder to receive a bond's remaining cashflows. It is typically shorter than residual maturity.

46 The Standard Formula capital charges for spread risk are set out in the EU Solvency II Delegated Act as modified by the UK "Solvency 2 and Insurance (Amendment, etc.) (EU Exit) Regulations 2019". Article 180 says that *"Exposures in the form of bonds and loans to the following shall be assigned a risk factor stress$_i$ of 0 %... United Kingdom central government and Bank of England denominated and funded in pounds sterling"*. In other words, there is a capital charge of 0% for NGs/ILGs. Article 176 shows the capital charges for corporate bonds in 176(3). AAA corporate bonds are of credit quality step 0 based on the EIOPA mapping table. Hence the capital charge for an AAA corporate bond with e.g. 12Y residual duration is 7% + 0.5% * (12Y – 10Y) = 8% multiplied by its current market value. Articles in the EU Solvency II Delegated Act can be found here, modifications to this act for the UK can be found here and the EIOPA mapping table can be found here.

5. Safety

- It might be argued that safety does not lead to CY as CY is the difference in return between two assets with identical cash flows i.e. that are equally safe. However, CY might still exist if the yield of a perfectly safe asset is significantly different from the yield of an asset that is almost perfectly safe and thus almost identical.
- If there were no CY, then as the risk of the asset falls, its yield would fall in a smooth manner. In reality, as the risk of the asset falls from very small to zero, its yield drops discontinuously. Thus, there is something particularly 'convenient' about an asset being perfectly risk-free, beyond the cash flow effect.
- This additional demand may stem from the reasons above, such as perfect safety allowing an asset to be posted as collateral and satisfy regulatory capital requirements. However, there may be additional reasons, e.g. the 'zero-risk bias' meaning that investors view a perfectly safe asset as markedly different from an almost perfectly safe one.
- As Krishnamurthy and Vissing-Jørgensen (2012) note: *"The safety explanation for low Treasury yields is distinct from that suggested by any of the standard representative agent model explanations of high risk premia in asset markets. This literature has demonstrated how altering the preferences of a representative agent to feature high risk aversion can produce low riskless interest rates and high risk premia. Thus, in the representative agent model there will be a negative relation between the price of a bond and its default risk. However, the quantity of convenience assets is unrelated to asset prices in the representative agent model. A way to think about how safety demand works is that the relation between price and default risk is very steep near zero default risk, over and above the negative relation implied by the representative agent model. Furthermore, the slope of this curve near zero default risk decreases in Treasury supply. This latter prediction generates a negative relation between the corporate Treasury bond spread and Treasury supply (at a given level of corporate bond default risk) and is how to distinguish the safety explanation from a standard risk-based explanation"*.
- Both NGs and ILGs bear no risk of default because the government can in practice always print money to honour its GBP debt obligations, and so both exhibit the safety element of CY. The CMA recognised the safety of NGs and ILGs in the PR19 FD: "*The UK government enjoys a very strong credit rating…and as a sovereign nation has monetary and fiscal levers to support debt repayment that are not available to commercial lenders*"[47].

In conclusion, the vast majority of CY factors apply similarly to NGs/ILGs at shorter tenors. This suggests that CY(NG) is a good benchmark for CY(ILG) at short tenors.

3.2. Quantitative analysis of 2Y CY(ILG)

This section sets out the quantitative analysis of 2Y CY(ILG).

An estimate of 2Y CY(ILG) can be obtained by applying the following formula from Liu et al. (2015)[48] to 2Y CY(NG) of 29bps from DVT (2025):

CY(NG) – CY(ILG) = Gilt BEI – Swap BEI (breakeven inflation) (1)

This approach was used by Ofwat in the PR24 FM[49]. This report, like Ofwat, has adopted an estimation window of 18/06/2007 to 27/07/2020 to broadly align with the estimation window in DVT (2025) of 01/02/2004 to 27/07/2020. An exact match is not possible due to data availability issues.

3.2.1. Inflation swap illiquidity premium

The formula in Liu et al. (2015) implicitly assumes that:

Swap BEI = expected inflation + inflation risk premium (2)

47 CMA (2021), PR19 Final Determination, para. 9.103.
48 Liu, Z., Vangelista, E., Kaminska, I. and Relleen, J. (2015), 'The informational content of market-based measures of inflation expectations derived from government bonds and inflation swaps in the United Kingdom'.
49 Ofwat (2022), PR24 Final Methodology, Appendix 11 – Allowed return on capital, p. 96-97.

i.e. that the swap BEI arises only because of expected inflation and the inflation risk premium. However, if inflation swaps are illiquid in reality, then the inflation seller will demand a higher rate to compensate for this illiquidity. As a result, the true swap BEI is given as follows:

Swap BEI = expected inflation + inflation risk premium + inflation swap illiquidity premium (3)

and so:

CY(NG) – CY(ILG) = Gilt BEI – Swap BEI + inflation swap illiquidity premium (4)

Christensen and Gillan (2012)[50] confirms that the gap between gilt BEI and swap BEI is due not only to the liquidity of NGs relative to ILGs, but also to the illiquidity of swaps. It comments *"…in a world without frictions to trade, BEI should equal the inflation swap rate. However, in reality, the observed BEI and inflation swap rates are not the same. We attribute the difference between the two to non-negative liquidity premiums in both the TIPS and inflation swap markets that reflect the distance these markets are from the ideal frictionless outcome"*. It explicitly refers to *"…our measure of the sum of TIPS and inflation swap liquidity premiums…"*, affirming that the difference between gilt BEI and swap BEI does not measure the liquidity of NGs relative to ILGs alone.

Practitioner articles suggest that short-dated inflation swaps in the UK, like the 2Y inflation swap that is relied on for swap BEI, may be illiquid: *""One of the downsides is that the sterling inflation swap market is less liquid than the sterling interest rate swap market," agrees Philip Rose, head of ALM at Redington Partners. "Liquidity is concentrated in the longer 20-to-50-year tenors, while short-dated inflation swaps - below 10 years - are relatively illiquid"*[51].

The inflation swap illiquidity premium in this report has been estimated as half of the bid-ask spread of the 2Y inflation swaps[52]. This is an underestimate as it is a measure of inflation swap illiquidity but what matters is both illiquidity and illiquidity risk (Pastor and Stambaugh, 2003[53]).

The illiquidity risk reflects the risk that inflation swaps become illiquid during market downturns. Investors demand compensation for the risk that they might need to liquidate in adverse conditions. This is the same intuition for why investors demand an inflation risk premium on top of expected inflation in formula (2).

It is likely that spreads widen in market downturns. This means that swap BEI is augmented not only by the average level of liquidity, but liquidity risk. In other words, swap BEI is augmented by the spread and the risk of the spreads widening in market downturns.

3.2.2. Other frictions in the swap market

The swap market is not perfectly frictionless and one friction in the swap market is illiquidity. There are many other frictions besides illiquidity, such as:

- Collateral and margining costs – Inflation swaps are derivatives; like any derivative, counterparties need to post margin to protect the other side from default. Dealers embed these costs into the fixed leg of the swap. This increases the quoted BEI to ensure the trade is profitable after accounting for expected margin usage.
- Inventory risk for dealers – Dealers often intermediate between buyers and sellers of inflation swaps. When a dealer cannot immediately find an offsetting trade, they must hold an unhedged position, exposing them to inventory risk. This risk may be reflected not only in wider bid-ask spreads (which would be captured in the swap illiquidity premium discussed above) but also in upward level shifts in quoted prices. While spreads compensate for uncertainty, they do not address the issue of consistently one-sided flow, which gives rise to inventory risk from directional exposure. Specifically, when a dealer has inventory risk from being short inflation (because a

50 Christensen, J. and Gillan, J. (2012), 'Could the U.S. Treasury Benefit from Issuing More TIPS?'.

51 https://www.ipe.com/inflation-buyers-using-swaps/28413.article

52 Bid and ask for an inflation swap relates to the fixed leg. The bid represents the yield the 'buyer' of the swap is willing to pay whereas the ask represents the yield the 'seller' of the swap is willing to accept. Half of the difference between the two (i.e. bid-ask spread) in absolute terms is the inflation swap illiquidity premium. It is only half the difference because the 'true' rate (with perfect liquidity) would be the midpoint. Thus, the penalty suffered from having to receive the bid or pay the ask is the difference between e.g. the ask and the midpoint.

53 Pastor, L. and Stambaugh, R. (2003), 'Liquidity Risk and Expected Stock Returns'.

client wishes to buy inflation), they are exposed to rising inflation. To compensate, the dealer may quote a higher fixed leg, i.e. a higher swap BEI.

- Market segmentation – The inflation swap and ILG markets serve different investor bases, which limits arbitrage. LDIs buy ILGs, while inflation swaps are used more by banks, hedge funds, and corporates (e.g. firms wishing to buy inflation to hedge liabilities). This segmentation creates persistent demand/supply imbalances, especially since many clients want to buy inflation exposure via swaps, while few want to sell. Dealers must step in as counterparties and therefore charge a premium, which raises the swap BEI. Market segmentation is a source of consistently one-sided flow, and thus a contributor to the inventory risk described above.

The inclusion of these other frictions results in the following:

$$\Delta CY = \text{Gilt BEI} - \text{Swap BEI} + \text{inflation swap premium} \quad (5)$$

The inflation swap premium reflects not just the illiquidity premium but the collateral and margining cost premium, inventory risk premium and market segmentation premium.

3.2.3. Quantitative estimate of 2Y CY(ILG)

The quantitative estimate of 2Y CY(ILG) in this report is based on formula (4), which implies an estimate of 2bps. This estimate omits the illiquidity risk component of the inflation swap illiquidity premium and omits entirely many other frictions in the swap market. Given the many omissions in this estimate, it is not correct to place sole weight on it.

3.3. Term structure of CY

This section considers the evidence on the term structure of CY in the UK.

For some parameters, it may be that non-UK data can provide some guidance for the UK. For CY in particular, it is important to focus on UK-specific evidence as CY depends on institutional factors such as LDI demand and collateral regimes. Ofgem appears to agree with this in the DD[54].

This matters for both the level of CY and the term structure of CY. Just as DVT (2025) finds significant variation in the level of CY across countries, the term structure of CY is likely to significantly vary across countries. For this reason, the below focuses on UK-specific evidence.

3.3.1. LDI demand

LDI demand is an important driver of CY and is widely recognised in academic research as “hedging demand”. LDIs, such as pension funds, have special demand for long-dated ILGs arising from their need to hedge contractual, inflation-sensitive liabilities over a long-time horizon. LDI demand is a key reason why CY for long-dated ILGs could be higher than short-dated gilts.

The effect of such LDI on CY is consistent with prior academic research in the US. For example, Krishnamurthy and Vissing-Jørgensen (2012) states: *“The safety attribute may also apply to long-term Treasuries, such as 30-year bonds, which carry significant price risk because of interest rate volatility… Greenwood and Vayanos (2010) suggest that investors such as defined-benefit pension funds have a special demand for certain long-term payoffs to back long-term nominal obligations”*.

It argues that the liquidity component of CY is common across all maturities, but the safety component of CY may be stronger for long-dated Treasuries due to LDI.

LDI demand is much greater in the UK than in the US. This is due to (1) mark-to-market pension accounting; (2) the mature nature of UK defined benefit schemes, meaning that a higher proportion of members are retirees; and (3) the UK Pensions Regulator encouraging pension funds to hedge, compared to US regulators which are less prescriptive.

3.3.2. Collateral value

The superior collateral value of gilts vs other safe assets is a driver of CY for gilts.

54 Ofgem (2025), RIIO-3 Draft Determination - Finance Annex, para. 3.26.

Counterparties need to pledge collateral to banks in order to engage in a range of transactions such as borrowing money, trading derivatives, entering into security financing transactions with banks. Banks require collateral to mitigate the credit risk generated by undertaking these transactions.

The collateral value of an asset is derived by applying a haircut to its current market value to account for valuation uncertainty[55]. The haircuts for gilts and AAA corporate bonds required by the applicable legislation are set out in the table below[56].

Table 3: Haircuts for gilts and AAA corporate bonds

Remaining maturity	Gilts			AAA corporate bonds		
	20-day liquidation period	10-day liquidation period	5-day liquidation period	20-day liquidation period	10-day liquidation period	5-day liquidation period
≤1Y	0.707%	0.5%	0.354%	1.414%	1%	0.707%
>1 and ≤5Y	2.828%	2%	1.414%	5.657%	4%	2.828%
>5Y	5.657%	4%	2.828%	11.314%	8%	5.657%

Source: KPMG analysis and data from Articles 197 and 224 and EBA mapping table

Reading the table vertically indicates that the haircuts on (1) gilts with tenors of 1-5Y are 4x that of gilts with tenors of ≤1Y; and (2) gilts with tenors of >5Y are 2x that of gilts with tenors of 1-5Y. This is irrespective of the liquidation period of the transaction for which the gilt is used as collateral[57].

However, the difference in collateral value between shorter- and longer-dated gilts is not relevant for the term structure of CY. This is because CY for gilts is the difference in yield between gilts and other safe assets, such as AAA corporate bonds, *of the same maturity*. It is necessary to hold constant the maturity as CY is the difference in yield between two assets with the same cash flow profile that differ only in terms of their convenience. As such, the table should only be read horizontally, not vertically, to evaluate the term structure of CY.

Reading the table horizontally indicates that the haircuts on gilts are half that for AAA corporate bonds at the same maturity (and liquidation period). The difference between the two in absolute terms becomes larger at higher maturities (and liquidation periods). This means that the collateral value component of CY could increase at longer tenors.

3.3.3. Empirical evidence

The CY term structure for the UK in DVT (2025) is mostly upward-sloping. 2Y is an exception but may be an outlier. The most reasonable conclusion to draw from the time series as a whole is that CY does not decline and could increase at longer tenors.

3.4. CY in current market conditions

The data cut-off in DVT (2025) is in 2020. Market conditions have changed since then and this section considers how these changes may have affected CY.

LDI demand

The UK has deep and persistent LDI demand for long-dated ILGs which suggests continued scarcity value for these assets, even if market conditions change.

The Bank of England has recognised the resilience of LDI: *"Given the progress made on LDI resilience across domestic and international authorities over the past 18 months, the FPC has*

55 The value of the non-cash asset may not be fixed. It may differ over time as a result of changes in market conditions or the perceived credit quality of the issuer of the bond/equity.

56 Article 224 illustrates the haircuts that have to be applied to the current market value of assets to derive their collateral value. Gilts fall in the category Article 197(1)(b) whereas AAA corporate bonds fall in the category Article 197(1)(c) and (d) based on Article 197. Gilts and AAA corporate bonds are both of credit quality step 1 based on the EBA mapping table. Articles can be found here and the EBA mapping table can be found here.

57 The liquidation periods that apply for different types of transactions are explained in Article 224(2).

decided to close its November 2022 and March 2023 Recommendations relating to LDI resilience"[58]. The resilience of LDI implies resilient demand for ILGs and so CY(ILG).

Interest rates

DVT (2025) finds that *"a country's average convenience yield increases 15 basis points with a 1% rise in nominal interest rates"*. Interest rates have increased significantly since 2020. This means that CY estimated in DVT (2025) could be higher under a more recent data cut-off.

3.5. Default risk in AAA corporate bonds

This section sets out the analysis of the default premium in AAA corporate bonds.

AAA corporate bonds bear very low risk but are not risk-free in the same way as gilts. This means that the yield on these bonds may contain a default premium.

The default premium can be estimated by multiplying the annualised default rate for AAA rated corporate issuers by the loss rate for senior unsecured bonds[59]. Default studies undertaken by rating agencies provide cumulative default rates and recovery rates which can be used to derive annualised default rates and loss rates. The data from these default studies are set out in the tables below.

Table 4: Cumulative and annualised default rates for AAA rated corporate issuers

Default study	Time period	Region	Time horizon	Cumulative default rate	Annualised default rate
Moody's (Apr 2021)[60]	1985-2020	Global	10Y	0.03%	0.00%
		Europe	10Y	0.04%	0.00%
Moody's (Feb 2025)[61]	1920-2024	Global	10Y	0.66%	0.07%
			20Y	1.25%	0.06%
	1970-2024	Global	10Y	0.34%	0.03%
			20Y	0.69%	0.03%
	1983-2024	Global	10Y	0.12%	0.01%
			20Y	0.12%	0.01%
	1998-2024	Global	10Y	0.02%	0.00%
			20Y	Data not published	
Fitch (Mar 2025)[62]	1990-2024	Global	10Y	1.29%	0.13%
		EMEA	10Y	-	-
S&P (Mar 2025)[63]	1981-2024	Global	10Y	0.67%	0.07%
			15Y	0.86%	0.06%
		Europe	10Y	0.00%	0.00%
			15Y	Data not published	

Notes: (1) Cumulative default rates are issuer-weighted; (2) Annualised default rate = cumulative default rate / time horizon
Source: KPMG analysis and data from Moody's, Fitch, and S&P

The default studies indicate that AAA rated corporate issuers have very low default rates, ranging between 0% and 0.13% on an annualised basis.

58 Bank of England (June 2024), Financial Stability Report, p. 58.
59 The RPI-linked AAA corporate bonds used in this report are senior unsecured.
60 Moody's (2021), Default and recovery rates of European corporate issuers, 1985-2020, Exhibit 15.
61 Moody's (2025), Annual default study: Corporate default rate to fall below its long-term average in 2025, Exhibits 38-42.
62 Fitch (2025), 2024 Transition and Default Studies, Tab "Global CF Default Rates".
63 S&P (2025), Default, Transition, and Recovery: 2024 Annual Global Corporate Default And Rating Transition Study, Tables 24-25.

The CMA at PR19 also cited default studies, namely the 2019 S&P study, in coming to its view that AAA corporate bonds were exceptionally low risk[64]. The 2019 S&P study showed that the 15-year cumulative average default rate was 0.91%. The most recent S&P study suggests that this rate has declined to even lower levels, specifically to 0.86% as illustrated in the table above. In other words, AAA corporate issuers have become slightly less risky since the CMA formed its view at PR19.

Table 5: Recovery and loss rates for senior unsecured bonds

Default study	Time period	Region	Recovery rate	Loss rate
Moody's (Apr 2021)[65]	1985-2020	Global	37.62%	62.38%
		Europe	36.75%	63.25%
Moody's (Feb 2025)[66]	1983-2024	Global	37.90%	62.10%

Notes: (1) Recovery rates are issuer-weighted; (2) Loss rate = 1 – recovery rate
Source: KPMG analysis and data from Moody's

The default studies indicate that the loss rate for senior unsecured bonds ranges between 62.10% and 63.25%. Berk and DeMarzo (2014) notes that the average loss rate for unsecured debt is about 60% which is broadly in line with the range from the default studies[67].

The overall range for default premium is therefore 0-8bps[68]. This range recognises that AAA corporate bonds are not risk-free but are very low risk.

64 CMA (2021), PR19 Final Determination, para. 9.147.
65 Moody's (2021), Default and recovery rates of European corporate issuers, 1985-2020, Exhibit 16.
66 Moody's (2025), Annual default study: Corporate default rate to fall below its long-term average in 2025, Exhibit 7.
67 Berk, J. and DeMarzo, P. (2014), Corporate Finance, p. 412.
68 Lower bound = 0% annualised default rate * 62.10% loss rate; upper bound = 0.13% annualised default rate * 63.25% loss rate.

4. Appendix 2: Differing risk-free saving and borrowing rates

4.1. Intuition behind the Brennan (1971) CAPM

This section explains the intuition behind the Brennan (1971) CAPM.

4.1.1. Same saving and borrowing rates

This section considers the case where investors can save and borrow at the same risk-free rate as assumed in the Sharpe-Lintner CAPM.

In the Sharpe-Lintner CAPM, an investor can invest their wealth in the market portfolio (beta of 1) and the risk-free asset (beta of 0).

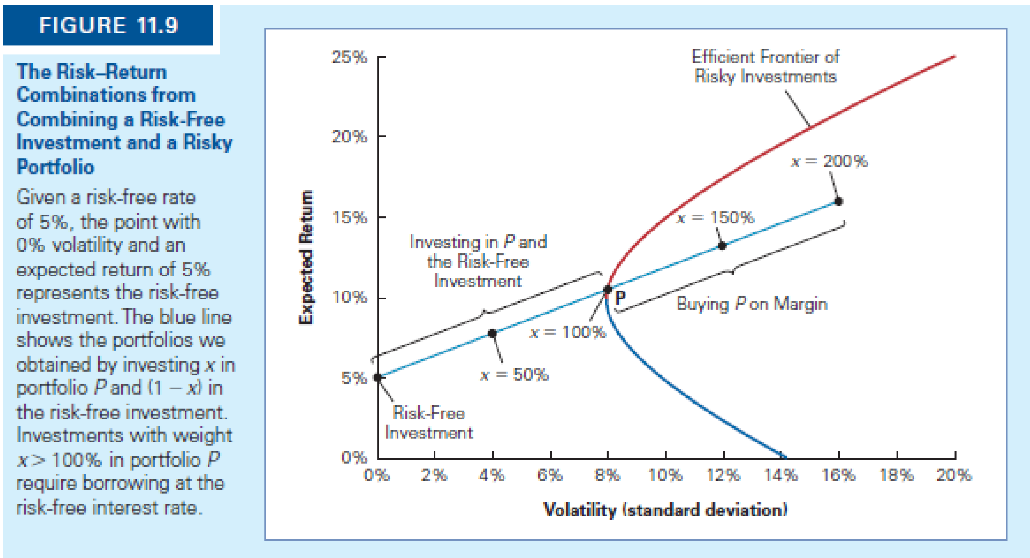
Let x be the proportion of their initial wealth that they invest in the market portfolio. Assume they start by investing their initial wealth entirely in the market portfolio, i.e. x = 1 and so beta = 1:

- A conservative investor can reduce their risk by moving some of their initial wealth out of the market portfolio and into the risk-free asset, i.e. saving at the risk-free rate. Their final portfolio has x of 0-1 and therefore beta of 0-1.
- An aggressive investor can increase their risk by short selling the risk-free asset, i.e. borrowing at the risk-free rate, and investing more than their initial wealth in the market portfolio (x > 1). Their final portfolio has x > 1 and therefore beta > 1[69].

Importantly, whilst the aggressive investor seeks a portfolio with a beta > 1, they are willing to hold the market portfolio even though its beta is only 1. The market portfolio contains some stocks with beta < 1 (such as utilities) and others with beta > 1 (such as tech), leading to an overall beta of 1. The aggressive investor achieves a beta > 1 not by selling utilities and holding only tech, but by borrowing to invest more than their initial wealth in the market portfolio.

This relationship is illustrated in the following figure from Berk and DeMarzo (2014).

Figure 1: The risk–return combinations from combining a risk-free investment and a risky portfolio



Source: Berk and DeMarzo (2014)

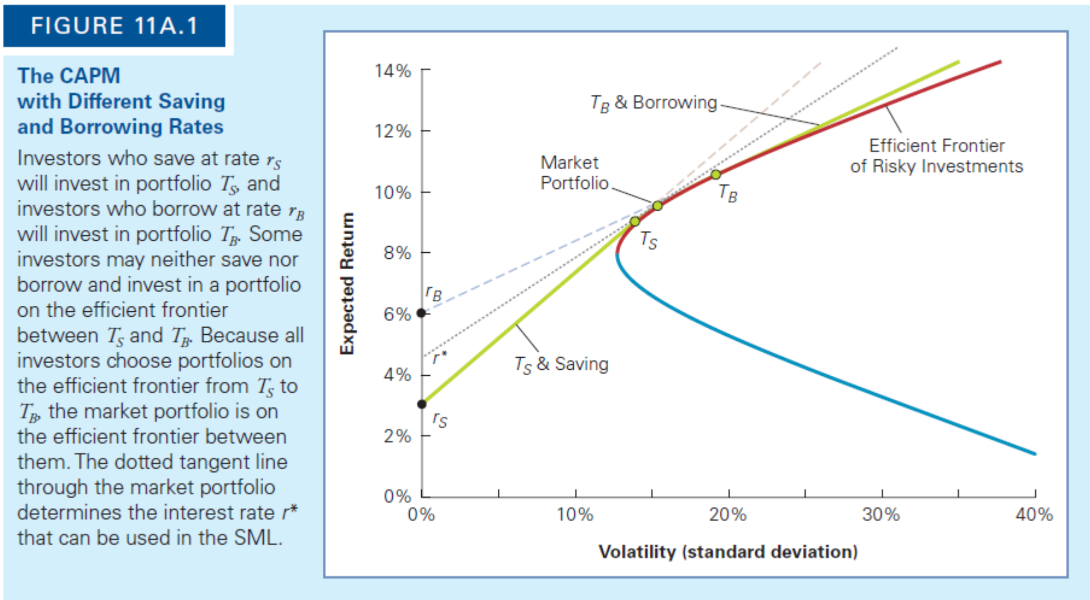
69 This leveraged investment in the market portfolio has higher risk than investing in the market portfolio using only the investor’s own wealth because leverage amplifies the impact of returns/losses on the market portfolio to the investor.

4.1.2. Different saving and borrowing rates

The Sharpe-Lintner CAPM assumes that investors can save and borrow at the same risk-free rate.

This section considers the case where the risk-free borrowing rate (r_B) is now higher than the risk-free saving rate (r_S)[70]. This is formally analysed in Brennan (1971)[71]; the following figure from Berk and DeMarzo (2014) illustrates its findings:

Figure 2: The CAPM with different saving and borrowing rates



Source: Berk and DeMarzo (2014)

As shown in the figure, the risk-free rate in the CAPM formula, r*, is a weighted average of the risk-free saving rate r_S and risk-free borrowing rate r_B. This is because some investors are conservative investors who save and face a risk-free rate of r_S; others are aggressive investors who borrow and face a risk-free rate of r_B. As Brennan (1971) writes:

"*…the only difference in the market equilibrium condition introduced by divergence of borrowing and lending rates is that the intercept of the capital market line is shifted. This intercept represents the expected rate of return on a security with a return which has zero covariance with the return on a value-weighted market portfolio of all securities and may be referred to as the market's equivalent risk-free rate.*

It is apparent…that this market equivalent risk-free rate of interest is a weighted average of the individual investor's equivalent risk-free rates…Thus the market equivalent risk-free rate is constrained to lie between the borrowing rate b and the lending rate l."

To understand why r* is the appropriate risk-free rate for the CAPM, assume the CAPM were instead based on the risk-free saving rate of r_S. Then the return on a utilities stock, r_U, would be given by:

$$r_U = r_S + \beta \times (r_M - r_S)$$

Since $r_B > r_S$, borrowing is relatively expensive. Aggressive investors respond by reducing their borrowing. Given their reduced borrowing, aggressive investors can now only achieve a beta > 1 by deviating from the market portfolio. In particular, they will invest more in beta > 1 stocks such as tech and less in beta < 1 stocks such as utilities. Selling out of utilities decreases their stock price and increases their expected return until it becomes:

$$r_U = r^* + \beta \times (r_M - r^*)$$

70 Note r_S is equal to the common risk-free rate in the previous section where it is assumed that investors save and borrow at the same risk-free rate. However, now r_B increases above r_S.

71 Brennan, M. (1971), 'Capital Market Equilibrium with Divergent Borrowing and Lending Rates'.

Market clearing implies that all assets have to be held by someone. Thus, if utilities are not held by aggressive investors, they must be disproportionately held by conservative investors. Such investors overweight utilities compared to the market portfolio and hence are not fully diversified; they bear the idiosyncratic risk of the utilities sector. The only way that they are willing to do so is if utilities offer a return of $r^* + \beta \times (r_M - r^*)$ rather than $r_S + \beta \times (r_M - r_S)$.

In sum, where $r_B > r_S$, utilities are less attractive to investors and so investors require a higher return to hold them. This is reflected by the risk-free rate in the CAPM increasing from r_S to r^*.

The CMA's interpretation of the figure from Berk and DeMarzo above at PR19 is consistent with the finding in Brennan (1971). The CMA's *"…interpretation of Berk and DeMarzo analysis is that in order to achieve an accurate estimate of the 'market rate' for the RFR, we need to find proxies that… are available to relevant market participants. We can then best estimate the RFR by using a level that takes account of rates suggested by these close proxies. We consider below the relevance of ILGs and high quality corporate bonds as proxies on that basis"*[72].

4.2. Saving and borrowing rates in the real world

The CAPM risk-free rate depends on whether investors' saving and borrowing rates are the same or different. This section discusses which of the two cases applies in the real world.

It is well established that, in the real world, investors borrow at a higher rate than they save:

- Brealey, Myers, Allen, and Edmans (2025): *"In practice, even though investors can save at the risk-free rate by buying Treasury bills, most can't borrow at that rate since they aren't risk free"*[73].
- Berk and DeMarzo (2014): *"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"*[74].
- CMA PR19 FD: *"Rather, we are trying to calibrate our estimate of the RFR acknowledging that the ILG rate is available to all lenders but only one borrower, and that even the highest quality borrowers in the country could not access this rate"*[75]. The CMA asserted repeatedly throughout the FD that the ILG rate was below the rate at which most investors could in practice borrow.

4.3. Default and illiquidity risks

This section considers whether it is correct to deduct default and illiquidity premia from the AAA corporate borrowing rate to derive the risk-free borrowing rate.

The AAA corporate borrowing rate represents the lowest possible and is likely an underestimate of the cost at which investors can in practice borrow as explained in section 2.3.3. It therefore represents the best possible estimate for the risk-free borrowing rate.

Default and illiquidity premia should not be deducted because they affect the actual rates faced by investors. They pay such risk premia because investors may default and borrowing markets are illiquid. Capital market imperfections are why investors face different borrowing and lending rates to begin with, and are the motivation for the Brennan (1971) extension of the CAPM.

Indeed, Brealey, Myers, Allen, and Edmans (2025) do not recommend removing default and illiquidity premia from AAA corporate bond yields. Berk and DeMarzo (2020) note that borrowing rates are percentage points (not basis points) higher than Treasury yields[76]; if default or illiquidity premia were subtracted, they would be very similar.

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72 CMA (2021), PR19 Final Determination, para. 9.94.
73 Brealey, R., Myers, S., Allen, F. and Edmans, A. (2025), 'Principles of Corporate Finance', Chapter 8.
74 Berk, J. and DeMarzo, P. (2014), Corporate Finance, p. 404.
75 CMA (2021), PR19 Final Determination, para 9.159.
76 Berk, J. and DeMarzo, P. (2020), 'Corporate Finance', p. 440.

Default premia should not be deducted because investors bear default premia as they may default. Indeed, default premia may be higher than for high-quality corporates since investors are backed by securities whose prices can significantly fluctuate whereas, corporates are backed by hard assets.

Illiquidity premia should not be deducted because borrowing markets are less liquid than lending markets. While investors can lend by investing in a wide range of safe assets all around the world, they have more limited sources of borrowing. In any case, it has been shown that the RPI-linked AAA corporate bonds used in this report are not illiquid in section 2.2.3.

4.4. Bounds for the CAPM risk-free rate

The bounds for the CAPM risk-free rate are summarised in the table below. In the table, r* is the CAPM risk-free rate, r_S is the risk-free saving rate and r_B is the risk-free borrowing rate.

Table 6: Bounds for the CAPM risk-free rate

Bounds for r*	r_S can be identified	r_S cannot be identified
Lower bound for r* (r_S)	ILG yield + CY(ILG)	Zero-beta return
Upper bound for r* (r_B)	ILG yield + AAA-ILG spread	Zero-beta return + shorting costs

Source: KPMG analysis

The table covers two separate cases.

In the first case, r_S can be identified. r* lies between r_S and r_B in line with Brennan (1971). r_S is derived by adding CY(ILG) to the ILG yield and r_B is derived by adding the AAA-ILG spread to the ILG yield, to end up with the AAA corporate bond yield. In other words, the lower bound adjustment to the ILG yield is CY(ILG) and the upper bound adjustment is the AAA-ILG spread.

In the second case, r_S cannot be identified. This may be the case if there is no risk-free asset, or the risk-free asset bears CY which cannot be estimated. r_S is replaced by the return on the zero-beta asset. The only way that an investor can borrow is by shorting the zero-beta asset and thus r_B is the return on the zero-beta asset plus shorting costs. Then r* lies between 'zero beta return' and 'zero beta return plus shorting costs' i.e. it becomes the zero-beta return plus a proportion of shorting costs.

This report considers that the first case rather than the second case applies. To this end, CY(ILG) and the AAA-ILG spread have been estimated in sections 2.2.2 and 2.3.4 respectively.

4.5. Quantitative analysis of AAA-ILG spread

This section sets out the quantitative analysis of the AAA-ILG spread.

This report estimates the AAA-ILG spread by comparing the yield on RPI-linked AAA corporate bonds to the yield on duration-matched ILGs.

Duration measures the weighted average time it takes for an investor to receive all the cashflows from a bond. Duration is shorter than the maturity of a bond where the bond has a non-zero coupon or is amortising. ILGs are zero coupon and bullet so their duration and maturity are equal. Matching on the basis of duration rather than maturity limits differences in cashflow structure between ILGs and RPI-linked AAA corporate bonds that could be coupon-paying and/or amortising.

The sample of RPI-linked AAA corporate bonds in the analysis comprises eight bonds; seven were issued by the EIB and one by the IBRD. These bonds met the following criteria:

- Bond is linked to RPI
- Bond has been rated AAA throughout its life
- Bond is GBP denominated
- Bond is not an asset-backed security
- Bloomberg has data for the bond. Bloomberg only has duration data for active bonds and the yields for active bonds was generally only available from December 2014. Hence, the earliest window that could be adopted was December 2014.

The analysis considers both long-run and short-run averages of the AAA-ILG spread. It focuses more on the 1m average as Ofgem uses a 1m average for its ex-ante forecast of the risk-free rate over RIIO-3. Indeed, the 1m average reflects the latest data and therefore may provide the most reliable estimator. The 1m average is cross-checked against the long-run average to ensure it does not reflect temporary factors. The 1m average over March 2025 is used in this analysis.

The BVAL algorithm is used to price the RPI-linked AAA corporate bonds. Bloomberg considers that "*a BVAL* [data quality] *score between 6 and 10 reflects that the BVAL price was generated by the Direct Observations model, using recent direct observations on the target bond such as trades, and/or with high corroboration across multiple executable or indicative data"*[77]. The analysis only uses bonds with a BVAL score of at least 6 on average over March 2025 to ensure the bond data is reliable.

The highest duration amongst the sample of eight RPI-linked AAA corporate bonds is 5.2Y as at 31 March 2025. The analysis uses the five bonds in the sample with a duration above 4.75Y (and a BVAL score of at least 6). The ISINs for the five bonds in the analysis are XS0132108704, XS0207445296, XS0172367921, XS0218874989 and XS0116389023. The last bond was issued by the IBRD and the other four bonds were issued by the EIB.

The analysis in this report is carried out as follows:

1) Download the daily yield, daily price and daily amount outstanding as well as the issue and maturity dates for the five RPI-linked AAA corporate bonds.
2) Calculate the daily AAA-ILG spread for each RPI-linked AAA corporate bond based on its yield less the yield on a duration-matched ILG where data for both is available.
3) Calculate the daily market value for each RPI-linked AAA corporate bond based on its price multiplied by its amount outstanding.
4) Calculate the daily market-value weighted-average of the AAA-ILG spread across the group of five RPI-linked AAA corporate bonds.
5) Average the daily market-value weighted-average AAA-ILG spread over the estimation window.

The 1m average over March 2025 is 69bps. The average BVAL scores over the same window for three of the five bonds were between 6-6.5 and the other two bonds were above 7. This means that the BVAL scores for the bonds meet Bloomberg's BVAL score threshold for reliable data of 6.

The long-run average over 08/12/2014 to 31/03/2025 across the eight bonds was 136bps. The market-value weighted-average duration of the bonds was 8Y. The BVAL scores for the bonds have been below 5 for periods within this window. This suggests that the 1m average is low relative to the long-run average but 1m average is based on significantly more reliable data.

On this basis, the 1m average of 69bps is selected as the point estimate.

77 Bloomberg (2023), BVAL's Pricing Methodologies, p. 3. Note that Bloomberg describes the BVAL score as "*a unique numerical rating (on a 1 to 10 scale) that shows the relative strength of the recency, quantity and quality of market data inputs used in calculating the BVAL price for a particular security at a particular snapshot"*.

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