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THE RELATIONSHIP BETWEEN TOTAL MARKET RETURN AND GILT YIELDS

PREPARED FOR NATIONAL GRID ELECTRICITY TRANSMISSION

06 MARCH 2024

Contents

frontier economics

Executive summary

Frontier has been commissioned by National Grid to explore the relationship between yields on gilts and forward looking Total Market Return (TMR). We have been asked to review the academic literature on this topic and to use that literature to undertake a review of the market evidence on this interlinkage. Finally, we have been asked to compare and contrast regulatory precedent on the determination of TMR with the empirical evidence. As a result of this work, we have developed the idea of a TMR Glider, that captures the relationship between gilt yields and TMR, as a potential input to regulatory decision making.

Overview

This report examines the relationship between the Total Market Return (TMR) and yields on 20-year government gilts, which are often used as a proxy for the Risk-Free Rate (RFR), in the context of estimating the cost of equity (CoE), and in particular in setting allowed equity returns for the regulated utility sectors in the UK.

It is well understood that investors' required TMR at any point will be influenced by the wider interest rate environment, including yields on key asset classes such as risk-free assets. Required returns for equity will move up and down over time with observable rates on risk-free assets. Various strands of empirical research inform us that this movement is not one-for-one. While TMR moves with yields on risk-free bonds, it is more stable, but not fixed.

UK regulatory practice over the past decade or more has been to move TMR down to reflect prevailing market conditions. As interest rates and yields on government bonds fell over much of the last decade, UK regulators responded by lowering their estimates of TMR used to determine the allowed cost of equity. This movement was not one-for-one, i.e. regulators moved TMR by a proportion of the fall in yields on government bonds. This "stable but not fixed" policy has been endorsed by the UK Regulators Network (UKRN).[1]

> *"There is significant alignment amongst regulators in the overall approach to the TMR/ERP, namely that in recent determinations UK regulators assume greater stability in the TMR and therefore estimate it directly from historical equity returns data. In the interests of maintaining consistency across sectors and also across time, continuing with this approach remains preferable. This approach does not imply that regulators should simply pick the same fixed value for the TMR in each decision for all time, but that the TMR would be relatively less variable than the underlying RFR. This would support greater stability in the cost of equity allowances over time. This policy choice seems appropriate in the wider context of the aspiration for greater predictability and transparency in the regulators' methodologies for estimating the allowed rate of return, and one that is fair to investors and customers over time."*

[1] UKRN (2023) UKRN guidance for regulators on the methodology for setting the cost of capital, p19.

The low interest rate environment has now reversed. The ultra-low, deeply negative real interest rates that caused regulators to lower their estimates of TMR over the last decade are no longer observed. On the contrary, real interest rates are now materially positive. All available evidence points to materially positive real rates persisting. There is no evidence to suggest extremely low rates are likely to return.

By the same logic that caused estimates of TMR to fall, it is now time for regulators to increase TMR. But by how much? This paper explores this question.

Our approach

We have explored what the academic literature tells us about the relationship between short run, forward-looking estimates of TMR and yields on index-linked gilts (ILGs). Mirroring the UKRN guidance, we find that the literature finds such a relationship, and confirms that this is not one-for-one, i.e. TMR is stable but not fixed.

We then follow the academic literature to develop our own model. In line with the approach taken in the academic literature, we begin by using a Dividend Discount Model (DDM) to estimate a more short run, 'market-based' measure of nominal TMR. In accordance with what we have found in the literature, we analyse the relationship between these estimates of TMR and yields on government bonds (in particular 20-year nominal gilt yields, which are often used as a proxy for the risk-free rate).[2]

We posit that this relationship can be used to calibrate a TMR Glider, i.e. an assessment of what market evidence tells us about the appropriate level of TMR implied by market movements given the observable level of yields on 20 year gilts used to proxy RFR. We estimate three different Glider specifications: a preferred specification alongside two sensitivities.

One question that might be asked is, why not just use DDM estimates of TMR directly to test regulatory decisions? Why fit a relationship to build a Glider? In our view, there would be risks associated with using 'spot' DDM estimates directly in a regulatory context. DDM estimates are volatile, and reliance on them for regulatory purposes would result in a regime where returns may vary materially from period to period. Neither customers nor investors would value such a regime. It would also be out of line with the UKRN guidance set out above, as a regime based on DDM would not deliver stable TMR. However, DDM remains a valid model for constructing expectations on forward-looking required returns, and can serve as a sound foundation for this analysis.[3]

While we would not use DDM directly, we consider that a Glider that embodies the underlying relationship between interest rates and DDM outputs, but smooths out the volatility, has far

[2] Also in line with the literature, we have conducted this analysis in nominal terms, also because the DDM input data is not expressed in real terms.

[3] As we describe later in this report, the Bank of England has used DDM approaches to support its analysis in the past.

better regulatory properties, while still being anchored to underlying finance market evidence. It is also in keeping with prevailing UKRN guidance that TMR should be considered stable but not fixed.

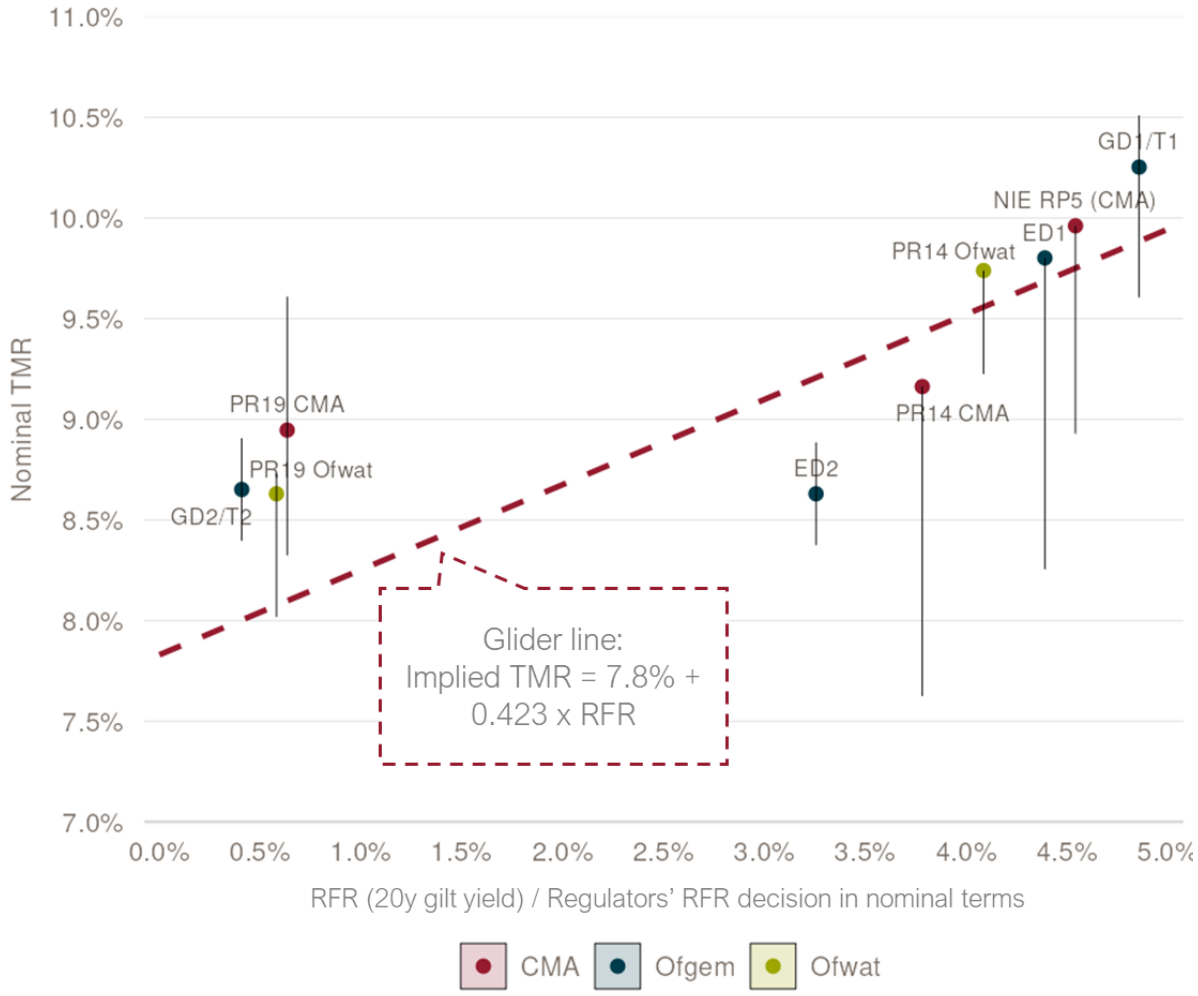
We note that, up until this stage, our approach has not drawn any input from regulatory decisions. The relationship we identify is based entirely on market evidence, i.e. yields on 20-year gilts and estimates of TMR derived from a DDM populated by wider market evidence and equity analysts forecasts.

Key findings

As a final step, we then test this model against regulatory practice. Is the Glider capable of explaining past regulatory decisions? If so, do past regulatory decisions appear reasonable by reference to our TMR Glider, which as noted simply reflects relevant market information? If so, what does the Glider tell us about how TMR should be set at RIIO-3?

Our assessment is that the Glider is able to explain past regulatory TMR decisions, given each regulator's assessment of RFR, reasonably well. Most points are close to the Glider line as shown in the figure below.

Figure 1 TMR Glider against regulatory TMR and RFR decisions



Source: *Frontier economics analysis of regulatory decisions, Ofwat, Ofgem, CMA,*

Note: *The **TMR Glider (dotted line),** i.e. the level of TMR consistent with varying levels of the 20-year nominal gilt yield, used as a proxy for the risk-free rate. This is the relationship estimated in Section 3.4 above using specification C controlling for outliers from high volatility events. This is the preferred Glider specification*
*We then **plot regulators' TMR decisions along the TMR Glider line**. We locate each dot on the basis of each regulator's own decisions for both TMR and RFR. We regard these as a matched pair, they reflect the choice each regulator made regarding TMR in the light of what they thought the wider interest rate environment was at the time Ofwat in its PR14 decision determined that the TMR was 6.75% and the corresponding RFR was 1.25%.[4] Both of these values are in RPI-real terms, and for the PR14 decision, Ofwat expected RPI inflation to be 2.8%. Hence, given Ofwat's inflation expectation, it considered the nominal RFR and TMR were 4.1% and 9.74% respectively. Therefore, the PR14 (Ofwat) decision point is located at 4.1% on the X-axis, and 9.74% on the Y-axis*
*For each regulatory decision, we also show the **TMR range**: this is represented by the solid black line running through each of the regulatory TMR point estimates (dots) in the figure. Where the dots lie at the top of the line, this demonstrates that the regulator had aimed up; where the dots lie in the middle of the line, this shows that regulators had aimed straight.*

The implication of what we observe in the figure is that past regulatory decisions have indeed responded to interest rate developments. While the UK regulatory regime has often been

[4] Ofwat (2014) Setting Price Controls for 2015-20, Final price control determination notice: policy chapter A7 – risk and reward, Table A7.10.

presented as relying on a fixed TMR construct, it seems that the prevailing UKRN guidance, which focuses on TMR being stable but not fixed, is indeed an accurate characterisation.

Implications for RIIO-3

We have considered what the Glider would imply for current and future regulatory decisions. On the basis of prevailing gilt yields, all Glider specifications predict a current TMR above 7.5%, in the range of 7.55%-7.86%.[5] Given that interest rates at prevailing levels have not been seen for decades, and the 'stable but not fixed' regulatory construct that has emerged, it is perhaps not surprising that the predicted TMR is considerably higher than observed in the most recent decisions.

This further highlights that, if the present interest rate environment or something like it is expected to persist, then a roll forward of the RIIO-2 TMR decision of 6.5% would be far too low for RIIO T3/GD3. This is entirely consistent with the findings set out in Oxera's 2024 report on the Cost of Equity for RIIO-3[6], and with the evidence presented in our Equity Investability Report.[7] A TMR decision of roughly 6.5% CPIH-real, based on a RIIO-2 roll-forward methodology, would be a significant departure from both market evidence and established regulatory precedent. It risks sending a message to investors that 'stable but not fixed' applies only when interest rates are falling, but not when they are rising, and we believe would undermine investor confidence.

5 We have considered three different Glider specifications, and Figure 1 shows our preferred specification. All three specifications are not that different, as shown by the relatively small range of implied TMR. Our preferred Glider specification (shown in Figure 1) implies a TMR of 7.55% CPI-real, at current interest rates.

6 Oxera (2024) RIIO-3 cost of equity, Prepared for the ENA.

7 Frontier (2024) Equity Investability in RIIO-3, Prepared for the ENA.

1 Introduction

Frontier has been commissioned by National Grid to explore the relationship between yields on gilts and forward-looking Total Market Return. We have been asked to review the academic literature on this topic and to use that literature to undertake a review of the market evidence on this interlinkage. Finally, we have been asked to compare and contrast regulatory precedent on the determination of TMR with the empirical evidence. As a result of this work, we have developed the idea of a TMR Glider, that captures the relationship between gilt yields and TMR, as a potential input to regulatory decision making.

The remainder of this report provides a full exposition of the points made in the Executive Summary, and is structured as follows:

- In Section 2 we set out the steps we have taken to develop the TMR Glider at a high level. Further detail is provided in annexes.
- In Section 3 we present the results of testing our Glider against past regulatory decisions. As noted above, we consider this a key test.
- In Section 4 we provide initial conclusions from our work to date on this topic, setting out what this could mean for RIIO-3 and highlighting the further work and engagement that may improve our understanding of how TMR might move in a regulatory construct where it is considered ‘stable but not fixed’.

Annexes provide the further detail, to aid review of our work.

2 Developing a TMR Glider

2.1 Overview

In this section, we set out the steps we have followed to develop our TMR Glider at a high level. Those with an interest in the underlying detail can find this in a range of annexes.

Our process can be summarised as follows.

- **Step 1, understanding the relationship between TMR and gilt yields**: we have explored the evidence on the relationship between TMR and interest rates. Our review of the academic literature has shown evidence of this relationship, although we note that different studies report different levels of responsiveness. This is inevitable as studies cover different markets and time periods do not all rely on the same measures of interest rates. Given this, we do not propose to simply adopt the academic literature directly to develop a TMR Glider which is relevant to the GB regulatory context.

- **Step 2, developing a DDM model to estimate short run forward-looking TMR**: the literature we have reviewed suggests that the relevant relationship is between the measure of the risk-free rate as proxied by the yield on safe government assets, and the forward-looking *required equity return*. This is also the relationship of interest for our purposes. We have followed the academic literature and have developed an equity cash flow Dividend Discount Model (DDM) to estimate required returns on a forward-looking basis. We note that this approach has also been adopted by the Bank of England.[8] Owing to data availability constraints, we produce results for the GB market for the period 2006-2023.

- **Step 3, estimating the relationship between DDM-derived TMR and 20-year gilt rates**: we identify the line of best fit between required TMR and yields on 20-year gilts commonly used to proxy the RFR. We have explored a range of potential specifications and time periods, and we have conducted sensitivity analyses to gauge whether and how to account for periods of high financial market volatility that may be outliers. Inevitably, our estimates of the relationship between TMR and nominal gilts is somewhat sensitive to these choices, but not unduly so, i.e. similar conclusions would emerge from all the specifications we have considered.

In the following chapter we evaluate whether the relationship we have developed leads to a Glider that is capable of explaining past TMR decisions taken by regulators.

[8] See for example: An improved model for understanding equity prices (2017), Will Dixon & Alex Ratten, Q2 2017 Bank of England Quarterly Bulletin https://www.bankofengland.co.uk/-/media/boe/files/quarterly-bulletin/2017/an-improved-model-for-understanding-equity-prices.pdf

2.2 Understanding the relationship between TMR and ILG yields as a proxy for RFR – the academic evidence

In this section, we set out evidence from the academic literature on the relationship of equity market returns and the RFR. These studies inform our approach to developing the TMR Glider.

2.2.1 Harris and Marston (2013)[9]

Harris and Marston examine whether there is evidence that the equity risk premium (ERP) is not constant, and consider whether there are any implications for estimating the cost of capital. Using data from US markets, Harris and Marston found that the equity risk premium varies over time. They found that these changes in the ERP could be linked to changes in long term interest rates, credit spreads on corporate bonds and anticipated volatility in equity markets.

More specifically, Harris and Marston use a discounted cash flow model (DCF) with US market data from 1986 to 2010 in order to estimate forward-looking market required returns.[10] The market required return is defined as the sum of the return on the risk-free asset and the market risk premium. In other words:

Total Market Return (TMR) = Risk-free rate (RFR) + Equity risk premium (ERP)

Given that Harris and Marston aim to examine the evolution of the ERP over time, they derive the forward-looking ERP by subtracting the RFR from the forward-looking TMR.

The authors use regression analysis to investigate the extent to which changes in their estimated ERP moves with changes in long term interest rates. They find a coefficient of -0.79%. They suggest that this coefficient can also be interpreted to mean that the coefficient between the change in TMR and change in interest rates would be +0.21%.

These findings support the premise that changes in TMR are related to changes in the RFR. However, we cannot consider Harris' and Marston's analysis directly for the purposes of specifying the TMR Glider. This is because Harris and Marston examine the relationship between changes in ERP and changes in RFR, which is related to our enquiry but not exactly the same.[11] Nevertheless, this study provides evidence that the required equity risk premium

9 Changes in the Market Risk Premium and the Cost of Capital: Implications for Practice (2015), Robert S. Harris & Felicia C. Marston. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2686739

10 Harris and Marston (2013) Equation 2. The authors use a static Dividend Discount Model (DDM). The data used includes SP500 dividend paying stock and individual analysts' forecasts of long-run growth in earnings.

11 Associating *changes* in *MRP* and *changes* in the RFR, cannot be transformed in a straightforward manner into a comparable coefficient for *levels* analysis. This is because the changes regression is identifying the rate of change of the slope of the line of best fit between the MRP and the RFR. This (i) suggests that the modelled overall relationship is non-linear, and (ii) a starting point for both the MRP and the RFR would be needed to identify the corresponding actual slope at one point on this non linear line of best fit.

does change alongside changes in risk-free rates, which provides a foundation for further considering a TMR Glider.

2.2.2 PwC for Ofwat (2017)[12]

PwC prepared a report for Ofwat that aimed to examine the balance of incentives introduced at Periodic Review 2014 (PR14), and potential improvements for the next periodic review (PR19). As part of this, PwC also examined the potential impacts of the 'lower for longer' interest rate era on estimating equity returns. The 'lower for longer' era was defined in a UK market context, as a period wherein the Bank of England was likely to keep the cost of borrowing ultra-low for a prolonged time.[13]

PwC sought to understand whether the 'lower for longer' environment justified a potential adaptation in Ofwat's approach to setting TMR, i.e. whether there was any reason to consider more current market evidence in addition to the conventional approach of relying on long term historical equity returns.[14] The consideration of current evidence would mean that the resulting cost of equity would be calibrated according to both short term market dynamics and long term market expectations.[15]

Following Harris and Marston, PwC used a dividend discount model (DDM) to estimate a market-implied TMR for the UK market, covering the period 2000 to 2016.[16] The PwC DDM model found the TMR value that equates the equity value today with the present value of future dividends. The authors relied on a multi-stage DDM growth model, in which there is a short term (5 year) growth rate of dividend value and an expected long term growth rate, used to calculate a "terminal dividend value".[17]

The dividend data used in the model are from the UK FTSE All-Share Index over the period January 2000 to December 2016. We also obtain data on the initial market value of the FTSE index and the observed cash yield. This dataset is combined with data on estimations for stock buyback yields. The expected short and long term growth rates are based on nominal growth

12 PWC (2017) Refining the balance of incentives for PR19. Accessible here: https://www.ofwat.gov.uk/wp-content/uploads/2017/07/PWC-Balance-of-incentives-June2017.pdf

13 PWC (2017), Refining the balance of incentives for PR19, Appendix B.

14 PWC (2017), Refining the balance of incentives for PR19, state that the approach to setting the cost of equity (including the choice RFR, EMRP and the TMR) on the basis of long run averages relies on the assumption that any current divergences are "temporary or exceptional in nature" (p77). They argue that if market conditions persistently deviate from the long run averages such as in the 'lower for longer' era, long run averages will overstate required returns (the inverse to be true if rates were higher than the long term rates).

15 PWC (2017), Refining the balance of incentives for PR19, p81.

16 The authors use a multi-stage Dividend Discount Model (DDM). They use data from the UK FTSE All-Share Index. The expected short- and long-term growth rates are nominal growth rates calculated from forecast real GDP growth rates and forecast inflation (this relies on the assumption that GDP growth is a reasonable proxy for their whole-market approach).

17 The underlying equation is as follows: $V_0 = \sum_{t=1}^{\infty} \frac{D_t}{(1+k_e)^t}$ where *V* is the intrinsic value (price today), *D* is the dividend value and *k* is the cost of equity.

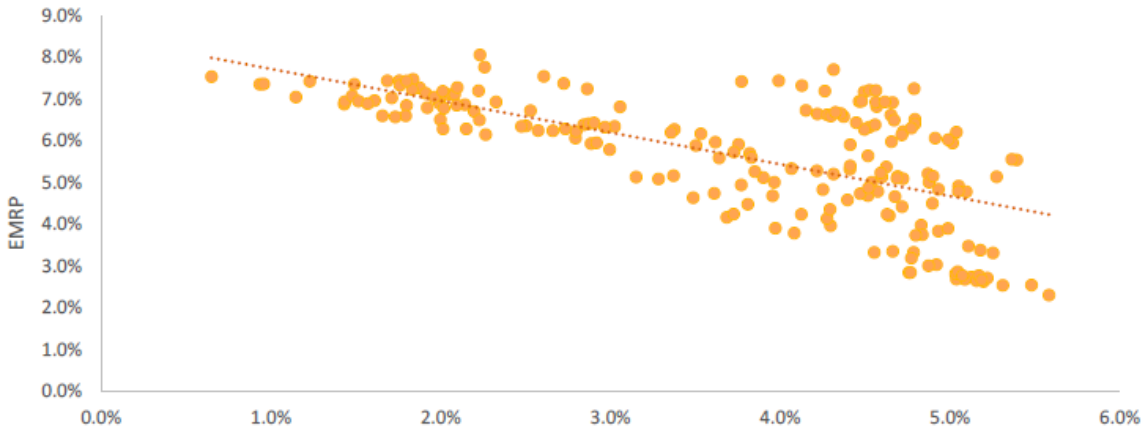
rates calculated from forecast real GDP growth rates and forecast inflation (thus making the assumption that GDP growth is a reasonable proxy for this whole-market approach).

The DDM model is run on a monthly basis and hence solves for monthly estimated TMR spot rates from 2000 to 2016. To provide an illustration of the results, the spot rate for December 2016 is 8.3% (in nominal terms).[18] The 5 year average of the DDM outputs for TMR is 8.8%.

The monthly TMR timeseries is in turn used to derive a monthly ERP by subtracting yields on UK nominal bonds, a proxy for RFR.[19]

The final step of the PwC analysis investigates the relationship between the RFR and the ERP. The authors plot these two variables over time (see Figure 1 below). They fit a linear relationship between the two variables, and report the gradient of this relationship for the full period of analysis, and separately for the later part of the period only (2010 to 2016). The best fit line has a gradient of approximately -0.76 for the period 2000 to 2016, suggesting that a 100 bps drop in the RFR is associated with a 76bps increase in the ERP. For the period 2010 to 2016 the equivalent figure was approximately -0.88.

Figure 2 Reproduction of Figure 23 from PwC's report, relationship between risk-free rate and EMRP from implied DDM (2000 to 2016)



Source: PWC

[18] The authors note that DDM outputs can be sensitive to the choice of data inputs, and therefore conduct sensitivity analyses; these analyses test the sensitivity of the TMR estimates to:

- The real growth rate of dividends and forecasted inflation: adding 1% to each of these increases the TMR by approximately 2%, reducing each of these by 1% decreases the TMR by approximately 1.5%.
- Share buybacks assumption: adding 1% to buybacks increases the TMR by approximately 1%, whilst excluding buybacks decreases it by approx.. 1%.

[19] Two alternatives are used for the RFR: the spot yield on 10 year UK nominal government bonds and on 20 year UK nominal government bonds.

PwC infer (based on their analysis) that if current market conditions are expected to diverge from long-run historical averages for an "extended period" of time, then one must consider the suitability of the long-run historical averages for calibrating price control returns.[20]

2.2.3 Damodaran (2020)[21]

In his 2020 paper Professor Damodaran considered the determinants of ERPs and provides a review of the techniques for estimating ERPs. He identified three approaches: survey premiums, historical premiums or implied equity premiums (including those estimated from discount cash flow models, default spread based ERPs or option pricing model based ERPs).

Damodaran used a variety of discounted cash flow models populated with US market data over the period 2008 and 2020. Damodaran compares the ERPs estimated using these methods with ERPs estimated using historical methods. Although this comparison is the focus of the paper, Damodaran notes the results of a series of simple regressions investigating the implied ERPs' relationship with other macroeconomic variables.[22] In particular, as an adjunct to his main analysis, Damodaran looks at the relationship between estimated ERP and interest rates, economic growth, inflation rates and exchange rates.

Damodaran does not find evidence of a significant relationship between the implied ERP and long term interest rates, although this finding is not explored or tested in great detail and, as noted, identifying the relationship between ERP and gilt yields was not the primary focus of the paper.[23] Damodaran's findings would however be consistent with a finding that TMR and gilt yields move together in line with the other academic studies we have reviewed, and the study does provide a potential further approach to testing the elasticity of TMR against risk-free rates.

2.2.4 Key findings from the literature and implications for our analysis

The academic literature reveals that there is evidence of a relationship between TMR and government bond yields, which are usually used in the regulatory context to set the RFR. However, we are not able to directly rely on the findings from the academic studies, given that they relate to different markets and time periods. We do not consider that it would be appropriate to rely on these models 'out of sample' to inform the cost of equity for RIIO-3.

Nevertheless, our review of the literature has shown that there is a fairly consistent approach to investigating the relationship between expected total market returns and risk-free rates.

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20 PWC (2017) Refining the balance of incentives for PR19, p79.

21 Damodaran (2020) Equity Risk Premiums (ERP): Determinants, Estimation and Implications – The 2020 Edition Accessible here: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3550293

22 Damodaran (2020) Equity Risk Premiums (ERP): Determinants, Estimation and Implications – The 2020 Edition, Table 21.

23 Damodaran (2020) Equity Risk Premiums (ERP): Determinants, Estimation and Implications – The 2020 Edition, p105-107.

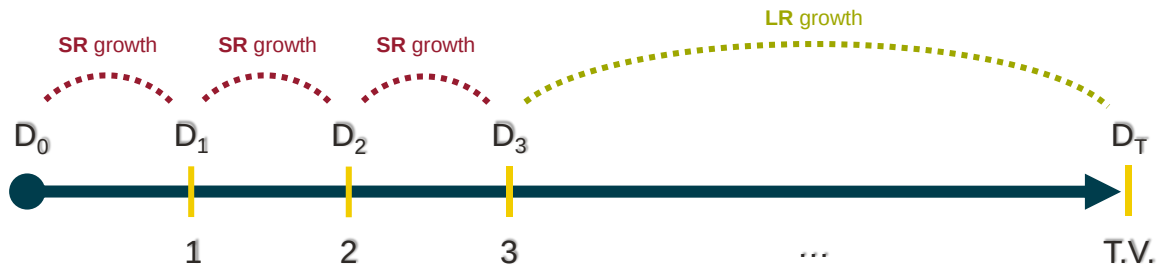
This involves first estimating the expected or required TMR via an equity cash flow model such as the dividend discount model.[24] The required TMR values derived from the DDM model can then be used to evaluate whether a relationship can be specified between the required equity market return and the prevailing risk-free rate at the time. We have adopted this approach in our analysis.

2.3 Estimating the required equity return using a DDM

In line with the approach set out in the literature, we have developed a Dividend Discount Model (DDM) to estimate a TMR timeseries for the UK from 2006 to 2023.[25] We note that our approach closely mirrors that adopted by PwC in their study for Ofwat, described above.

We have also adopted a two-stage growth DDM model. This requires an assumption of a short-run growth rate for the first three periods and a long-run growth rate used in perpetuity thereafter, as illustrated below. The short term growth assumption uses dividend forward rates sourced from Bloomberg. The long term growth rate is the IMF's nominal GDP long-run growth forecast. Our DDM also takes account of share buybacks as part of our assessment of the cash flows that will accrue to equity holders. We consider that accounting for buybacks more accurately reflects the overall cash return for investors, and note that this matches the approach adopted by PwC.[26]

Figure 3 Growth assumptions required to operationalise the DGM model



Source: Frontier internal

Using these assumptions, we are able to construct a stream of *expected* equity cash flows for the period 2006-2023. We note that data availability prevents us from extending the analysis

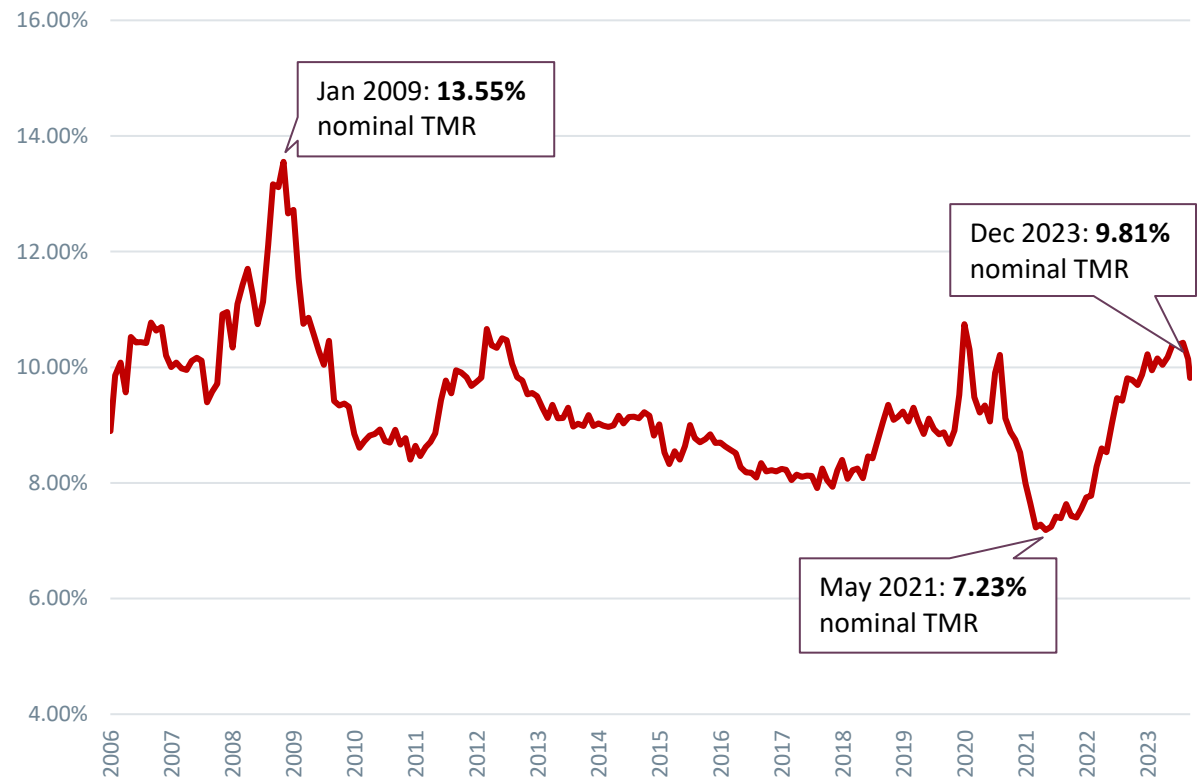
24 In addition to the academic literature investigating the relationship between ERP/TMR and the RFR, the Bank of England have a set of papers using DDM to estimate TMR over time. These papers also support our use of DDM to estimate required returns to equity. We summarise the findings of these papers in Annex A.

25 The data we have used in the DDM model is outlined in Annex B.

26 We have explored a range of further specifications in the course of this work. We find that different specifications make only minor differences to the resulting TMR. For the reasons provided in the main body of this report, we consider that our chosen approach is the most robust and reasonable.

back further. The present value of expected equity cash flows are then equated with the level of the FTSE All Share[27] at any given point in this time window, to infer the *required* equity return on the FTSE All Share.[28] The model output is illustrated in the figure below.

Figure 4 Estimated TMR from DDM modelling



Source: *Frontier Economics DDM Model output*

Note: *Our preferred specification uses analyst dividend yields and buyback yields to capture shareholder returns, dividend 3Y forward expectations for short-run growth and IMF nominal long-run GDP growth forecasts for long-run growth.*

The pattern of this chart fits most of the macro events that one would expect to have affected the TMR over the time period. For example, the height of the global financial crisis saw the peak of the TMR, followed by a second (albeit lower) high during the Eurozone sovereign debt crisis. Further down, the Covid-19 market turbulence marked another high market premium point, whilst the continued loosening of monetary policy meant that once the market recovered from the Covid-19 shock the TMR was at its lowest in recent history in line with the lowest

27 More details on the datasets used are given in Annex B. We test the underlying data assumptions for robustness on several dimensions. We use FTSE 100 data rather than the FTSE All Share Index, and find results to be similar. We use quarterly rather than monthly data, and again we find the results to be similar. We use actual dividends data rather than analyst dividend estimates, and we find the results are more robust across the specifications with the estimated data.

28 See Annex A of this report for a full explanation of the DDM model.

RFR in recent history. The Ukraine war and the ensuing interest rate hikes by the Bank of England contribute to the recent peak of the TMR, with risk premium and RFR increasing simultaneously.

We have compared our above DDM TMR output against the output of a similar exercise undertaken by the Bank of England. The results of this comparison can be found in Annex A.5. We consider this comparison broadly supportive of our DDM approach and findings.

2.4 Estimating the relationship between TMR and the RFR

Our final step is to evaluate the relationship between the forward-looking required equity return and contemporaneous 20-year gilt yields, i.e. to estimate the observed change in TMR given changes in bond yields.

To do this, we identify the line of best fit between required equity returns (TMR) and 20-year gilt yields as a proxy for RFR. More specifically, we estimate the slope (β) and intercept (α) of this line of best fit, per the following equation:

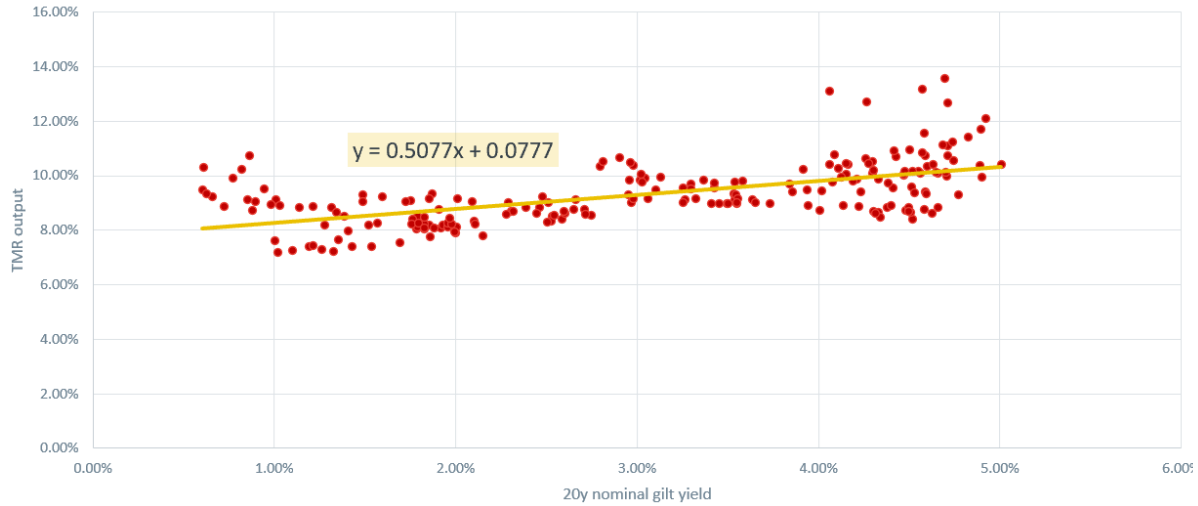
$$TMR_t = \alpha + \beta \cdot 20\ year\ ILG\ ytm_t$$

Following the academic literature, the purpose of this analysis is clearly not to provide a fully fitted, multidimensional macroeconomic model that explains the relative importance of all the potential determinants of TMR. Rather, we look to identify the simple relationship between the two variables over time in order to inform our TMR Glider.

We have considered three different specifications that result in slightly different parameter estimates.

Our first specification (Specification A) simply examines the relationship between our DDM TMR and 20-year gilt yields, over the entire period we have studied and including all observations. The outcome is shown in Figure 4 below. We find that we are able to specify a linear relationship between TMR and RFR which reasonably runs through the data, but for a number of outliers on the top right hand corner of the figure.

Figure 5 Line of best fit between forward-looking required TMR and 20 year gilt yields using DDM



Source: *Frontier internal DDM model output*
Note: *The TMR output is from Specification 3 of the DDM model. The 20y nominal gilt yield is our proxy for the RFR.*

The line of best fit has an estimated slope of 50.8%, i.e. this evidence suggests a 100bps increase in yields on 20-year gilts is associated with a corresponding 50.8bps increase in the TMR. The intercept is estimated to be 7.8%, i.e. if nominal interest rates were to fall to 0%, the line of best fit would predict a nominal TMR of 7.8%.[29]

One possible concern with financial market data is outliers. In Specification B we retain the same simple model as for Specification A, but rely on statistical tests to identify outliers (values lying more than 3 standard deviations from the mean TMR). Five outliers are identified by this test, and these observations can be observed in the top right hand section of the graph. In each case, these points represent periods with estimated nominal TMR of greater than 12.5%. All five of these points occurred during the last quarter of 2008 and the first quarter of 2009. We therefore fit another line of best fit that excludes these outliers, and the results are presented in the table below (Specification B).[30]

For Specification C, we consider alternative ways to address potential outliers. Our examination of potential outliers indicates that there are historical events that we may wish to control for, such as the GFC and the Covid-19 pandemic, given that these episodes caused significant volatility in financial markets. To systematically identify such events, we consider

29 Note that this is an out of sample prediction: there are no observations in our sample with a nominal RFR of 0%. Hence, the TMR prediction for this should be treated with caution.

30 As one would expect, excluding these five outliers leads to the line of best fit becoming marginally shallower and the intercept moving marginally higher (see the results in Table 1).

the VIX index to specify which windows of significant volatility should be controlled for.[31] We therefore fit a third line where we control for these events, shown as Specification C in the table below.[32]

Table 1 TMR and RFR relationship results

	Spec A	Spec B (drop outliers)	Spec C (control for shocks using dummies)
Time period	*2006-2023*	*2006-2023*	*2006-2023*
Intercept (nominal)	**7.8%**	**7.9%**	**7.8%**
Slope (nominal)	**50.8%**	**44.5%**	**42.3%**
Other dummies	N	N	Y
Implied TMR today (nominal)	10.0%	9.9%	9.7%

Source: Frontier analysis

The three approaches to fitting a relationship between TMR and 20-year gilt yields are shown in the table above. The results suggest that there is a change of 0.4%-0.5% to TMR when gilt yields change by 1%. The intercepts of the lines of best fit also remain in a tight range, between 7.8% to 7.9%.

In comparison to the past PwC study, our analysis indicates that TMR is more responsive to changes in gilt yields. We consider that this is likely to be a consequence of the period of analysis – PwC's study ran from 2000 to 2017, whereas ours runs from 2006 to the present (due to data availability). This does suggest that a Glider of this kind should not become a 'fit and forget' kind of mechanism, if it came to play some role in UK regulation, but should be revisited over time.

In the following chapter we explore further the results from Specification C. We do however note that our analysis shows that specification choice does not have a particularly material effect on the location of the line of best fit.

[32] The VIX index is an index that captures market expectations regarding volatility over a future fixed period, usually 30 or 60 days ahead. The VIX timeseries allows us to identify periods of greater than usual volatility: we define this as VIX levels greater than 2 standard deviations from the mean VIX over our time period. The results as precisely: from 23/01/2008 to 22/04/2009 (the Global Financial Crisis) and from 28/02/2020 – 15/06/2020 (the Covid-19 pandemic). We use dummies to control for these two periods in Specification C..

3 Testing past regulatory decisions against the TMR Glider

Based on our DDM modelling and analysis of the relationship between the TMR estimates produced by that model and 20 year gilt yields, we have established a candidate Glider calibration. We now consider how well our Glider 'explains' previous regulatory decisions, particularly how those decisions moved down with the decreasing interest rate since the global financial crisis.

Below we show a comparison between our TMR Glider and regulatory decisions taken since 2012. This captures a reasonable number of regulatory decisions, starting from the last decisions taken before the start of the era of cheap money, and before regulatory TMR decisions began to be lowered (starting with the CMA NIE RP5 decision). The figure shows:

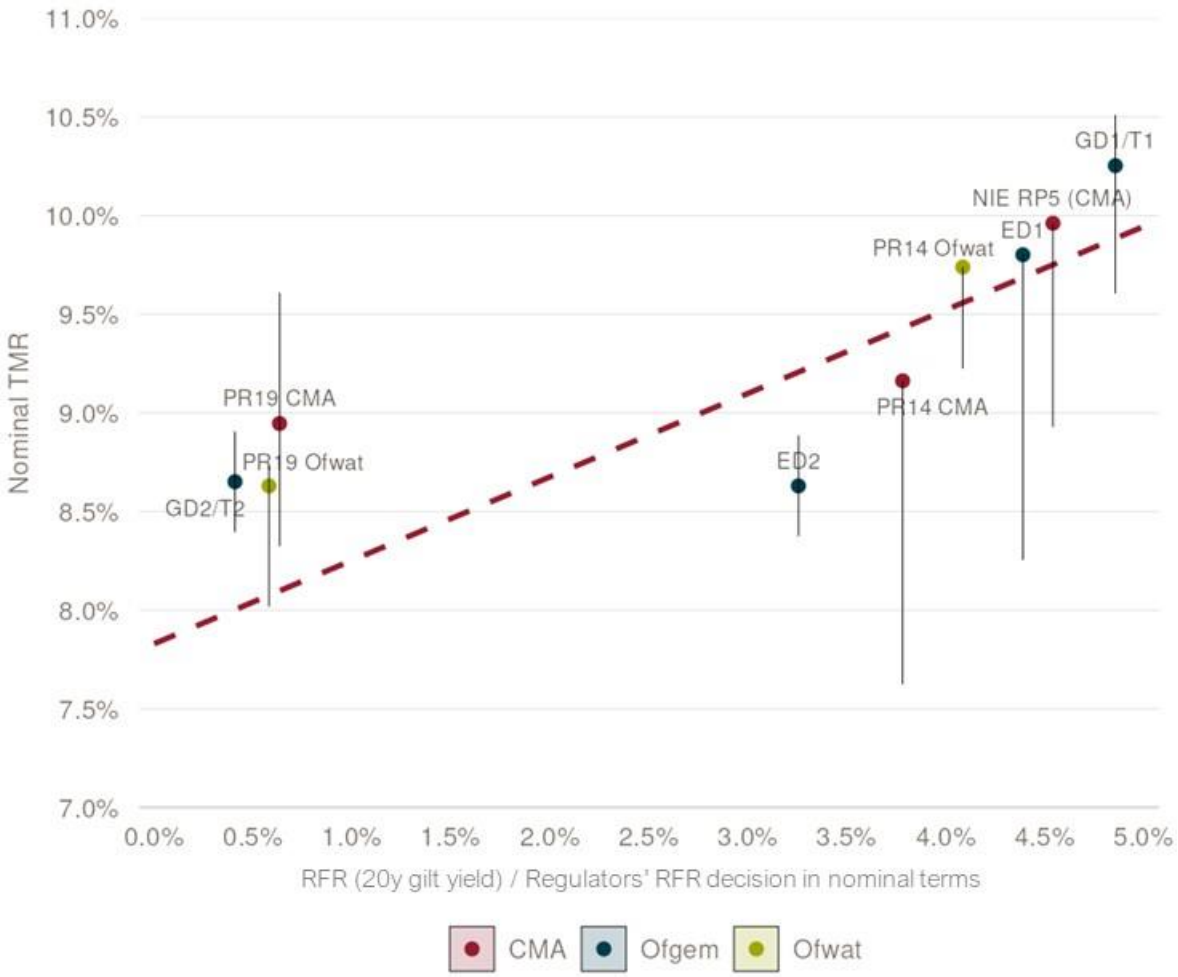
- **The TMR Glider (dotted line)** i.e. the level of TMR consistent with varying levels of the 20-year nominal gilt yield, used as a proxy for the risk-free rate. This is the relationship estimated in Section 3.4 above using specification C, controlling for outliers from high volatility events.
- We then **plot regulators' decisions along the TMR Glider line**. We locate each dot on the basis of each regulator's own decisions for both TMR and RFR. We regard these as a matched pair, reflecting the choice each regulator made regarding TMR in the light of what they thought the wider interest rate environment was at the time. To illustrate how each dot has been located:
  - Ofwat in its PR14 decision determined that the TMR was 6.75% and the corresponding RFR was 1.25%.[33] Both of these values are in RPI-real terms, and for the PR14 decision, Ofwat expected RPI inflation to be 2.8%.[34]
  - Hence, given Ofwat's inflation expectation, it considered the nominal RFR and TMR were 4.1% and 9.74% respectively.
  - Therefore, the PR14 (Ofwat) decision point is located at 4.1% on the X-axis, and 9.74% on the Y-axis.
- We repeat this process for the regulatory decisions made since 2012 to locate each decision along the Glider line.
- For each regulatory decision, we also show the **TMR range**: this is represented by the solid black line running through each of the regulatory TMR point estimates (dots) in the figure. Where the dots lie at the top of the line, this demonstrates that the regulator had

33 Ofwat (2014) Setting Price Controls for 2015-20, Final price control determination notice: policy chapter A7 – risk and reward, Table A7.10.

34 Ofwat (2014) Setting Price Controls for 2015-20, Final price control determination notice: policy chapter A7 – risk and reward , p36.

aimed up; where the dots lie in the middle of the line, this shows that regulators had aimed straight.

Figure 6 TMR Glider against regulatory TMR and RFR decisions



Source: Frontier economics analysis of regulatory decisions, Ofwat, Ofgem, CMA

Our assessment is that the Glider is able to explain past regulatory TMR decisions, given each regulator's assessment of RFR, reasonably well. Most points lie close to the Glider line.

The implication of this is that past regulatory decisions have indeed responded to interest rate developments. While the UK regulatory regime has often been presented as relying on a fixed TMR construct, it seems that the prevailing UKRN guidance, which focuses on TMR being stable but not fixed, is indeed an accurate characterisation.

We also observe that to understand past decisions one must also consider aiming up. In the past it was common for regulators to aim up – over this period we see aiming up when interest

rates have been high. This practice has actually aided regulators in sticking to the line, i.e. by aiming up they have better reflected prevailing interest rates.[35]

Conversely, when interest rates were low, regulators appeared to have 'aimed straight' (Ofgem GD2/T2, Ofwat PR19). This has (obviously) tended to lower TMR versus historical decisions, and has been part of the reason why regulatory decisions on TMR have followed rates down.

ED2 appears to be something of an anomaly – it embodied a TMR decision materially below the line. The ED2 decision (dated 30 November 2022) came approximately a year after the CMA found Ofgem's RIIO-2 CoE calibration was "not wrong" at ELMA 2021, and the ED2 process was also concluded during a highly volatile period for capital markets.[36] The UK economy, still recovering from the Covid-19 pandemic, was destabilised by the short Truss tenure as Prime Minister, in particular the much discussed "fiscal event". In the run up to the ED2 FD, gilt yields were at the highest levels observed over most of the RIIO-T1/GD1 and T2/GD2 consultation period, but had only been at those high levels for a short period.

The TMR Glider suggests that the ED2 decision on TMR was too low, based on the high risk-free rates at the time of the decision, but the decision may have been judged closer to the line based on the interest rates that prevailed as the price control was being designed.

A final insight we can draw from the figure is with regards to the PR19 CMA redetermination, which appears to represent the final attempt at implementing a long-term, 'fixed' TMR model. The PR19 redetermination included a lengthy debate on TMR, but we note there was a significant shift in approach and range between the draft and final report,[37] where the final report represented a higher TMR point estimate. This change may have reflected the tension between fully upholding the long-term model (with more emphasis on 'fixed' TMR) in the face of a continued low interest rate environment, which prevailed during the redetermination process.

While there is always important context and detail around any price control decision, we can conclude that the Glider performs reasonably well in terms of characterising regulatory decisions on TMR taken in the past decade. On this basis, we think that the Glider provides useful guidance and insight on how the TMR can be set for future price controls. In fact, using the TMR Glider would represent a consistent approach to how regulators have set TMR so far. We discuss this in the following section.

35 Regulators have aimed up at GD1/T1, NIE RPG (CMA), ED1, PR14 Ofwat, and PR14 CMA.

36 We note that capital market conditions now are arguably similarly volatile to the ED2 period, but interest rates are starting this period at a much higher level.

37 We also note that this change in approach was largely unexplained in the PR19 redeterminations Final Report, and it is our understanding that the final position on TMR was established in closed Working Groups that took place after the publication of the Draft Report.

4 Implications for future TMR decisions based on the TMR Glider

Above we have shown that our candidate TMR Glider is able to explain, to a reasonable degree of accuracy, past TMR decisions given the regulators' assumptions of RFR, albeit with the need to understand some context. Given this, we now ask what the Glider would imply for current and future regulatory decisions. Is it capable of acting as a guide rail?

4.1 TMR Glider predictions for current environment

Using the various Glider specifications we explored in Section 3, we show below what the TMR Glider predicts the TMR should be given today's RFR levels.

Table 2 TMR Glider predictions based on current RFR

	Spec A	Spec B (drop outliers)	Spec C (control for shocks)
Time period	*2006-2023*	*2006-2023*	*2006-2023*
Intercept (nominal)	**7.8%**	**7.9%**	**7.8%**
Slope (nominal)	**50.8%**	**44.5%**	**42.3%**
Implied TMR today (nominal)	10.0%	9.9%	9.7%
Implied TMR today (CPI-real)	**7.86%**	**7.71%**	**7.55%**

Source: Fronter analysis

Note: The Risk Free Rate is the UK 20Y Gilt from 31 January 2024, which was 4.49% in nominal terms.

All Glider specifications predict a current TMR above 7.5%, in the range of 7.55%-7.86%. Given that interest rates at prevailing levels have not been seen for decades, and the stable but not fixed regulatory construct that has emerged, it is perhaps not surprising that the predicted TMR is considerably higher than observed in most recent decisions.

While we would not propose that the Glider should be used mechanistically to set TMR, this brings a key insight. If the present interest rate environment, or something like it, is expected to persist then a roll forward of the RIIO-2 TMR decision of 6.5% would be far too low for RIIO

T3/GD3. This is entirely consistent with the findings set out in Oxera's 2024 report on the Cost of Equity for RIIO-3[38], and with the evidence presented in our Equity Investability Report.[39]

4.2 Interpretation of the Glider prediction

Based on today's interest rate environment, rigid adherence to the TMR Glider would suggest a TMR of 7.55%-7.86% is appropriate. This would be broadly consistent with the line of best fit that emerges from our analysis of short-term market conditions, and, based on our tests, in line with past regulatory practice. It would lead to a CoE that is more likely to pass the investability tests supported by reference to various cross checks, in particular the hybrid bond cross check.

However, the balance of evidence presented in this paper would support a TMR towards the top of the historic decisions taken by the regulators in the past decade based on:

- the way interest rates have moved over that period of time; and
- how regulators have reacted to the move in interest rates to date.

A TMR decision of roughly 6.5% CPIH-real, based on a RIIO-2 roll-forward methodology, would be a significant departure from both market evidence and established regulatory precedent. It risks sending a message to investors that 'stable but not fixed' applies only when interest rates are falling, but not when they are rising, and we believe would undermine investor confidence.

This paper has aimed to offer a helpful lens through which regulators can re-appraise past decisions on the TMR, focus on how market evidence has influenced those decisions, and, hopefully, help to inform a proportionate and appropriate TMR decision for RIIO-3. Given the scale of investment Electricity Transmission networks need to deliver in the period ahead, it is clearly critical important to get this right, in the interests of both investors and consumers.

38 Oxera (2024) RIIO-3 cost of equity, Prepared for the ENA.

39 Frontier (2024) Equity Investability in RIIO-3, Prepared for the ENA.

Annex A An introduction to Dividend Discount Models

A.1 What is the Dividend Discount Model (DDM)?

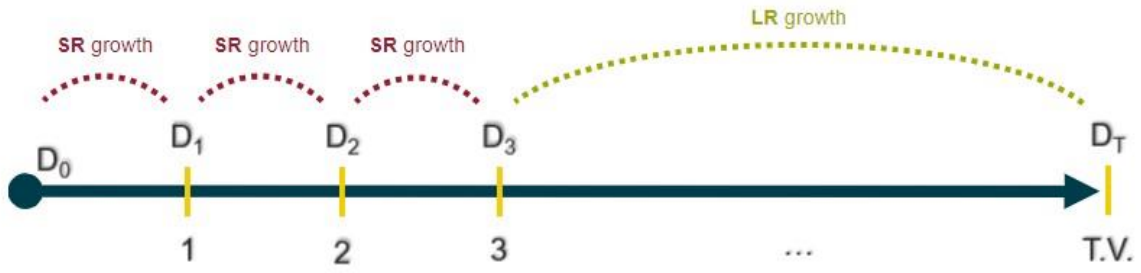
The DDM is a standard method for calculating the expected forward-looking return on a security, based on the fundamental assumption that the present value of a dividend is the sum of all its future dividends discounted to the present. The model is used in one of two forms; (i) a constant growth model, or (ii) a two-stage DDM.

As discussed in the main body of the report, we consider it appropriate to take account of share buy backs in a DDM, as such buy backs are an important form of cash received by equity investors.

A.2 The two-stage DDM

The two-stage model is used to calculate the current present value of expected future dividends (or current index price), P_0, for a stock that is expected to grow dividends at different rates over different periods.

The following diagram shows a model which assumes a short-run growth rate for a company to determine dividends in the first three years, and then a long-run growth rate to determine a terminal dividend value from year 3.



The below formula is used to solve for the expected return:

$$P_0 = \left\{ \frac{D_1}{1+r} + \frac{D_2}{(1+r)^2} + \frac{D_3}{(1+r)^3} + D_3 \frac{(1+g)}{(r-g)(1+r)^3} \right\}$$

Find the **r** that equates the **index price today** to the **sum of future dividends** in present value terms

- D_1, D_2, D_3 represent the expected dividends per share for each of the first three periods, calculated using the initial dividend value and the short term growth rate, *f*:
  - $D_1 = D_0 * f$

- $D_2 = D_1 * f$
- $D_3 = D_2 * f$

- r is the required rate of return.
- g is the expected future growth rate in perpetuity.

A.3 Usefulness of the DDM and its limitations

Many academic papers agree that the DDM is an effective method to infer a forward-looking TMR, since it reflects current stock prices (that should embody the investors' best view of value) plus upcoming market and future growth expectations. For example, Damodaran (2016) found that the use of DDMs resulted in the best predictive power of actual returns in the US market, and a 2015 working paper by the Bank of England found similar results.[40]

By estimating the forward-looking growth rate, the model provides insights into how expected future earnings growth contributes to the equity risk premium. Its long term focus and flexible framework make it a more realistic model than a model using historic dividend returns to estimate forward-looking returns.

The two-stage model in particular takes a more realistic view than the constant growth rate model, as it recognises that a company's growth rate in dividends varies over time, and captures the transition period that a company may face when moving from the short-run to the long-run.

The main drawback of DDM analysis is its sensitivity to key assumptions. Changes in the assumptions underlying the discount rate, growth rate and dividend payouts can have significant implications to the DDM. Forecasting future dividend growth rates can also be a challenging aspect of DDM analysis, especially for companies with unstable earnings. However, sensitivity analyses can be performed on the model to assess the impact of any changes in the inputs, and how these could change the estimated stock value.

A.4 Bank of England's use of DDM

In addition to the academic literature investigating the relationship between ERP/TMR and the RFR, we note the Bank of England's work on using DDM to estimate TMR over time. This work supports our use of DDM to estimate required returns to equity.

A 2015 working paper by Chin and Polk at the Bank of England seeks to evaluates two measures of expected returns: (i) Campbell's 1991 vector autoregression model (VAR) which looks at the relationship between short-term returns and other variables; and (ii) a DDM model. Specifically, the authors test whether the VAR and DDM models can forecast realised returns

[40] Working Paper No.520, A forecast evaluation of expected return measures (2015), Michael Chin and Christopher Polk, accessible here: https://www.bankofengland.co.uk/-/media/boe/files/working-paper/2015/a-forecast-evaluation-of-expected-equity-return-measures.pdf

in a range of tests. They then compare the two models' performance against a range of traditional predictor variables such as the price-earnings ratio and term spread.

They find that both VAR and DDM perform favourably in simple forecast regression tests, where they significantly predict realised returns at a range of horizons. In-sample, they generate substantially lower forecast errors compared to the alternative predictors. Out-of-sample, they compare the range of forecast variables to a historical average benchmark forecast and find that the VAR and DDM offer economically and statistically significant forecast improvements. This paper therefore provides support for the appropriateness and accuracy of using DDM to estimate expected market returns.

We also note that a speech by Martin Taylor (External Member of the Financial Policy Committee of the Bank of England) in 2016 references DDM analysis that the Bank of England conducted (to investigate ERP rather than directly the TMR).[41] This speech commends DDM as a useful method to measure contemporary ERPs.

In 2017, Dison and Ratten published an article in the Bank of England Quarterly Bulletin, [42] updating the Bank's DDM analysis from the model that had been in use since 2010. In the next section, we compare this output to our own DDM output.

A.5 Comparison of Frontier and Bank of England DDM outputs

Helpfully, the Bank of England's 2017 paper includes outputs from the BOE's own DDM modelling. We find that our model outputs closely resemble the BOE's, as shown in the figure below. The BOE's paper does not report TMR, but rather ERP. To conduct a high-level check of our modelling output, we first calculated the implied ERP, by subtracting the 20-year gilt yield from the required TMR reported by our DDM model.[43]

Note that we did not have access to the BOE's source data. As such, we simply super-imposed our DDM outputs alongside the BOE's, as a high level cross-check. Our DDM outputs are represented by the red, dotted line in the chart.

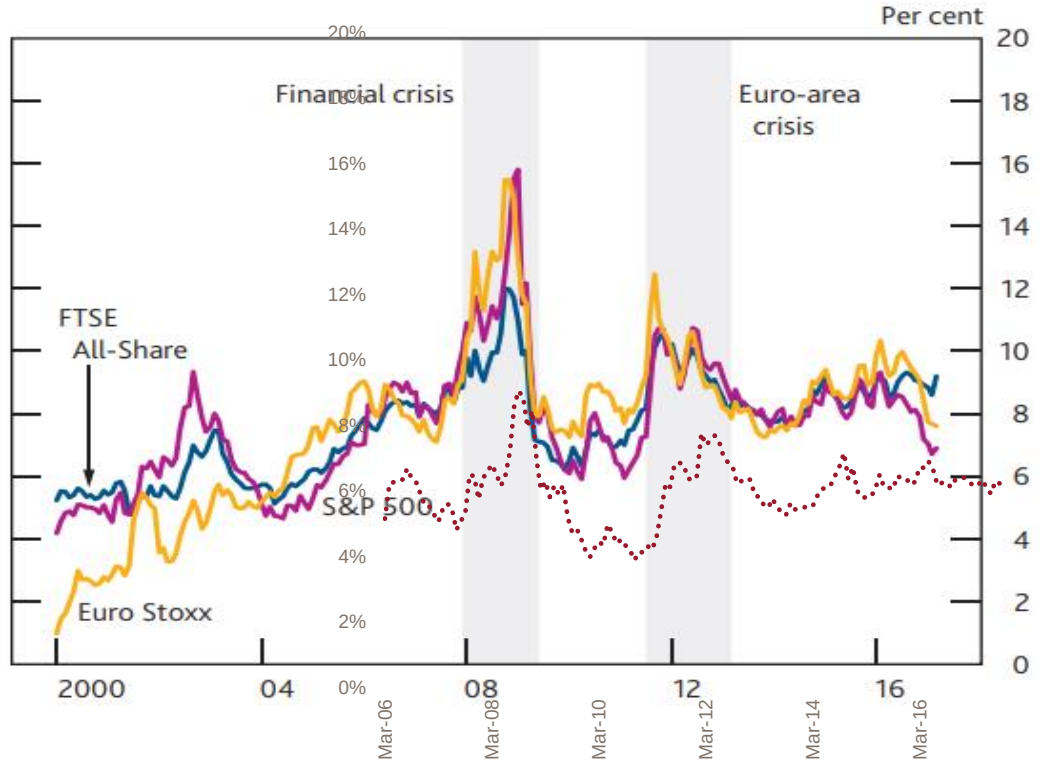
We observe that our DDM model outputs match the BOE's model outputs very well in terms of the rise and fall of the expected TMR, and our DDM outputs can almost be described as being a constant distance from the BOE's outputs. We understand that the difference between the outputs lies in the difference in RFR assumptions.

41 Banking in the tundra (2016) Martin Taylor https://www.bankofengland.co.uk/-/media/boe/files/speech/2016/banking-in-the-tundra.pdf

42 Bank of England (2017), Quarterly Bulletin, An improved model for understanding equity prices.

43 The output from our DDM model is shown in Figure 4. To derive the ERP, we subtracting the 20-year gilt yield from the TMR values shown in Figure 4.

Figure 7 ERP, Our DDM outputs and BOE's 2017 DDM modelling



Source: Frontier Analysis, Bank of England (https://www.bankofengland.co.uk/-/media/boe/files/quarterly-bulletin/2017/an-improved-model-for-understanding-equity-prices.pdf)

Our understanding is the BOE's modelling attempts to use a RFR which is proxied by the yields of extremely long-dated government bonds (longer than 20 years, which is what we have considered), to approximate the perpetual nature of equity. The BOE also noted that actual gilts covering such long term maturities do not exist, and the yields for this had to be extrapolated.[44]

Given the differences in RFR assumptions we consider that our modelling should produce a different result to the BOE's, but the similarities of both model outputs provides us a degree of comfort in the manner in which we have specified our DDM model for the analysis set out in this paper.

[44] Bank of England (2017), Quarterly Bulletin, An improved model for understanding equity prices, p8.

Annex B – Frontier's DDM data sources

We use the following data sources for our main DDM analyses and DDM sensitivities. We note that the results of our primary DDM model and the sensitivity analyses are similar (Footnote 27) and therefore we focus our discussion on the results derived from our primary DDM model. Nevertheless, we have also listed the data sources we considered for our sensitivity modelling in the table below (flagged in italics).

Table 3 DDM and Glider data sources

Data item	Data item name	Data fields and granularity	Data provider
Expected equity cash flow	FTSE Allshare index, analyst dividend yield consensus estimates	Monthly	Bloomberg
	Buyback yields	Calculated from shares buyback actual yields, at a monthly frequency	Bloomberg
Current index price	FTSE Allshare total returns index	Actual last price, at a monthly frequency	Bloomberg
	FTSE 100 total returns index (sensitivity)	*Actual last price, at a monthly frequency*	*Bloomberg*
Short-term growth rate (f), used for dividend growth in the first 3 years	Dividend 3 year forward rates	Calculated from analyst forecasts, at a monthly frequency	Bloomberg
	Blended rate from 3 sources (sensitivity)	*Nominal GDP growth, at a monthly frequency*	*HMT* *Bank of England* *IMF*
Long-term growth rates, used for dividend growth in perpetuity after 3 years (g)	Long run nominal GDP growth forecast	Monthly	IMF
Risk free rate	Nominal UK gilt spot curve for 20 year maturity	Monthly	Bloomberg

Source: Frontier Economics