# The Weighted Average Cost of Capital for Ofgem's Future Price Control

# Final Phase I Report by Europe Economics

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# 1 EXECUTIVE SUMMARY

1 This report evaluates at a high level the cost of capital inputs and methodologies for transmission system operators and gas distribution networks, in the context of the RIIO model, and calculates a range for the cost of equity.

2 In particular, the methodology for cost of debt indexation is developed; empirical evidence on the effect of changes in cash flow duration on the equity beta are examined; and mechanisms for smoothing the cash flow impact of moving towards a depreciation charge that is more closely reflective of economic asset lives are explored.

3 The main findings and recommendations are summarised below

**Risk-free rate**

4 Over the last ten years, the yields on index-linked gilts, which have long been considered a good proxy for the risk-free rate, have exhibited a continual downward trend. Some of this depression in current yields may be due to Quantitative Easing (we believe yields could be biased downwards by around 100 basis points).

5 In addition to examining ILGs, we have carried out cross-checks using nominal gilts and international data. International data showed that yields on index-linked bonds had also fallen to historic lows over the last 12 months in both Germany and France.

6 Regulatory precedents have typically been above market data, but have also fallen through time. Most recently, the Competition Commission in the Bristol Water case went for a range of 1 to 2 per cent, while the NATS 2010 decision settled at a point estimate of 1.75.

7 Our recommended range for the risk-free rate lies between **1-2 per cent**.

**Equity beta**

8 Our primary estimate of equity betas derives from a sector beta for the portfolio of: National Grid; Scottish Power (until takeover in 2007); and Scottish and Southern Energy. Two years of daily data was used on a rolling basis for the estimation conducted on data from 2000 onwards.

9 Our point equity beta estimate is 0.69, with a 95 per cent confidence interval of 0.55 to 0.83.

10 Given the incomplete market data available on the regulated companies, our estimate drawn from the market data was cross-checked against:

(a) Company-specific betas (calculated using accounting data).

(b) Comparator betas (using listed UK water companies and European energy utilities).

(c) Regulatory precedents.

11 Estimations based on these cross-checks are all broadly consistent with the sectoral beta range calculated from the equity market data. Our rage for the equity beta is therefore **0.55-0.83**.

### Equity risk premium

12 We drew on the widely quoted estimates of the equity risk premium from Dimson, Marsh and Staunton (DMS) as presented in Table 1.1.

**Table 1.1: DMS ERP Estimates 1900-2009**

| | Arithmetic mean | Geometric mean |
|---|---|---|
| Belgium | 4.9 | 2.6 |
| France | 5.7 | 3.3 |
| Germany | 8.8 | 5.4 |
| Ireland | 4.7 | 2.6 |
| Italy | 7.3 | 3.8 |
| Netherlands | 5.9 | 3.5 |
| Spain | 4.4 | 2.4 |
| **UK** | **5.2** | **3.9** |
| USA | 6.3 | 4.2 |
| **Europe** | **5.2** | **3.9** |
| **World** | **4.9** | **3.7** |

13 In addition to reviewing DMS data, we also reviewed regulatory precedents. The most recent regulatory precedent is 4-5 per cent (Competition Commission in Bristol Water). Other recent regulatory precedents are higher — CAA used 5.25 for NATS in 2010 and Ofwat used 5.4 in 2009.

14 Working with 0.5 intervals on the latest DMS estimates, our initial recommended range is **4.0 to 5.5.**

### Conclusions on cost of equity

15 Table 1.2 brings together the above estimates into an overall range for the cost of equity. In line with the view that the total market return should be expected to be more stable than either the risk-free rate or the equity risk premium (e.g. as expressed by Smithers & Co (2003)), we associate our upper estimate for the risk-free rate with our lower estimate of the equity risk premium and vice versa.

**Table 1.2: Overall Cost of Equity Ranges**

| | Low | High |
|---|---|---|
| Risk-free rate | 2.0 | 1.0 |
| ERP | 4.0 | 5.5 |
| Equity beta | 0.55 | 0.83 |
| Cost of equity (before re-levering) | 4.2 | 5.6 |

**Cost of debt indexation**

16 Ofgem has proposed calculating cost of debt as long term trailing average of real yields on some index of corporate bonds. Our brief was to develop this proposition by looking at design and implementation issues. Each possibility was evaluated against the following criteria to reflect inherent trade-offs:

(a) Accuracy

(b) Simplicity, including data availability

(c) Transparency

(d) Credibility

(e) Fully mechanistic

(f) Cannot be manipulated

(g) Preserves efficiency incentives

17 Specific areas we examined, along with or preferred approach in each area is summarised below.

*Overall form of indexation mechanism*

18 The index used should reflect the total cost of debt rather than a component such as the risk free rate or debt premium so that it more accurately reflects the companies' financing costs.

*Utilities versus wider corporate index*

19 A market index non-specific to the bonds of the regulated company should be used to provide incentives for outperformance and avoid a situation whereby companies may have an influence on the index.

*Inflation adjustment*

20 Expected inflation should be accounted for by using implied inflation from the gilt market as published by the Bank of England. This method is widely used and data are easily available over the relevant time period, unlike other inflation forecasts.

*Tenor of debt used*

21 The choice of tenor for the index should be guided by the actual tenor of the regulated companies' debt. Creating a bespoke index to reflect tenors in the actual bond portfolio of the industry will entail a one-off set up burden as well as periodic adjustments to maintain the index. It makes better sense to use an existing and recognised market index, such as a 10 year, 20 year or 10+ years, which will have a mix of tenors.

22 Since 10 year bonds are the standard financial market benchmark, and the key benchmark we ourselves focus upon in our risk-free rate analysis, we propose the use of a 10 year bonds index. That leaves the question of whether the index itself should be used to calculate adjustments to a "baseline" cost of debt calculated at each price control on the basis of the real yields on a mix of tenors or simply based on the 10 year bond. In our view the former approach is better — i.e. we recommend that a baseline cost of debt be calculated, and then adjusted proportionately to changes in an index based on 10 year bonds.

*Length of trailing window*

23 Given the nature of the debt portfolio, a trailing window below 5 years seems inappropriate. A range between eight and ten years seems suitable. We would recommend eight years taking into account the length of the price control period and the improvement in data availability with an eight rather than ten year window.

*Credit rating of debt used*

24 Either A or BBB would be in line with the investment grade rating required by Ofgem in previous price controls. As an alternative, Ofgem can take an average of the yields on an A and BBB rated index.

*Weighting of historic data*

25 Weighting historic data can better reflect the years in which debt was issued. The data input requirements rises and this is an issue for RAV for which there tends to be a time lag between the year in which additions are realised and reported. This fundamental problem means at this stage either a simple trailing average of all years (effectively ignoring variable rate debt) or simple weighting of current and historic debt based on an assumed split between variable and fixed debt is preferred.

*Implementation issues:*

26 Subject to time constraints, Ofgem will need to think about what data would be available at the time when the calculation needs to be done each year and whether this data would be sufficient.

27 The data sources picked for the calculations will have different details and costs. Once the principles above are decided, Ofgem can explore the data sources further.

**Cash flow duration**

28 The proposed move to economic asset lives will increase the duration of cash flows for some companies. Oxera (2010) argues that increasing the duration of cash flows increases the cost of capital, while CEPA (2010) has responded on theoretical grounds to rebut Oxera's argument. Our analysis on whether increasing the duration of the cast flow had an effect on the cost of capital focused purely on empirical case studies to ascertain whether there is a beta effect.

29 The case studies we looked at were the introduction of accelerated depreciation for electricity DNOs in 1999/2000 and changes to capital allowances for oil industry that affected timing of cash flows. In both instances we examined whether there was any change in beta when the policy was first mooted, when it was first announced and when it was first implemented.

30 All these examples involved a reduction in duration of cash flows and hence – if Oxera's arguments apply in practice – should have decreased company betas. Our analysis found no effect on betas

**Transitional arrangements**

31 There are a number of different economic rationales for implementing transitional arrangements rather than fully applying economic asset lives from the first year of the next price control.

32 If Ofgem is primarily concerned about avoiding perceptions of regulatory risk, then the transitional approach which would appear to meet this objective best would be to apply the change in asset lives to new RAV additions only, while continuing to apply current depreciation policy for the existing RAV. Under this approach, the switch to economic asset lives would not be fully implemented until all of the existing RAV had been depreciated (which would be 20 years after the start of the first RIIO price control, for sectors where the current asset life being used is 20 years).

33 On the other hand, if Ofgem is more concerned about avoiding the need for sudden, large equity injections, allowing firms time to increase their equity through retained earnings, and avoiding the need for large reductions in gearing in the short term, then there are a wider range of options that would appear to meet these objectives. One leading option would be to change the asset life gradually over a number of years, with the time period

over which the transition is made depending on the outcome of the financial modelling which Ofgem carries out at the next price control review. This is our favoured option at this stage.

# 2 INTRODUCTION

2.1 This report constitutes the draft final output under Phase I of Europe Economics' advice to Ofgem on cost of capital for transmission system operators and gas distribution networks, in the context of the approach developed during RPI-X@20 review.

## Ofgem's Future Regulatory Framework

2.2 Following an extensive review of the performance of the RPI-X regulatory framework in the UK over the last 20 years, the set of recommendations for the future regulatory framework were released for consultation on 26 July 2010, with the final decision document made available on 4 October 2010. The review concluded on a new regulatory approach for Ofgem, referred to as 'RIIO'.[1]

2.3 The RIIO model continues to advocate a WACC based approach to setting the allowed return. Ofgem have maintained up-front price controls but it is proposed that they would be set for eight instead of five years with the provision for a mid-term review.

2.4 The Decision Document had the following to say on the key components of WACC:[2]

> **(a) Cost of equity:** We will set the cost of equity based on a capital asset pricing model (CAPM) approach but will also consider evidence from other models.
>
> **(b) Cost of debt:** The cost of debt embedded in the allowed return will be a backwards looking determination, based on a long-term trailing average of forward interest rates. There will be an annual adjustment in the allowed return on debt, based on movements in the trailing average rather than making a step movement at every price control. The index will likely be based on the real yields of sterling issuers of a similar credit rating to regulated utilities.
>
> **(c) Notional gearing**: The size of the notional equity wedge will reflect the company's risk exposure and may vary within and between sectors, but only where there is material difference in the risk faced. The magnitude of the risk exposure will depend on the strength of the various output incentives and the uncertainty mechanisms of the package. In making any changes to the notional gearing between control periods, we will take into account the effect that this might have on a company's ability to finance itself, particularly where there is a decline in the notional gearing assumption.

2.5 With respect to depreciation:

> When considering depreciation we will focus on how best to balance the costs paid by existing and future consumers, taking account of the expected economic life of assets and uncertainty in the future use (and usefulness) of assets.

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1 RIIO stands for Revenue set to deliver strong Incentives, Innovation and Outputs.

2 Ofgem (2010) 'RIIO: A new way to regulate energy networks final decision', 4 October 2010

2.6 On financeability,

> Our financeability assessment of proposed price controls will be informed by a number of sources including ratings agency credit metrics and relevant equity metrics considered over the long term. As now, network companies will be expected to manage their business, including capital structure, efficiently to ensure that they are financeable. Where there are concerns with financeability we will consider whether and how best to transition the application of our financeability principles.

2.7 On 26 July, Ofgem released an Implementation Paper which further explained the practicalities of how each aspect of the recommendation would work.

## This Report

2.8 This report develops appropriate methodologies for the key inputs into cost of capital for transmission system operators and gas distribution networks, in the context of the RIIO model.

2.9 The methodologies and recommendations developed during Phase I of the study are anticipated to inform Ofgem's December policy papers for RIIO GD1 and RIIO T1.

2.10 The current price control for transmission companies (TPCR4), which came into effect on 1 April 2007 is due to expire on 31 March 2012, while the current price control for gas distribution companies came into effect on 1 April 2008 and is set to expire on 31 March 2013. In the context of the RIIO model, it has been decided to extend TPCR4 to another year, so that RIIO GD1 and RIIO T1 could come into effect at the same time (the work for which has already begun).

2.11 Phase II of the study will specifically review the cost of capital inputs of the TPCR4 decision, and update the parameters that have moved significantly since the original TPCR4 decision for the rollover.

2.12 Phase III of the study will involve reviewing comments received by Ofgem on its December Consultation and updating the calculations in these reports to reach a narrower range for the cost of equity.

2.13 This report is structured into two parts, as follows:

(a) Part I: Components of WACC

- The risk free rate
- Equity beta estimation
- Equity risk premium
- Conclusions and range for the cost of equity

(b) Part II: Other issues

- The mechanisms for setting the cost of debt with annual indexation
- Evidence on the impact of the timing of cash flows on cost of equity
- Assessment of cash flow volatility and setting the notional gearing assumption
- Smoothing cash flow impact of transition away from accelerated depreciation

# PART I: COMPONENTS OF WACC

# 3 RISK-FREE RATE[3]

## Introduction

3.1 This section discusses evidence on the risk-free rate and sets out our recommendation of the appropriate range that Ofgem should use in its estimation of the cost of equity for RIIO T1 and RIIO GD1. This Section is structured as follows:

(a) an analysis of UK government index-linked gilt yields;

(b) an analysis of UK government nominal gilt yields;

(c) an international comparison of index-linked government gilt yields;

(d) regulatory precedents on the risk-free rate; and

(e) our conclusion – setting out our suggested range for the risk-free rate.

## UK Government Index-linked Gilt (ILG) Yields

3.2 Investors have traditionally regarded the return on UK index-linked gilts as a good proxy for the risk-free rate (i.e. the theoretical rate of return that an investor would earn on an investment with zero risk) given the very low default risk associated with government borrowing. Thus, yields on government bonds are generally considered to be as close to risk-free as possible for an investor to obtain. Further, the index-linkage feature of these bonds means that inflation expectations are already accounted for in observed yields (i.e. they are real yields) and, therefore, inflation expectations do not need to be stripped out. Given these characteristics, previous regulatory decisions have, in general, tended to focus on ILG yields when estimating the risk-free rate.

3.3 Using data from the Bank of England, Figure 3.1 illustrates the yields on index-linked gilts (and their liner trend) for terms to maturity of 5, 10 and 20 years over the last 10 years.

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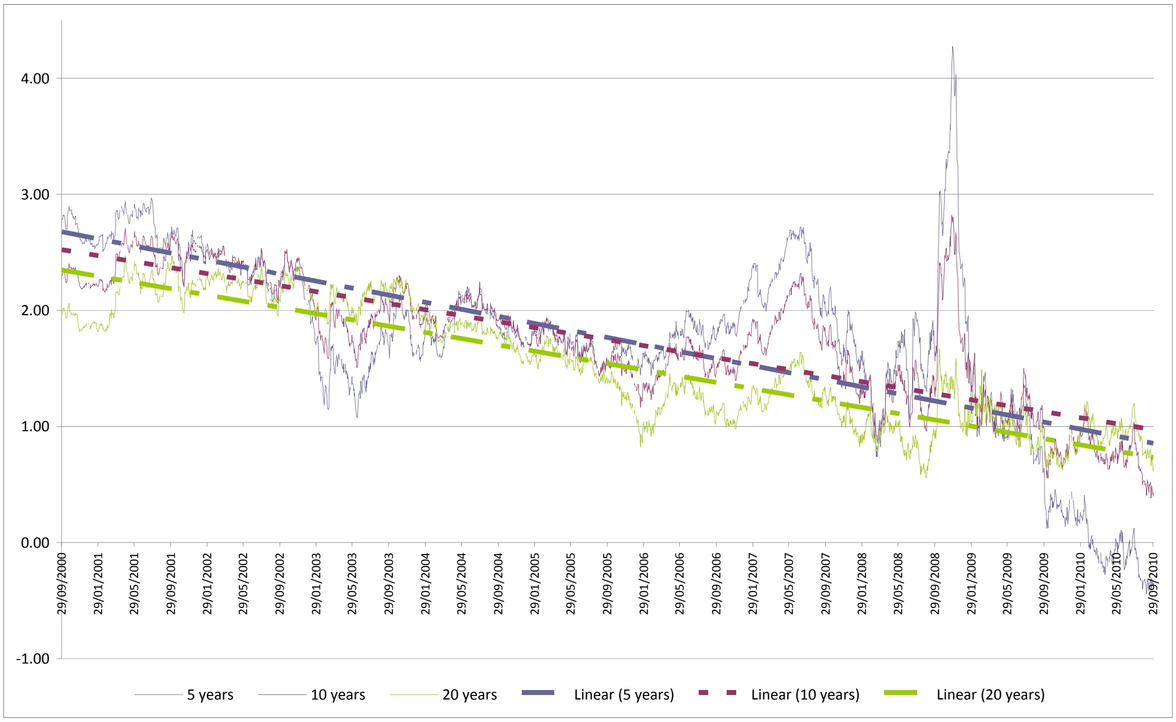
3 Please note that unless otherwise stated, the data used in this section is subject to a cut-off date of 30 September 2010.

**Figure 3.1: UK ILG Yields for the 10 years to 30 September**




*Notes: These data are real spot curve rates – these are the interest rate calculated for index-linked zero coupon gilts where the principal is indexed to the RPI index.*

*Source: Bank of England*

3.4 As can be seen in Figure 3.1 real yields over the last 10 years have tended to move together (apart from a period during 2003/04) with short term yields (i.e. on 5 year gilts) generally exhibiting higher yields that longer term gilts.

3.5 As can also be seen from Figure 3.1 the period during which financial markets were subject to significant market turbulence was reflected in volatile yields across gilts of all three maturities (with yields on 10 year gilts increasing from 1 per cent in September 2008 to approximately 2.75 per cent in November 2008). Factors perceived to have contributed to the volatility of real gilt yields over this period included increases in the perceived risk of sovereign debt (e.g. due to increased concerns over public borrowing or a perceived risk associated with a nationalised bank defaulting), deflation expectations, wider market impacts of un-winding hedge fund positions following the collapse of Fannie Mae and Lehman Brothers and uncertainty over the medium-term growth outlook for developed economies.

3.6 Despite the period of volatile yields described above, the trend in yields over the 10 year period, as illustrated in Figure 3.1, does not appear to have been materially affected by that period of turbulence and has subsequently continued the steady downward trend of the past ten years.

3.7 Indeed, in recent months yields on all three gilts have fallen to historic lows (coupled with the divergence in yields on shorter and longer term gilts increasing markedly from historic trends) with spot data suggesting that yields on 10 year gilts – our main area of focus – (which were as low as 0.4 per cent as of 30 September 2010) are still over 50 bps below their long term trend. Remarkably, yields on shorter term gilts have turned negative — investors now (on a real-terms basis, not merely nominally) pay the British government for the privilege of lending it money! The recent decline in real yields may, in part, have been driven both by increased speculation that the Bank of England will expand its current £200bn programme of quantitative easing and the expectation of a larger than previously anticipated cuts in government spending.

3.8 Negative yields are a curious phenomenon which deserves some further focus. As noted earlier, index-linked yields are structured in a way that provides an element of inflation protection. However, negative yields imply that investors are, in effect, *paying* to hold UK government bonds (i.e. by losing money at the beginning of the trade). While this may at first appear counterintuitive, the demand for government bonds with negative yields suggests that the distribution of investors' expectations about future inflation may be positively skewed and thus investors are willing to pay a risk premium for 5 year gilts that reflects this skewed distribution to ensure that that they will be more than compensated for the premium they pay today. Put more bluntly, index-linked gilts function as an upside inflation hedge, insuring lenders against the risk of inflation out-turns being much higher than markets currently expect.

3.9 Table 3.1 below, summarises real gilt yields in the UK over different time periods. As illustrated in the table, average real gilt yields for 5, 10 and 20 years bonds over the last 5 years have fallen consistently when calculated for the last 10, 5 and 20 years.

**Table 3.1: UK Index-linked Gilt Yields**

| | 5 years | 10 years | 20 years |
|---|---|---|---|
| ***Latest market data*** | | | |
| Spot rate on September 30th 2010 | -0.35 | 0.43 | 0.64 |
| September 2008 to September 2010 | 0.85 | 1.11 | 0.99 |
| ***Longer run averages*** | | | |
| September 05 to September 10 | 1.43 | 1.38 | 1.09 |
| September 00 to September 10 | 1.77 | 1.75 | 1.54 |

*Source: EE calculations using Bank of England data*

## Nominal Gilt Yields

3.10 In theory, the yields on index-linked gilts should be equal to the yields on nominal gilts minus:

(a) inflation expectations; and

(b) an inflation risk premium

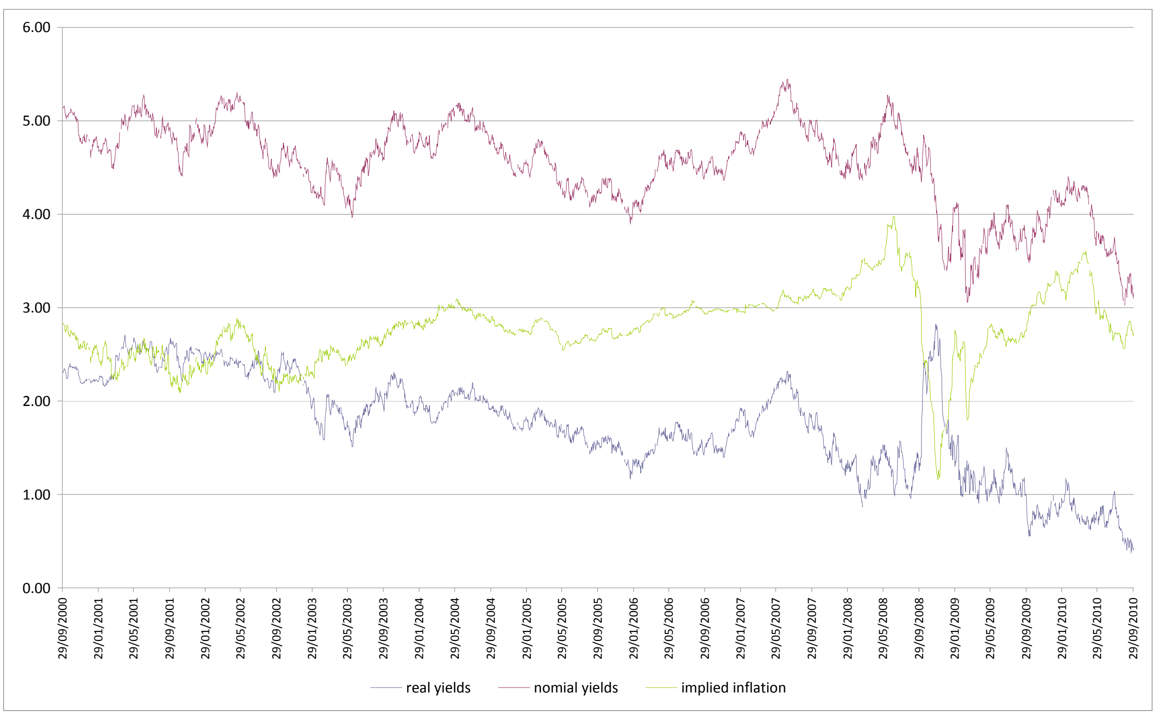
3.11 The yields on nominal gilts can, therefore, be used to cross-check the risk-free rate as implied by the yields on index-linked gilts by stripping away inflation expectations.[4]

3.12 Some also allege that another component of differences between yields on nominal gilts and those on ILG's arise from a liquidity premium. This is the idea that the observed gap between yields on nominal gilts and those on ILGs (after the former has been deflated by inflation expectations and then adjusted by an inflation risk premium) reflect low liquidity of ILGs in an environment in which some purchasers (e.g. pension funds) face regulatory requirements to hold ILGs. We do not, however, accept this view as if ILG prices were inflated by this factor, it would create arbitrage opportunities for other buyers and sellers in the market which would result in the elimination of this differential.

### Nominal gilts deflated using inflation expectations

3.13 Implied inflation expectations (in RPI), which have been calculated by subtracting yields on index-linked gilts with a maturity to term of 10 years from yields on the nominal gilts of the same maturity, are illustrated in Figure 3.2.

**Figure 3.2: Comparison of nominal and index-linked gilt yields with maturity of 10 years**




*Source: Bank of England*

4 As we have noted, an inflation risk premium as well as inflation expectations should be deducted from nominal yields. We do not, however, carry out this step given the difficulties in calculating the inflation risk premium and the fact that we are using nominal yields only as a cross-check for the risk-free rate.

3.14 Over the past two years, yields on nominal bonds have fluctuated between approximately 3.0 and 4.3 per cent (i.e. reaching 4.3 per cent in February 2010 and falling to just over 3 per cent by the end of September 2010). (Index-linked yields, by contrast, fell fairly consistently over the same period.)

3.15 As the figure suggests, the downward movement in index-linked yields despite the more volatile movements in nominal yields, implies that inflation expectations over this period varied. Indeed, implied inflation, as indicated in the figure, rose in the 12 months up to April 2010 (i.e. from approximately 2.3 per cent to 3.6 per cent). From April 2010 however, implied inflation began to fall again although it is unclear from recent market data (up to September 2010) whether it will continue to fall or whether it will rise again.

3.16 As noted above, while inflation expectations are likely to account for most of the variance between nominal and index-linked yields, the difference may also, at least in part, be attributed to an inflation risk premium. The risk of inflation turning out to be higher than anticipated over the term of the investment means that risk-averse investors may be willing to pay a premium (in the form of lower yields) to ensure that the bond provides a real return by the maturity date. This may be a contributory factor to the negative yields observed for 5 year ILGs.

**Implied risk free rate**

3.17 An alternative view of inflation expectations is provided by the Treasury's projection for inflation (in RPI) over the next 5 years is set out in Table 3.2.

**Table 3.2: Projected UK RPI over the next 5 years**

| | Outturn 2008-09 | Estimate 2009-10 | 2010-11 | 2011-12 | 2012-13 | 2013-14 | 2014-15 |
|---|---|---|---|---|---|---|---|
| RPI (% annual change) | 5 | -1.4 | 4.2 | 3.4 | 3 | 3.2 | 3.4 |

*Source: 2010 Budget Report*

3.18 Table 3.3 sets out the independent inflation expectations (collected by the Treasury in its publication "Forecasts for the UK economy: a comparison on independent forecasts") over the next five years.[5]

5 HM Treasury: Forecasts for the UK economy – A comparison of independent forecasts, August 2010. No.280

**Table 3.3: Independent inflation expectations**

| | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|
| RPI (% change on previous year) | 4.2 | 3.4 | 2.7 | 3.0 | 3.2 |

3.19 The average inflation rate over the five years, as implied by the Treasury's own projection figures is 3.45 per cent, 38 bps above the 3.08 per cent average of the independent forecasts (we note there is a slight difference of time period between these forecasts).

*Nominal yields and inflation expectations as an estimate of the risk-free rate*

3.20 Using inflation forecasts is not a perfectly robust cross-check of the risk-free rate estimated obtained from yields on index-linked gilts. As a further cross-check, in Table 3.4 we present a comparison between yields on index-linked gilts with a maturity of 10 years and inflation the forecasts for the corresponding period. Table 3.4 illustrates the comparison between the latest spot rates (as of 30 September 2010) on nominal gilts with a term to maturity of 10 years less average expected inflation over the next 10 years, as projected by independent forecasters, with the actual spot rate for the yield on index linked gilts.[6]

**Table 3.4: Comparison using nominal ILG and inflation forecast – 10 years**

| | Yield (%) |
|---|---|
| 10 year average RPI (average of "independent forecasts") | 3.00 |
| Spot rate (30 September 10) nominal 10 year gilt | 3.15 |
| Calculated risk-free rate (nominal spot - inflation expectations) | 0.15 |
| Spot rate (30 September 10) index linked 10 year gilt | 0.43 |

*Source: EE calculations with Bank of England and Treasury collected data on independent forecasts*

3.21 As can been seen from this table, the risk-free rate estimated using gilts with 10 year maturities less inflation expectations is lower (by 28 bps) than the spot rate on yields on index-linked gilts. This suggests that expected inflation over next 10 years (as indicated in Table 3.4) is greater than that implied by the yields on index-linked bonds (i.e. 3 per cent compared with 2.72 per cent).[7]

6 Independent inflation forecasts for the next 10 and 20 years are not available and thus the expected inflation rates assumed for 10 and 20 years have been based on the latest independent RPI forecasts available for 5 years, adjusted for longer time periods according to the RPI rate consistent with the 2 per cent target for the consumer price index set by the Bank of England (We assume a CPI target of 2 per cent which equates to an RPI value, on average over time, of 2.8 per cent).

7 i.e. 3.15 (nominal yield) – 0.43 (index-linked yield) = 2.72 (implied inflation).

3.22 Table 3.5 and Table 3.6 below illustrate the same exercise for gilts with terms to maturity of 5 and 20 years as a cross-check or our findings relating to 10 year gilts.[8]

**Table 3.5: Comparison using nominal ILG and inflation forecast – 5 years**

| | Yield (%) |
|---|---|
| 5 year average RPI (average of "independent forecasts") | 3.08 |
| Spot rate (30 September 10) nominal 5 year gilt | 1.81 |
| Calculated risk-free rate (nominal spot - inflation expectations) | -1.39 |
| Spot rate (30 September 10) index linked 5 year gilt | -0.35 |

*Source: EE calculations with Bank of England and Treasury collected data on independent forecasts*

3.23 Similar to the case with gilts of a maturity of 10 years, the risk-free rate estimated using nominal yields with a maturity of 5 years less inflation expectations over the same period is also lower than the spot rate on 5 year index-linked gilts. As with the case highlighted above for 10 year government bonds, this also suggests that expected inflation over next 5 years (as indicated in Table 3.5) is greater than that implied by the yields on index-linked bonds (i.e. 3.08 per cent compared with 2.16 per cent).[9]

**Table 3.6: Comparison using nominal ILG and inflation forecast – 20 years**

| | Yield (%) |
|---|---|
| 20 year average RPI (average of "independent forecasts") | 2.9 |
| Spot rate (30 September 10) nominal 20 year guilt | 4.01 |
| Calculated risk-free rate (nominal spot - inflation expectations) | 1.11 |
| Spot rate (30 September 10) index linked 20 year guilt | 0.64 |

*Source: EE calculations with Bank of England and Treasury collected data on independent forecasts*

3.24 In contrast, the risk-free rate estimated using gilts with 20 year maturities less inflation expectations is higher (by 47bps) than the spot rate on yields on index-linked gilts, which suggests, therefore, that expected inflation over next 20 years (as indicated in Table 3.6) is less than that implied by the yields on index-linked bonds (i.e. 2.9 per cent compared with 3.37 per cent).[10]

8 See footnote 6
9 1.81-(-0.35) compared with 3.08.
10 4.01 (nominal yield) – 0.4 (index-linked yield) = 2.72 (implied inflation).

3.25 Overall, our estimations of the risk-free rate based on nominal gilts stripped of inflation expectations, as set out in Table 3.4 to Table 3.6, differ notably from the estimates implied by index-linked gilts yields. This variance may, in part be attributed to inflation risk premiums (which, as noted earlier are difficult to observe in market data) that are not accounted for by independent inflation forecasts. An alternative interpretation of these variances may be that market expectations (as indicated by gilt yields) are currently at odds with independent forecasts of inflation.

## International Trends in the Risk-free Rate

3.26 Reductions in yields on index-linked government bonds have not been confined to the UK, with yields on index-linked bonds also falling to historic lows over the last 12 months in both Germany and France (see Appendix 1 to this Section). In Germany, for example, yields on 10 and 5 year index-linked bonds have declined markedly over the last 15 months, with yields on 10 year bonds falling from just under 1.8 per cent in June 2009 to approximately 0.64 per cent on 30 September 2010 (i.e. see Figure A1.2 in Appendix 1 to this Section).[11] The story for France is similar with yields on 10 year index-linked bonds falling from just over 1.30 per cent in January 2010 to just under 0.65 by the end of September 2010 (i.e. see Figure A1.4 in Appendix 1).[12]

## Regulatory Precedents

3.27 Table 3.7 below summarises previous regulatory decisions on the risk free by UK regulators over the last 10 years.

[11] Data on yields for 10 year ILG is only available from June 2009.

[12] Data for 10 year IGLS in France between May 2008 and January 2010 and data on yields on 5 year IGLs beyond March 2010 is not available.

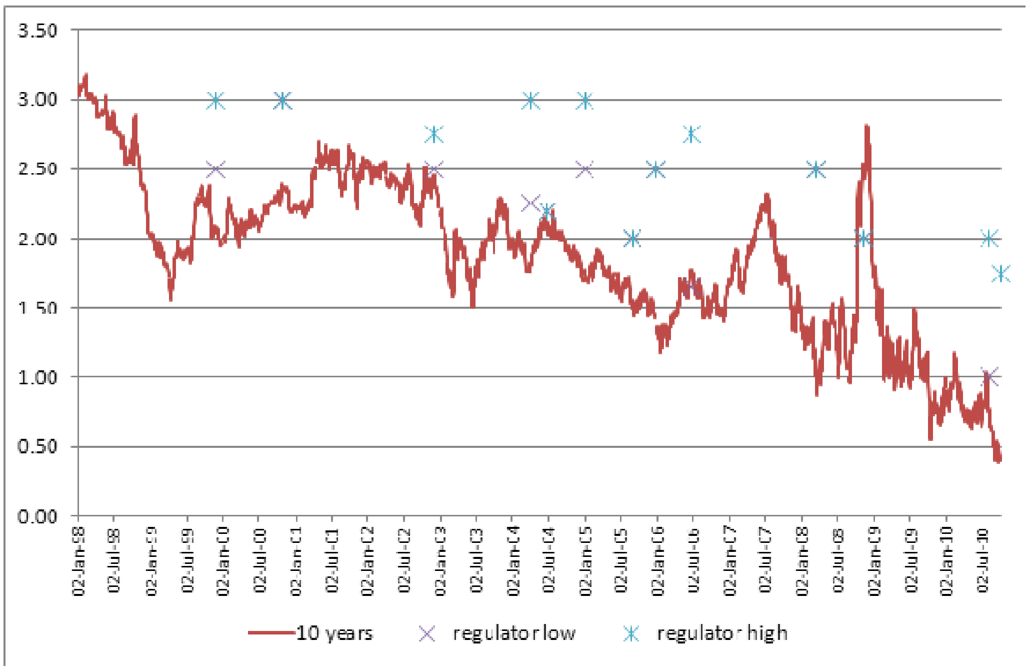
**Table 3.7: Previous regulatory decisions on the risk-free rate**

| Regulator | Case | Real risk-free rate (%) |
|---|---|---|
| CC | Bristol water (2010) | 1.0-2.0 |
| CAA | NATS (2010) | 1.75 |
| Ofwat | Water (2009) | 2.0 |
| Ofcom | Openreach (2009) | 2 (4.5 nominal) |
| NIAUR | SONI (2008) | 2.5 |
| Ofgem | Electricity distribution (2009) | 2.00 |
| CC | Stansted (2008) | 2.0 |
| CAA | Heathrow and Gatwick (2008) | 2.5 |
| CC | Heathrow and Gatwick (2008) | 2.5 |
| Ofgem | Gas distribution (2007) | 2.5 |
| Ofgem | Transmission (2006) | 2.5 |
| Ofcom | General approach – applied to BT (2005) | 2.0 |
| CAA | NATS (2005) | 2.5 |
| Postcomm | Royal Mail (2005) | 2.5 |
| Ofwat | Water and sewerage (2004) | 2.5-3.0 |
| Ofgem | Electricity distribution (2004) | 2.25-3.0 (2.75) |
| Competition Commission | BAA (2002) | 2.5-2.75 |
| ORR | Access charges (2000) | 3.0 |
| Competition Commission | Mid Kent Water (2000) | 3.0 |
| Ofgem | Transmission (2000) | 2.5-2.75 |
| Ofwat | Water (1999) | 2.5-3.0 |
| **Regulatory high (2005-10)** | | **2.5** |
| **Regulatory low (2005-10)** | | **1.75** |
| **Regulatory high (1999-10)** | | **3.0** |
| **Regulatory low (1999-10)** | | **1.75** |

*Source: Regulatory determinations*

3.28 Figure 3.3 plots these regulatory decisions over time and illustrates the relationship between these regulatory estimations of the risk-free rate and the yields on 10-year index-linked gilts since January 1998.

**Figure 3.3: Previous regulatory decision on the risk-free rate and yields on ILGS for 10 year index-linked gilts since 1998**




*Source: Bank of England data and EE review of regulatory determination*

3.29 As can be seen from Figure 3.3 in most case, regulators have set a range for the risk-free rate above real yields on 10 year gilts. Indeed, in some cases, regulators have set the risk-free rate at over 100 bps above gilt yields. However, when considering the whole period in question it is clear that, on average, the range set by regulators in the UK has come down from approximately 2.5-3 per cent in the first half of the decade to 2 per cent or less in the past couple of years.

3.30 The evidence presented here may be explained by regulators having engaged in a form of Bayesian updating of beliefs (i.e. where a prior belief about the risk-free rate has been only gradually lowered as sustained reductions in ILG yields have provided evidence that the risk-free rate has fallen).

3.31 We do not believe that there is a compelling reason to continue to doubt the index-linked gilts data. It is our view that regulatory judgements should accept the consistent and sustained message of the gilts data that the risk-free rate has fallen considerably.

3.32 However, we also recognize the need and importance of regulatory consistently. Thus, the given the large gap between past regulatory judgement and the current data, we believe there may still be some case for not setting the risk free rate at a level moving all the way to the index linked gilts data, retaining some limited inertia in estimation to reflection the Bayesian concern.

## Conclusion

3.33 There is no reliable precise mechanical method by which to calculate the risk-free rate and thus some element of judgement is required. Market proxies for the risk-free rate have been on a sustained underlying downward trend for the past ten years.

**Table 3.8: Summary of real government bond yields**

| Spot rates on 30 September 2010 | % |
|---|---|
| **UK - Inflation linked yields** | |
| 5 year | -0.35 |
| 10 year | 0.43 |
| 20 year | 0.64 |
| **UK - nominal yields deflated by inflation expectations** | |
| 5 year | -1.39 |
| 10 year | 0.15 |
| 20 year | 1.11 |
| **UK – ILG historical averages** | |
| 5 year UK ILG, 5 year average (Sept 2005-Sept 2010) | 1.43 |
| 10 year UK ILG, 5 year average (Sept 2005-Sept 2010) | 1.38 |
| 20 year UK ILG, 5 year average (Sept 2005-Sept 2010) | 1.09 |

3.34 However, we do not believe that recent negative values for five year bonds can properly be taken as indicative that risk-free rates are now negative. Ten year government bonds are likely to be downwards biased by around 100 basis points by quantitative easing (as estimated by the Bank of England)[13] [14], and there is also likely to be an element of inflation risk hedging in five-year index-linked gilt yields. Focusing upon the 10-year benchmark, a 100 basis points adjustment would suggest a spot rate of around 1.4 per cent, in line with the five year averages for 10 year index-linked bonds (indeed, also the average for five year index-linked bonds).

3.35 We take particular note of the recent precedent of the Competition Commission's choice of a 1-2 per cent range in the Bristol Water judgement, and observe that this naturally encompasses not only the 1.4 per cent spot estimate for (quantitative-easing-adjusted) 10 year index-linked bonds, but also, towards the bottom of the range the inflation-adjusted 10 year nominal bonds adjusted further for quantitative easing (which would be around 1.1 per cent, adding 100 basis point for QE), and at the top of the range the comparatively

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13 "New Instruments of Monetary Policy: The Challenges", Speech by Spencer Dale, Executive Director and Chief Economist at the Bank of England, *Remarks at the CIMF and MMF Conference, Cambridge* (12 March 2010), available at: http://www.bankofengland.co.uk/publications/news/2010/027.htm

14 "The financial market impacts of quantitative easing ", Joyce. M et al. (July 2010, revised August 2010), Bank of England, *Working Paper. 393,* available at: http://www.bankofengland.co.uk/publications/workingpapers/wp393.pdf

recent regulatory determinations in the Stansted and Ofwat cases, both of which were 2.0 per cent, and five-year averages on French and German government bonds.

3.36 Our preferred range is therefore **1-2** per cent.

# 4 EQUITY BETA ESTIMATION

## Introduction

4.1 This section sets out our approach to calculate the equity and asset beta of the energy (transmission and distribution) sector, and the equity and asset betas of the regulated entities operating in these sectors. The section is structured as follows:

(a) Overview of the methodology

(b) Estimation of the energy sector's betas from stock market data

(c) Calculation of company-specific betas from accounting data

(d) Comparators analysis

(e) Regulatory precedents

(f) Conclusions

## Overview of the Approach

### Estimation of beta from stock market data

4.2 We provide below a short description of the generic principles underpinning our estimation approach. More technical details concerning the estimation procedure are provided in the Section 3 Appendix.

(a) *Industry returns* — In order to calculate the equity beta for the relevant energy sector we have defined the sector's return as a weighted average of the companies' returns, where each company's weight is proportional to the company's market capitalisation.

(b) *Data frequency* — In principle daily data are preferred to weekly, monthly, or yearly data, because they allow estimates on larger samples. We have therefore estimated equity betas on daily data, and we have carried out the estimations controlling for both heteroskedasticity and serial correlation.

(c) *Estimation period* — Equity betas vary over time. It is important, therefore, to choose an estimation window that is as recent as possible, because today's observation is the forward looking estimate, while still giving reasonably accurate estimates. Consequently, we have based our final estimates on the last two years of data available. As a robustness check we have also calculated one and two years rolling betas from 2000 to 2010.

### Assessing betas for non-listed companies

4.3 Calculating betas for listed companies is relatively straightforward. However, while some company groups are listed, the regulated transmission and distribution divisions of these parent companies are not listed as separate entities. Furthermore, some companies are unlisted and therefore there is a complete lack of market data on which equity betas could be computed. Information on whether regulated entities belong to a listed parent company or are unlisted is provided in the table below.

**Table 4.1: List of regulated entities**

| Parent company listed | Relevant Regulated Entities |
|---|---|
| National Grid (NG) | National Grid Electricity Transmission (NGET)<br>National Grid Gas NTS (NGG NTS)<br>National Grid Gas Distribution (NGG DN) |
| Scottish Power (SP)* | Scottish Power Transmission Ltd. (SPTL) |
| Scottish and Southern Energy (SSE)* | Scottish Hydro Electric Transmission Ltd. (SHELT) |
| *unlisted* | Northern Gas Network (NGN) |
| *unlisted* | Scotia Gas Networks (SGN) – Scotland Gas Networks |
| *unlisted* | Scotia Gas Networks (SGN) – Southern Gas Networks |
| *unlisted* | Wales and West Utilities (WWU) |

** Note that Scottish Power and Scottish and Southern also own electricity DNOs*

4.4 In order to assess betas for regulated entities for which there is a lack of stock market data we have adopted three different approaches.

(a) We have used companies' accounting data to disaggregate the energy sector's beta to assess company specific betas.

(b) We have calculated beta estimates for a set of comparators – ideally, listed companies carrying out comparable activities and subject to similar economic regulation.

(c) We have looked at other regulatory precedents.

## Estimation of the Energy Sector's Betas from Stock Market Data

4.5 The listed companies for which market information is available are:

– National Grid (NG);

– Scottish and Southern Energy (SSE);

– Scottish Power (SP).

4.6 For each of these companies we downloaded from Bloomberg the following data covering the period 01/January/2000 — 13/October/2010.

– daily stock price data;

– daily share dividends data; and

– daily market capitalisation data.

4.7 The same information was obtained also for the FTSE All Share Index, from which the excess market returns index was calculated.

4.8 Based on this information we calculated an excess market return index (based on FTSE All Share Index) and we constructed the energy sector excess returns as a weighted average of the companies' returns, where each company's weight is proportional to the company's market capitalisation (see the Appendix for more details).[15] It is worth noticing that, by defining the energy sector in this way, we do not consider those regulated entities (i.e. NGN, SGN-Scotland Gas Network, SGN-Southern Gas Network, and WWU) that are not listed, and do not belong to a listed group. Therefore, as a robustness check, we have calculated separate raw betas for each listed company and compared them with the energy sector's beta. If the listed groups' betas are similar to the sector's beta this would suggest that the industry return index defined on a limited number of companies is a good approximation of the hypothetical index we would have obtained had all companies been listed on the stock market.

4.9 The log-transformation of the sector and the market returns were then used to estimate the raw equity through the empirical model described in Appendix. The estimation has been carried out through Ordinary Least Squares (OLS), and we controlled for the possibility of heteroskedasticity and autocorrelation by using both the Newey-West and the White correction methods. The point estimates of the energy sector beta, based on the last 12 months and the last 24 months of data, are reported below (standard errors are in parentheses).

**Table 4.2: Equity beta's point estimate of the energy sector (12 months window, 13/10/2009-13/10/2010)**

| Estimation method | Beta estimate | p-value | 95% confidence interval |
|---|---|---|---|
| OLS | 0.49<br>*(0.045)* | 0.000 | [0.4—0.58] |
| Newey-West autocorrelation correction | 0.49<br>*(0.049)* | 0.000 | [0.39—0.59] |
| White heteroskedasticity correction | 0.49<br>*(0.048)* | 0.000 | [0.39—0.59] |

[15] Data for Scottish Power are available only until 19/April/2007 since the company's shares were subsequently delisted following a takeover by Iberdrola. Consequently the sector's returns after that date have been calculated based only on National Grid and Scottish and Southern Energy data.

**Table 4.3: Equity beta's point estimate of the energy sector (24 months window, 13/10/2008-13/10/2010)**

| Estimation method | Beta estimate | p-value | 95% confidence interval |
|---|---|---|---|
| OLS | 0.69<br>*(0.036)* | 0.000 | [0.62—0.76] |
| Newey-West autocorrelation correction | 0.69<br>*(0.068)* | 0.000 | [0.55—0.83] |
| White heteroskedasticity correction | 0.69<br>*(0.069)* | 0.000 | [0.55—0.83] |

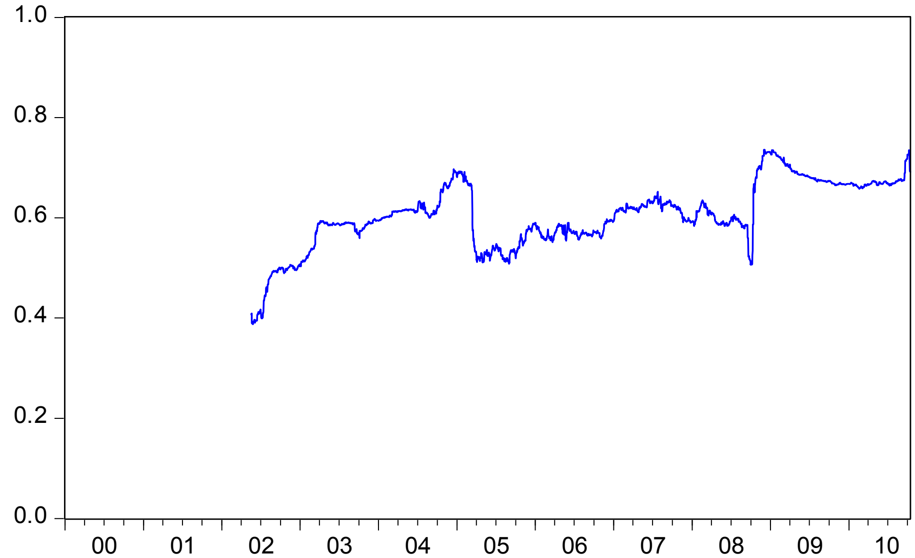
4.10 It can be noticed that the beta estimates based on the last 24 months of data (i.e. 0.69) is significantly higher than the one based on the last 12 months of data (i.e. 0.49). It may be tempting to rationalize this by noticing that the 24 months window includes the period of financial turbulence triggered by the bankruptcy of Lehman Brothers. However, the experience in other utility sectors suggests that the recent financial turmoil had relatively little (if any) impact on the equity betas of utility industries. Another possible explanation would be to attribute the differences in the beta values of the table above to the energy price spikes of 2007-2008. We return to this issue below.

4.11 The same econometric model was used to calculate the energy sector's rolling betas based on, both, 12 months and 24 months rolling windows. These are reported in the figures below.

**Figure 4.1: Rolling beta of the energy sector (12 months rolling window)**


*Source: EE based on Bloomberg data*

**Figure 4.2: Rolling beta of the energy sector (24 months rolling window)**



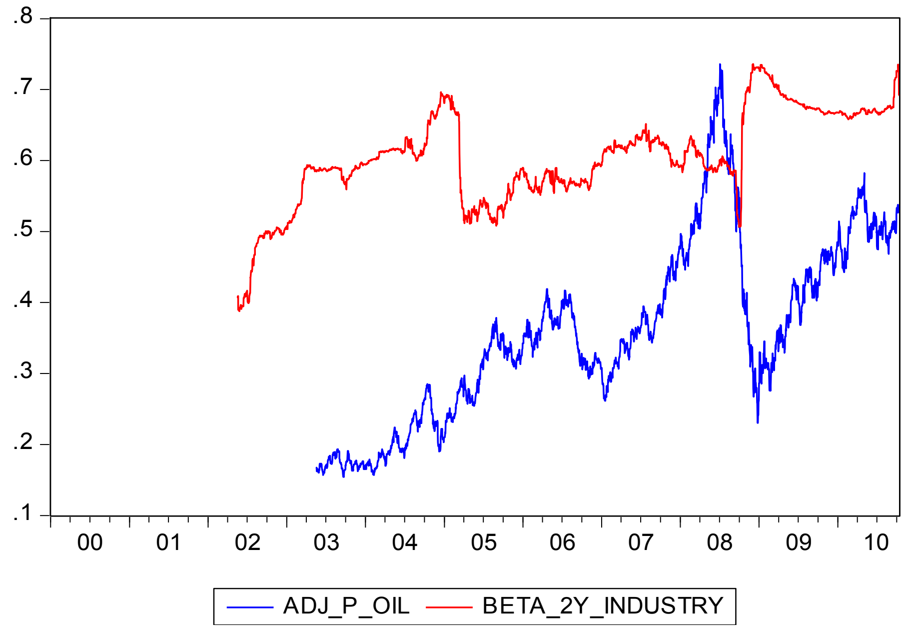

*Source: EE based on Bloomberg data*

4.12 In the graph below we have depicted the industry rolling beta (estimated on a 24 months rolling window) and the crude oil prices.[16] The oil price index has been rescaled in order to make it comparable with the industry beta, and is indicated as ADJ_P_OIL.

4.13 The sharp increase in the industry beta of late 2008 embodies the energy price spike to mid 2008 (bearing in mind that this is a two-year rolling window) and thus might naturally be interpreted as reflecting a market view that energy costs had transpired to be more cyclical (raising costs when the wider economy was in a downturn, and thus depressing profits at the same time as the wider economy went into recession) more than had previously been believed. We note that this spike gradually fades away as the energy price drops once economies go into recession.

[16] We used the Ecubren Crude Oil Index as available from Bloomberg.

**Figure 4.3: Industry beta and energy prices**




*Source: EE based on Bloomberg data*

4.14 The 10-year and five years average of the energy sector's rolling betas (calculated on 12 months and 24 months rolling windows) are reported in the table below.

**Table 4.4: Five and 10-year average rolling beta of the energy sector**

| Rolling window used for the estimation | 5-year average (2005-2010) | 95 per cent confidence interval | 10-year average (2000-2010) | 95% confidence interval |
|---|---|---|---|---|
| 12 months | 0.60 | [0.40—0.79] | 0.57 | [0.36—0.78] |
| 24 months | 0.62 | [0.51—0.74] | 0.60 | [0.47—0.74] |

*Source: EE based on Bloomberg data*

## Equity betas for NG, SEE, and SP

4.15 We have replicated the analysis based on the excess returns of NG, SE, and SP. The beta estimates based on the last 24 months of data available are reported in the table below.

**Table 4.5: Equity beta's point estimate of NG (24 months window 13/10/2008-13/10/2010)**

| Estimation method | Beta estimate | p-value | 95% confidence interval |
|---|---|---|---|
| OLS | 0.73 *(0.039)* | 0.000 | [0.65—0.81] |
| Newey-West autocorrelation correction | 0.73 *(0.075)* | 0.000 | [0.58—0.88] |
| White heteroskedasticity correction | 0.73 *(0.075)* | 0.000 | [0.58—0.88] |

*Source: EE based on Bloomberg data*

**Table 4.6: Equity beta's point estimate of SSE (24 months window, 13/10/2008-13/10/2010)**

| Estimation method | Beta estimate | p-value | 95% confidence interval |
|---|---|---|---|
| OLS | 0.63 *(0.039)* | 0.000 | [0.55—0.71] |
| Newey-West autocorrelation correction | 0.63 *(0.067)* | 0.000 | [0.50—0.76] |
| White heteroskedasticity correction | 0.63 *(0.068)* | 0.000 | [0.49—0.77] |

*Source: EE based on Bloomberg data*

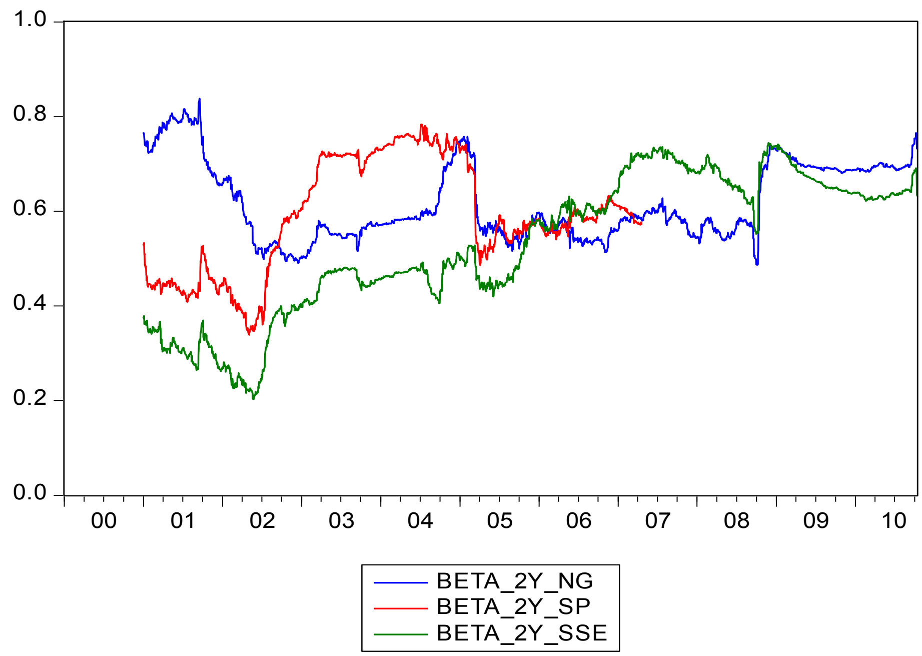
**Table 4.7: Equity beta's point estimate of SP (24 months window, 04/19/2005-04/19/2007)**

| Estimation method | Beta estimate | p-value | 95 per cent confidence interval |
|---|---|---|---|
| OLS | 0.57 *(0.062)* | 0.000 | [0.45—0.69] |
| Newey-West autocorrelation correction | 0.57 *(0.050)* | 0.000 | [0.47—0.67] |
| White heteroskedasticity correction | 0.57 *(0.058)* | 0.000 | [0.45—0.69] |

*Source: EE based on Bloomberg data*

4.16 The rolling betas of the three companies estimated on a 24 months rolling window (indicated respectively as BETA_2Y_NG, BETA_2Y_SP, and BETA_2Y_SSE) are depicted below.

**Figure 4.4: Rolling betas for NG, SSE, and SP (24 months rolling window)**




*Source: EE based on Bloomberg data*

4.17 The table below provides 10-year and five year average rolling betas (calculated on 24 months rolling windows) of the three companies.

**Table 4.8: Five and 10-year average rolling beta of NG, SSE, and SP (24 months rolling window)**

| Company | 5-year average (2005-2010) | 95% confidence interval | 10-year average (2000-2010) | 95% confidence interval |
|---|---|---|---|---|
| **NG** | 0.62 | [0.48—0.76] | 0.62 | [0.45—0.78] |
| **SSE** | 0.63 | [0.47—0. 79] | 0.53 | [0.24—0. 82] |
| **SP** | 0.58 | [0.49—0. 68] | 0.59 | [0.35—0. 82] |

*Source: EE calculations using Bloomberg data. Note: due to unavailability of data over the whole of the period for SP the average for this company refers to the average of the data available within that period.*

4.18 The 10-year averages of the rolling betas are in the range of 0.53 and 0.62, and the five year averages are in the range of 0.58 and 0.63.

4.19 Table 4.9 below summarises our estimated equity betas of both the energy sector and the three listed companies.

**Table 4.9: Equity beta's point estimate (24 months rolling window)**

| | Beta "point estimate" | 95% confidence interval |
|---|---|---|
| **Energy sector** | **0.69** | **[0.55—0.83]** |
| **NG** | 0.73 | [0.58—0.88] |
| **SSE** | 0.63 | [0.50—0.76] |
| **SP** | 0.57 | [0.47—0.67] |

*Source: EE calculations using Bloomberg data. Note: due to unavailability of data over the whole of the period for SP the beta has been estimated on the last 24 months of data available.*

4.20 The betas reported in Table 4.9 above are the equity beta point estimates calculated on a 24 months window, using the Newey-West correction method. This choice is justified on the ground that::

(a) A point estimate is preferable to an average of rolling beta because recent periods' estimates are more appropriate in order to infer a forward looking estimate.

(b) Point estimates based on a 24 months rolling windows are preferable to those based on a 12 months rolling window because they use a larger amount of observations.

4.21 It is important to note that the "point estimates" in Table 3.9 should not be interpreted as any kind of recommendation to Ofgem as to where within our range to select. At this stage we are producing only range estimates. The "point estimates" here are merely statistical devices.

## Testing for Robustness

4.22 We now move on to test the robustness and relevance of the range obtained from equity market data by:

(a) Constructing individual company betas, based on variations in volatilities in accounting data to proxy for variations in betas between companies, using our notional "point estimate" for the energy sector as a calculation device. As we shall see, the constructed estimates of individual company betas have a range a little broader than the confidence interval of our equity beta range, with gas distribution tending to be higher than transmission.

(b) considering comparators. We shall find that the comparator data lies within the range.

(c) Considering regulatory precedent, in some cases by constructing implied notional "asset betas" for calculation purposes from other regulatory decisions.[17] We shall find that the range of asset betas implied by our confidence intervals for market data on

[17] We note that in certain of these cases there was no regulatory determination as to asset beta.

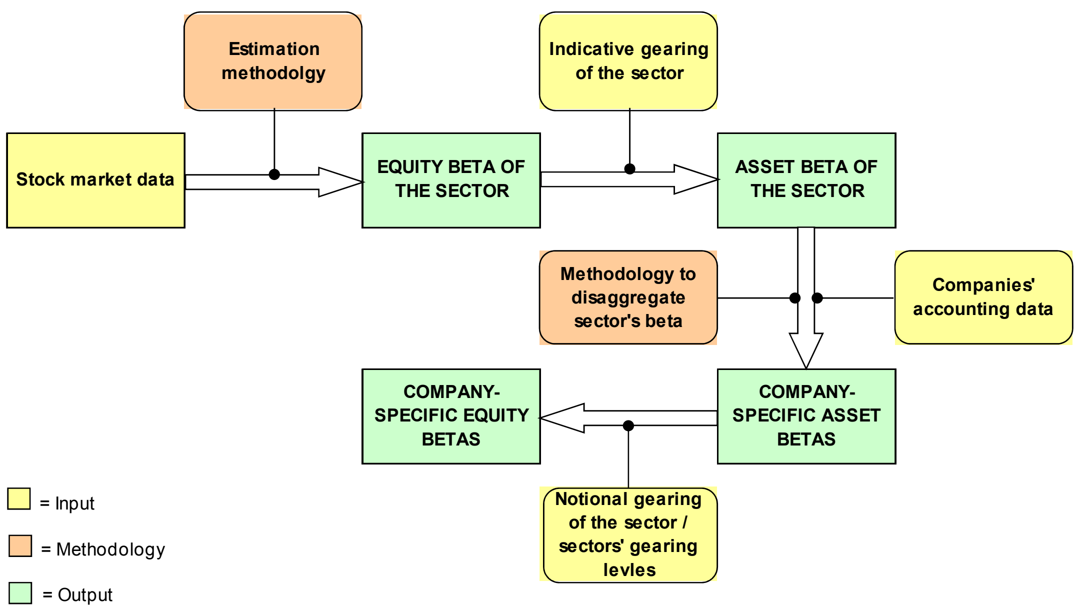
equity betas lies within the range of regulatory precedents, in the lower part of that range.

## Construction of company-specific betas from accounting data

4.23 Companies may be exposed to different levels of systematic risk, which implies that company-specific betas may differ from the beta of the energy sector. Since we do not have stock market data for the regulated entities of interest, we have inferred the company specific betas based on accounting data.

4.24 The overall methodology used to disaggregate the energy sector beta into company-specific betas is illustrated by the following diagram. It is clear from the diagram below that some of the analysis is circular in nature and we therefore we stress that this section is intended purely as an indication of how the range based on market data might encompass variation between firms — and in particular whether there might be any natural basis for assuming that, within our range, there might be differences between the betas of transmission and gas distribution.

**Figure 4.5: Overall methodology for estimating company specific betas**




4.25 As a first step we have calculated the asset beta from the energy sector. The energy sector's equity beta estimated in Table 4.9 is a raw beta because it does not account for the levels of gearing. The correct way to control for changes in gearing levels is to obtain an estimate of the sector's underlying asset beta, using the formula shown below as:

$$\beta^A = \beta^E (1 - g) + g\beta^D$$

where g is the gearing level of the sector, $\beta^E$ is the raw equity beta, and $\beta^D$ is the debt beta. The indicative gearing levels for the distribution and the transmission sectors (calculated as weighted averages of the gearing levels of the regulated entities operating of the two sectors) were provided by Ofgem and are 0.69 for the transmission sector, and 0.70 for the distribution sector. We have therefore used these gearing figures in order to calculate two separate asset betas, one for the distribution segment, and one for the transmission segment.

4.26 We report the results of this exercise, under the assumption that the debt beta is equal to zero, in Table 4.10 below.[18] The sector's raw equity beta used is 0.69, i.e. the equity beta's point estimate calculated on 24 months window (see Table 4.9 above).

**Table 4.10: Asset betas for the energy distribution and transmission sector**

| Sector | Equity beta | Gearing | Asset beta (debt beta = 0) |
|---|---|---|---|
| **Transmission** | 0.69 | 0.69 | 0.214 |
| **Gas Distribution** | 0.69 | 0.70 | 0.207 |

*Source: EE calculations using Bloomberg data and Ofgem's indicative weighted average gearing levels.*

4.27 The gearing levels in Table 4.10 are calculated as net debt over RAV (with shadow RAV included for the transmission companies) and are based on figures provided by the companies' regulatory reports. The gearing levels for individual companies are reported below.

**Table 4.11: Companies' gearing levels**

| Gas distribution operators | Gearing |
|---|---|
| NGG DN | 0.67 |
| NGN | 0.68 |
| SGN – Scotland Gas Networks | 0.75 |
| SGN – Southern Gas Networks | 0.72 |
| WWU | 0.75 |
| **Transmission owners** | **Gearing** |
| NGG NTS | 0.74 |
| NGET | 0.70 |
| SPTL | 0.43 |
| SHET | 0.41 |

[18] A non-zero debt beta has been assumed in some recent regulatory precedents. See for example the Competition Commission determination both for Stansted and Gatwick and Heathrow Airports.

4.28 We have then used company-specific accounting data in order to disaggregate the sector's beta reported above into companies-specific betas. Approaches to calculate betas of non-listed companies based on accounting data have been used in recent regulatory decisions, and consultancy reports.[19] The approach we follow here is based on the methodology recently adopted by the Competition Commission.[20] This method involves inferring company-specific asset betas by adjusting the sector's asset beta with an appropriate risk-adjustment factor. The risk-adjustment factor is calculated from regulatory accounts data by comparing the ratio of revenue to unexposed asset value of a firm to that of the sector as a whole. More specifically, the risk-adjustment factor is defined as follows:

$$f = \frac{r_s - r_i}{r_i}$$

where $r_i$ is the share of revenues non-accounted for by opex and tax (i.e. the ratio of revenue to unexposed asset value) of firm $i$ and $r_S$ is the share of revenues non accounted for by opex and tax of the sector as a whole. The value of the risk-adjustment factor $f$ is then used to calculate the percentage deviation of the company's asset beta from the sector's asset beta.

4.29 We have conducted this adjustment exercise in the table below, where revenues, opex, and tax figures have been provided by Ofgem.

[19] See, e.g. "Stand-alone costs of capital of Heathrow, Gatwick and Stansted Airports (2006)" prepared by Oxera for BAA.
[20] See http://www.competition-commission.org.uk/rep_pub/reports/2010/fulltext/558_appendices.pdf, footnote 61, pg. N36.

**Table 4.12: Calculation of adjustment factors for assessing company specific asset betas**

| Regulated entity | Revenues (£m) | Operating costs (£m) | Tax (£m) | Share of revenues non accounted for by opex, depreciation and tax (r) | Adjustment factor (f) |
|---|---|---|---|---|---|
| **NGET** | 2484.0 | 1693.0 | 183.0 | 0.24 | -0.02 |
| **NGG NTS** | 948.0 | 703.0 | 92.0 | 0.16 | 0.48 |
| **SPTL** | 196.8 | 50.0 | 36.0 | 0.56 | -0.58 |
| **SHETL** | 63.7 | 27.9 | 7.4 | 0.45 | -0.46 |
| **NGG DN** | 1818.0 | 1140.0 | 196.0 | 0.27 | -0.10 |
| **NGN** | 340.0 | 242.4 | 16.1 | 0.24 | 0.00 |
| **SGN – Scotland Gas Networks** | 243.1 | 181.7 | 4.8 | 0.23 | 0.03 |
| **SGN – Southern Gas Networks** | 540.4 | 445.0 | 12.0 | 0.15 | 0.55 |
| **WWU** | 314.0 | 263.0 | -5.5 | 0.18 | 0.33 |
| **Sector** | 6948.0 | 4746.0 | 541.8 | 0.24 | - |

*Source: EE calculations using companies' accounts data as provided by Ofgem*

4.30 Based on the adjustment factors calculated above we have worked out the company-specific asset betas. These have been derived based on two different values of the sector's asset beta:

(a) For regulated entities that operate in the transmission sector we have used the sector asset beta of 0.214, as reported in the first row of Table 4.10.

(b) For regulated entities that operate in the distribution segment we have used the sector's asset betas of 0.207 as beta reported in the second row of Table 4.10.

4.31 The outcomes of these calculations are reported in the table below.

**Table 4.13: Company specific asset beta (sector's debt beta = 0)**

| Regulated entity | Sector | Sector's asset beta | Adjustment factor | Company's asset beta |
|---|---|---|---|---|
| **NGET** | Transmission | 0.214 | -0.02 | 0.21 |
| **NGG NTS** | Transmission | 0.214 | 0.48 | 0.32 |
| **SPTL** | Transmission | 0.214 | -0.58 | 0.09 |
| **SHELT** | Transmission | 0.214 | -0.46 | 0.11 |
| **NGG DN** | Gas Distribution | 0.207 | -0.10 | 0.19 |
| **NGN** | Gas Distribution | 0.207 | 0.00 | 0.21 |
| **SGN– Scotland Gas Networks** | Gas Distribution | 0.207 | 0.03 | 0.21 |
| **SGN – Southern Gas Networks** | Gas Distribution | 0.207 | 0.55 | 0.32 |
| **WWU** | Gas Distribution | 0.207 | 0.33 | 0.27 |

*Source: EE calculations using Bloomberg data and, companies' accounts data and indicative gearing figures as provided by Ofgem.*

4.32 The final step consists in re-levering the company specific asset betas in order to obtain company-specific equity betas that are consistent with pre-determined gearing levels. This transformation is made through the following formula:

$$\beta_i = \frac{\beta_i^{A} - \beta_i^{D} g}{1 - g}$$

where g is the gearing level as applicable to firm $i$, $\beta_i$ is the company-specific equity beta, and $\beta_i^D$ is the debt beta of company $i$.

4.33 At the last price review, Ofgem used a notional gearing assumption of 62.5 per cent for the gas distribution networks and 60 per cent for the transmission companies. We have therefore carried out the re-levering exercise based on these notional gearing figures. The results are provided below.

**Table 4.14: Company specific equity betas calculated using notional gearing levels (debt beta =0)**

| | Sector | Notional gearing | Constructed Asset beta for calculation purposes | Equity beta |
|---|---|---|---|---|
| **NGET** | Transmission | 0.60 | 0.21 | 0.52 |
| **NGG NTS** | Transmission | 0.60 | 0.32 | 0.79 |
| **SPTL** | Transmission | 0.60 | 0.09 | 0.23 |
| **SHELT** | Transmission | 0.60 | 0.11 | 0.29 |
| **NGG DN** | Gas Distribution | 0.625 | 0.19 | 0.50 |
| **NGN** | Gas distribution | 0.625 | 0.21 | 0.55 |
| **SGN– Scotland Gas Networks** | Gas distribution | 0.625 | 0.21 | 0.57 |
| **SGN – Southern Gas Networks** | Gas distribution | 0.625 | 0.32 | 0.85 |
| **WWU** | Gas distribution | 0.625 | 0.27 | 0.73 |

*Source: EE calculations using Bloomberg data, and gearing figures provided by Ofgem.*

4.34 We have also replicated the de-levering exercise by using the indicative weighted average gearing levels for the gas distribution and transmission sectors (i.e. those reported in Table 4.10). The results are provided below.

**Table 4.15: Company specific equity betas calculated using weighted average gearing levels (debt beta =0)**

| | Sector | Weighted average gearing | Constructed Asset beta for calculation purposes | Equity beta |
|---|---|---|---|---|
| **NGET** | Transmission | 0.69 | 0.21 | 0.67 |
| **NGG NTS** | Transmission | 0.69 | 0.32 | 1.02 |
| **SPTL** | Transmission | 0.69 | 0.09 | 0.29 |
| **SHELT** | Transmission | 0.69 | 0.11 | 0.37 |
| **NGG DN** | Gas Distribution | 0.70 | 0.19 | 0.62 |
| **NGN** | Gas distribution | 0.70 | 0.21 | 0.69 |
| **SGN– Scotland Gas Networks** | Gas distribution | 0.70 | 0.21 | 0.71 |
| **SGN – Southern Gas Networks** | Gas distribution | 0.70 | 0.32 | 1.07 |
| **WWU** | Gas distribution | 0.70 | 0.27 | 0.92 |

*Source: EE calculations using Bloomberg data, and gearing figures provided by Ofgem.*

4.35 As we see from Table 4.14 and Table 4.15 above, the constructed estimates of individual company betas have a range a little broader than the confidence interval of our equity beta range, with gas distribution tending to be a little higher than transmission (though not universally so).

## Comparator Analysis

### Choice of comparators

4.36 We chose comparators which carry out similar activities to those of the network operators.

4.37 Most of the comparators that we have selected operate in the European energy sector and own electricity or gas transmission and distribution networks. In addition, we have included five comparator companies that operate in the UK water sector, reflecting the similarities between water and energy networks.[21] The network businesses of these comparators would in many cases be subject to broadly similar RPI-X regulation. Based on these similarities, we consider that these comparators are likely to be exposed to a similar level of systematic risk.

4.38 A caveat surrounding this sample of comparators is that many of the companies also operate in other parts of the value chain (i.e. generation and supply) as well as owning and operating transmission and distribution networks. Some companies may also be involved in non-energy activities.

4.39 The comparators chosen are:

(a) UK water companies

- Kelda Group (KEL)
- Northumbrian Water (NWG)
- Pennon (PNN)
- Severn Trent (SVT)
- United Utilities (UU)

(b) European energy utilities

- Centrica (CNA)
- ENEL (ENEL)
- GDF Suez (GSZ)
- International Power (IPR)

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[21] The five UK water and sewerage companies are Kelda Group, Northumbrian Water, Pennon, Severn Trent, and United Utilities. These companies are included as comparators due to the similarities in activities of energy and water companies in terms of network activities, exposure to volume risk and the need for infrastructure investment.

– Red Electrica (REE)

– RWE (RWE)

– Terna (TRN)

– Viridian (VRD)

4.40 A more detailed description of the activities carried out by these companies is provided in the table below.

**Table 4.16: Utilities used as comparators**

| Company | Energy-related activities[22] | Other (non- energy) activities | Main countries operates in | Regulator | Turnover (2009, £m) | Percentage of turnover from regulated businesses[23] |
|---|---|---|---|---|---|---|
| CNA | Electricity: generation; retail<br>Gas: exploration; production; storage; retail<br>Renewables | Drain cleaning; plumbing | UK, US | Ofgem.[24] | 21,963 | 0 |
| ENEL | Electricity: generation; transmission; distribution; supply.<br>Gas: exploration; production; supply. | | 23 countries (based Italy) – includes: Europe, North and Latin America. | Various | 64,035 | 11 |
| GSZ | Electricity: production; transmission; distribution; supply<br>Gas: exploration; production; transmission; distribution; supply<br>Energy procurement & trading | Water and waste treatment | Various (based France) – includes: Europe; North America; South America; Africa; Asia & Pacific | Various | 79,908 | 6 |
| IPR | Electricity: generation; retail<br>Gas: transportation<br>Renewables | Fresh water production; steam production; coal mining | 21 countries | | 3,471 | 0 |
| KEL | None | Water and waste water | UK | Ofwat | 878[25] | 91 |

22 These lists are non-exhaustive.
23 This figure is approximate and is calculated from Bloomberg data and segment analysis of companies' accounts for 2009.
24 Regulatory framework devised Ofgem, but revenue is not subject to Ofgem controls.

| Company | Energy-related activities[22] | Other (non- energy) activities | Main countries operates in | Regulator | Turnover (2009, £m) | Percentage of turnover from regulated businesses[23] |
|---|---|---|---|---|---|---|
| REE | Electricity: transmission | | Spain | CNE - Spain | 1,222 | 100 |
| RWE | Electricity: generation; distribution; supply.<br>Gas: exploration; production; transport; distribution. | | Europe (based Germany) | BNA /FNA - Germany | 46,191 | Not Available |
| SVT | None | Water and sewerage | GB | Ofwat | 1,642 | 80 |
| TRN | Electricity: transmission. | | Italy | AEEG - Italy | 1,361 | 100 |
| UU | Gas Metering (contracted by Northern Gas Networks) | Water and waste water | UK | Ofwat | 2,427 | 62 |
| VRD[26] | Electricity: major subsidiary – Northern Ireland Electricity: transmission and distribution asset owner (N Ireland); distribution operator (N Ireland). NI Energy: supply (NI). NIE energy power procurement business (PPB): generation. Energia: renewable energy. Gas: Energia: supply (NI and RoI). | | Northern Ireland | NIAUR -NI | 2,253 | 10 |
| PNN | Renewable energy generation. | Water distribution, sewerage, reservoirs, water treatment, waste | UK | Ofwat | 1068.9 | 40 |

[25] 2008 figures

[26] Note for Viridian the equity beta figures quoted later in this section refer to the group. Northern Ireland Electricity is the main subsidiary but the group also includes: NIE Energy; Powerteam Electrical Services; Viridian Power & Energy.

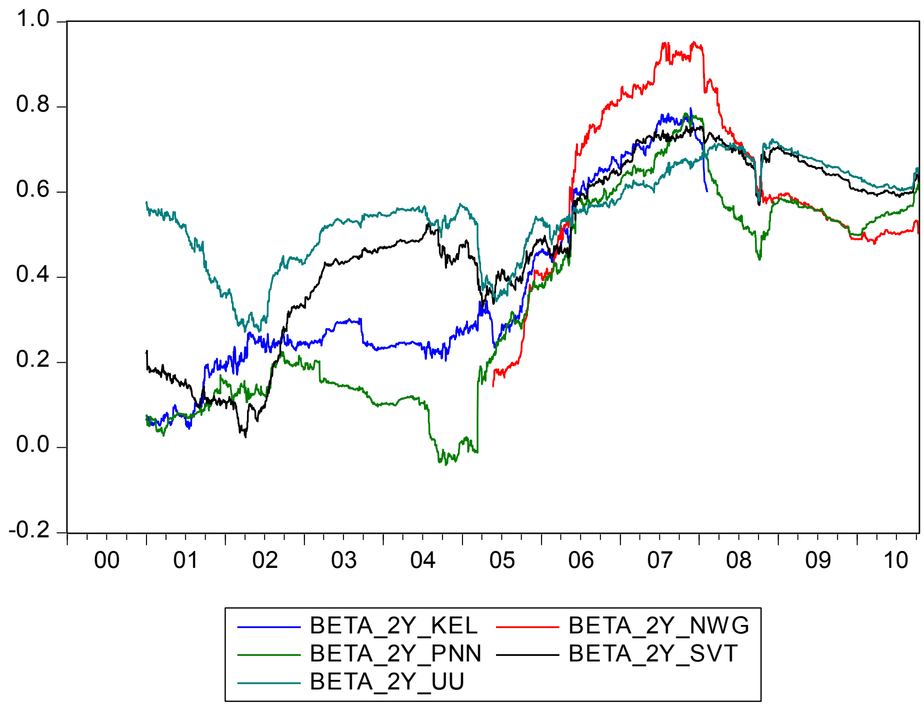
| Company | Energy-related activities[22] | Other (non- energy) activities | Main countries operates in | Regulator | Turnover (2009, £m) | Percentage of turnover from regulated businesses[23] |
|---|---|---|---|---|---|---|
| | | water treatment, waste management, recycling. | | | | |
| NWG | | Drinking water collection, treatment and supply; sewage and sewage sludge collection, treatment and disposal; holiday accommodation, conferencing, recreation, fishing facilities; searches for homeowners; analytical laboratory and scientific services; design and implementation of projects in framework of international co-operation and partnership agreements; plant and vehicle leasing services. | UK | Ofwat | 704.7 | 88 |

## Equity betas of comparator utilities 2000-2010

4.41 The betas for comparator companies have been estimated following the same approach used for the UK energy sector and for NG, SSE, and SP. However, for non-UK companies (i.e. VRD, ENEL, GSZ, REE, and RWE) the FTSE All Share Index was replaced by the Euronext 150 Index (N150) in the beta estimation.[27]

4.42 The figures below show the equity betas for the UK water companies and for the European energy utilities, over the 10-year period January 2000 – October 2010.

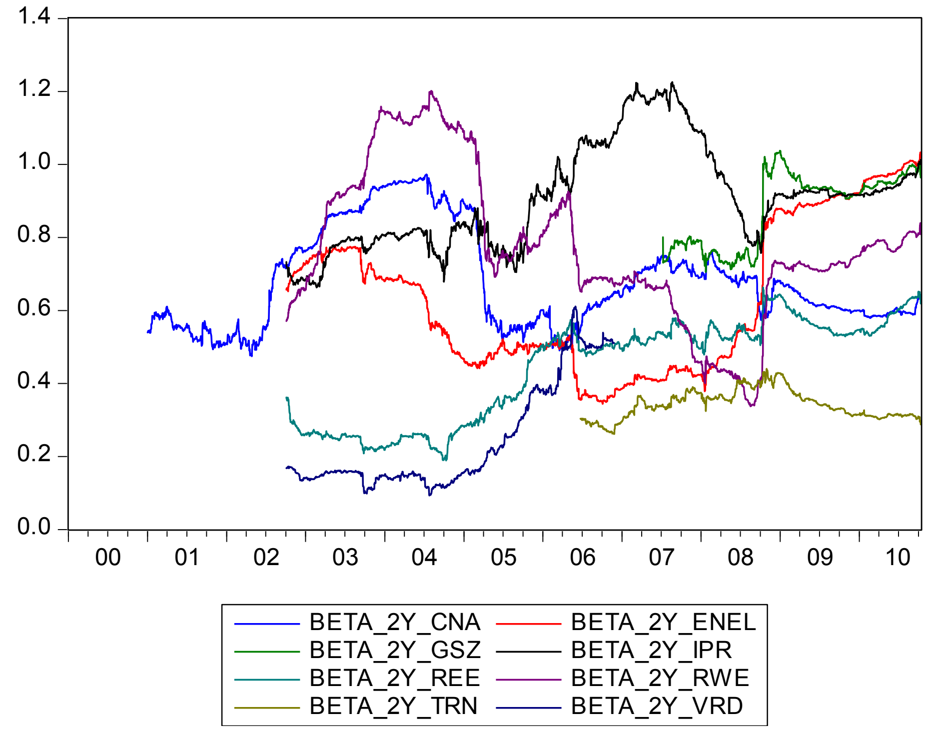
**Figure 4.6: Rolling betas of UK water companies (24 months rolling window)**




*Source: EE based on Bloomberg data*

[27] The N150 is a market capitalization weighted index of the 150 largest and most liquid stocks traded on Euronext.

**Figure 4.7: Rolling betas of European energy utilities (24 months rolling window)**




*Source: EE calculations based on Bloomberg data*

4.43 The Table below provides 5 and 10-year averages for the equity betas for each of the two comparator groups

**Table 4.17: Five and 10-year averages for comparators' equity betas**

| | 5-year average (2005-2010) | 10-year average (2000-2010) |
|---|---|---|
| KEL | 0.55 | 0.36 |
| NWG | 0.62 | 0.62 |
| PNN | 0.51 | 0.35 |
| SVT | 0.61 | 0.48 |
| UU | 0.60 | 0.55 |
| **Average for the UK water companies' group** | **0.58** | **0.47** |
| CAN | 0.64 | 0.68 |
| ENEL | 0.62 | 0.63 |
| GSZ | 0.88 | 0.88 |
| IPR | 0.96 | 0.91 |
| REE | 0.51 | 0.44 |
| RWE | 0.69 | 0.77 |
| TRN | 0.34 | 0.34 |
| VRD | 0.36 | 0.24 |
| **Average for the European energy utilities' group** | **0.63** | **0.61** |

*Source: EE calculations using Bloomberg data. Note: due to unavailability of data over the whole of the period for some companies the averages for those companies refer to the average of the data available within that period.*

4.44 The figures provided in Table 4.17 constitute evidence in support of our suggested energy sector's beta estimate. In fact, even if the averages (both 5-year and 10-year averages) calculated for the UK water companies' group tend to be lower than the ones calculated for the European energy utilities' group, the latter lie well within our calculated equity beta range of **0.55-0.83** (i.e. the confidence interval around our energy sector beta calculated using two years of data).

## Regulatory Precedents

### Asset beta estimates used in recent regulatory reviews

4.45 The Table below shows equity betas, gearing levels, and asset betas used in recent regulatory reviews. As we consider the decisions of energy regulators to be most relevant as comparators, these decisions are shown first and shaded in the table.

**Table 4.18: Previous regulatory decisions on asset betas**

| Regulator | Case | Equity beta | Gearing (%) | Notional Asset beta for calculation purposes (as constructed by EE) |
|---|---|---|---|---|
| Ofgem | Electricity distribution (2009) | 0.69-0.97 [0.9] | [65] | 0.24-0.34 |
| Ofgem | Gas Distribution (2007) | [1] | [62.5] | [0.375] |
| Ofgem | Transmission (2006) | [1] | [60] | [0.4] |
| Ofgem | Electricity distribution (2004) | [1] | 57.5 | [0.425] |
| CC | Bristol Water (2010) | 0.64 to 0.92 | 60 | 0.32 to 0.43 |
| Ofwat | Water and sewerage (2004) | [1.0] | [55] | *0.45* |
| Ofwat | Water and sewerage (2009) | [0.9] | 55-65 [57.5] | [0.4] |
| CC | Stansted (2008) | 1.0-1.24 | [50] | 0.55-0.67 [0.61] |
| CAA | Heathrow (2008) | 0.9-1.15 | [50] | 0.55-0.67 [0.61] |
| CAA | Gatwick (2008) | 1.0-1.3 | [60] | 0.40-0.52 |
| Ofcom | General approach – applied to BT (2005) | 1.14-1.23 | 30-35 | 0.74-0.86 |
| Ofcom | Openreach / BT's other activities (2009) | 0.76 / 0.96 | 35 | 0.49 to 0.62 |
| Postcomm | Royal Mail (2005) | 0.81-0.94 | [20] | 0.65-0.75 |

*Source: Regulatory determinations. Note: point estimates are shown in square brackets; asset betas shown in italics were calculated from equity betas and gearing assuming debt beta=0.*

4.46 The asset betas used by regulators vary significantly from one sector to another. The asset beta ranges for each sector are summarised in the Table below.

**Table 4.19: Sector asset beta ranges**

| Sector | Asset beta range |
|---|---|
| Energy | 0.24-0.425 |
| Water | 0.32-0.45 |
| Airports | 0.40-0.67 |
| Post | 0.65-0.75 |
| Telecoms | 0.49-0.86 |

*Source: Regulatory determinations. Note: some asset betas were calculated from equity betas and gearing assuming debt beta=0.*

4.47 The regulatory precedents give an asset beta range of 0.24 to 0.425 for energy transmission and distribution companies. As can be seen from Table 4.19 this is significantly below the asset beta ranges for airports, post and telecoms, but has some overlap with the range for water and sewerage companies.

4.48 This suggests that the energy sector has been regarded by regulators as exposed to less systematic risk than the other sectors. One reason for this is differences in volume risk. For example, airports tend to be exposed to greater volume risk than utilities as air travel has a higher income elasticity of demand.

4.49 However, we acknowledge that a degree of caution should be exercised when using previous regulatory decisions as an indicator of a company's asset beta due to the risk of propagating any errors made in previous regulatory decisions.

4.50 At gearing levels of 62.5 per cent for gas distribution and 60 per cent for transmission, the implied asset beta ranges associated with an equity beta range of 0.55-0.83, for a debt beta of zero, are 0.21-0.31 for gas distribution and 0.22-0.33 for transmission.

4.51 Thus our proposed range lies within the range of recent implied asset betas constructed from other regulatory judgements in the energy sector.

## Conclusions

4.52 Estimations based on accounting data, comparators, and regulatory precedent all broadly support the sectoral beta range calculated from the equity market data. Insofar as these other data have implications for our range, one might be inclined towards thinking that the gas distribution betas are more likely to lie within the lower half of that range than are the transmission betas.

4.53 Our estimated equity beta for the energy (distribution and transmission) sector is thus as provided in Table 4.9, lying in the 95 per cent confidence range of **0.55—0.83**. This range is consistent with past regulatory precedent on the asset beta for the energy sector, assuming reasonable gearing assumptions. This range is sufficiently broad at this stage, and the differences in gearing between sectors sufficiently narrow, not to require further adjustments. However, we note that if gas distribution gearing is ultimately determined to be higher than transmission gearing whilst the point estimate of the asset betas were to be the same, the implied equity beta for gas distribution would be slightly higher — a result at least compatible with the findings of our accounting data betas analysis.

# 5 EQUITY RISK PREMIUM

5.1 In this section we summarise the approach and range Europe Economics has taken on the equity risk premium to enable us to reach a range for the cost of equity. It is structured as follows:

(a) The equity risk premium

(b) Regulatory precedents

(c) Historical estimates

(d) Europe Economics ERP choice.

## The Market and Equity Risk Premium

5.2 The CAPM equation[28] states that the expected return on a capital asset is equal to the return required on a risk-free asset plus a premium to compensate for non-diversifiable risk. The right-hand side of the CAPM equation therefore includes a term defined as the Market Risk Premium (MRP) ($E(R_m)$-$R_f$). Strictly speaking, a fully diversified portfolio might include assets such as land or gold, but no usable all-assets index exists.

5.3 The normal proxy employed is the Equity Risk Premium (ERP) — the implicit assumption being that stock markets are, by themselves, sufficiently diverse to span all risks and allow of perfect diversification with a stocks-only portfolio. The ERP is the difference in the rate of return expected by shareholders for holding risky equities rather than risk-free securities.

5.4 The ERP is the difference in the rate of return expected by shareholders for holding risky equities rather than risk-free securities. Standard practice of most financial economists estimating ERP is to measure the historical equity premium (i.e. the excess of equity returns over the returns on a benchmark risk-free asset) by analysing historical equity returns over fairly long periods and making extrapolations based on this about the expected ERP.

5.5 A few points to note about the relationship between the ERP and MRP:

(a) Developed equity markets with greater diversification should serve as a better proxy for the MRP.

(b) Over time, the ERP may improve as a proxy for the MRP as diversification increases. Note that the MRP could also vary over time as investor taste for risks evolve.

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28 CAPM states that $E(R_i) = R_f + \beta_i(E(R_m) - R_f)$.

(c) During periods where equity markets become impaired (say, because of panic in a financial crisis or inappropriate regulation reducing market efficiency), but full diversification is still possible via other assets (e.g. gold, land, machinery, etc.), ERP will become a less good proxy for the MRP.

## Methodological Issues

5.6 We summarise the key methodological issues which arise in ERP estimation below, before examining historical estimates and moving on to our recommended range.

### Length of the time period

5.7 There are recognised issues both with the length and choice of time period over which analysis is undertaken.

5.8 Short-term time frames clearly do not provide a solid basis for generalising about future returns — stock markets are far too volatile on a year-to-year basis for good predictions to be made. A common choice of timeframe has been 10 years, but even looking over a decade will not produce robust results since it is not long enough to cancel out “good and bad luck”. For example, the 2010 estimates by Dimson, Marsh, Staunton and Wilmot for the ERP between 2000 and 2009 is negative is many countries (-7.40 per cent in the US) but is positive in all countries between 1900 and 2009 (4.20 per cent in the US).

5.9 Using the achieved premium in returns to forecast the required risk premium depends on having a long enough period. Even with 102 years of data, market fluctuations have some impact. For example, Damodaran (2010)[29] reported that if the period 1928-2008 were used to estimate the ERP instead of 1928-2009, 2009 being a year of high returns as equity markets recovered from lows of the previous year, the geometric average premium over T bonds in the US would have been 0.41 per cent lower (3.88 compared to 4.29).

5.10 A problem with overly-long time frames, however, is that the underlying MRP could vary over time (e.g. as tastes for risk evolve) such that data from the early part of the 20$^{th}$ century may be less relevant. It is also possible that modern equity markets are more efficient, offer greater opportunity for diversification, and are more globally integrated (hence more affected by global MRP developments, relative to domestic risk taste changes), than in the past.

### Arithmetic versus geometric mean

5.11 Discussions of the ERP explore the implications of using the arithmetic or the geometric mean of historical equity premia. Different authors favour different approaches.

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[29] Damodaran (2010) ‘Equity Risk Premium (ERP): Determinants, Estimation and Implications – the 2010 edition’

5.12 The arithmetic mean treats each estimate as independent of the others and thus provides a better estimate when returns are not serially correlated. The geometric mean necessarily tracks past estimates, and will therefore always be smaller than the arithmetic mean in the presence of market volatility. Use of the geometric mean, in principle, implies mean reversion in returns (subject to certain qualifications we shall discuss below), and since there cannot be mean reversion in efficient markets, it is thus an implication of efficient markets theory (and thence a requirement of CAPM) that arithmetic means be preferred.

5.13 Damodaran (2010) has argued that there is “extensive” evidence of serial correlation and the argument for using a geometric average is strong. Other experts who assume lognormality of returns including Dimson *et al*. opt for using geometric means for part or the entirety of calculating the expected premium. Others such as Ibbotson SBBI have advocated arithmetic mean due to: empirical evidence from which they do not find evidence of serial correlation; and the belief that the most reasonable expectation is the weighted average of all outcomes.

5.14 The two means are also linked by volatility when returns are distributed along a lognormal distribution, which is commonly assumed in long-term equity markets.[30] Lognormality can often characterise observed returns which exhibit a skewed distribution; allowing returns to be unbounded above zero, but to not drop below -100 per cent (i.e. the distribution is one-tailed).

5.15 Jensen’s inequality implies that, under lognormal distribution, the arithmetic average risk premium is approximately equal to the geometric average risk premium plus half the variance.[31]

5.16 An example provided by Smithers & Co (2003) supposes that with a volatility[32] of log returns of 0.2 (an estimate for a range of equity markets), the implied difference between arithmetic and geometric means will be approximately $0.2^2/2=0.02$ (two percentage points). The gap rises sharply for higher volatility.

5.17 Experts who assume lognormality of returns (Campbell, Dimson *et al.*) opt for using geometric means for part or the entirety of calculating the expected premium. Others such as Fama and French believe that the arithmetic mean is stable and should therefore be used because changes in returns are serially uncorrelated. The approach adopted by

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[30] Wright, Stephen, Mason, Robert, and Miles, David (2003) “A study into certain aspects of the cost of capital for regulated utilities in the UK” London: Smithers & Co Ltd.

[31] Gregory, Alan (2007) “How low is the UK equity risk premium?” XFi Centre for Finance and Investment paper number 07/09, University of Exeter.

[32] Appropriate measure of volatility is the standard deviation of log returns. Standard deviation is square root of the variance.

most UK regulators in recent years may be found in the report written by Wright *et al.* for Smithers & Co (2003):[33]

> Given the absence of a clear consensus on the best way to model the underlying properties of returns, the only clear-cut recommendation must be to deal consistently with the difference between the two averaging methods, to be precise in noting which estimate is being used in any context, and to be aware of the potentially significant differences between the two.

## Regulatory Precedents

5.18 We summarise recent regulatory precedents on the ERP below.

**Table 5.1: UK Regulatory precedents of ERP estimates**

| | Year | Sector/company | ERP % |
|---|---|---|---|
| Competition Commission | 2010 | Bristol Water | 4.0 to 5.0 |
| CAA | 2010 | NATS | 5.25 |
| Ofwat | 2009 | Water | 5.4 |
| Ofcom | 2009 | Openreach (BT's other activities) | 5.0 |
| NIAUR | 2008 | SONI | 4.5 |
| Ofgem | 2009 | Electricity distribution | 5.25 |
| CEPA for Office of Rail Regulation | 2008 | Network Rail | 3.0 to 5.0 but may be as high as 7 |
| Civil Aviation Authority | 2008 | Heathrow and Gatwick (BAA) | 4.5 |
| Competition Commission | 2007 | Heathrow and Gatwick (BAA) | 2.5 to 4.5 |
| Ofgem | 2007 | Gas Distribution | 4.75 |
| Ofgem | 2006 | Transmission | 4.50 |
| Smithers & Co for Ofgem | 2006 | Four electricity and gas licensees | higher end of 2.5 to 4.5 |
| Ofcom | 2005 | BT | 4.0 to 5.0 |
| Postcomm | 2005 | Royal Mail | 3.5 to 4.0 |
| Ofwat | 2004 | Water (WaSCs and WoCs) | 4.0 to 5.0 |
| Ofgem | 2004 | Electricity Distribution | 4.75 |

*Sources: Respective regulator reports.*

### Bristol Water, Competition Commission and Ofwat (2010)

5.19 The June 2010 decision by Competition Commission (CC) concerning Bristol Water plc's WACC provides one of the most recent UK regulatory decisions following the crisis period of 2008 and 2009.

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[33] p27: Wright, Stephen, Mason, Robert, and Miles, David (2003) "A study into certain aspects of the cost of capital for regulated utilities in the UK" London: Smithers & Co Ltd.

5.20 The CC considered both historical and forward looking approaches to arrive at an estimate of the ERP. Their preferred approach was to estimate first the market return and then net off the risk free rate to get a range for the ERP. The arithmetic average of historical returns over different holding periods was used. A range of 5 to 7 was concluded for the market return, similar to the range used by the CC previously during 2007 and 2008 airport determinations. Subtracting 1 and 2 percent respectively from the lower and upper end of the range led to an estimated range of 4 to 5 per cent for the ERP.

5.21 With regards to any mark-up for the ERP during the credit-crunch as allowed for by Ofwat during PR09, the CC argued that any upward movement in the risk premium should be considered alongside downward movement in the RFR. They concluded that the evidence reviewed did not suggest a need to depart from the implied range for the ERP of 4 to 5 per cent.

5.22 Note that Ofgem in its final decision paper for DPCR5, rejected the argument put forward by the DNOs that the recent financial crisis has resulted in a "fundamental re-pricing of equity risk". Rather, Ofgem believed there was sufficient evidence to suggest that the recovery in equity prices had been strong after the low point in April 2009 and in recent months had returned to "normal" levels. Ofgem therefore decided that there was "no reason to believe that there has been a fundamental departure from the long-term trend in the equity risk premium which is generally estimated by academics to be in the 3 to 5 per cent range."

## Historical Studies

### Dimson, Marsh and Staunton

5.23 Prior to the end of the technology bubble (2000), the most widely cited US source was Ibbotson Associates' figures, whose equity premium history starts in 1926. Research by Dimson, Marsh and Staunton published in 2002 raised the bar for the both data and methods used to estimate the ERP.[34] The study carried out by Dimson *et al*. sought to address the fact that many of the long-run empirical studies on the equity risk premium had been based on the experience of the US only. Dimson *et al.* argued that, given how successful the US economy had been, the US risk premium was unlikely to be representative. Thus, they extended the evidence on the equity risk premium by examining data on bond and bill returns in 16 countries over a 102 year period (1900-2002). Their results showed that the equity risk premium has typically been lower than previous research had suggested.

5.24 Table 5.2 summarises their latest estimates (1900-2009), along with their estimate over the period 1900-2005. .

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[34] Dimson, Elroy, Marsh, Paul and Staunton, Mike (2002) "Global evidence on the equity risk premium" London: London Business School.

**Table 5.2: ERP estimates and volatility levels, 1900-2005 and 1900-2009**

| | 1900-2005 | | | 1900-2009 | | |
|---|---|---|---|---|---|---|
| | **Geometric mean** | **Arithmetic mean** | **Standard error** | **Geometric mean** | **Arithmetic mean** | **Standard error** |
| Belgium | 2.57 | 4.37 | 1.95 | 2.6 | 4.9 | 2.1 |
| France | 3.86 | 6.03 | 2.16 | 3.3 | 5.7 | 2.2 |
| Germany | 5.28 | 8.35 | 2.69 | 5.4 | 8.8 | 2.8 |
| Ireland | 3.62 | 5.18 | 1.78 | 2.6 | 4.7 | 1.9 |
| Italy | 4.30 | 7.68 | 2.89 | 3.8 | 7.3 | 2.8 |
| Netherlands | 3.86 | 5.95 | 2.10 | 3.5 | 5.9 | 2.1 |
| Spain | 2.32 | 4.21 | 1.96 | 2.4 | 4.4 | 2.0 |
| **UK** | **4.06** | **5.29** | **1.61** | **3.9** | **5.2** | **1.6** |
| USA | 4.52 | 6.49 | 1.96 | 4.2 | 6.3 | 2.0 |
| **Europe** | | | | **3.9** | **5.2** | **1.6** |
| **World** | **4.04** | **5.15** | **1.45** | **3.7** | **4.9** | **1.5** |

*Source: Dimson, Marsh and Staunton (2006) 'The worldwide equity premium: a smaller puzzle' and Credit Suisse Global Investment Returns Sourcebook 2010*

5.25 As can be seen, low equity returns, particularly in 2007 2008, have generally pulled down the ERP in the latest estimates.

### Smithers & Co 2003

5.26 In the seminal 2003 Smithers Report,[35] Wright *et al.* derive a (global) geometric ERP of 3 per cent and an arithmetic ERP of 4 to 5 per cent. In the context of cost of capital estimation, the authors argue that it is important to start with average equity returns and calculate the ERP by subtracting the safe rate, due to greater historic uncertainty over the ERP than over the average cost of equity. Put another way, they argue that the overall market return (safe rate plus ERP) is more stable than the ERP alone.

### Ibbotson SBBI

5.27 The Ibbotson SBBI 2010 report estimates the ERP for large company stocks to be 5.2 per cent, based on the US stock market.[36] The authors use the arithmetic mean to arrive at this estimate.

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[35] Wright, S., Mason, R., and D Miles, (2003), "A Study into Certain Aspects of the Cost of Capital for Regulated Utilities in the U.K.", *A paper on behalf of Smithers&Co*

[36] Ibbotson SBBI Valuation Yearbook 2010

**Variation of the ERP in times of recession**

5.28 The use of the DMS methodology, which we still consider the most robust approach to infer the ERP, presents some problems in current financial and economic context, in which consistent variations in risk premia are likely to be observed.

5.29 For example, evidence reported in De Paoli and Zabczyk (2009) suggests that the size of this risk premium depends on whether the economy is in a period of stagnation or prosperity. In particular, investors seem to require higher premia during economic slowdowns than during booms. This empirical regularity has been termed "premium counter-cyclicality".[37]

5.30 Cochrane and Piazzesi (2005) argue that the ERP increases by almost 20 per cent in a period of crisis, coming back to its previous "normal level" three years after the end of the recession, on average.

5.31 During the most recent crisis, Ofwat picked a point estimate of 5.4, above the range assumed in its 2004 determination. Europe Economics, advising Ofwat at the time, recommended an ERP of 5 per cent for the non-crisis period and 6 per cent for the crisis period, which overlapped partly with the duration of the price control. Ofcom in its 2009 Openreach decision proposed a range of 4 to 5 for the ERP, picking a point estimate of 5 to reflect increased levels of volatility and turbulence in the market.

5.32 We stated in our 2009 report for Ofwat[38] that normal market conditions were expected to be re-established by 2011. Based on this, it is reasonable to move away from the crisis period adjustments to the ERP. This is also in line with the most recent CC ruling on the Bristol Water case and Ofgem's decision during DPCR5. We note also that the CAA in its October 2010 final proposals for NATS price control period 2011-2014 revised its ERP to 5.25, downwards from 5.5 in its Initial Proposals of May 2010.

5.33 The question remains as to what the ERP returns to. One possibility of course is that equity market return to the pre-crisis norm. Alternatively, if equity market functioning becomes impaired, the ERP may still be higher than pre-crisis. If serial correlation between returns becomes more apparent, a geometric mean approach would be preferred which would have the opposite effect of giving lower ERP estimates.

5.34 Another possibility is that the period of crisis changes investor views about the likely distribution of returns. If that expected distribution becomes more skewed in such a way

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[37] See B. De Paoli and P. Zabczyk (2009) "Why do risk premia vary over time? A theoretical investigation under habit formation. Harvey (1989) showed that US equity risk premia are higher at business cycle troughs than they are at peaks. Subsequent results of Bekaert and Harvey (1995), He, Kan, Ng and Zhang (1996) and Li (2001) confirmed these findings. Cochrane and Piazessi (2005) find that the term premium is countercyclical in the United States while Lustig and Verdelhan (2007) document strong countercyclicality in the exchange rate risk premium. The two most popular asset pricing models attribute this variation either to countercyclical changes in risk aversion (Campbell and Cochrane (1999)) or to changes in the volatility of the consumption process (Bansal and Yaron (2004))

[38] Europe Economics (2009) 'Cost of Capital and Financeability at PR09'

that the lognormal distribution becomes a more relevant model, the case for using geometric means increases.

5.35 It should be noted that any reduction in the post-crisis ERP might be associated with some rise in observed proxies for the risk-free rate, as the expected medium-term sustainable growth rate of the economy recovers.[39] Conversely, if it is to be credibly argued that the risk-free rate will be higher than crisis period observable proxies, it would be natural to question whether this also implied a fall in the ERP. As Smithers & Co. (2003) emphasized, the total market return (the sum of risk-free rate and ERP) tends to be more stable than the individual components (though we do not accept that this is an argument that these components always evolve in lock-step such that the total market return never changes).

## Recommended Range

### Range for the ERP

5.36 At this stage, we take the DMS estimate of the ERP for the UK for 1900-2009 — 3.9 to 5.2 — as the basis for our range, resolved to 0.5 intervals i.e. a range of **4.0 to 5.5.** Our range is based on an expectation that the effects of the crisis are expected to be resolved by the time RIIO T1 and GD1 come into effect and hence they are not materially relevant to the ERP at present.

[39] In a standard Cass-Koopmans growth model without population growth, the long-term growth rate of the economy, on the stable growth path, is equal to the risk-free rate. Hence rises in the expected sustainable growth rate of the economy should be expected to be correlated with increases in the risk-free rate.

# 6 CONCLUSIONS ON THE COST OF EQUITY

6.1 In this section we draw the material of previous sections together into a provisional overall range estimates for the cost of equity. We emphasise that there is no implied preference for the centre-point of these ranges. Neither is there any assumption that we would always prefer figures in the upper part of ranges by way of regulatory conservatism.

## Constructing "Low" and "High" Estimates

6.2 We note the arguments of Smithers & Co that the total market return should be expected to be more stable than either the risk-free rate or the equity risk premium, and we note also the Competition Commission's practice in the Bristol Water judgement of constructing its ERP range estimate by subtracting the upper end of its risk-free rate range (2.0 per cent) from the upper end of its total market return estimate (7 per cent) and the lower end of its risk-free rate range (1.0 per cent) from the lower end of its total market return estimate (5.0 per cent). In each case the effect narrows the range.

6.3 In constructing our range here, we narrow the overall range by associating our upper estimate for the risk-free rate (2.0 per cent) with our lower estimate of the equity risk premium (4.0 per cent) — implying a total market return of 6.0 per cent — and our lower estimate of the risk-free rate (1.0 per cent) with our upper estimate of the equity risk premium (5.5 per cent) — implying a total market return of 6.5 per cent. We place the first in our "lower" range estimate, along with the lower bound of our estimate for the beta, and the latter in our "higher" range estimate, along with the upper bound of our estimate for the beta. The results appear in Table 6.1.

**Table 6.1: Overall Cost of Equity Ranges**

| | **Gas distribution** | | | **Transmission** | |
|---|---|---|---|---|---|
| | **Lower** | **Higher** | | **Lower** | **Higher** |
| Risk-free rate | 2.0 | 1.0 | | 2.0 | 1.0 |
| ERP | 4.0 | 5.5 | | 4.0 | 5.5 |
| Equity beta | 0.55 | 0.83 | | 0.55 | 0.83 |
| Cost of equity (before re-levering) | 4.2 | 5.6 | | 4.2 | 5.6 |

# PART II: OTHER ISSUES

# 7 COST OF DEBT INDEXATION

7.1 This section assesses and develops the options for debt indexation proposed by Ofgem for future price control reviews.

7.2 It is structured along the following lines:

(a) Description of Ofgem's proposal for debt indexation;

(b) Policy objectives and criteria for assessing options;

(c) Overall form of indexation mechanism (i.e. whether the total cost of debt should be indexed, or just risk free rate or debt premium, whether the index should be market-wide or more specific to the sector);

(d) Key issues in the design of the mechanism, which addresses in turn:

- Utilities versus wider corporate index
- Inflation adjustment
- Tenor of debt used
- Length of trailing window
- Credit rating of debt used

(e) Weighting of historic data

(f) Implementation issues:

- Data sources
- Timing issues (i.e. based on thinking about what data would be available at the time when the calculation needs to be done each year)

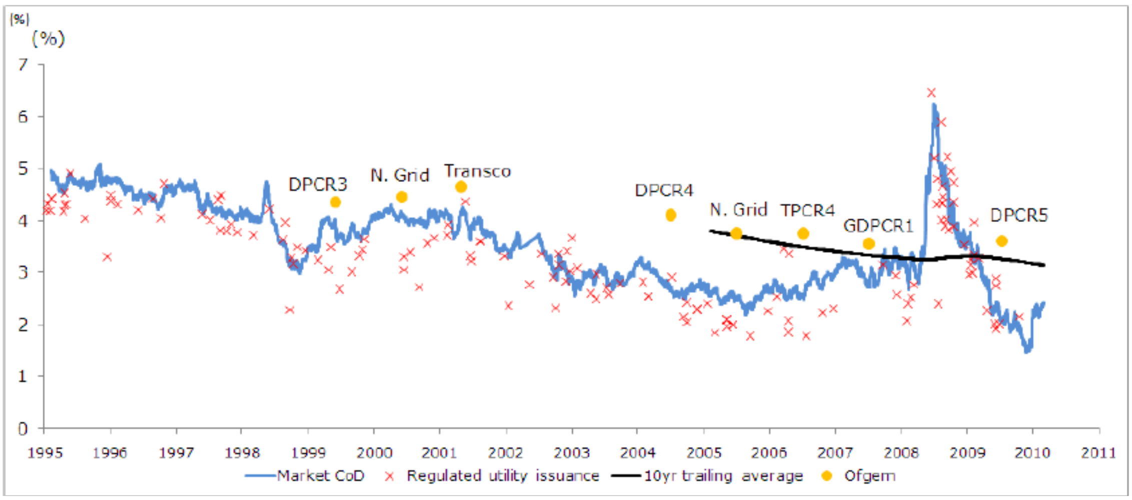
(g) Conclusions

## Proposal for Indexation

7.3 Ofgem has proposed that, in future price controls, the cost of debt will be calculated on a long-term (e.g. ten year) trailing average of forward interest rates of a chosen market index. The index will be based on the real yields of sterling issuers of a similar credit rating to regulated utilities. As a consequence, the revenues allowed during the price control period of eight years would be adjusted annually and mechanistically to reflect changes in the real yield on the long term trailing average of the index.

7.4 Figure 7.1, taken from Ofgem's July 2010 paper illustrates the advantage of this proposed approach. As compared to the approach for setting allowed cost of debt in past decisions, where cost of debt decisions were fixed for a 5-year period and regulators often aimed up from observed current rates, the trailing average is a more transparent and objective approach. It also avoids step changes in the allowed cost of debt between price reviews.

**Figure 7.1: The forward cost of debt (real) vs. regulated utility bond issuance vs. Ofgem's allowed return on debt**




*Source: Ofgem (2010) 'Regulating energy networks for the future: RPI-X@20 Recommendations: Implementing Sustainable Network Regulation' Supporting paper of 26 July 2010. Based on data from Bloomberg*

## Policy Objectives and Assessment Criteria

7.5 The indexation proposal has the benefit of being a type of uncertainty mechanism. As outlined in Ofgem's 26 July Implementation Paper,

> "Estimating the cost of debt on this basis should provide comfort that new debt, financed at efficient rates - even at levels higher than the allowed return - will be fully funded in the future. Furthermore, customers would benefit from this approach as there would clearly be no need for headroom to be included in any future determinations."[40]

7.6 In our analysis we have taken the following as given:

(a) That the allowed cost of debt should be indexed in some way. In other words, we have not revisited the arguments for and against indexation itself.

40 Ofgem (2010) 'Regulating energy networks for the future: RPI-X@20 Recommendations: Implementing Sustainable Network Regulation' Supporting paper of 26 July 2010.

(b) That the allowed cost of debt should reflect embedded debt as well as the forwards-looking market cost of debt. In other words, we have not set out the arguments for taking a trailing average of the market cost of debt.

7.7 A list of criteria against which the options for indexation will be assessed include:

(a) **Accuracy**. The indexation proposal should accurately reflect the cost of debt for an efficient company, including embedded debt. This criterion carries a high weight.

(b) **Simplicity, including data availability**. The indexation mechanism needs to be simple to understand and acceptable to stakeholders. Since calculations will have to be carried out on an annual basis, the method of calculation should not be onerous and data should be readily available.

(c) **Transparency**. The indexation mechanism needs to be based on data and calculations which can be replicated by stakeholders.

(d) **Credibility**. The indexation mechanism needs to be based on credible data sources and calculations.

(e) **Fully mechanistic**. The indexation mechanism should not require any regulatory judgment.

(f) **Cannot be manipulated**. The data used should be such that the regulated companies cannot manipulate the outcome of the calculations (e.g. by their own financing decisions).

(g) **Preserves efficiency incentives**. The indexation mechanism should preserve incentives for companies to raise their finance in an efficient way (i.e. if costs are high due to poor financing decisions, this should not feed through into a higher cost of debt through the indexation mechanism).

7.8 There is some potential for trade-offs between these criteria (e.g. accuracy and simplicity). We carry out multi-criteria analysis by assessing options for the indexation mechanism against the above criteria, in order to identify which options perform best against these objectives and to highlight any trade-offs involved.

## Overall Form of Indexation Mechanism

7.9 The indexation mechanism could take any of the following forms:

(a) Indexation of the total cost of debt.

(b) A fixed risk-free rate and indexation of the debt premium.

(c) A fixed debt premium, and indexation of the risk-free rate just for the cost of debt part of the WACC.

(d) A fixed debt premium, and indexation of the risk-free rate for both the cost of debt and the cost of equity.

7.10 Table 7.1 sets out the assessment of these options against the above criteria according to whether the proposed option is, broadly speaking, weak, satisfactory, strong or fails.

**Table 7.1: Performance of Different forms of Indexation against Assessment Criteria**

| | Accuracy | Simplicity including data availability | Transparency | Credibility | Fully mechanistic | Cannot be manipulated | Preserves efficiency incentives |
|---|---|---|---|---|---|---|---|
| Indexation of the total cost of debt | Strong | Strong | Strong | Strong | Strong | Strong | Satisfactory |
| A fixed risk-free rate, and indexation of the debt premium | Weak | Strong | Strong | Weak | Strong | Strong | Satisfactory |
| A fixed debt premium, and indexation of the risk-free rate just for the cost of debt part of the WACC | Weak | Strong | Strong | Satisfactory or weak? | Strong | Strong | Satisfactory |
| A fixed debt premium, and indexation of the risk-free rate for both the cost of debt and the cost of equity | Weak | Satisfactory | Strong | Satisfactory | Strong | Strong | Satisfactory |

7.11 All options considered above are strong in the transparency of the approach, mechanical nature and inability to manipulate a pre-specified measure.

7.12 Indexation of the total cost of debt will most accurately capture changes in the cost of debt, hence is the more credible measure. By contrast, indexing just part of the cost of debt may lead to inaccuracy — for instance, if the risk-free rate falls but the debt premium rises by an offsetting amount, indexing just part of the cost of debt would lead to a change in the regulatory cost of debt despite the fact that the total cost of debt has not changed.

7.13 Hence, indexation of the total cost of debt is the best approach in our view. The rest of the section deals with the details of how such an indexation mechanism might work.

## Key Choices in Designing Indexation Mechanism

7.14 There are six main issues on which this section focuses:

(a) Utilities versus wider corporate index

(b) Inflation adjustment

(c) The tenor of debt that should be covered by the index;

(d) The length of the trailing window that should be used;

(e) The credit rating of the bonds in the chosen index

(f) Whether the trailing average should be weighted according to level of additions to the RAV in each year.

7.15 We discuss each of these issues in turn below.

**Utilities versus wider corporate index**

7.16 A utilities index may be closer to actual debt finance costs for the relevant companies. iBoxx construct a utilities index, which has over 90 bonds. These bonds will not necessarily be very reflective of the companies of interest given their relatively small number.

7.17 More pertinently, an exogenous index is less affected by actual decisions of the companies and so will provide more of an incentive to outperform rather than an index of bonds issued by the regulated companies, which would leave open the possibility of companies being able to influence the outcome of the calculation.

7.18 When using a wider corporate index, the fact that all bonds have the same category rating and/ or tenor helps ensure that the bonds included from other sectors are comparable.

7.19 Hence we recommend a wider corporate bond index.

**Inflation adjustment**

7.20 The cost of debt is to be calculated on a real basis, whereas bond yields on indices tend to be in nominal term. An index of inflation-linked bonds would overcome this problem; however, the market is very small and unlikely to be representative of the wider market cost of debt. Historic data is also sparse.

7.21 This leaves two main options for converting nominal bonds yields into real terms:

(a) Use of Bank of England data on index-linked and nominal gilts to net off the implied inflation from nominal yields.

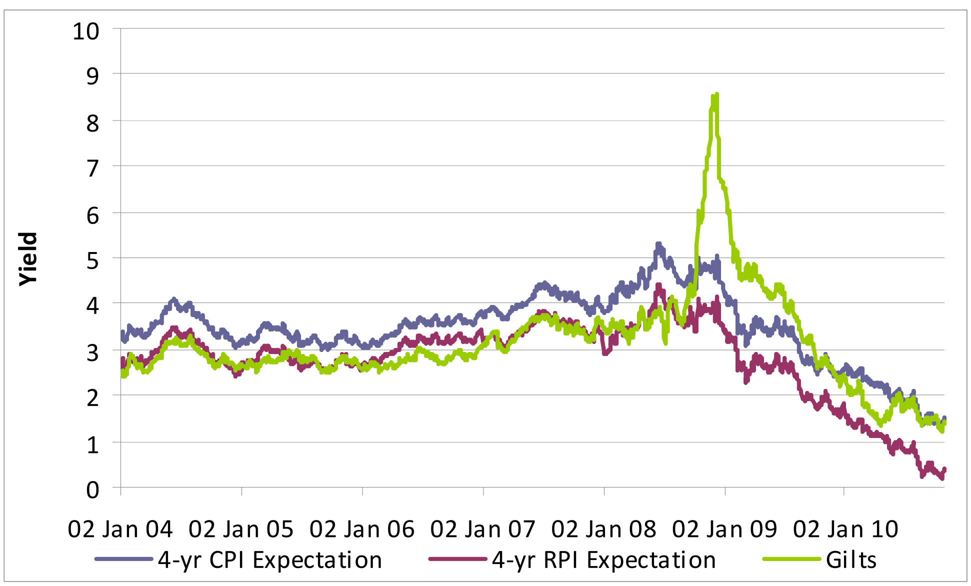
(b) Use of an average of historic inflation forecasts by other parties to net off from nominal yields.

7.22 The latter of these approaches may be said to better reflect actual inflation expectations and be less prone to temporary distortions in gilt markets. However, the former approach is more transparent (Bank of England published implied inflation going back to 1985); is available on a daily basis; and can be calculated over required period into future (unlike inflation forecasts which may only go a couple of years ahead).

7.23 Figure 7.5 presents a 5 year BBB rated index from Bloomberg, whose nominal yields have been adjusted for inflation using different forecasts of inflation and data from the gilt markets. It is difficult to get inflation forecasts for more than four years I advance, and even when they are available there is a great deal of uncertainty around the figures.

7.24 Also, as in the Figure, real yields do not differ consistently between the two methods. For these reasons, we prefer the use of implied inflation from the gilt market.

**Figure 7.2: 5 Year BBB rated Index, adjusted for Inflation Using CPI, RPI forecasts and Implied Inflation from the Gilt Market**




*Source: HM Treasury: Forecasts for the UK Economy (2004-2010), Bank of England: UK Yield Curve Data, Bloomberg*

## Tenor of debt

7.25 Given that one of the aims of the indexation mechanism is to better reflect the actual cost of debt of the regulated companies, the choice of tenor for the index should be guided by the actual tenor of the regulated companies' debt.

7.26 The tenor at the time of issue is relevant for fixed rate debt, since the interest rate is fixed at that stage. For variable rate debt, historic data is not relevant at all – what matters is the current market yield on debt with the same outstanding tenor. The breakdown of bonds between fixed and variable coupon is presented in Table 7.2.

**Table 7.2: Percentage of Fixed Coupon Bonds**

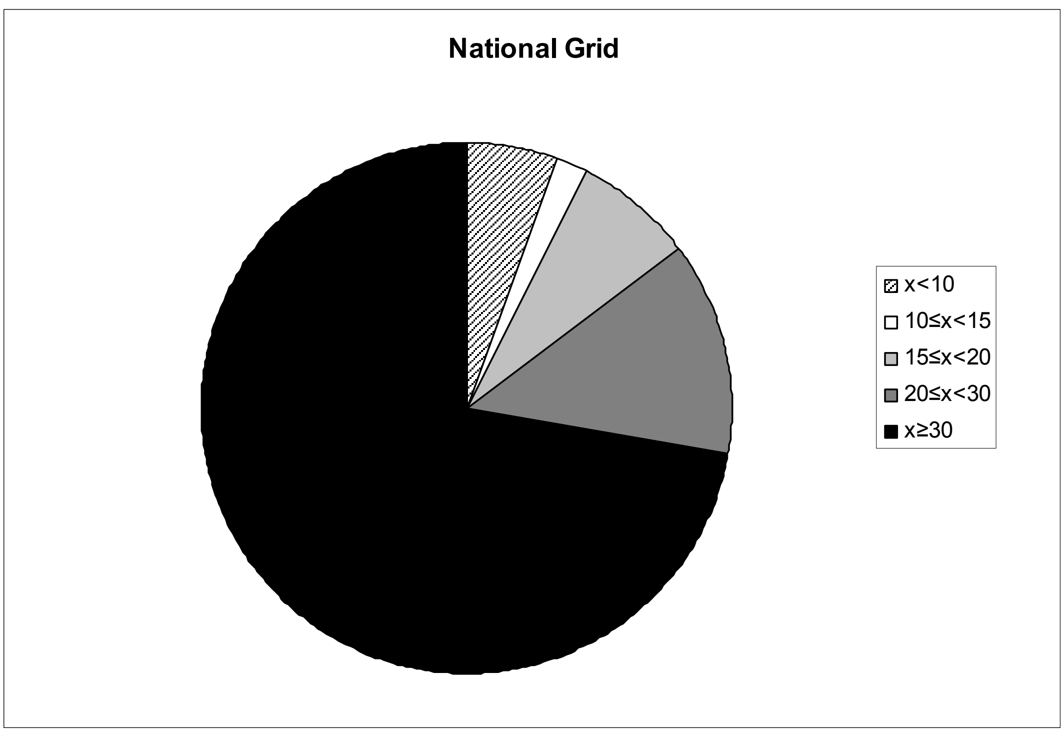
| Company | % of outstanding GBP bonds which are fixed coupon (including RPI indexed bonds) |
|---|---|
| National Grid plc | 100% |
| Northern Gas Networks | 100% |
| Scottish Power | 88% |
| Scottish & Southern | 77% |
| Scotia Gas Networks | 67% |
| Wales and West Utilities | 80% |

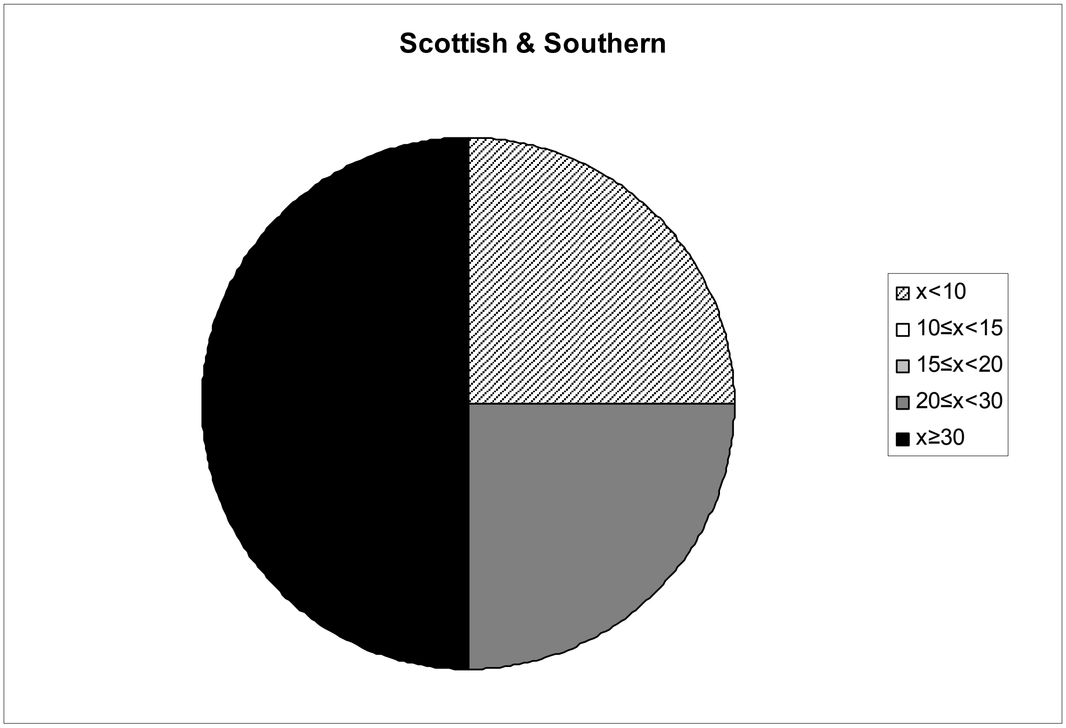
*Source: Bloomberg. Similar information is presented for electricity DNOs where available in the Section 6 Appendix*

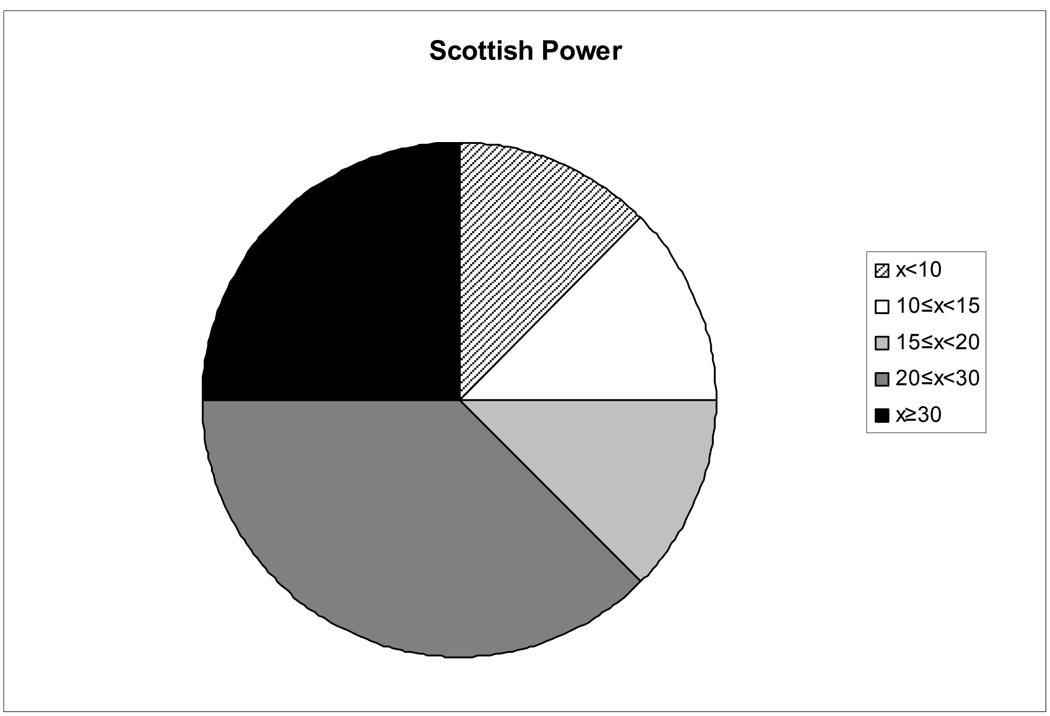
7.27 A ten year index was considered by Ofgem in the 26 July publication. However, to provide further evidence on debt tenor, we have gathered information on bonds issued by the relevant companies.

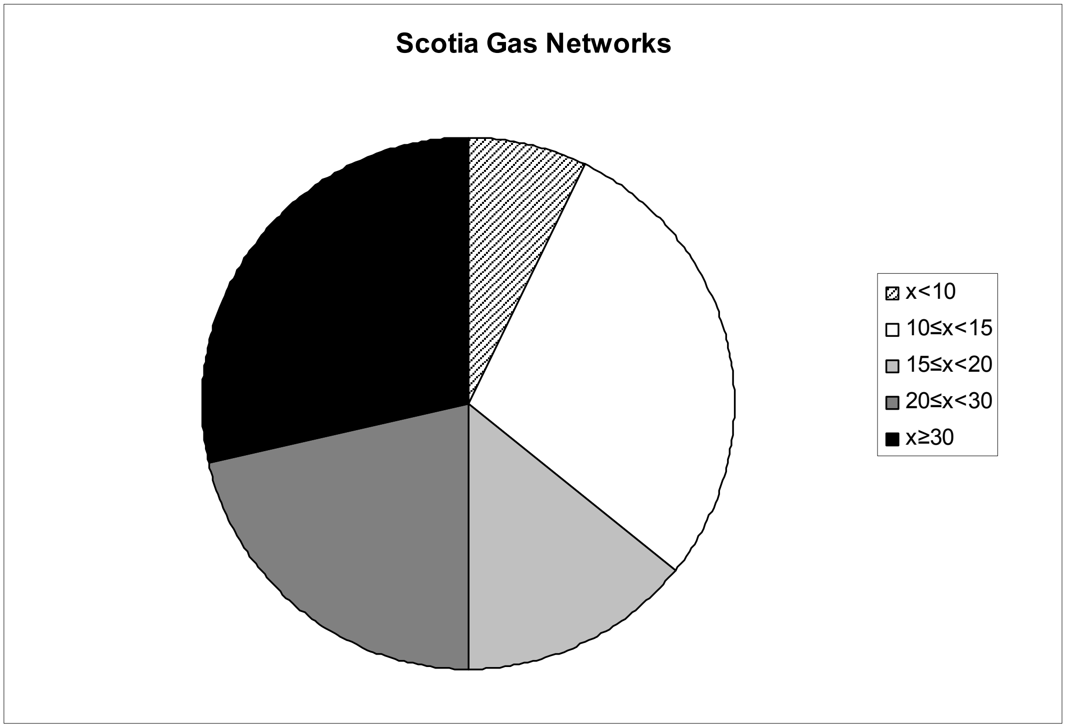
7.28 Of the listed companies for which data is available, at least a quarter of GBP bonds issued historically mature at least 30 years after they were issued. For National Grid, this figure is almost three quarters, as illustrated in the figures below.

**Figure 7.3: Tenor at Time of Issue of Outstanding GBP Bonds by Company**




Scottish & Southern
x<10
10≤x<15
15≤x<20
20≤x<30
x≥30


Scottish Power
x<10
10≤x<15
15≤x<20
20≤x<30
x≥30




*Source: Bloomberg. Similar information is presented for electricity DNOs where available in the Section 6 Appendix*

7.29 Bank borrowing is another source of finance which companies rely on. It typically offers shorter term financing than the bond portfolio above. Looking at the breakdown between bank borrowing and bonds, companies tend to rely on bonds to a larger extent. For example, in 2009 63 per cent of NGG DN's borrowings were in the form of bonds and 19 per cent in the form of bank loans. In the same year, over 80 per cent of Scotland Gas Networks' debt was in the form of bonds.

7.30 The key options for the tenor of debt in the chosen index are:

(a) Use of 5-year debt

(b) Use of 10-year debt

(c) Use of 15-year debt

(d) Use of 20-year debt

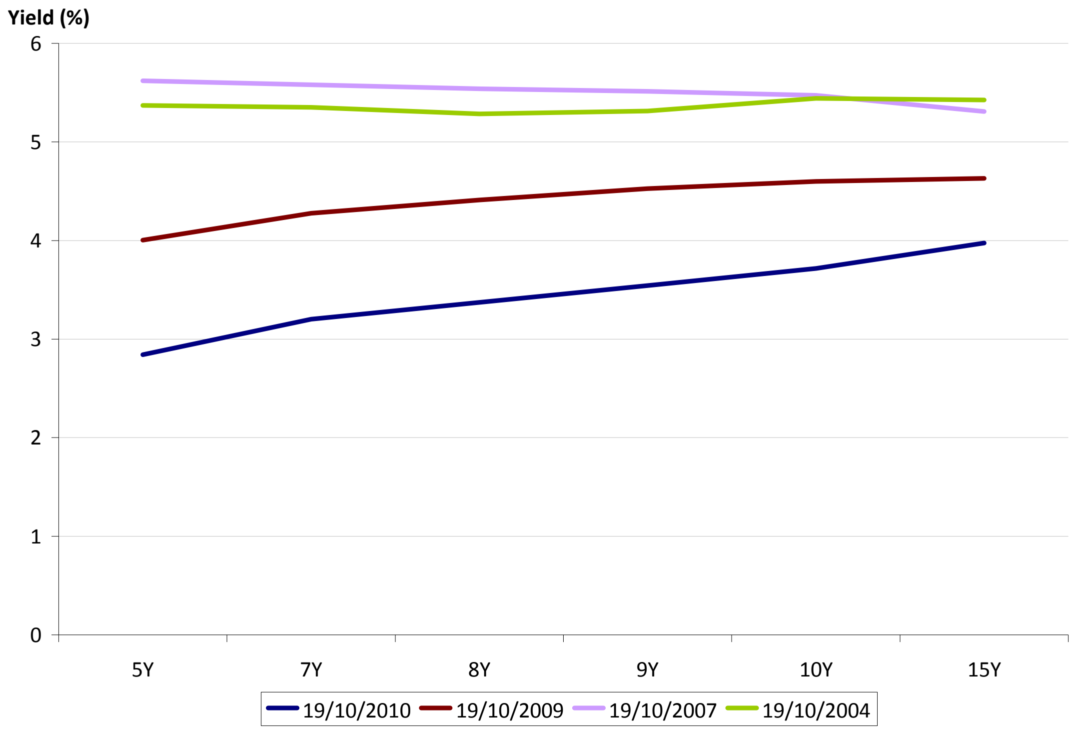
(e) Use of 10+ year debt

(f) A simple average of different tenors

(g) A weighted average of different tenors, with the weights based on debt profile of industry

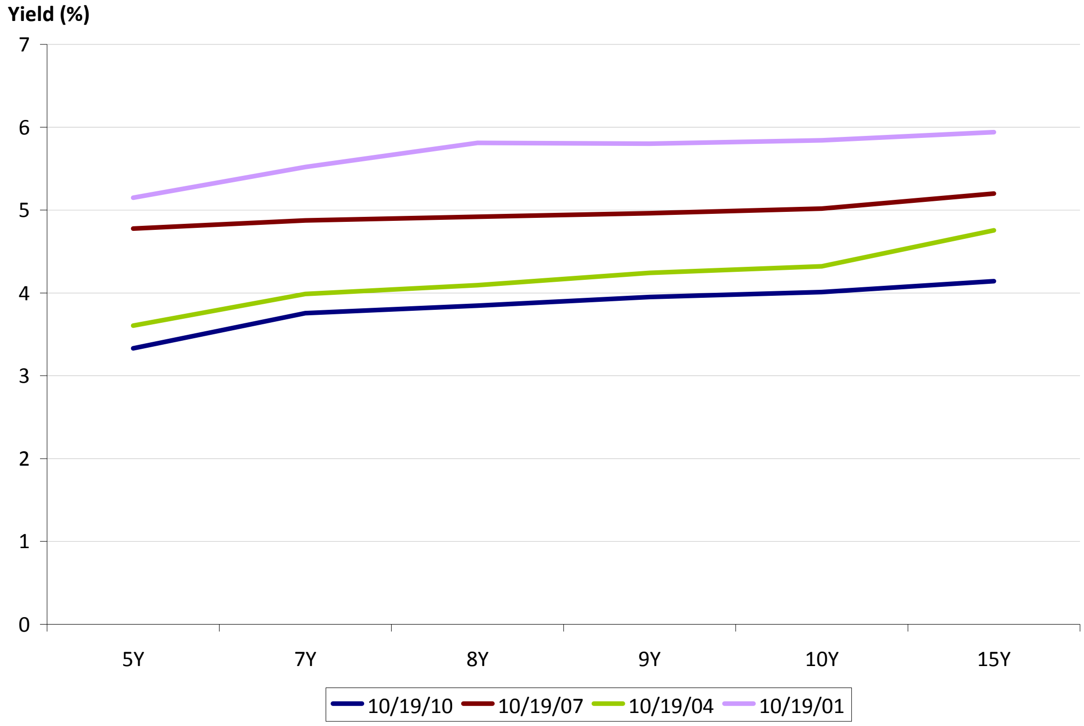
7.31 The yield curve generally exhibits a declining upward slope. Figure 7.4 and Figure 7.5 presents a snapshot of the yield curve for UK and Euro corporate debt at different points in time. As shown the difference in yield in moving from a 10 year to 15 year tenor tends to be marginal. This observation is much the same as tenor is extended to 20 or 30 years.

**Figure 7.4: Nominal Yield Curve of Selected Dates for A, A-, A+ rated UK Fixed Rate Corporate Bonds**




*Source: Bloomberg*

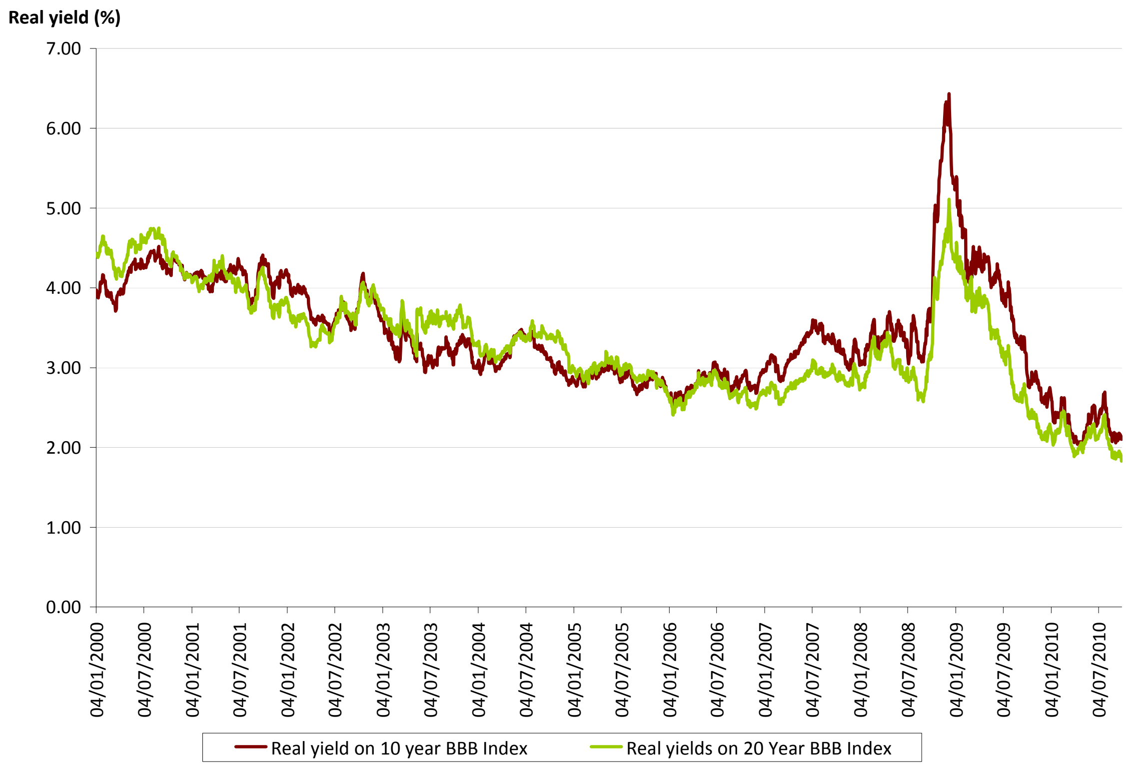
**Figure 7.5: Nominal Yield Curve of Selected Dates for A, A-, A+ rated Euro Denominated Debt of UK issuers**




*Source: Bloomberg*

7.32 Thus, using a tenor of bonds of 10, 15, 20 or longer is not expected to make a large difference to the observed yields. This is confirmed by the comparison of historical real yields on a 10 year and 20 year BBB index in Figure 7.6 below.

**Figure 7.6: Real Yields on 10 and 20 Year BBB Index**




*Source: Bloomberg*

7.33 The potential tenor mix of indices is considered against our criteria below.

**Table 7.3: Assessment of Different Tenor of Indices**

| | Accuracy | Simplicity including data availability | Transparency | Credibility | Fully mechanistic | Cannot be manipulated | Preserves efficiency incentives |
|---|---|---|---|---|---|---|---|
| 5-year index | Weak | Strong | Strong | Weak | Strong | Strong | Satisfactory |
| 10-year index | Satisfactory | Strong | Strong | Strong | Strong | Strong | Satisfactory |
| 15-year index | Satisfactory | Fails[41] | Strong | Satisfactory | Strong | Strong | Satisfactory |
| 20-year | Satisfactory | Strong | Strong | Satisfactory | Strong | Strong | Satisfactory |
| 10+ year index | Strong | Strong | Satisfactory | Strong | Strong | Strong | Strong |
| A simple average of different tenors e.g. 10 and 20 | Strong | Satisfactory | Weak | Strong | Satisfactory | Satisfactory | Strong |
| A weighted average of different tenors, with the weights based on debt profile of industry | Strong | Weak | Weak | Strong | Satisfactory | Satisfactory | Strong |

7.34 As outlined above, a pre-existing and widely available single tenor index such as 10-year from Bloomberg has the advantage of simplicity in terms of both data availability, ease of calculation and transparency of index.

7.35 Existing indices also account for some ranges in tenor such as the10+ years from iBoxx or the 10-15 years also available from iBoxx. These offer the advantage of some mix of tenors which more accurately reflects the mix of bonds issued by company, although they will not be tailored exactly to the industry portfolio.

41 A 15 year index is not available on Bloomberg or iBoxx but could be available from another source or constructed.

7.36 The alternative is to create a bespoke index with weights attached to bonds of different tenors to reflect the industry portfolio. However, this approach scores weakly on the simplicity of calculation and transparency, and is more open to criticism.

7.37 It is for Ofgem to decide the trade-off between accuracy and simplicity associated with the following likely options:

(a) Use of 10-year debt, which is the tenor which has historically been used by Ofgem to reflect the tenor of the regulated companies' debt.

(b) Use of the 10+ index to reflect the observation that most bonds issued by the regulated companies have a longer-term maturity.

(c) Use of a simple or weighted average of different tenors, which may be more accurate but is more complex.

(d) Use of a "baseline" figure for the start of each price control calculated from a weighted average of different tenors, adjusted during price controls on the basis of changes in an index built on 10 year debt. (So, for example, if the cost of debt calculated at the start of a price control were 4 per cent whilst the trailing average yield on 10-year debt were 3.5 per cent, then during the price control the trailing average yield on 10-year debt fell to 3.15 per cent (i.e. fell by a tenth) then the overall cost of debt would fall to 3.6 per cent (i.e. fall by a tenth from 4 per cent).)

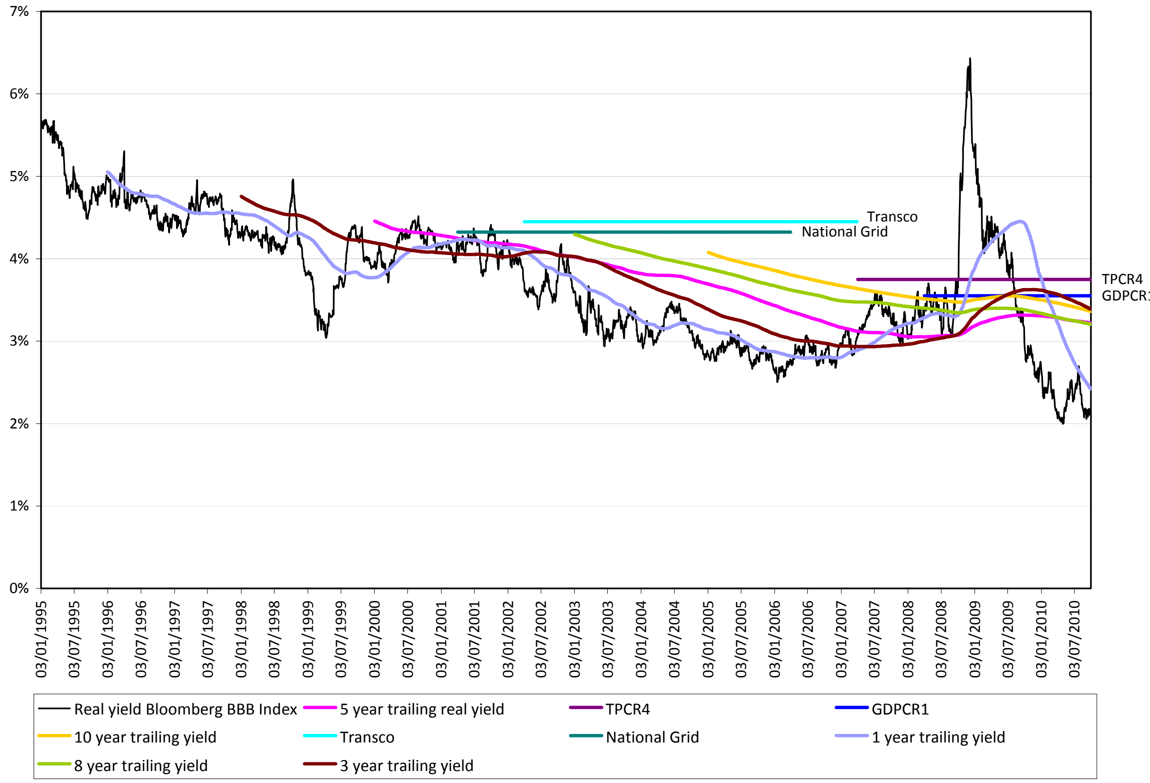
7.38 For the purposes of our analysis we have used 10 year and 7-10 years.

**Length of trailing window**

7.39 In Figure 7.7 we plot the real yield on the Bloomberg index of BBB rated bonds, and the 1, 3, 5, 8 and 10 year trailing average of daily yields.[42]

[42] To obtain real yields, the difference between yields on 10 year nominal and real Gilts (implied inflation expectation) was netted off from the nominal yield.

**Figure 7.7: Implied Cost of Debt using Bloomberg BBB 10 Year Index**




*Source: Europe Economics based on data from Bloomberg, Bank of England and Ofgem*

7.40 The options for the trailing window we consider are:

(a) One year trailing average

(b) Five year trailing average

(c) Eight year trailing average

(d) Ten year trailing average

**Table 7.4: Assessment of Different Trailing Averages**

| | Accuracy | Simplicity including data availability | Transparency | Credibility | Fully mechanistic | Cannot be manipulated | Preserves efficiency incentives |
|---|---|---|---|---|---|---|---|
| 1 year trailing average | Weak | Strong | Strong | Weak | Strong | Strong | Weak |
| 5 year trailing average | Satisfactory | Strong | Strong | Satisfactory | Strong | Strong | Satisfactory |
| 8 year trailing average | Strong | Satisfactory | Strong | Strong | Strong | Strong | Strong |
| 10 year trailing average | Strong | Satisfactory | Strong | Strong | Strong | Strong | Strong |

7.41 A one or two year trailing average would more closely track the market cost of debt, suitable in a situation where the majority of the debt is at a floating rate. Many of the bonds historically issued by the regulated companies have been at a fixed coupon rate, suggesting that a longer term trailing average may be more appropriate.

7.42 The 10 year trailing average corresponds well to the current allowed cost of debt in GDPCR1 and TPCR4 and is above the five year average. The longer the trailing window, the less affected the measure is by spikes and troughs in the cost of debt index.

7.43 Given the borrowing profile of the regulated companies and the 8 year length of the new price control period, we would see 8 years as a lower limit and 10 years as an upper limit for the length of the trailing window.

**Credit rating of debt used in index**

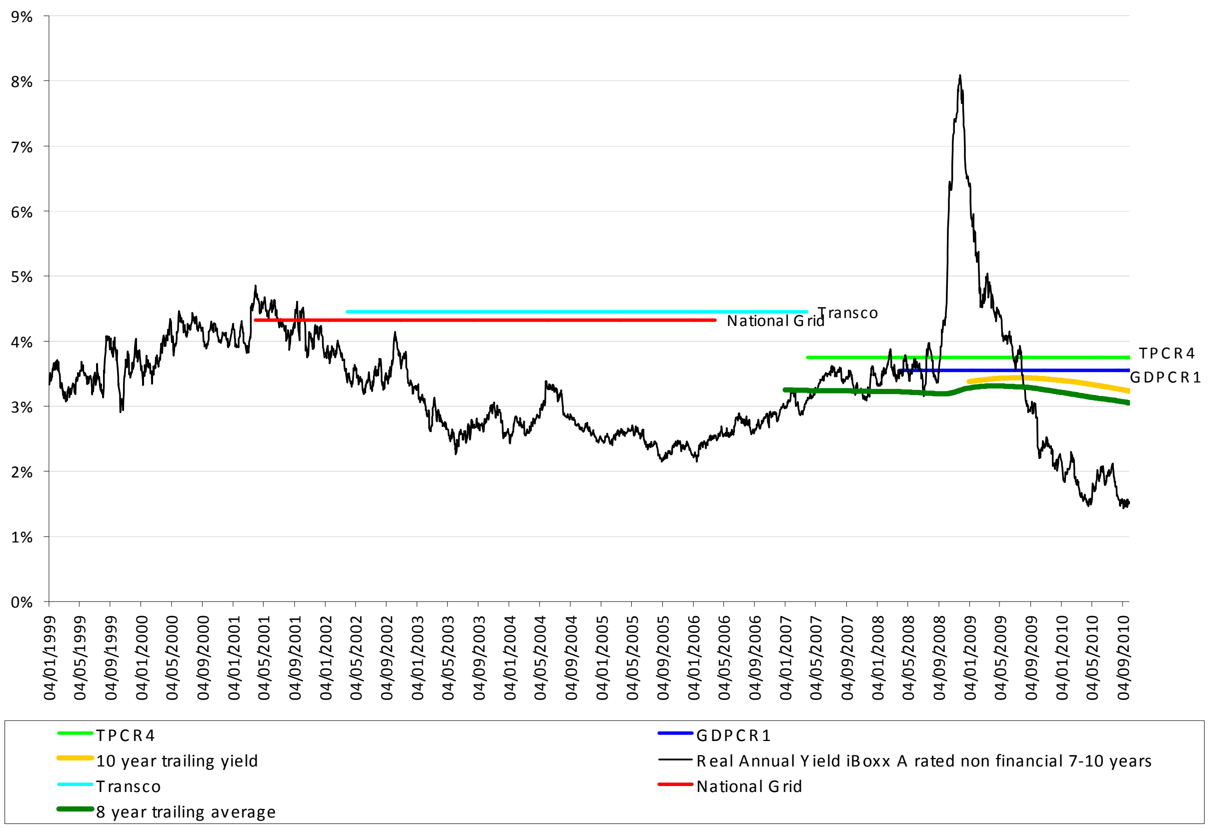
7.44 The target credit rating chosen by Ofgem in previous price controls has been investment grade or above, which corresponds to a credit rating of BBB or above in Standard and Poor's and Moody's terms.

7.45 In order for the market index to reflect the cost of debt environment of the regulated companies, indices of similar rating (BBB to A), or an average of the two, are required.

7.46 Data for BBB-rated debt was presented above in Figure 7.7. Figure 7.8 repeats the analysis with an index of A rated bonds. As expected, the yields on this index are a little below that on the BBB index.

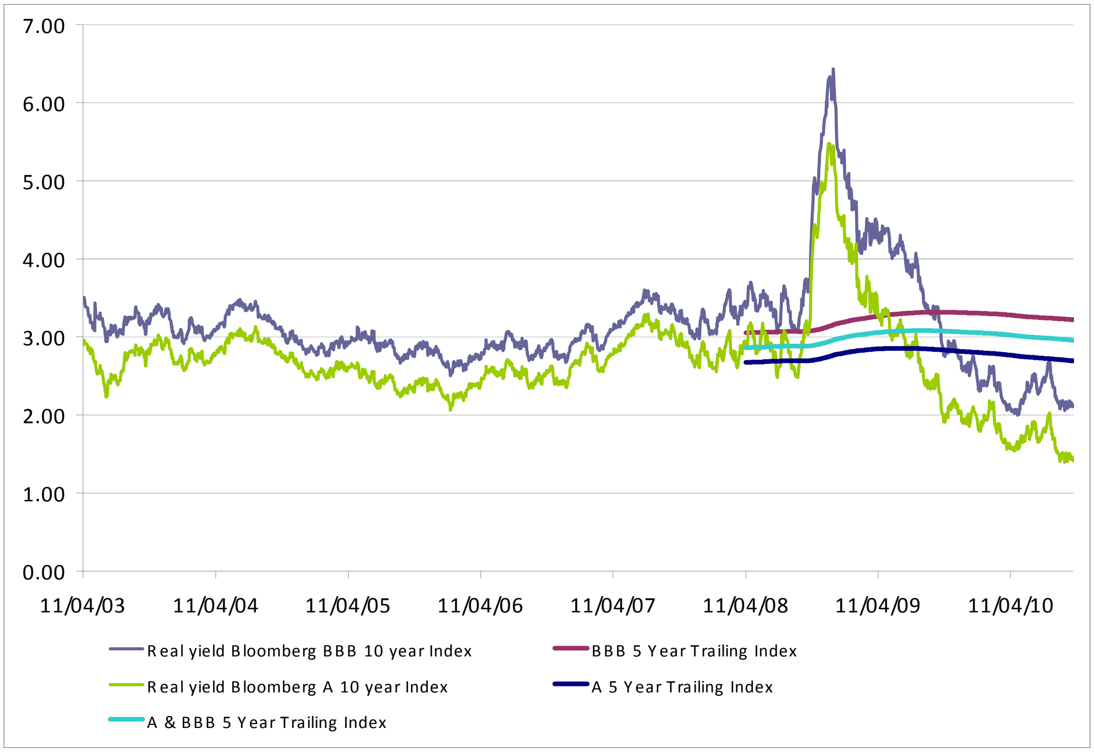
7.47 We have repeated the analysis in Figure 7.8 by averaging the real yields on the A and BBB rated indices.

**Figure 7.8: Implied Cost of Debt using iBoxx 7-10 years A rated non-Financials Index**




7.48 Figure 7.9 presents a comparison of the yields on two ten-year indices, one with A rates bonds and the other with BBB rated bonds.

**Figure 7.9: Implied Cost of Debt Using Average of Yield on A and BBB Rated 10 Year Index**




*Source: Bloomberg. Note data for the A rated index only begins in 2003 therefore the calculation of eight and ten year averages not possible. Shorter-term average calculated for illustration only. .*

7.49 Some sensitivities around using indices of different credit ratings and length of trailing window are presented in Table 7.5.

**Table 7.5: Implied Cost of Debt with Different Credit Ratings and Trailing Windows**

| Index | 10 year trailing average on 30/09/2010 | 8 year trailing average on 30/09/2010 |
|---|---|---|
| 10 year BBB | 3.36 | 3.20 |
| 7-10 year A | 3.23 | 3.05 |

7.50 The Options for credit rating of the chosen index are:

(a) Use of A rated debt

(b) Use of BBB rated debt

(c) Using a simple average of yields on A and BBB rated debt

(d) Using a weighted average of yields on A and BBB rated debt, with the weight based on mix of credit rating achieved by bonds of regulated companies.

7.51 Table 7.6 evaluates the options against the criteria.

**Table 7.6: Assessment of Different Credit Ratings for Indices**

| | Accuracy | Simplicity including data availability | Transparency | Credibility | Fully mechanistic | Cannot be manipulated | Preserves efficiency incentives |
|---|---|---|---|---|---|---|---|
| A rated debt index | Satisfactory | Strong | Strong | Strong | Strong | Strong | Strong |
| BBB rated debt index | Satisfactory | Strong | Strong | Strong | Strong | Strong | Satisfactory |
| Simple average of yields on A and BBB rated debt | Strong | Strong | Strong | Strong | Strong | Strong | Strong |
| Weighted average of yields on A and BBB rated debt based on industry portfolio | Strong | Weak | Satisfactory | Strong | Strong | Satisfactory | Strong |

7.52 Both Bloomberg and iBoxx consolidate the bond ratings within each rating category i.e. the A rated index would include A- and A+ rated bonds. A simple average of the yields on an A rated and a BBB rated index of similar tenor would be a good way to proceed as this would proxy for the yield of bonds with a rating BBB+ or A-, which is comfortably within investment grade.

**Weighting of historic data**

7.53 Another avenue to explore is whether the trailing average is weighted according to level of additions to the RAV in each year. By weighting by actual debt raised in each year the index will more closely reflect the cost of fixed rate debt of companies.

7.54 There are two issues: weighting between current market data and historic data, and weighting the different years of historic data. In theory, the weighting on current market data needs to reflect not only the proportion of total debt which will be issued this year, but also the proportion of total debt issued in the past which is variable rather than fixed rate.

7.55 The majority of bonds issued by the regulated companies have a fixed coupon i.e. not linked to market interest rates, although the coupon is often linked to RPI inflation (see Table 7.2).

7.56 Table 7.7 and Table 7.8 present the changes to the RAV in the years for which data is available.

**Table 7.7: Changes to the RAB for Gas Distribution, £ millions, 2005-06 prices**

| | 2001-02 | 2002-3 | 2003-4 | 2004-5 | 2005-6 | 2006-7 |
|---|---|---|---|---|---|---|
| National Grid Gas Closing RAV | 5640.4 | 5699.0 | 5705.8 | 5704.9 | 5769.8 | 5857.6 |
| National Grid Gas Change during year | | 58.6 | 6.8 | -0.9 | 64.9 | 87.8 |
| Northern Gas Networks Closing RAV | 1226.7 | 1255.4 | 1269.7 | 1276.7 | 1292.5 | 1313.9 |
| Northern Gas Networks Change during year | | 28.7 | 14.3 | 7.0 | 15.8 | 21.4 |
| Scotland Closing RAV | 766.0 | 789.9 | 802.7 | 835.2 | 884.2 | 915.1 |
| Scotland Change during year | | 23.9 | 12.8 | 32.5 | 49 | 30.9 |
| Southern Closing RAV | 2046.6 | 2068.3 | 2087.3 | 2097.3 | 2110.0 | 2169.3 |
| Southern Change during year | | 21.7 | 19 | 10 | 12.7 | 59.3 |
| Total Scotia Gas Closing RAV | 2812.6 | 2858.2 | 2890.0 | 2932.5 | 2994.2 | 3084.4 |
| Total Scotia Gas Change during the year | | 45.6 | 31.8 | 42.5 | 61.7 | 90.2 |
| Wales & West Utilities Closing RAV | 1047.0 | 1096.4 | 1130.2 | 1144.1 | 1178.1 | 1209.8 |
| Wales & West Utilities change during the year | | 49.4 | 33.8 | 13.9 | 34 | 31.7 |
| **Total added during period all companies** | | **182.3** | **86.7** | **62.5** | **176.4** | **231.1** |
| **Proportion of total additions during a given year** | | **25%** | **12%** | **8%** | **24%** | **31%** |

*Source: Ofgem*

**Table 7.8: Changes to the RAB for Transmission, £ millions, 2005-06 prices**

| | | 1999-0 | 2000-1 | 2001-2 | 2002-3 | 2003-4 | 2004-5 | 2005-6 | 2006-7 |
|---|---|---|---|---|---|---|---|---|---|
| National Grid Electricity Transmission | Closing RAV | 5113.0 | 5031.0 | 5066.0 | 5066.0 | 5042.0 | 5064.0 | 5305.0 | 5416.0 |
| | Change during year | | -82.0 | 35.0 | 0.0 | -24.0 | 22.0 | 241.0 | 111.0 |
| Scottish Hydro Electricity Transmission | Closing RAV | 253.5 | 250.0 | 243.7 | 238.3 | 233.3 | 233.7 | 276.2 | 288.3 |
| | Change during year | | -3.5 | -6.3 | -5.4 | -5 | 0.4 | 42.5 | 12.1 |
| Scottish Power Transmission | Closing RAV | 654.0 | 629.0 | 594.0 | 580.0 | 575.0 | 555.0 | 716.0 | 764.0 |
| | Change during year | | -25.0 | -35.0 | -14.0 | -5.0 | -20.0 | 161.0 | 48.0 |
| National Grid Gas (Transmission) | Closing RAV | | | 2328.0 | 2380.0 | 2424.0 | 2424.0 | 2591.0 | 2981.0 |
| | Change during year | | | | 52.0 | 44.0 | 0.0 | 167.0 | 390.0 |
| **Total added during period** | | | | | **32.6** | **10.0** | **2.4** | **611.5** | **561.1** |
| **Proportion of total additions during a given year** | | | | | **2.7%** | **0.8%** | **0.2%** | **50.2%** | **46.1%** |

*Source: Ofgem*

7.57 When weighting the various historic years, RAV obviously can act as a proxy for debt raised at that time. However, there are some curlicues which need to be discussed here, such as:

(a) Pre-financing – companies would typically raise capital in advance of spending it and hence in advance of it being added to the RAB. Pre-funding is likely to happen 12 months in advance.

(b) Inflation – The RAV can be considered in cash terms or in same year's prices. If companies are issuing mostly nominal debt, there would be an argument for using cash figures, although real figures would be more consistent with use of a real cost of capital.

(c) Data constraint – Ofgem does not have currently calculated actual RAV figures for 2007/8 and 2008/9. Combined with changes in the structure of the industry a few years ago, this imposes a severe data constraint on this method.

7.58 The key options Ofgem may wish to consider are:

(a) Approach 1: Calculate the index based on an assumed split of debt between fixed and variable rate debt e.g. 80 per cent fixed, 20 per cent variable. The cost of debt for the percentage assumed to be variable should be based on current market data. The cost of debt for the percentage assumed to be fixed should be based on a weighted average of all years within the chosen trailing window, with the weight based on the RAV addition in each year.

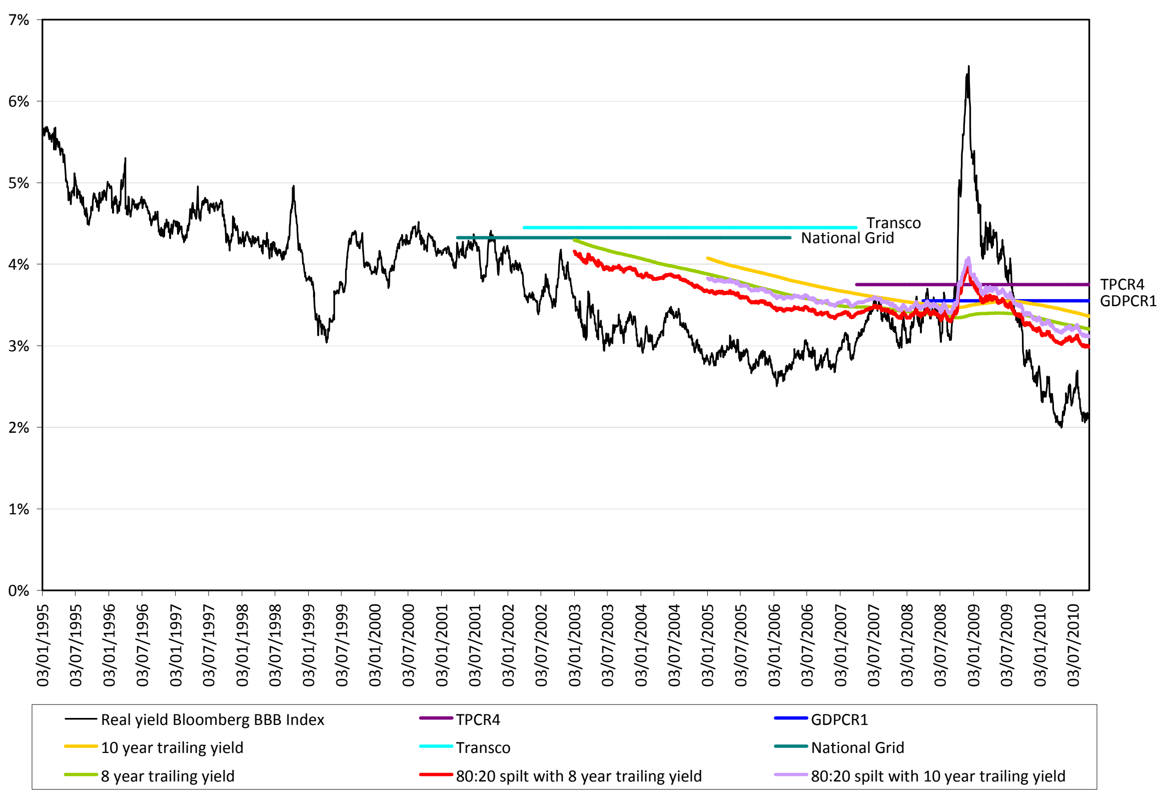
(b) Approach 2: Calculate the index based on an assumed split of debt between fixed and variable rate debt. The cost of debt for the percentage assumed to be variable should be based on current market data. The cost of debt for the percentage assumed to be fixed should be based on a simple average of all years within the chosen trailing window

(c) Approach 3: Take a simple average of all years (effectively ignoring variable rate debt and differences in capital raised in different years)

(d) Approach 4: Take a weighted average of all years, with the weight based on RAV additions in each year (effectively ignoring variable rate debt, but taking account of differences in capital raised in different years).

7.59 For approaches 1 and 2, Ofgem may wish to consider whether the RAV weights should be company specific or aggregated for the industry. The former would reflect each company's specific circumstances but the latter would better preserve incentives to time the CAPEX programme efficiently and be easier to implement.

**Figure 7.10: 5, 8 and 10 year Trailing Average of 10 year BBB Index, Weighted According to 80:20 Split between Fixed and Variable Debt, Approach 2**



*Source: Europe Economics calculations based on data from Bloomberg*

7.60 Table 7.9 assess the above options against our criteria.

**Table 7.9: Assessment of the Options for Weighting against Criteria**

| | Accuracy | Simplicity including data availability | Transparency | Credibility | Fully mechanistic | Cannot be manipulated | Preserves efficiency incentives |
|---|---|---|---|---|---|---|---|
| Approach 1 | Strong | Fails* | Satisfactory | Strong | Weak | Satisfactory | Strong |
| Approach 2 | Satisfactory | Strong | Strong | Strong | Weak | Satisfactory | Strong |
| Approach 3 | Satisfactory | Strong | Strong | Satisfactory | Strong | Strong | Satisfactory |
| Approach 4 | Satisfactory | Fails* | Strong | Strong | Strong | Strong | Strong |

** RAV data not confirmed for 2008-2010*

7.61 In terms of enhanced accuracy, the most complicated calculation, Approach 1, best reflects the cost of debt experienced by the industry. All the RAV weighed approaches have a weakness based on the availability of data since data prior to 2002-2003 are not available for all companies and most recent RAV figures are also not finalised. Without this data, a longer trailing window is not possible.

7.62 Approach 3, the unweighted approach, was considered in earlier discussions and appears satisfactory despite a slightly lower degree of accuracy. Given that the calculations are to be repeated each year, the simplicity and data availability criteria are important.

7.63 Since variable rate debt represents a relatively smaller component of the companies' outstanding bonds, ignoring the variable component, as in Approaches 3 and 4, does not represent a major weakness.

7.64 In conclusion, some weighting to reflect portfolio of actual debt would be desirable on theoretical grounds but this must be traded against the important issue of data availability on RAV changes. To our knowledge the data on RAV would not be available sufficiently ahead of time to take RAV-based weighting and therefore Approaches 2 and 3 are more practical.

## Practical Implementation

### Data sources

7.65 Once the above principles have been determined, the specific data sources that should be used need to be identified and implementation issues addressed.

7.66 Some options for established market indices are outlined in Table 7.10

**Table 7.10: Bond Market Indices**

| | Index | Sector | Currency | Number of bonds | Credit rating | Tenor of bonds | Start year of data* |
|---|---|---|---|---|---|---|---|
| 1 | iBoxx non Financials 7-10 A | Non-financials mixed | Sterling | 24 | A | 7-10 years | 1997 |
| 2 | iBoxx non Financials 7-10 BBB | Non-financials mixed | Sterling | 30 | BBB | 7-10 years | 1995 |
| 3 | iBoxx non Financials 10+ A | Non-financials mixed | Sterling | 71 | A | 10+ years | 1997 |
| 4 | iBoxx non Financials 10+ BBB | Non-financials mixed | Sterling | 38 | BBB | 10+ years | 1997 |
| 5 | iBoxx £ Utilities | Utilities | Sterling | 96 | Mixed | Mixed | 1997 |
| 6 | iBoxx £ Utilities 10+ | Utilities | Sterling | 62 | Mixed | 10+ years | 1997 |
| 7 | Market iBoxx £ Electricity | Electricity | Sterling | 46 | Mixed | Mixed | 1997 |
| 8 | Bloomberg C41110Y Index | Mixed | Sterling | Unclear | A | 10 years | 2003 |
| 9 | Bloomberg C40510Y Index | Mixed | Sterling | Unclear | BBB | 10 years | 1993 |
| 10 | Bloomberg C41115Y Index | Mixed | Sterling | Unclear | A | 15 years | 2003 |
| 11 | Bloomberg C40515Y Index | Mixed | Sterling | Unclear | BBB | 15 years | 1996 |
| 12 | Bloomberg C41120Y Index | Mixed | Sterling | Unclear | A | 20 years | 2003 |
| 13 | Bloomberg C40520Y Index | Mixed | Sterling | Unclear | BBB | 20 years | 1993 |

** We are informed by iBoxx that daily data for their other indices are available from 1997. This should be confirmed with them directly before subscribing.*

7.67 We re-iterate our earlier comment that a wider market index is preferable to a utilities-specific index. Given the debt portfolio of the companies, a minimum tenor of 10 years is advisable. The specification of a single tenor could in principle not fully reflect actual debt portfolios or somewhat distort the financing decision of firms towards a tenor.

7.68 One potential response to this would be to use the 10+ Index, though the bonds profile of this index is unclear and may be subject to change. Our cross-check analysis (shown in Figure 7.4 to Figure 7.6) suggests that averages for 10 and 20 year bonds move in such similar ways that there little gain from this added complexity. Use of a 10 year tenor is simple and clear, and bonds of this tenor constitute a standard benchmark in financial markets — as indeed for example in our own analysis of the risk-free rate above. However, another alternative would be for Ofgem to take an average of yields on say a 10 year and a 20 year index.

7.69 As a further alternative to the available indices, Ofgem could create a bespoke index with a mix of tenor and bond ratings tailored to the industry. This approach would impose further regulatory burden on Ofgem and the choice of bonds would be more open to debate and critique. In addition, obtaining historical yields will present more of a challenge. We have not considered this approach further.

7.70 Finally, it is advisable to use one data source where a number of different indices are to be averaged and to check the exact composition of the portfolio beforehand.

## Conclusions on Indexation Mechanism

7.71 We summarise the main conclusions of the earlier discussion below.

**Overall form of indexation mechanism**

7.72 The index used should reflect the total cost of debt rather than a component such as the risk free rate or debt premium since it more accurately reflects the companies' financing costs.

7.73 A market index non-specific to the bonds of the regulated company should be used to provide incentives for outperformance and avoid a situation whereby companies may have an influence on the index.

7.74 Expected inflation should be accounted for by using implied inflation from the gilt market as published by the Bank of England.

**Key issues in the design of the mechanism**

*Tenor of debt used*

7.75 The choice of tenor for the index should be guided by the actual tenor of the regulated companies' debt. Creating a bespoke index to reflect tenors in the actual bond portfolio of the industry will entail a one-off set up burden as well as periodic adjustments to maintain the index. It makes better sense to use an existing and recognised market index, such as a 10 year, 20 year or 10+ years, which will have a mix of tenors.

7.76 Since 10 year bonds are the standard financial market benchmark, and the key benchmark we ourselves focus upon in our risk-free rate analysis, we propose the use of a 10 year bonds index. That leaves the question of whether the index itself should be used to calculate adjustments to a "baseline" cost of debt calculated at each price control on the basis of a mix of tenors or simply based on the 10 year bond. In our view the former approach is better — i.e. we recommend that a baseline cost of debt be calculated, and then adjusted proportionately to changes in an index based on 10 year bonds.[43]

7.77 Note that the key difference between our recommended approach and an approach in which a bespoke index, reflecting firms' actual mix of tenors, were used is that whilst the use of a bespoke index would imply calculating mixed baskets all the time, our recommended approach only involves calculating full baskets at each price review.

7.78 We emphasise that the above recommendation should be interpreted in the light of RIIO and such that it is compatible with it. That is to say, this recommendation does not involve any process of "headroom" or regulatory judgement. It is simply a mechanism for calculating the index, whereby a baseline value for the index is re-calculated at each price review based on a weighted basket of actual tenors, and the evolution of the index during price control periods is based on changes in the trailing average for 10 year bonds.

*Length of trailing window*

7.79 Given the nature of the debt portfolio, a trailing window below 5 years seems inappropriate. A range between eight and ten years seems suitable. We would recommend eight years taking into account the length of the price control period and the improvement in data availability with an eight rather than ten year window.

*Credit rating of debt used*

7.80 Either A or BBB would be in line with the investment grade rating required by Ofgem in previous price controls. As an alternative, Ofgem can take an average of the yields on an A and BBB rated index. We support this approach with the warning that it may mean referring to both iBoxx and Bloomberg for data since the Bloomberg Sterling A rated index only begins in 2003 (meaning that calculation of an eight year trailing average only becomes possible from 11 April 2011).

*Weighting of historic data*

7.81 Weighting historic data increases the sophistication of the analysis by better reflecting the years in which debt was issued. The data input requirements rises and this is an issue for RAV for which there tends to be a time lag between the year in which additions to RAV are realised and reported. This fundamental problem means at this stage either a simple trailing average of all years (effectively ignoring variable rate debt) or simple weighting of current and historic debt based on an assumed split between variable and fixed debt is preferred.

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43 So, to repeat our earlier example, if the cost of debt calculated at the start of a price control were 4 per cent whilst the yield on 10-year debt were 3.5 per cent, then during the price control the yield on 10-year debt fell to 3.15 per cent (i.e. fell by a tenth) then the overall cost of debt would fall to 3.6 per cent (i.e. fall by a tenth from 4 per cent).

## Implementation issues

*Data sources*

7.82 The data sources picked for the calculations will have different details and costs. Once the principles above are decided, Ofgem can explore the data sources, as presented here, further.

*Timing issues*

7.83 Subject to time constraints, Ofgem will need to think about what data would be available at the time when the calculation needs to be done each year and whether this data would be sufficient.

## Sensitivity analysis

7.84 We have conducted sensitivity analysis on the types of figures one gets for the real cost of debt using different indices in Table 7.11. The range we have obtained is 2.75 to 3.36.

**Table 7.11: Sensitivity Analysis on Key Parameters and Implied Cost of Debt**

| Index | 10 year trailing average 30/09/2010 | 8 year trailing average 30/09/2010 |
|---|---|---|
| Bloomberg £ 10 year BBB | 3.36 | 3.20 |
| iBoxx £ 7-10 year A | 3.23 | 3.05 |
| Average of £ A and BBB 7-10 years | 3.30 | 3.13 |
| Bloomberg £ 10 year A | Insufficient historic data | Insufficient historic data |
| Average Bloomberg £ 10 year A and BBB | Insufficient historic data | Insufficient historic data |
| iBoxx £ 10+ year A | Insufficient historic data | Insufficient historic data |
| Bloomberg £ 20 year BBB | 3.36 | 3.20 |
| Bloomberg £ 10 year BBB with 80:20 split fixed: variable | 3.11 | 2.99 |
| iBoxx £ 7-10 year A with 80:20 split fixed: variable | 2.89 | 2.75 |

*Source: Europe Economics calculations based on data from Bloomberg and iBoxx. Note eight year calculation for Bloomberg £ 10 year A Index will be possible from April 2011. Note that since the 10 year trailing average for 10 year bonds is the same as that for 20 year bonds, then if a weighted index of tenors were constructed from 10 year and 20 year bonds, the results in this table would unaffected by whether one uses the index to adjust a baseline or to construct a figure.*

# 8 CASH FLOW DURATION

8.1 In this section we address the issue of whether the time profile of cash flows affects the cost of capital. The assumption underlying the debate is that the cash flows vary only in ways that, for a given cost of capital, are NPV-neutral. This concept can be illustrated with an extreme stylised example. Consider two cash flow profiles.

(a) Year 1: £0; Year 2: £100; Year 3: £100

(b) Year 1: £0; Year 2: £195.24; Year 3: £0

8.2 Suppose that the cost of capital is 5 per cent. Then each of cash flow profiles (a) and (b) has a Year 0 net present value (NPV) of £177.09. For example, the NPV of profile (a) is

(a) $NPV = £0 / 1.05 + £100 / 1.05^{2} + £100 / 1.05^{3} = £177.09$

8.3 According to standard corporate finance theory, investment decisions depend upon the net present value. Specifically, investment will occur if the net present value of a project is higher than that of the next best available alternative (including the option of not investing at all). So in that sense the time profile of cash flows is irrelevant.

8.4 If the time profile of cash flows *is* to be relevant, therefore, then that must either be because standard corporate finance theory is wrong, or because changes to the time profile change the cost of capital. In its key submissions on this issue, Oxera has argued both these points.[44] CEPA, advising Ofgem, has responded.[45]

## Oxera and CEPA debate on the effect of the duration of cash flows on the cost of capital

8.5 Oxera argues that increasing the duration of cash flows increases the cost of capital. Oxera argues that such an increase affects the cost of capital operates along three channels: i) a 'term premium' effect, as the net present value of a longer stream of cash flows is more sensitive to interest rates due to compounding; ii) a beta effect, as a longer stream of cash flows may, in theory, increase the sensitivity of the asset to the market price of risk; and iii) a time-inconsistency effect, as regulators' inability to bind their successors or give commitments to future cash flows increases uncertainty about the future, especially at the far end of the cash flow stream.[46]

8.6 Oxera contends that, for an increase in cash flow duration, the 'term premium' effect means it is appropriate to use a higher risk free rate in the estimation of the cost of equity. To maintain consistency, an increase in the term premium on the risk-free rate should be

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[44] Oxera (2010) 'What is the impact of financeability on the cost of capital and gearing capacity?'
[45] CEPA (2010) 'Cashflow profiles and the allowed WACC'
[46] Oxera (2010) 'What is the impact of financeability on the cost of capital and gearing capacity?' p13

matched by an equal decrease in the market risk premium. Since, under CAPM, the cost of equity is equal to the risk-free rate plus the equity risk premium multiplied by the beta, the cost of equity also increases for companies whose beta is less than one, which is likely to be the case for utilities.[47]

8.7 CEPA counters that the term premium effect is already taken into account by regulators when setting allowed WACC. In terms of the cost of debt, this is done by basing estimates of the risk-free rate on yields for debt at the longer end of the yield curve. In terms of equity, this is implicitly controlled for by the cost of equity remaining largely invariant throughout the lifetime of the asset.[48]

8.8 Moreover, CEPA argues that the effect of a change in cash flow duration depends on the relevant section of the yield curve. In particular, at the longer end, yield curves for risk-free rates are relatively flat, so the impact of a cash flow change would be small in any case.[49]

8.9 Oxera points to a paper by Brennan and Xia (2006) that illustrates the possibility that, in theory, increasing cash flow duration can increase an asset's beta.[50] The paper presents an intertemporal capital asset pricing model and specifies conditions that are sufficient for an asset's beta to be an increasing, but nonlinear, function of time to cash-flow maturity, provided that cash flow carries a positive risk premium.[51]

8.10 CEPA points out that utility company returns are among the less sensitive to the market, though they acknowledge that it is unclear whether this sensitivity is low enough to ensure that their betas are decreasing in the duration of their cash flows.[52] Their overall conclusion is that that the impact on beta of changes in cash flow for utility companies is unclear.[53]

8.11 Oxera argues, in particular, that time inconsistency may be exacerbated by uncertainty about how the regulator will act in the future, given the current framework; uncertainty about how the regulatory framework may resist political pressures; and uncertainty about how to address events not covered by the current framework.[54]

8.12 CEPA argues that long term deals and explicit, ex ante rules can address regulatory commitment without the need for a WACC uplift.[55]

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47 Oxera (2010) 'What is the impact of financeability on the cost of capital and gearing capacity?' p15
48 CEPA (2010) 'Cashflow profiles and the allowed WACC' p3-4
49 CEPA (2010) 'Cashflow profiles and the allowed WACC' p4
50. Oxera (2010) 'What is the impact of financeability on the cost of capital and gearing capacity?' p15
51 Brennan, M. and Xia, Y. 2006. 'Risk and Valuation under an Intertemporal Capital Asset Pricing Model'. *Journal of Business*, Vol.79 No.1 p11
52 CEPA (2010) 'Cashflow profiles and the allowed WACC' p6
53 CEPA (2010) 'Cashflow profiles and the allowed WACC' p8
54 Oxera (2010) 'What is the impact of financeability on the cost of capital and gearing capacity?' p18
55 CEPA (2010) 'Cashflow profiles and the allowed WACC' p6

8.13 CEPA also gathered market evidence as to whether regulated companies with long cash flows need a premium to attract investment from capital markets. They take the example of Phoenix Natural Gas (PNG), a Northern Irish company, whose spreads on medium term debt attract a premium of around 80 base points compared to debt issued by mainland UK regulated companies. CEPA argues that this most likely reflects the fact that the Northern Irish gas sector is subject to greater demand risk, rather than PNG's longer cash flow.[56]

8.14 At the most general level, CEPA questioned whether the duration of the cash-flow profile is relevant to the regulator-determined allowed WACC. This was because this WACC was predicated, in the first place, on returns earned on the regulatory asset base over the duration of its lifetime.[57]

8.15 In a later note, Oxera responded to some of the issues raised by CEPA. On the time inconsistency problem, Oxera asserted that while mechanisms to reduce uncertainty about a regulator's future actions and about a regulator's resistance to political pressure were possible in theory, neither Ofgem nor CEPA have specified how this would occur in practice.[58]

8.16 On the relevance of the duration of the cash-flow profile, Oxera argued that it was necessary to distinguish between the duration of cash flows in the regulatory period and the duration of cash flows over the lifetime of the assets. In the absence of a time consistency problem, the latter is indeed the relevant benchmark. However, where there is a risk of time inconsistency, the former becomes pertinent.[59]

**Europe Economics comments**

8.17 Europe Economics has been asked to consider whether concrete evidence can be provided of specific instances in which changes to cash profiles have or have not changed the cost of capital. We turn to that in a moment. But first we offer a few brief theoretical remarks.

(a) We do not regard it as appropriate for a regulator to entertain a large departure from corporate finance theory, without having a clear alternative theoretical structure to offer in its place and a clear evidential rationale for preferring that latter theoretical framework. Every economic theory can be criticised; every theory can be characterised as having weaknesses (especially very robust and powerful theories that involve strong claims). It is one thing to offer criticisms of a model; it is quite another to demonstrate that some other model works better. In particular, we would

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56 CEPA (2010) 'Cashflow profiles and the allowed WACC' p2
57 CEPA (2010) 'Cashflow profiles and the allowed WACC' p1-2
58 Oxera (2010) 'Cash-flow profiles and the allowed WACC—a response' p3
59 Oxera (2010) 'Cash-flow profiles and the allowed WACC—a response' p4

caution against making ad hoc adjustments to a modelling framework, departing from standard finance theory, to accommodate alleged "flaws" in the standard theory.

(b) The strongest version of Oxera's critique would appear to us to be an argument that, in fact, the net present value of a bundled project stream such as a company (regarding a company as such a bundle, in the standard corporate finance tradition) is an idealised construction out of multiple projects with multiple costs of capital, potentially involving time profiles. The idea that the cost of capital can be subject to a time profile is a standard one, reflected for example in Stewart Myers "ladder" in which different phases of a project are of fundamentally different natures and risk profiles (e.g. there might be a research phase, in which one suggests many options; a development phase in which one trials a smaller number of options; and a production phase in which one settles upon a few choices).

(c) One of the relevant driver of differential risk across the project life in Oxera's argument is regulatory risk. Oxera's concept is that because regulatory risk might vary through time, the cost of capital at different points in an asset's life might vary. It is important to recognise that, for inclusion in the cost of capital, regulatory risk would need to be correlated with the broader economic cycle — e.g. that regulators became more inclined to impose low returns in economic busts than in booms. Regulatory risk that is uncorrelated with the broader cycle can be diversified away, and though it would still affect the expected value of cash flows (if a regulator were suddenly to impose low returns in order to exploit sunk investments the cash flows from those investments would fall), that would need to be addressed in other parts of the price control — it would not affect the cost of capital. To argue that regulatory risk changes through asset lifetime, one would need to show that the correlation of regulatory risk with the broader economic cycle would change over the asset's life. For example, in order to argue that costs of capital in later periods would be expected to be higher than in earlier periods, and hence that average lifetime discounting rates would be higher for longer-lived assets, one would need to provide a compelling rationale for why the correlation of regulatory risk with the broader economic cycle should *increase*. We are unconvinced that Oxera offers any compelling basis for believing that this is indeed so.

(d) Of course, if the effect of diversifiable regulatory risk upon expected cash flows is not accounted for elsewhere in the price control, one second-best "correction" mechanism would be to offer a higher WACC, above the expected WACC of corporate finance theory, such that once diversifiable regulatory risk is taken into account, the regulatory determined WACC, adjusted for diversifiable regulatory risk, equals the expected WACC. We recommend against this approach, but if it were adopted, then in principle changes in the time profile of diversifiable regulatory risk could affect the adjustment between "determined" and "expected" WACC. But even in this case we are unclear on what basis changes to the time profile of cash flows would be systemically expected to increase or decrease that wedge[60] — it is one thing to accept that, in principle, such a wedge could change, but another to believe there is a systematic direction for such change.

## Empirical Methodological Issues

8.18 The above observations made, we now move to consider whether we can identify concrete evidence of changes to cash-flow profiles changing the cost of capital. As will now be seen, at this stage we find no such evidence. However, interpretation of these results is not straightforward.

8.19 The approach we take is to analyse betas at or about the time of announcements or implementation of measures that affect time profiles of cash flows. At a stylised level, we would hope to observe a measure announced and then, if Oxera were correct, if the measure extended cash flow durations the observed beta should rise and if the measure reduced cash flow durations the observed beta would fall. However:

(a) other changes could well affect betas of at least some companies in the relevant periods;

(b) company values could be affected as well as betas (it is not obvious that all the measures we consider are actually NPV-neutral);

(c) it is unclear how *large* an effect one would expect to observe — in particular, different firms could be affected to different degrees, possibly resulting in its being much more apparent that there are changes for some firms than others, which would be easily interpreted as implying that there were special factors for that firm unrelated to the measure being tested;

(d) causality can be tricky — for example, if Oxera's argument implies a fall but we observe a rise when a measure is announced, does that mean that Oxera was wrong, or does it mean that the market had anticipated the announcement but priced in a downwards effect *larger* than that actually announced and hence reacted to the announcement by increasing the beta?

## Oil Industry Capital Allowances

8.20 The oil industry has experienced a number of sector-specific changes to its capital allowances. Since depreciation is tax-deductible, increasing capital allowances changes the profile of taxes over time, so that when depreciation is higher in early years, less tax is

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60 Is the thought, perhaps, that with a longer asset life there would be longer for regulators to opportunistically sequester sunk assets?

paid than in later years when depreciation is lower. A decrease in capital allowances has the opposite effect.

8.21 Nine oil companies are examined: BP, Shell, Centrica, Serica Energy, Dana Petroleum, Tullow Oil, Faroe Petroleum, Valiant Petroleum and Premier Oil. All of the companies are involved in exploration – the subject of most of the changes in capital allowances – and all but one, Faroe Petroleum, is involved in production. BP, Shell and Centrica also have interests in other areas of energy production.

8.22 Four changes to capital allowances are considered. Three involved the creation of new capital allowances: the introduction of Mineral Extraction Allowance in 2002; the introduction of Exploration Expenditure Allowance in 2004; and the introduction of Ring Fence Expenditure Supplement in 2006. One, in 2009, involved a decrease in the time period in which tax relief for decommissioning costs could be reclaimed.

8.23 The first three of these measures decrease tax liabilities in the short term and increases them in the longer term. Thus it decreases the duration of cash flows (i.e. the proportion of total cash is greater at the start and less later than would be the case without the measure). The last forces cash benefits from tax relief to be taken earlier or not at all, and thus again means that a greater proportion of cash comes earlier and a lesser proportion later, than in the absence of the measure.

8.24 Thus if Oxera's argument were correct and applicable to the oil industry (noting that regulatory risk might differ in nature as well as degree in respect of oil), this decreased duration of cash flows should mean that the cost of capital falls.

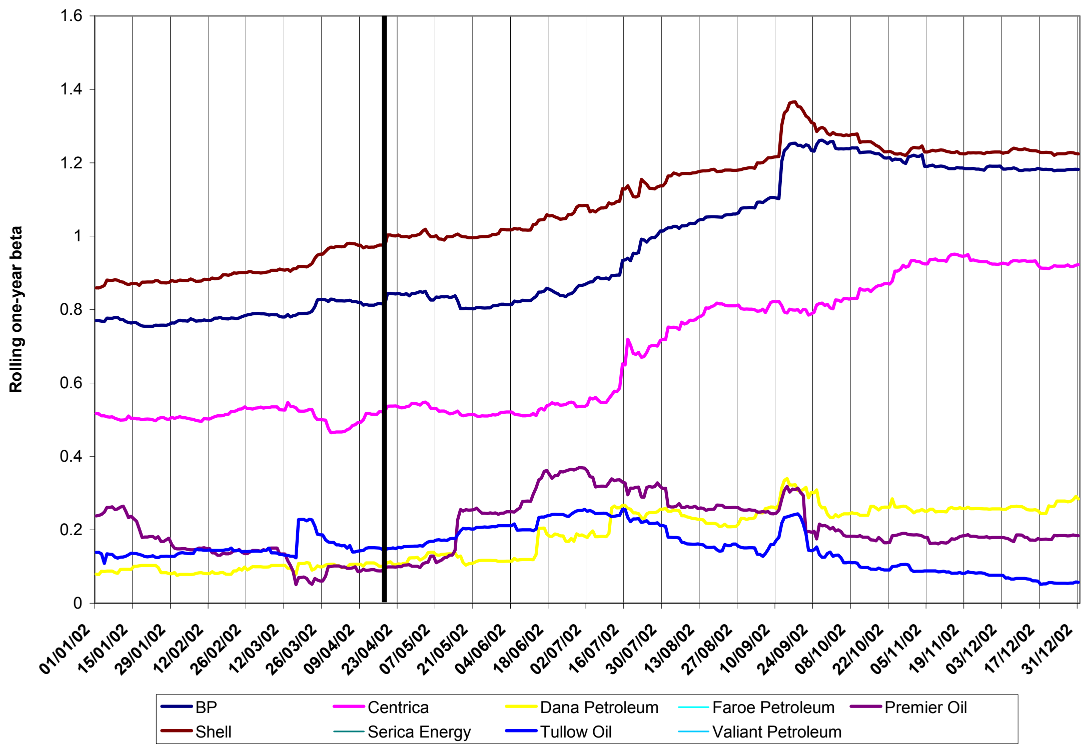
**Mineral Extraction Allowance (2002)**

8.25 The Mineral Extraction Allowance created one hundred per cent first-year allowances for expenditure on mineral exploration and access, excluding expenditure on mineral assets and assets representing expenditure of a connected person. It was introduced from 17 April 2002 in the Finance Act 2002. The measures in the 2002 Finance Act were announced in the Budget on 24th April 2002.[61]

8.26 One-year rolling equity betas for the oil companies for 2002 are shown below. The thick black line represents the date on which the new allowance was announced.

[61] HMRC Website.

**Figure 8.1: Oil Company Equity Betas, 2002**




*Source: Europe Economics calculations based on Bloomberg data*

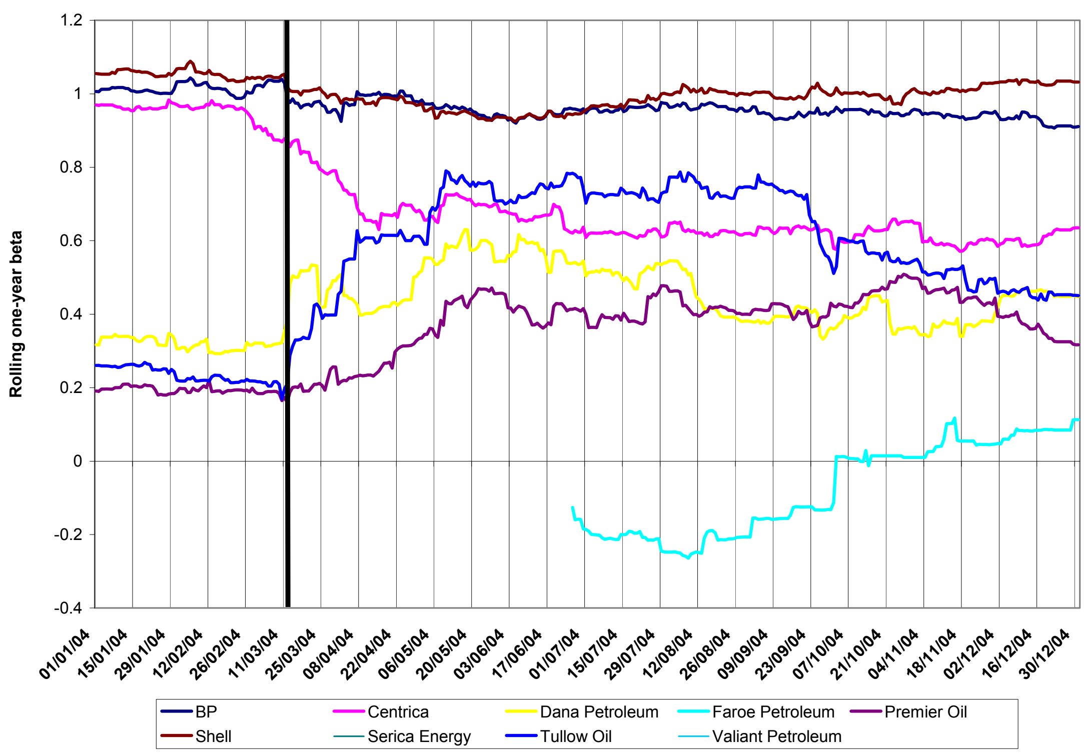
8.27 If the lowering of the duration of cash flows due to the change in capital allowances was associated with a decrease in betas — the flip-side of Oxera's argument with respect to the lengthening of cash flows — we would expect to see a betas fall for the oil companies around the date of the announcement. There is, instead, a small upwards shift for four of the six firms at about the date of the announcement. No downwards trend or jump is visible, however, with the betas relatively flat for most firms in the months following the announcement, the exception being Premier Oil, the beta of which increases following the announcement.

### Exploration Expenditure Allowance (2004)

8.28 Exploration Expenditure Supplement (EES) was introduced in the Finance Act 2004 and covers the period from 1st January 2004 to 31st December 2005. EES could be claimed by qualifying companies which incurred qualifying exploration and appraisal expenditure on or after 1 January 2004. EES increased the value of unused R&D allowances on qualifying exploration and appraisal expenditure carried forward from one period to another by a compound 6 per cent a year. The supplement was also available on unused EES carried forwards. The measures in the Finance Act 2004 were announced in the Budget on 17th March 2004.[62]

8.29 One-year equity rolling betas for the oil companies for 2004 are shown below. The thick black line again represents the date on which the new allowance was announced.

**Figure 8.2: Oil Company Equity Betas, 2004**




*Source: Europe Economics calculations based on Bloomberg data*

8.30 The betas of Dana Petroleum, Tullow Oil and Premier Oil increase at or around the time of the announcement, while the betas for Shell and BP remain relatively constant. The betas for Centrica do fall, as the cash flow argument suggests, but this seems to be a continuation of an earlier trend.

## Ring Fence Expenditure Supplement (2006)

8.31 The Finance Act 2006 introduced a new Ring Fence Expenditure Supplement (RFES) for accounting periods beginning on or after 1st January 2006, in order to extend and replace

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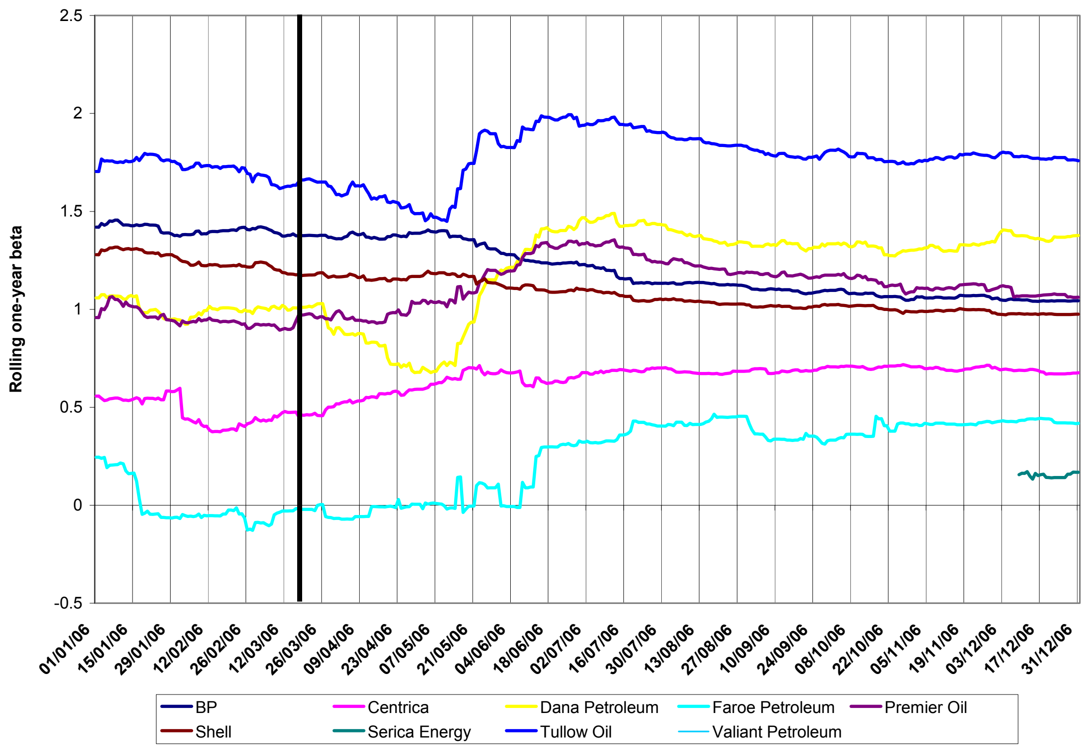
62 HMRC Website.

EES. RFES adds a six per cent annual supplement to the value of unused expenditure carried forward from one period to another, to maintain the time value of exploration, appraisal and development costs. RFES applies to any expenditure relating to oil extraction, whereas EES was restricted to expenditure on exploration and appraisal. The measures in the Finance Act 2006 were announced in the Budget on 22nd March 2006.[63]

8.32 One-year rolling equity betas for the oil companies for 2006 are shown below. The thick black line again represents the date on which the new allowance was announced.

**Figure 8.3: Oil Company Equity Betas, 2006**




*Source: Europe Economics calculations based on Bloomberg data*

8.33 There is again a lack of a common trend. The betas of Shell, BP and Centrica continue to have a relatively flat profile. Those of Tullow Oil and Dana Petroleum continue to move downward, before increasing sharply in June. Faroe Petroleum's betas are erratic, but have also increased by July 2006, while Premier Oil's betas move gradually upward from the date of the announcement.

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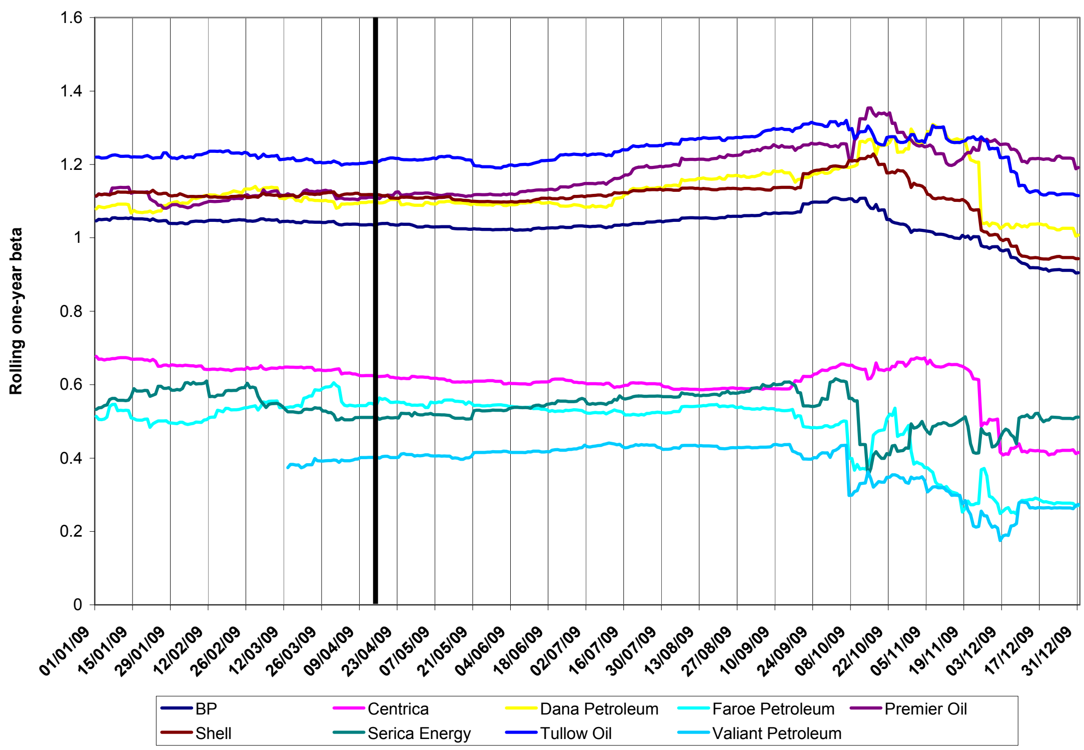
63 HMRC Website.

**Change to capital allowances for oil decommissioning expenditure (2009)**

8.34 Capital Allowances for oil decommissioning expenditure changed on 22nd April 2009. Tax relief for decommissioning costs could only be claimed for the accounting period in which the work was carried out. The change affected decommissioning costs incurred on or after 22 April 2009. The 2009 budget was announced Wednesday 22nd April 2009.

8.35 One-year rolling equity betas for the oil companies for 2004-2009 are shown below. The thick black line represents the date on which the change to allowances was announced.

**Figure 8.4: Oil Company Equity Betas, 2009**




*Source: Europe Economics calculations based on Bloomberg data*

8.36 The company betas are extremely stable across most of 2009, whereas if the cash flow argument were correct we would expect betas to change following the announcement of the measure. A common change to the trends in betas does occur, but this is not until October, when the betas of most companies move down.

8.37 Taken together, there is little evidence that changes to cash flow duration in the oil industry affected companies' betas. It should be borne in mind, however, that there may be some endogeneity issues at play, for example if changes in capital allowances were introduced in anticipation of shocks that would have lengthened cash flow durations in the first place.

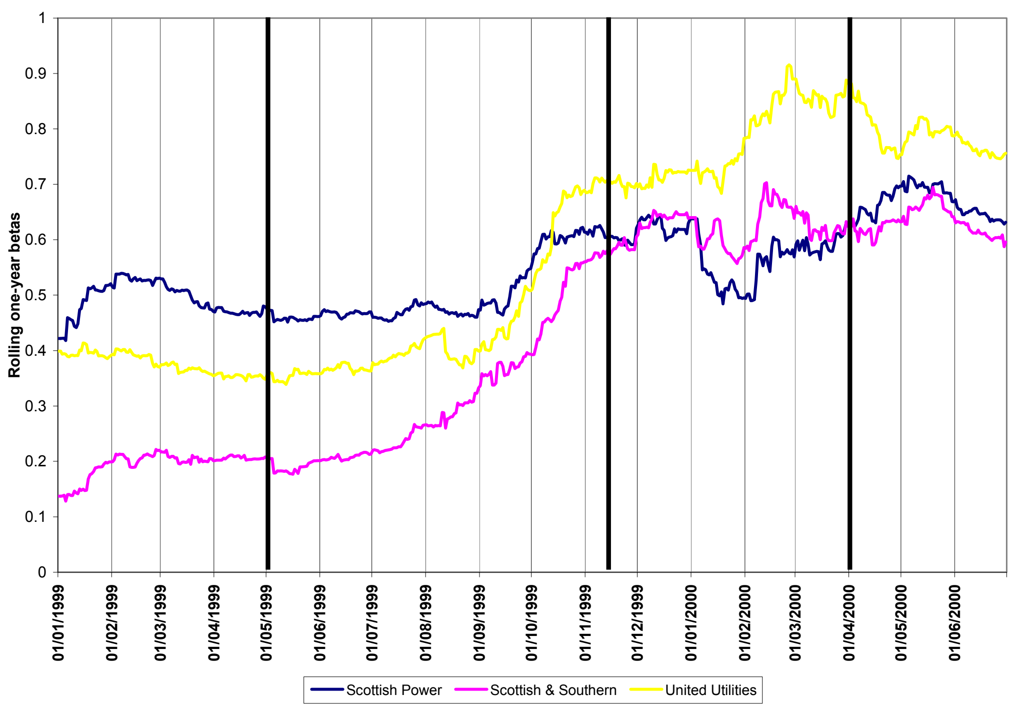
## Electricity Distribution Accelerated Depreciation

8.38 To further examine the impact of cash flows, the introduction of accelerated depreciation for electricity distribution companies is examined. This was introduced in the third distribution price control review (DPCR3). The idea of accelerated depreciation was first noted in the DPCR3 initial consultation document in May 1999, and Ofgem committed itself to the final proposals for DPCR3 in December 1999. Changes in the distribution companies' licenses took place from 1st April 2000.

8.39 Accelerated depreciation allows the amount of depreciation of an asset taken to be higher in the earlier years of that asset's life than in the later years. The firm's cash flow profile is thus shortened as revenues are brought forwards.

8.40 One-year rolling equity betas were calculated for these firms involved in electricity distribution for which data was available: United Utilities, Scottish Power and Scottish & Southern Energy. These are shown below for the period from January 1999 to June 2000. From left to right, the black lines represent: the raising of the possibility of accelerated depreciation in May 1999; Ofgem's commitment to accelerated depreciation in December 1999; and the introduction of new licenses from 1st April 2000.

**Figure 8.5: Electricity Distribution Company Equity Betas, 01/1999-06/2000**




*Source: Europe Economics calculations based on Bloomberg data*

8.41 During May 1999 when the possibility of accelerated depreciation was first raised, the companies' betas are relatively stable, and all ended the month at levels that are very close to the levels at which they began the month. All three companies' betas experience a slight fall towards the beginning of May 1999, though the magnitudes of these falls are tiny at around 0.02 or less for all of the companies. This was the month that the change in policy was mooted (though not confirmed) and hence in principle it could have been a contributory factor in the fall. During the rest of May, however, the companies' betas begin to rise, though the magnitude of these increases is, again, very small.

8.42 During December, when Ofgem committed itself to the policy of accelerated depreciation, the companies' betas are comparatively volatile. However, all of the companies end the month with betas that are at least as high as when they started the month. United Utilities' and Scottish Power's betas do experience falls over that month, but these are not clearly distinguishable from the usual fluctuations that one would expect, month to month, in companies' equity betas.

8.43 From April 2000, when the new licenses came into force, United Utilities did experience a material fall in its beta, but Scottish Power's and Scottish & Southern's betas rise within the same period. Given that the accelerated depreciation was also introduced for these companies, this does not provide a clear basis for concluding that the same factor is driving the fall in United Utilities' betas as is driving the increase in those of Scottish Power and Scottish & Southern.

8.44 Overall, examining the introduction of accelerated depreciation for electricity distribution companies has presented little evidence that shortening cash flow duration results in a reduction in companies' equity betas.

8.45 This statistical study is not in itself decisive, and if there were good theoretical grounds for supposing that betas are, in fact, affected by duration then a more extensive statistical analysis might be warranted. However, since there are, on the contrary, strong theoretical grounds for supposing that cash flow durations have little, if any effects on betas (and that if they do it will not be in any clear systematic direction) we believe that this brief statistical review is sufficient to illustrate that the theoretical case for no effect is not clearly at variance with the statistical evidence.

# 9 TRANSITIONAL ARRANGEMENTS

9.1 This section of the report advises on a mechanism that might be applied to smooth the cash flow impact of the transition away from accelerated depreciation and towards a depreciation charge that is more closely reflective of economic asset lives.

9.2 In its document on implementing sustainable network regulation,[64] Ofgem stated that:

> "… where application of our principles in a single step could cause excessive disruption to capital markets and/or raise concerns about financeability, we would adopt appropriate transition arrangements at price control reviews. The focus would be on ensuring that the principles are applied but over a period of time, which we expect to be no longer than a single control period (eight years). In seeking to identify whether transition arrangements are necessary, the types of factors that we would have regard to include:
>
> - The length of the price control and options for phasing within the control period;
> - The effects of the proposals on allowed revenue
> - The impact on the notional company's ability to raise necessary finance, both debt and equity; and
> - The impact on key cash flow rations, as calculated by credit ratings agencies."

9.3 In the discussion which follows, we first consider the rationale for transitional period and then consider some of the options that are available to Ofgem.

## Rationale for Transitional Arrangements

9.4 A sudden move away from accelerated depreciation towards economic depreciation would lead towards a sudden fall in depreciation allowances and hence in allowed revenues for regulated companies. This would weaken firms' financial ratios and could (in the absence of offsetting actions by firms) lead to a down-rating of the firms' credit ratings.

9.5 However, in its RPI-X@20 conclusions, Ofgem has made clear that financeability problems are for firms to address themselves. In particular it has said that where there are short-term dips in cash flow metrics:

> "the onus would be on the company to resolve the situation, including by injecting equity and/or reducing dividend payments as they see fit."

9.6 Hence, *prima facie* this policy would appear to argue against allowing any transition period, with the onus on firms to engage in new equity formation if this is needed for them to maintain investment grade credit ratings.

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64 Ofgem, "Regulating energy networks for the future: RPI-X@20 Recommendations: Implementing Sustainable Network Reguation", 26 July 2010

9.7 However, there are a number of potential rationales for including a transitional period in this instance, given the potentially large amount of new equity that might be required to address any financeability problems. In particular:

(a) Immediate injections of equity are infeasible – firms would need some minimum period of time to re-organise their financing arrangements.

(b) A transition period of several years would potentially allow firms to increase equity by retaining earnings (e.g. by cutting dividends or implementing a dividend holiday) rather than by new rights issues, which may reduce the transactions costs to firms of altering their capital structure.

(c) A transition period would avoid forcing firms to engage in a new rights issue at a time when equity market conditions may not be ideal. For instance, there is some academic evidence that the Equity Risk Premium is temporarily elevated during and immediately following a recession. By contrast, a longer transition period would allow firms to raise the new equity when they judged market conditions to be most propitious.

(d) A transition period could avoid the increased tax liabilities which might arise in the short term if firms had to significantly reduce their short-term reliance of debt finance. (That said, deferring cash flows would eventually have the opposite effect of potentially allowing a higher level of gearing to be sustained in some future period, with consequent reductions in tax liabilities in that future period.)

(e) A sudden deferral of cash flows could increase perceptions of regulatory risk in the sector, particularly if applied retrospectively to investment which has already taken place. While regulatory risk is a diversifiable risk which does not affect the underlying market cost of capital, it may mean that the regulator has to promise a higher regulatory WACC in order to convince investors that the expected return equals the market cost of capital once the risk of the regulator reneging on its commitments is factored in.

9.8 In addition to the economic rationales set out above, Ofgem may also wish to implement a transition period to smooth cash flows for the purposes of stakeholder management.

## Options for Transitional Arrangements

9.9 In the analysis which follows, we assume that the transitional period cannot be longer than the length of the first price control implemented using RIIO principles, in line with the Ofgem statement quoted earlier in this section.

9.10 There a range of different options that could be used to smooth cash flows, including:

(a) A gradual change in the asset life used to depreciate the RAV, over a number of years;

(b) Applying economic asset lives to new RAV additions from the start of the next price control period, but continuing to apply current depreciation policy to the existing RAV;

(c) Applying economic asset lives to new RAV additions from the start of the next price control period, and making a partial adjustment to the asset life for the existing RAV (i.e. without moving all the way to economic asset lives for the existing RAV);

(d) Applying economic asset lives to all of the RAV from the start of the next price control period, but applying a front-loaded depreciation profile to existing RAV to help offset the cash flow impact;

(e) Applying a one-off NPV-neutral “revenue advancement” at the next price review not specifically linked to depreciation;

(f) Some combination of the above (e.g. applying economic asset lives for new RAV additions from the start of the next price control, but changing asset lives gradually for the existing RAV).

9.11 Within most of these options there would be choices to be made about the precise parameters of the transitional arrangement. For example, if Ofgem were to adopt a gradual change in asset live, then there would be a choice about how many years (between two and eight) this change should be spread over. The asset life that would apply in each year under each different parameter choices is set out in the table below. (The table assumes a move away from an accelerated asset life of 20 years to an economic asset life of 40 years.)

**Table 9.1: Asset life applying in each year of price control, under different options for gradual change in asset life**

| Year of price control | | **Number of years over which adjustment is spread** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** |
| Last year of previous price control | | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| First RIIO price control | Year 1 | 40 | 30 | 27 | 25 | 24 | 23 | 23 | 23 | 22 |
| | Year 2 | 40 | 40 | 33 | 30 | 28 | 27 | 26 | 25 | 24 |
| | Year 3 | 40 | 40 | 40 | 35 | 32 | 30 | 29 | 28 | 27 |
| | Year 4 | 40 | 40 | 40 | 40 | 36 | 33 | 31 | 30 | 29 |
| | Year 5 | 40 | 40 | 40 | 40 | 40 | 37 | 34 | 33 | 31 |
| | Year 6 | 40 | 40 | 40 | 40 | 40 | 40 | 37 | 35 | 33 |
| | Year 7 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 38 | 36 |
| | Year 8 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 38 |
| First year of second RIIO price control | | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |

*Note: numbers have been rounded to the nearest integer*

## Assessment of Options for Transitional Arrangements

9.12 In Figure 31 of its report on implementing sustainable network regulation, Ofgem presents some modelling numbers showing the effect of some of the high level options for smoothing cash flows on allowed revenues. In particular, Ofgem shows results for full implementation in year 1 of the next price control, a gradual move over the length of the price control, application of economic asset lives only to new RAV additions, and full implementation in year 1 but with front-loading of depreciation for the existing RAV.

9.13 In our view, modelling of the effect on allowed revenues is insufficient to explore the effect of the different options on the financeability of energy networks. For instance, if a firm's debt and hence interest payments are rising due to a large CAPEX programme which is partly or wholly debt-financed, then interest coverage ratios and the firm's credit rating may deteriorate over the course of the price control period even if cash flows are smoothed.

9.14 Indeed, in our view the full effect of the different options on financeability can only be assessed within the context of the financial modelling that Ofgem will carry out at the next price control review. Hence, we have based our assessment of the various options on qualitative analysis, as set out below.

9.15 The appropriateness of the different options depends on what the rationale is for applying an adjustment mechanism. The table below considers each of economic rationales presented earlier in turn, and comments on what they imply for the objective and possible design of transitional arrangements.

**Table 9.2: Links between rationale, objective and possible design**

| Economic rationale | Corresponding Objective | Possible Design of Transitional Arrangement |
|---|---|---|
| Firms require time to arrange equity injections | Allow firms time to alter their capital structure (e.g. by carrying out a rights issue) | Provide a warning (e.g. of 2 years?) before implementing the change, although when implemented it can still be done suddenly (since by then firms will have had time to prepare). |
| Transitional period potentially allows equity formation through retained earnings rather than new rights issues, potentially reducing transactions costs | Spread the transition over a period long enough for the required new equity to be formed through retained earnings. | Any mechanism which smoothes cash flows, although a gradual change in asset life over the course of the next price control might fit well with this objective.<br>Whether a particular approach would allow sufficient new equity to be built up through retained earnings can only be assessed by Ofgem's financial modelling at the next price control review. |
| Transitional period allows firms to raise new equity when they deem market conditions are most propitious | Ensure that any requirement for a new rights issue does not arise for several years, thus giving firms a choice as to | Any mechanism which smoothes cash flows so as to delay any requirement for a new rights issue.<br>Whether a particular approach would do this can only be assessed by Ofgem's financial |

| Economic rationale | Corresponding Objective | Possible Design of Transitional Arrangement |
|---|---|---|
| | when to go to the market | modelling at the next price control review. |
| Smoothing cash flows may reduce need to lower gearing in short term, thus avoiding increased tax liabilities | Increase the gearing level which can be sustained in the next few years, compared with immediate implementation | Any mechanism which smoothes cash flows so as to reduce the requirement for lower gearing in the next few years.<br>While any mechanism which smoothes cash flows is likely to contribute towards this objective, the extent to which it reduces the need to lower gearing can only be assessed by Ofgem's financial modelling at the next price control review. |
| Smoothing cash flows may reduce perceptions of regulatory risk | Avoid perceptions that the regulator has reneged on past commitments | Apply the change in asset lives to new RAV additions only, while maintaining the current depreciation policy for existing RAV<br>Other options to smooth cash flows would also reduce perceptions of regulatory risk, but given they would involve changing depreciation policy for the existing RAV they may not fully meet this objective. |

## Conclusion on Transitional Arrangements

9.16 There are a number of different economic rationales for implementing transitional arrangements rather than fully applying economic asset lives from the first year of the next price control. The appropriate design of the transitional arrangements will depend on the weight that Ofgem attaches to each of these rationales.

9.17 If Ofgem is primarily concerned about avoiding perceptions of regulatory risk, then the transitional approach which would appear to meet this objective best would be to apply the change in asset lives to new RAV additions only, while continuing to apply current depreciation policy for the existing RAV. Under this approach, the switch to economic asset lives would not be fully implemented until all of the existing RAV had been depreciated (which would be 20 years after the start of the first RIIO price control, for sectors where the current asset life being used is 20 years).

9.18 On the other hand, if Ofgem is more concerned about avoiding the need for sudden, large equity injections, allowing firms time to increase their equity through retained earnings, and avoiding the need for large reductions in gearing in the short term, then there are a wider range of options that would appear to meet these objectives. One leading option would be to change the asset life gradually over a number of years, with the time period over which the transition is made depending on the outcome of the financial modelling which Ofgem carries out at the next price control review. This is our favoured option at this stage.

# APPENDIX 1: INTERNATIONAL COMPARISONS OF THE RISK-FREE RATE

A1.1 In theory, if European capital markets were perfectly competitive and if there were no other factors creating market segmentation then one would expect there to be a common risk-free rate, as if the risk-free rate differed, there would be an arbitrage opportunity as one could borrow at the lower risk-free rate and lend at the higher, generating an infinite return risk-free.

A1.2 In practice however, this is unlikely to be case as yet. Although considerable effort has been made towards this in Europe, e.g. with the implementation of the Financial Services Action Plan (FSA) and other regulatory programmes, it has yet to become a truly single market in the ways described above.

A1.3 Thus, for reference only, the following sub-section compares yields on UK government with those on French and German government bonds.

**German real government bond yields**

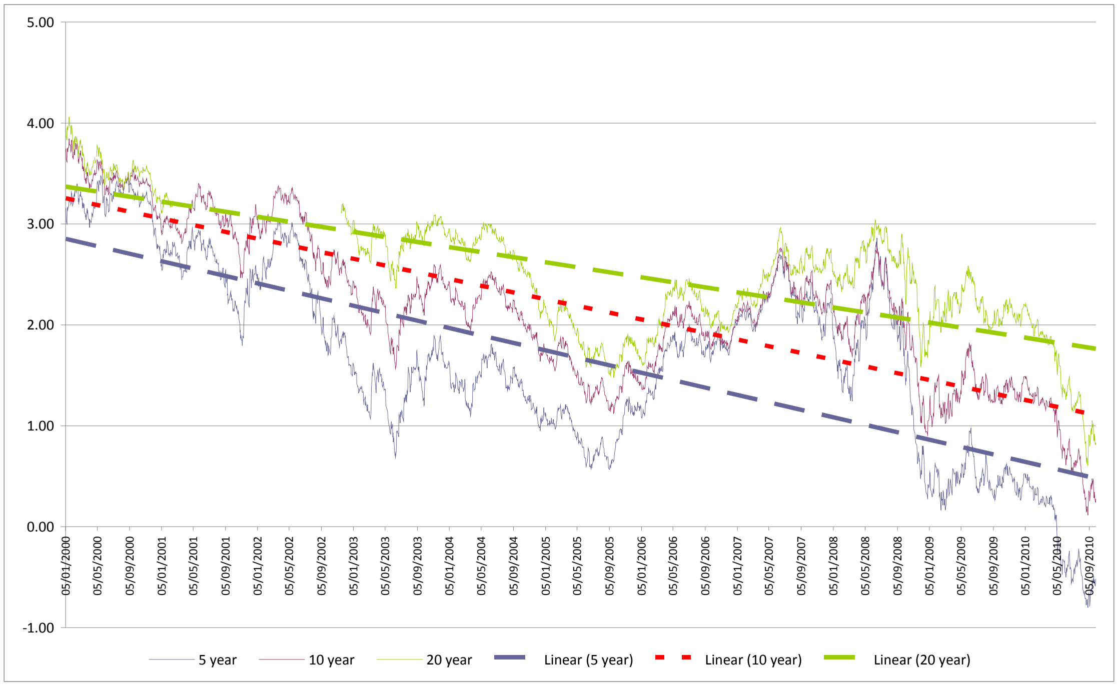
A1.4 As discussed earlier, real yields on government bonds can be examined either by looking at yields on index-linked gilts or by deflating nominal yields by inflation expectations.

*German real government yields – stripping out inflation expectations from nominal bonds*

A1.5 Figure A1.1 shows real yields on 5, 10 and 20 year German bonds which have been obtained by deducting inflation expectations from the nominal yields.[65]

[65] Inflation expectations refer to the average annual inflation rate for the next 5 years which has been sourced from the European Central Bank. As inflation expectations do not extent beyond the next 5 years, the real yields we have calculated for 10 and 20 year bonds have been based on the assumption that the average inflation expected to prevail over the next 5 years is equal to the expected average inflation for the next 10 and 20 years.

**Figure A1.1: Real yields on German government bonds**




*Source: Bloomberg*

A1.6 Table A1.1 summarises real yields on German government bonds for selected time periods.

**Table A1.1: Real yields on German government bonds**

| | 5 years | 10 years | 20 years |
|---|---|---|---|
| ***Latest market data*** | | | |
| Spot rate on September 30th 2010 | -0.52 | 0.28 | 0.83 |
| September 2008 to September 2010 | 0.37 | 1.23 | 1.96 |
| ***Longer run averages*** | | | |
| September 05 to September 10 | 1.25 | 1.71 | 2.18 |
| September 00 to September 10 | 1.42 | 1.97 | 2.32 |

*Source: EE calculations using Bloomberg data*

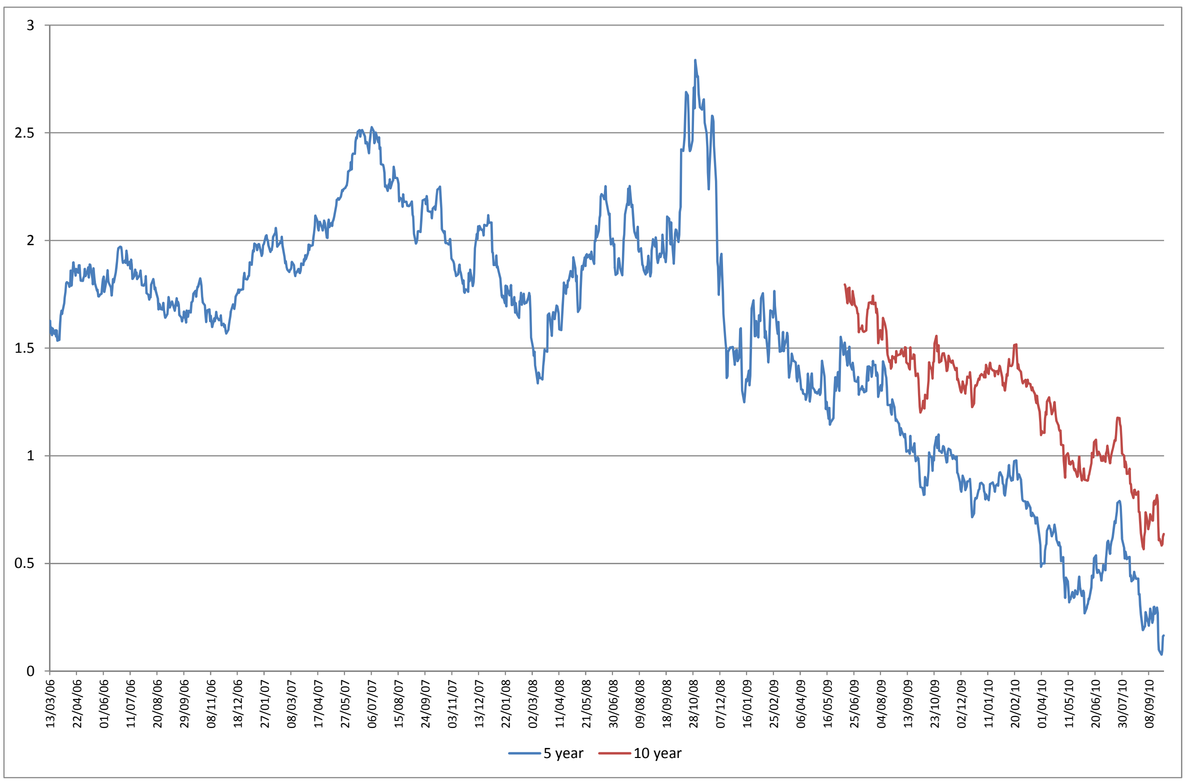
A1.7 As illustrated in Figure A1.1, there has been a declining trend in real yields over the last 10 years. On average, yields on gilts with terms to maturity of 10 and 20 years have tended to move together more closely than those on 5 year gilts. Further, real bond yields have tended to be lower for shorter than for longer-term government bonds over our period of interest.

A1.8 Like yields on UK government bonds, spot rates have come down considerably since the peak of the crisis in financial markets (during which yields become considerably more volatile than the period either before or after), with real yields on 5 year bonds turning negative in May 2010. This does, however, appear to be consistent with the general downward trend in yields that has characterised the period. Further, Table A.1 indicates that, in general real, medium- to long-term average yields on both 5 and 10 year government bonds have been below 2 per cent.

*German real government yields – inflation-linked yields*

A1.9 In addition to looking at real yields by considering nominal yields deflated by inflation expectations, we also consider trends in the yields on inflation-linked Germen government bonds. In contrast to the UK, Germany has only two inflation-linked government bonds (for 5 years and for 10 years). Figure A1.2 tracks the yields on these two bonds since 2006.[66]

**Figure A1.2: German inflation-linked bonds yields**




66 Data for yields on 5 year bonds were not available before March 2006 and for 10 years bonds were not available before June 2009.

*Source: Bloomberg*

A1.10 Yields on 5 and 10 year bonds have appeared to have moved fairly close together (i.e. since the 10 year bond was issued in 2009) and have been on a steep downward trend from October 2008 for 5 year bonds and from issuance in June 2009 for 10 year bonds. In general, however, yields on shorter-term bonds tend to be lower than on the 10 year bond. In contrast to recent and spot yields for UK inflation-linked yields on 5 year bonds (and indeed to our estimates of the real yield on bonds set out in Figure 1.7), inflation-linked yields on 5 year German government bonds have not become negative in recent months.

A1.11 Table A1.2 summarises inflation linked yields for German government bonds across different periods. Again, data in this table suggest that, on average, yields on both 5 and 10 year bonds have remained consistently below 2 per cent.

**Table A1.2: German index-linked government bond yields**

| | **5 years** | **10 years** |
|---|---|---|
| ***Latest market data*** | | |
| Spot rate on September 30th 2010 | 0.17 | 0.64 |
| September 2008 to September 2010 | 1.15 | 1.25 |
| ***Longer run averages*** | | |
| March 06 to September 10 | 1.56 | n.a[1] |
| September 00 to September 10 | n.a[2] | n.a[3] |

*Notes: [1] Data for this period was unavailable to enable a calculation of the average yield,*

*[2] Data for this period was unavailable to enable a calculation of the average yield,*

*[3] Data for this period was unavailable to enable a calculation of the average yield*

*Source: EE calculations using Bank of England data*

## France real government bond yields

*French real government yields – stripping out inflation expectations from nominal bonds*

A1.12 Figure A1.3 illustrates the real yields on 5, 10 and 20 year bonds calculated by subtracting inflation expectations from nominal yields.[67] Yields on bonds of all three maturities moved relatively closely together over the last ten years. During the period between November 2009 and January 2009, movements in yields moved particularly close together, although movements in all three began to diverge from then end of 2008 (with yields on 5 year bonds tuning negative in April 2010).

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[67] Inflation expectations refer to the average annual inflation rate for the next 5 years which has been sourced from the European Central Bank. As inflation expectations do not extent beyond the next 5 years, the real yields we have calculated for 10 and 20 year bonds have been based on the assumption that the average inflation expected to prevail over the next 5 years is equal to the expected average inflation for the next 10 and 20 years.

**Figure A1.3: Real yields on French government bonds**


*Source: Bloomberg*

A1.13 Table A1.3 summarises the real yields on French bonds across different time periods. In general, spot and average yields on 5 year have been consistently below 2 per cent while the yields on 10 year bonds have tended to be higher (i.e. in the region of 1.5-2.5 per cent).

**Table A1.3: Real yields on French government bonds**

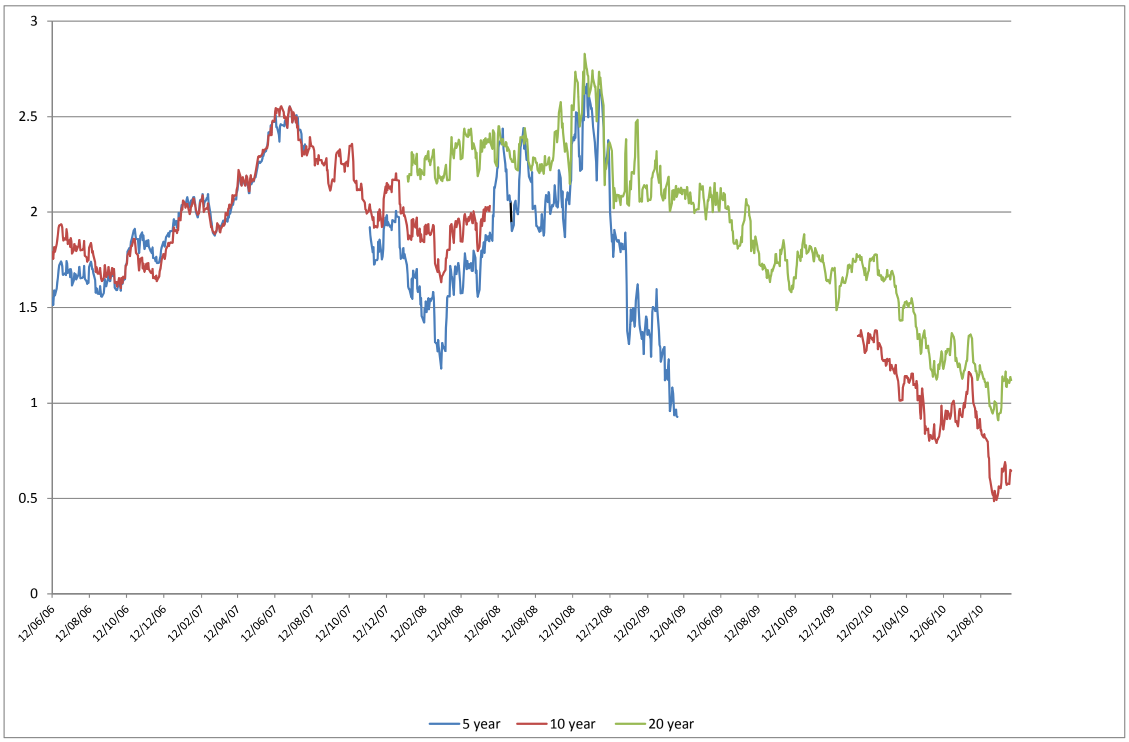
| | 5 years | 10 years | 20 years |
|---|---|---|---|
| ***Latest market data*** | | | |
| Spot rate on September 30th 2010 | -0.26 | 0.66 | 1.16 |
| September 2008 to September 2010 | 0.63 | 1.58 | 2.14 |
| ***Longer run averages*** | | | |
| September 05 to September 10 | 1.38 | 1.89 | 2.25 |
| September 00 to September 10 | 1.64 | 2.22 | 2.60 |

*Source: EE calculations using Bank of England data*

*French real government yields – inflation-linked yields*

A1.14 Figure A1.4 sets out inflation-linked yields on 5, 10 and 20 year French government bonds (given data constraints, the data presented in the figure are not continuous). As shown by the figure, yields on inflation linked bonds have tended to be relatively volatile over the last seven years. However, the data does suggest a downward trend in yields for bonds of all three maturities.

**Figure A1.4: French inflation-linked bond yields**




*Source: Bloomberg*

**Table A1.4: French index-linked government bond yields**

| | 5 years | 10 years | 20 years |
|---|---|---|---|
| ***Latest market data*** | | | |
| Spot rate on September 30th 2010 | 0.93[1] | 0.65 | 1.12 |
| September 2008 to September 2010 | 1.85 | 0.90 | 1.81 |
| ***Longer run averages*** | | | |
| September 05 to September 10 | 1.82 | 1.71 | 1.93 |
| September 00 to September 10 | 1.79 | 1.83 | 1.93 |

*Notes: The most recent spot data available 5 year bonds were on 1st April 2010*

*Source: EE calculations using Bank of England data*

**Summary of trends in German and French government bond yields**

A1.15 Over the last decade, real yields (i.e. nominal yields deflated by inflation expectations) on both French and German government bonds have been following a declining trend path, Further, data available for recent years on yields on 10 year inflation linked bonds for both these countries suggest that the a similar story holds for these bonds as well. Indeed, yields on index-linked bonds have fallen to historic lows over the last 12 months in both Germany and France thus indicating that recent reductions in yields on index-linked government bonds have not been confined to the UK (e.g. spot yields on 5 year inflation linked bonds have also turned negative in recent months). Table A.5 provides a summary of spot rates on nominal and inflation linked yields on German and French government bonds.

**Table A1.5: Summary of real government bond yields**

| Spot rates on 30 September 2010 | % |
|---|---|
| **Germany - Inflation linked yields** | |
| 5 year | 0.17 |
| 10 year | 0.64 |
| **Germany - nominal yields deflated by inflation expectations** | |
| 5 year | -0.52 |
| 10 year | 0.28 |
| 20 year | 0.83 |
| **France - inflation liked yields** | |
| 5 year | 0.93[1] |
| 10 year | 0.65 |
| 20 year | 1.12 |
| **France - nominal yields deflated by inflation expectations** | |
| 5 year | -0.26 |
| 10 year | 0.66 |
| 20 year | 1.16 |

*Notes: [1]The latest available spot data was 1at April 2010*

# APPENDIX 2: EQUITY BETA ESTIMATION – METHODOLOGICAL ISSUES

## Empirical specification

A2.1 The (raw) equity beta measures the covariance between the company return over the safe rate with the market return over the safe rate.[68] The equation to be estimated is usually:

$$R_{it} = \alpha + \beta R_{mt} + e_{it}$$

A2.2 Where $R_{it}$ is the log excess return on asset $i$ at date $t$ (log return net of the logarithmic safe rate), $R_{mt}$ is the log excess return on the market, $\alpha$ is a constant, $\beta$ is the equity beta, $e_{it}$ is an error term — the non-systematic component of the return to the asset — which may display both heteroskedasticity and autocorrelation.

A2.3 The excess return $R_{it}$ is constructed as a data manipulation prior to estimation and is defined as:

$$R_{it} = \ln\left(\frac{P_t + D_t}{P_{t-1}}\right) - \ln(1 + R_{ft})$$

A2.4 where $P_t$ is the price today, $D_t$ is dividend per share that becomes known today, $P_{t-1}$ is the price yesterday, and $R_{ft}$ is the safe rate available today.

A2.5 Since a substantial body of academic and regulatory literature supports that the idea the potential bias from not netting off the risk free rate is negligible in most cases, we have therefore opted for carrying out the estimation without netting off the risk-free rate from individual share and market index returns.[69]

## Choice of the market portfolio

A2.6 With regard to the market portfolio for calculating $R_{mt}$, an index relating to the UK stock market, such as the FTSE All Share, would be an obvious choice. We have therefore adopted this approach which Smithers & Co (2003) endorse to some extent, and which has been recently adopted by the Competition Commission.

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[68] Note that the weaker is this correlation, the greater the contribution that the stock could make to reducing exposure to systematic risk, and therefore the lower the expected return required.

[69] See for example NERA (2008), Patterson (1995) and Roll (1969).

**Definition of energy sector returns**

A2.7 In order to calculate the equity beta for the relevant energy sector we have used an approach which consists of defining the sector's return as a weighted average of the companies' returns, where each company's weight is proportional to the company's market capitalisation. In formal terms, the sector's returns have been calculated as follows:

$$R_{St} = \ln\left(\sum_{i=1}^{N} \alpha_{it}\left(\frac{P_{it} + D_{it}}{P_{it-1}}\right)\right), \ where\ \alpha_{it} = \frac{MktCap_{it}}{\sum_{i=1}^{N} MktCap_{it}}$$

where $MktCap_{it}$ represents the market capitalisation of firm $i$ at date $t$, and $N$ is the number of firms that compose the sector.

A2.8 Since some companies are not listed, the sector returns have been based on market data of listed companies only. We return to this issue below.

**Data frequency**

A2.9 In principle daily data are preferred to weekly, monthly, or yearly data because they allow estimates on larger samples. However, as Smithers & Co (2003) illustrate, a concern with the use of daily data is represented by the possibility of returns being serially correlated, while this risk is likely to be less material in the presence of weekly or monthly data.[70] Nevertheless, Smithers & Co (2003) point out that it is possible to control for autocorrelation by using the Newey-West correction method in order to obtain consisted standard errors. Furthermore, if there are reasons to believe that heteroskedasticity may also be a problem, White's heteroskedasticity corrected error terms can also be computed.

A2.10 We have therefore decided to estimate equity betas on daily data, and we have carried out the estimations controlling for both heteroskedasticity and serial correlation.

**Estimation period**

A2.11 Equity betas vary over time. This might be because of changes in gearing or changes in the underlying correlations between company and aggregate returns (i.e. asset betas). It would be sensible, therefore, to choose an estimation window that is as recent as possible, because today's observation is the forward looking estimate, while still giving reasonably accurate estimates.

[70] If the error terms are auto correlated the estimated standard errors can be misleading.

A2.12 Smithers & Co (2003) investigate the matter, noting that gains in estimation accuracy become less as more observations are added. For example, going from one year to two years of daily data (i.e. 250 observations to 500 observations) will reduce the standard error by 40 per cent, but going from three to four years only reduces the error by 15 per cent.

A2.13 It would be possible to use an explicit time-series estimation technique to account for the time variation. However, these techniques, as noted by Smithers & Co (2003), are susceptible to over-fitting and can find apparent time variation where none exists. The techniques are also non-linear and not widely used for regulatory purposes.

A2.14 We have therefore adopted the Smithers & Co (2003) recommendation of calculating one and two years rolling betas.

**Adjustments to estimated betas**

A2.15 Two main adjustments, the so-called Bayesian and Blume adjustments, have been used in some past estimations of beta, with the effect of bringing the estimated betas closer to one.

A2.16 The argument for Bayesian adjustment is that the estimation of beta ignores the fact that the beta of an average company is by definition equal to one.[71] The Bayesian adjustment takes account of measurement uncertainty (as estimated explicitly in the calculation of the raw beta) by employing a weighted average between the beta estimate for the company and a constructed average beta for the market as a whole that would be equal to one. The weights are based on the relative uncertainty in measurement — the higher the uncertainty in the company beta estimates relative to the variance of all betas in the market, the less weight is placed on the company beta:

$$\beta_{adj} = \beta_{OLS} \times \frac{Var(\beta_{pop})}{Var(\beta_{pop}) + Var(\beta_{est})} + 1 \times \frac{Var(\beta_{est})}{Var(\beta_{pop}) + Var(\beta_{est})}$$

A2.17 The Blume adjustment is based on an empirical observation (made in 1971) that betas tended to move towards one over a (long) time period. Mean reversion is sometimes offered as an explanation for this observed movement. In later investigations, however, Blume found that the reasons for the movement in the betas had to be explained by some real changes in the perceived risks of the companies — the tendency for companies to evolve could mean that companies of extreme risk (high or low) tend to have less extreme risks over time.[72]

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71 Note that this concerns the *average* company. It is straightforward to test whether the estimated beta of an individual stock or portfolio is statistically significantly different from one.

72 Blume, M.E: "Betas and their regression tendencies" Journal of Finance, 1975 and "Betas and their regression tendencies: further evidence", Journal of Finance, 1979

A2.18 Our view is that the use of the Blume adjustment is arbitrary and inappropriate. While a Bayesian adjustment has a stronger theoretical rationale, Smithers & Co (2003) found that in practice it may not make much difference if daily data are used in the estimation.

# APPENDIX 3: COST OF DEBT APPENDIX

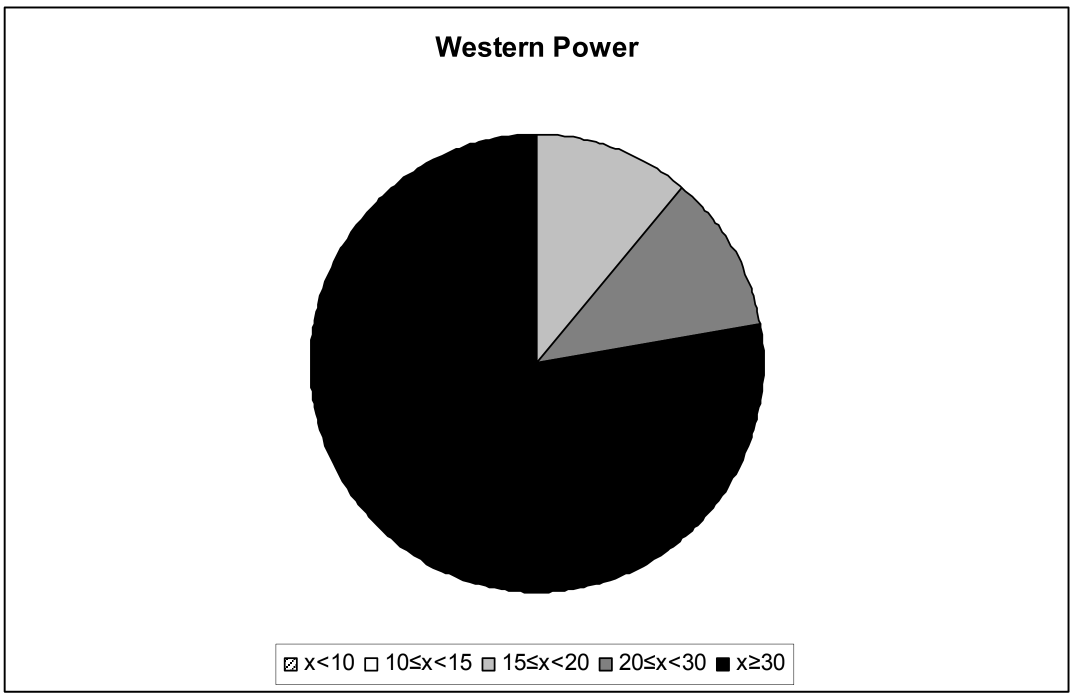
## Bonds Issued by DNOs

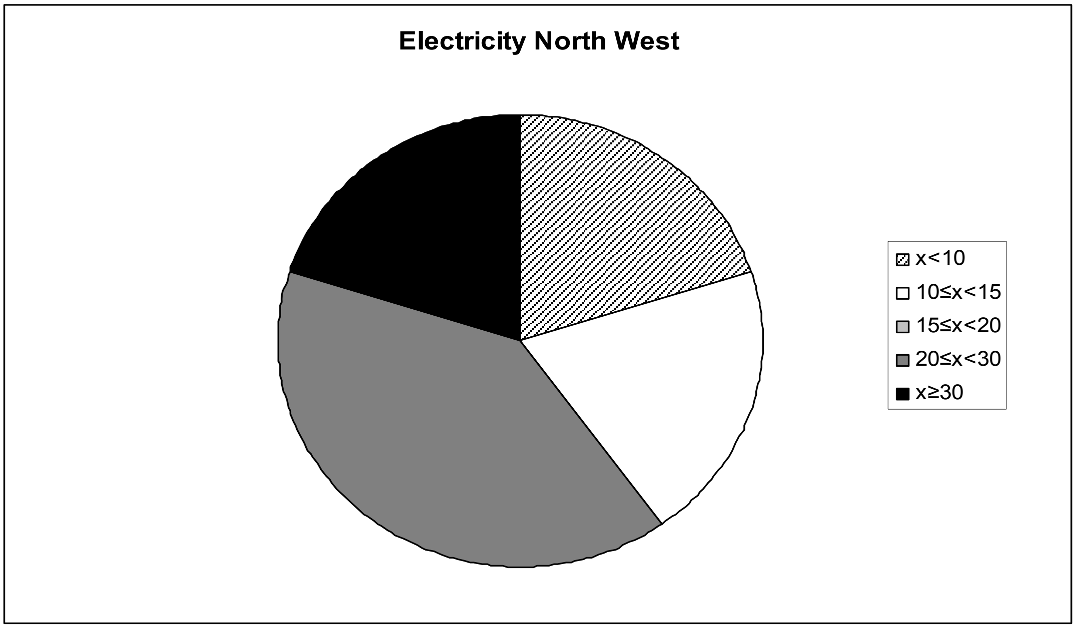
**Table A3.1: Percentage of Fixed Coupon Bonds, DNOs**

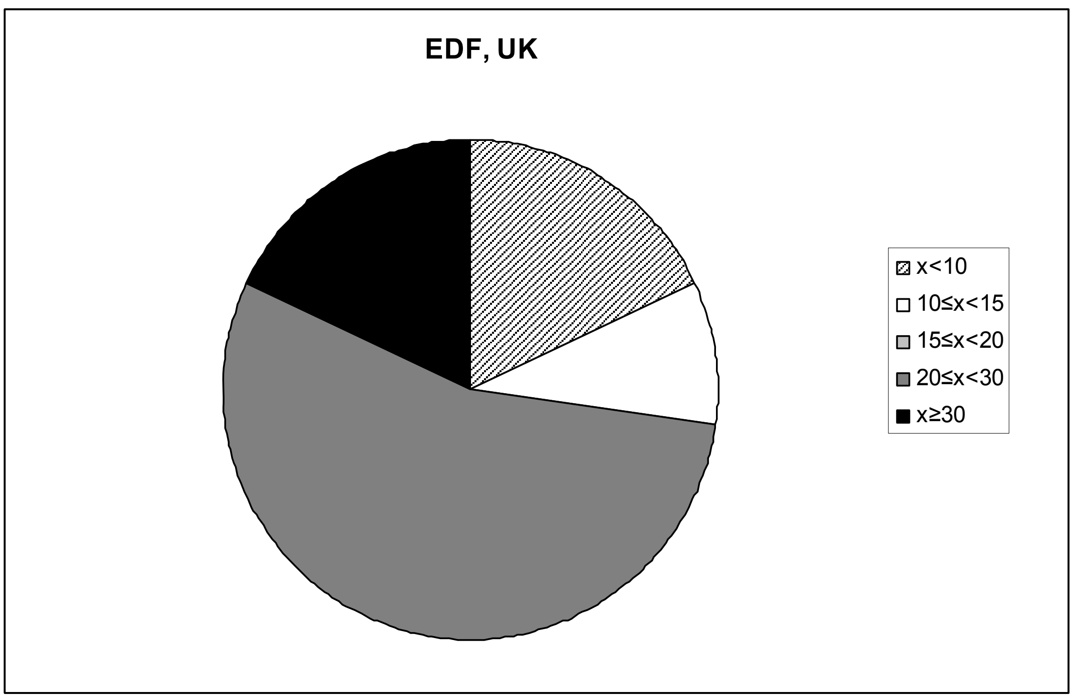
| Company | % of outstanding GBP bonds on Bloomberg which are fixed coupon (including RPI indexed bonds) |
|---|---|
| EDF Energy Networks | 92% |
| Electricity North West | 100% |
| Scottish Power | 88% |
| Scottish & Southern Energy | 77% |
| Western Power Distribution | 100% |

*Source: Bloomberg. Bond data not available for other electricity DNOs.*

**Figure A3.1: Tenor at Time of Issue of Outstanding GBP Bonds of other DNOs**






*Source: Bloomberg*

## Regulatory Precedent on the Cost of Debt

9.19 Table A3.2 sets out some past regulatory decisions in the UK on the cost of debt. In the past this has remained fixed for the duration of the five year price control period.

**Table A3.2: UK Regulatory Precedents on Cost of Debt**

| Regulator | Decision | Period Applicable | Estimated cost of debt (pre-tax) (%) |
|---|---|---|---|
| Ofgem | DPCR5 December 2009 | 1 April 2010 to 31 March 2015 | 3.60 |
| Ofgem | DPCR4 November 2004 | 1 April 2005 to 31 March 2010 | 4.10 |
| Ofgem | DPCR3 1999 | 1 April 2000 to 31 March 2005 | 4.35 |
| Ofgem | GDPCR1 December 2007 | 1 April 2008 to 31 March 2013 | 3.55 |
| Ofgem | TCPR4 December 2006 | 1 April 2007 to 31 March 2012 | 3.75 |
| Ofgem | National Grid 2000 | 1 April 2001 to 31 March 2006 | 4.45 |
| Ofgem | Transco 2001 | 1 April 2002 to 31 March 2007 | 4.65 |
| Ofwat | PR09 November 2009 | April 2010 to March 2015 | 3.6% |
| Ofwat | PR04 December 2004 | April 2005 to March 2010 | 3.30% to 4.40% |
| Competition Commission | Stansted Airport 2009 decision | 1 April 2009 to 31 March 2014 | 3.40% to 3.70% |
| Civil Aviation Authority | Heathrow/ Gatwick March 2008 | 1 April 2008 to 31 March 2013 | 3.55% |
| Office of Rail Regulation | Network Rail October 2008 | 1 April 2009 to 31 March 2014 | 3.25% to 3.50% |
| Ofcom | BT and copper access August 2005 | 1 October 2005 to 30 September 2009 | 5.6% (nominal) |
| Ofcom | BT Openreach and rest of BT, 22 May 2009 | 22 May 2009 to 31 March 2011 | 7.5% (nominal) |

*Source: Regulatory documents*