Europe Economics

PR4 WACC for EirGrid and ESB Network

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Contents

1 Introduction and Context

The current report has been prepared by Europe Economics for the Commission for Energy Regulation (CER) and sets out our views on the cost of capital for the Transmission System Operator (TSO) EirGrid and ESB Networks (ESBN) which serves as both the Transmission Asset Owner (TAO) and Distribution System Operator (DSO) and Distribution Asset Owner (DAO).

The role of the TSO in Ireland is to operate and maintain a safe, secure, reliable, economical and efficient transmission system, as well as to plan and develop key infrastructural projects which are vital for the socio-economic development of the State.[1] As the DSO, ESBN builds, operates and maintains a nationwide distribution system. ESBN also has the role of a TAO which is to "ensure that the Transmission System is developed and maintained in accordance with the requirements set down by EirGrid".[2]

We outline below relevant developments that took place in the years leading up to PR4, we briefly summarise the methodological framework adopted, and we set out the structure of the remainder of the report.

1.1 Background

This section provides an outline of the developments that took place in the years leading up to PR4. We first present a summary of the 2010 determination followed by a description of the Mid-Term WACC review that was conducted in 2013 along with CER's determination at the time.

1.1.1 The 2010 determination

Europe Economics advised the CER on the WACC during the last price review for electricity transmission and distribution networks in Ireland (PR3). Based on market data up to the data cut-off point of February 2010, Europe Economics' suggested a range estimate of the WACC (on a real pre-tax basis) of 3.2-5.6 per cent and a point estimate (without aiming-up) of 4.6 per cent. The recommended regulatory WACC was somewhat higher at 5.0 per cent, and drawn from a range of 4.8-5.2. This uplift was the result of a deliberately "aiming up" to reflect the asymmetry of consequences for consumers if the WACC is set too low rather than too high. The Europe Economics recommended estimates of each WACC component in PR3 are summarised in the table below.

1 Source: http://www.EirGrid.com/aboutus/.
2 Source: http://www.esb.ie/esbnetworks/en/about-us/index.jsp.

Table 1.1: Europe Economics estimates and recommendation of the WACC for ESB and EirGrid, based on data to the end of February 2010

	Low	High	Point estimate	Recommended value
Cost of equity				
Risk-free rate	1.6	2.2	2.0	
Equity risk premium	4.5	5.4	5.2	
Asset beta	0.2	0.4	0.3	
Equity beta	0.4	1.0	0.67	
Post-tax cost of equity	3.4	7.6	5.5	
Pre-tax cost of equity	3.9	8.7	6.2	
Cost of debt				
Debt premium	1.0	1.4	1.2	
Pre-tax cost of debt	2.6	3.6	3.2	
Post-tax cost of debt	2.3	3.2	2.8	
WACC				
Notional gearing (%)	50	60	55	
Corporation tax rate (%)	12.5	12.5	12.5	
Post-tax WACC	2.8	4.9	4.0	
Vanilla WACC	3.0	5.2	4.2	
Pre-tax WACC	3.2	5.6	4.6	5.0 (Range 4.8-5.2)

The CER consulted on a WACC figure of 5.0 per cent in August 2010, and by the time of the final decision (November 2010) it concluded that , there had been significant market developments in Ireland following Europe Economics' recommendation due to the rapid worsening of the Irish sovereign debt crisis during that period.

By the time that of the final determination in November 2010, the CER deemed a WACC figure of 5.0 to be no longer appropriate and consequently the CER allowed a real, pre-tax WACC of 5.95 per cent for both EirGrid and ESB in its final determination.[3]

1.1.2 The Mid-Term review

The PR3 determination was made in the context of significant economic volatility, which created particular uncertainty over the components used to estimate the WACC. CER raised its determined cost of capital markedly above the figure it had initially consulted on. This was done, necessarily, in the absence of a decisive evidence base upon which to determine the extent to which conditions merited such an increase. At the time, it was argued by some parties that the elevation was too high, and by others that it was too low. Moreover, the economic outlook from the 2010 determination was also uncertain. In light of this, the CER introduced a trigger mechanism for a potential Mid-Term review which was, in the end, activated.

Europe Economics advised the CER in the Mid-Term WACC review concluding that the 5.95 per cent WACC figure had been broadly appropriate for the period 2011-2013, but if continued into 2014 and 2015 it would imply material over-recovery of capital costs for the entities regulated.

As regards 2014 and 2015, Europe Economics' advice was that the cost capital would lie in the 4.37 to 5.05 range. For a regulatory purpose Europe Economics argued that it would be appropriate to aim-up upon that range, by between 5 and 10 per cent, implying ranges of 4.59-5.31 per cent and 4.81-5.56 per cent (with a modest preference for the former range — Table below).

[3] We note that, according to CEPA's submission to this Mid-Term WACC review, the underlying final determination for ESB should be interpreted as 5.75 per cent, but uplifted by 0.20 per cent based on an Opex allowance swap — CEPA, 2013, *Mid-Term WACC Review EirGrid* p2-3.

Table 1.2: Forward-looking WACC for the Mid-Term review

WACC components	Low	High
Risk-free rate	1.75	2.00
Debt premium	1.70	2.20
Cost of debt	**3.45**	**4.20**
ERP	4.60	5.00
Asset beta	0.30	0.30
Equity beta	0.67	0.67
Cost of equity (pre-tax)	**5.50**	**6.10**
Gearing	0.55	0.55
Tax	0.125	0.125
WACC (pre-tax)	**4.37**	**5.05**
WACC (pre-tax) aimed up 5%	**4.59**	**5.31**
WACC (pre-tax) aimed up 10%	**4.81**	**5.56**

The final determination by the CER was the following:

> "The CER considers that a WACC of 5.2% real, applicable to both utilities, is appropriate for the 2014 to 2015 period."

1.1.3 PR4

Since the time of the Mid-Term review the macroeconomic conditions in Ireland, and the Eurozone more broadly, have evolved further, and they appear to have somewhat deteriorated in recent months. The IMF has recently cut its growth prediction for the world economy, and the drop in oil prices and recent Swiss National Bank's decision to de-peg the Swiss Franck form the euro have created some turbulence in financial markets.

In the meantime, the yields on Eurozone sovereign bonds have continued to decrease possibly as a result from markets discounting the introduction of a QE programme by the ECB, which was formally announced on January 22nd 2015, to commence in March 2015.

However the outlook for Ireland appears to remain relatively positive, with the European Commission predicting in its autumn forecast that Ireland will have the largest economic growth in the EU in 2014, 2015 and 2016.

Overall we believe that, at the time of writing this report, the degree of economic uncertainty is lower than that experienced at the time of the Mid-Term WACC review and there is markedly less uncertainty than in 2010 during PR3.

1.2 Overview of methodology

1.2.1 The CAPM-WACC framework

The current report relies on the use of the Weighted Average Cost of Capital (WACC) and the Capital Asset Pricing Model (CAPM) framework to derive cost of capital estimate. For the purpose of introduction, we briefly rehearse what this framework is.

The cost of capital allowed by a regulator in setting price limits should reflect the opportunity cost of the funds invested in assets; it represents the rate of return that an investor would be likely to require in order

to invest in a company, given its risk profile compared with other potential investments. It can also be thought of as the discount rate which an investor would use in evaluating the income stream to be expected from investing in the company.

The weighted average cost of capital (WACC) is computed from (a) the average cost of debt for the various forms of debt held by the company, and (b) the cost of equity. This is the return that investors (shareholders and lenders of various types) require in order to invest in the company.

Mathematically, the following formula is used:

$$WACC = r_E \cdot \frac{E}{D+E} + r_D \frac{D}{D+E} \quad [1]$$

where r_E is the cost of equity, r_D is the cost of debt, and E and D are the total values of equity and debt respectively used to determine the level of gearing in the company, so giving the relative weights between the cost of equity and debt finance.

Cost of debt

The cost of debt measures the combination of interest rates charged by banks to the company and the return paid by the company on any corporate bonds or other loan instruments issued. It is standard practice to think of this as being made up of a risk-free component and a company-specific risk premium.

$$r_d = r_f + \ debt\ premium \quad [2]$$

- rf is the return on a risk-free asset, usually proxied by a measure of the rate on medium to long-term government bonds.

There are generally two main approaches for estimating the cost of debt.

- Estimating the all-in cost of debt directly by analysing corporate bonds' yields.
- Estimating corporate bonds spread over the risk-free rate and expressing the cost of debt by its two identifying components, i.e. risk-free rate plus debt premium.

For reasons we shall explain later, we prefer the second approach.

Cost of equity

The capital asset pricing model (CAPM) is used to determine the cost of equity, r_E, applying the following equation:

- $$r_E = r_f + \beta_E * MRP \quad [3]$$

  β_E is the correlation between the risk in company returns and those of the market as a whole, which can be estimated from primary market data for listed companies, or by analysing the betas of comparators for companies which are not listed.
- *MRP* is the market-risk premium over the risk-free rate, an Irish economy-wide parameter. Conceptually, the market includes all assets. In practice, however, it is generally assumed that a broad equity market-base index is a good proxy. Thus, estimates of the equity risk premium are used as a proxy in estimating the MRP.

Thus in the standard CAPM there are three determinants of the expected return on any asset: the return on a riskless asset - the market premium over that riskless rate that is earned by investors as a whole, reflecting systematic risk; and the particular company's exposure to systematic risk. As discussed further below, company specific risks do not enter the cost of capital in the CAPM model, as they can, by definition, be diversified away by investors.

Approach to risks

Under CAPM, risks are divided into two major categories:

- systematic risks; and
- specific risks.

Systematic risks are risks that affect the whole market. Systematic risks relate to outcomes that cause the whole market to move, such as economic growth or recession, or wars. Even fully diversified investors are subject to systematic risk, and require a compensation for it through the cost of capital. The amount of compensation (the level of the cost of capital) they require from a particular company or a project depends on how exposed that company is to systematic risks.

The specific risks affecting an individual firm are those risks that can be offset by investors diversifying their investments. These are not taken into account in CAPM because it is assumed that in an efficient capital market investors can protect themselves against such risks by holding a diversified portfolio. Thus, in CAPM, specific risks are assumed not to affect the rate of return to investors (i.e. because they can be diversified away) that the company has to cover through its cost of capital.

If you consider an industry in which there is no systematic risk (and no industry-specific risk), but each of the companies in the industry faces company-specific risk CAPM predicts that the rate of return in this industry would be the risk-free rate. Since there is no systematic risk, an investor with equal shares in all the companies in the industry would be guaranteed to receive the risk-free rate every period — the company-specific risks taken that turned out badly in some companies would exactly balance those that turned out well in others (that is precisely what it means to say that there is no systematic risk).[4]

An example of a specific risk would be cost shocks caused by failure of the engineering solutions adopted by an electricity network company.

1.2.2 Structure of the report

The report is organised in the following sections:

- Risk-free rate
- Debt premium and cost of debt
- Equity risk premium
- Equity beta and cost of equity
- Capital structure
- Taxes
- WACC

[4] Note that industry-wide industry-specific risks can be diversified by investors, in an analogous way to that set out in the thought experiment above, through holding shares across industries.

2 Risk-Free Rate

2.1 PR3, Mid-Term Review and stakeholder submissions

In PR3 (2010) we recommended a risk–free rate range of 1.6-2.2 with a point estimate of 2.0. Our advice for the Mid-Term WACC review (2013) was for a range of 1.75-2.0.

ESBN proposes a risk-free rate estimate of 2.0 per cent, based on Frontier's analysis, and EirGrid, based on KPMG's analysis adopts a 1.75 per cent estimate, noting upward potential which would justify a 2.0 per cent level.

2.2 Characteristics of a risk-free asset

By definition a risk-free asset is an asset that bears no risk (e.g. no credit or default risk, no currency risk, no inflation risk and no reinvestment risk). Therefore the rate of return on a risk-free asset reflects, partially but not exclusively, economic agents' impatience, i.e. how much agents would rather have things today than tomorrow. However, the risk-free rate is not simply the return any one individual would require to hold a risk-free asset. Rather, it is the return that would be available in such an asset. As such, (a) it reflects collective tastes, rather than those of any individual — the "taste" of the Market; and (b) it reflects an (albeit notional) equilibrium condition. In standard long-term economic growth models, such as the Ramsey-Cass-Koopmans model, a key equilibrium condition is that (absent population growth) the sustainable growth rate of the economy is a function of the risk-free rate.[5] Indeed, in corporate finance theory the risk-free rate of return is sometimes viewed as arising from the sustainable growth rate (i.e. causality runs from the sustainable growth rate to the risk-free rate).

2.3 Methodological issues

For PR4, we propose a single Eurozone risk-free rate figure, in line with the methodology we adopted for the Mid-Term WACC review. As argued at the time of the mid-term WACC review, the use of a single Eurozone risk-free rate reflects (a) the absence of currency exchange risk; (b) the high degree of capital market integration within the Eurozone. As noted at the mid-term WACC review, this is a change from the PR3 approach in which an Irish risk-free rate was estimated. This partly reflects the ongoing process of capital market integration within the Eurozone but also reflects the fact that the data basis for estimating any within-Eurozone variations in the risk-free rate (arising from residual segmentation of the Single Capital Market) is weaker that was the case in 2010 — in recent years it has been very clear that Irish sovereign bonds have not been treated as risk-free and there is no secure and robust basis for using any spreads between Irish and other Eurozone sovereign bonds for estimating risk-free rate differentials as opposed to, say, differences in perceived default risk or differences in the usefulness of such bonds as a speculative hedge against euro disintegration. Candidates such as the use of sovereign credit default swaps prices have a number of well-known weaknesses (e.g. low credibility — the Eurozone authorities went to great lengths, and in very public ways, to try to design the Greek sovereign bonds default of 2012 such that it would not trigger CDS payouts. Although, in the end, Greek sovereign CDS did pay out, the efforts to avoid such a payout are widely acknowledged to have reduced the utility of sovereign CDS as a default hedge.).

5 Ramsey, F.P. (1928), "A mathematical theory of saving", Economic Journal, 38, 152, pp543–559. Cass, D. (1965), "Optimum Growth in an Aggregative Model of Capital Accumulation", *Review of Economic Studies*, 37 (3), pp233–240.

This has two implications:

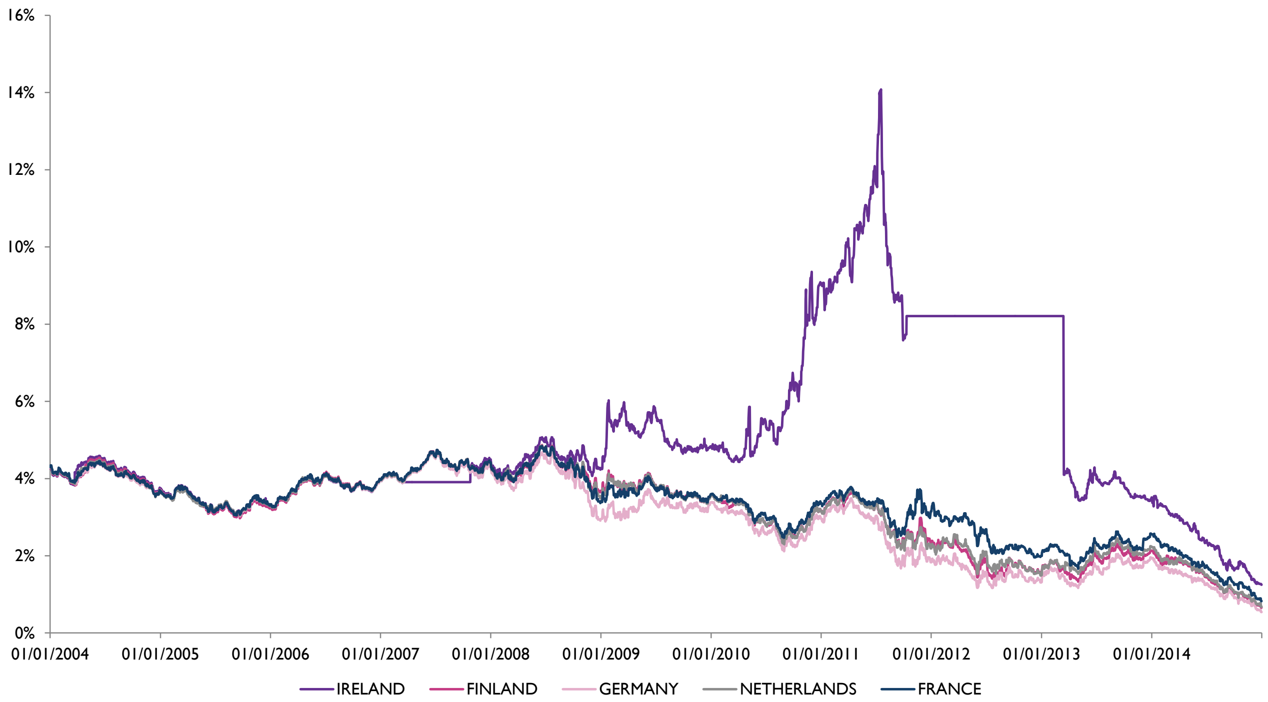
- Spreads (for the purpose of estimating risk asset premia (in particular debt premia with some implication, also, for equity premia)) are estimated relative to the benchmark German government bond as selected by Bloomberg.
- The risk-free rate is determined based on Eurozone-wide macroeconomic considerations.

In the following sub-sections we present our thinking behind our recommended range and point estimate for the risk-free rate that can be found in section 2.6.

2.3.1 Use of sovereign bonds

It is clear from the discussion above that, the risk–free asset is a theoretical concept rather than a particular actual asset. For this reason, risk free-rate estimates are in practice carried out using the returns on assets that are believed to constitute good proxies of riskless assets as a reference point. Government bonds have typically been used as benchmarks for such exercise. As illustrated in Figure 2.1, over the last year government bond yields in Eurozone countries have decreased significantly, and have tended to converge.

Figure 2.1: 10 year nominal government bond yields (IE, DE, FR, NL and FI for 01/01/2004-31/12/2014)



Source: Bloomberg, Europe Economics' calculations.

However, in the context of the current price control, an excessive reliance on Eurozone government bond yields for the purpose of determining the risk-free rate is problematic for a number of reasons. In particular, at the moment of writing the current report, it is unclear the extent to which such historically low yields levels are a reflection of markets discounting the potential effects of the introduction of quantitative measures by the ECB, or are attributable to a worsening outlook for the Eurozone.

2.4 Regulatory precedent

The table below summarises the most recent decisions made by regulators in the UK and Ireland with regards to the chosen level of the risk-free rate. We note that in PR3 (2010) we advised the CER for a risk–free rate

range of 1.6-2.2 with a point estimate of 2.0. Our advice for the Mid-Term WACC review (2013) was for a range of 1.75-2.0.

Table 2.1: Recent regulatory precedent for the risk-free rate in the UK and Ireland

Company	Ofwat (2014)	CER Irish Water (2014)	ComReg Eircom (2014)	CAR DAA (2014)	CC NIE (2013)	CRE France (2013)*	Bundesnetzagentur Germany (2013)*	Ofgem NGET (2012)
Risk-free rate	1.25%	2.00%	2.10%	1.50%	1.50%	4.00%	3.80%	2.00%

*Note: Obtained from an Ernst & Young 2013 report: http://www.ey.com/Publication/vwLUAssets/Mapping_power_and_utilities_regulation_in_Europe/$FILE/Mapping_power_and_utilities_regulation_in_Europe_DX0181.pdf.

Our 2010 advice to the CER relied primarily on the yields of German and French government bonds, and on Irish government bonds after adjustment using CDS data. It also took into account regulatory precedents, and the tendency for regulators to estimate the risk-free rate to be slightly higher than real yields on government bonds (which is why the bottom of our range was not extended to encompass all of the market data we presented).

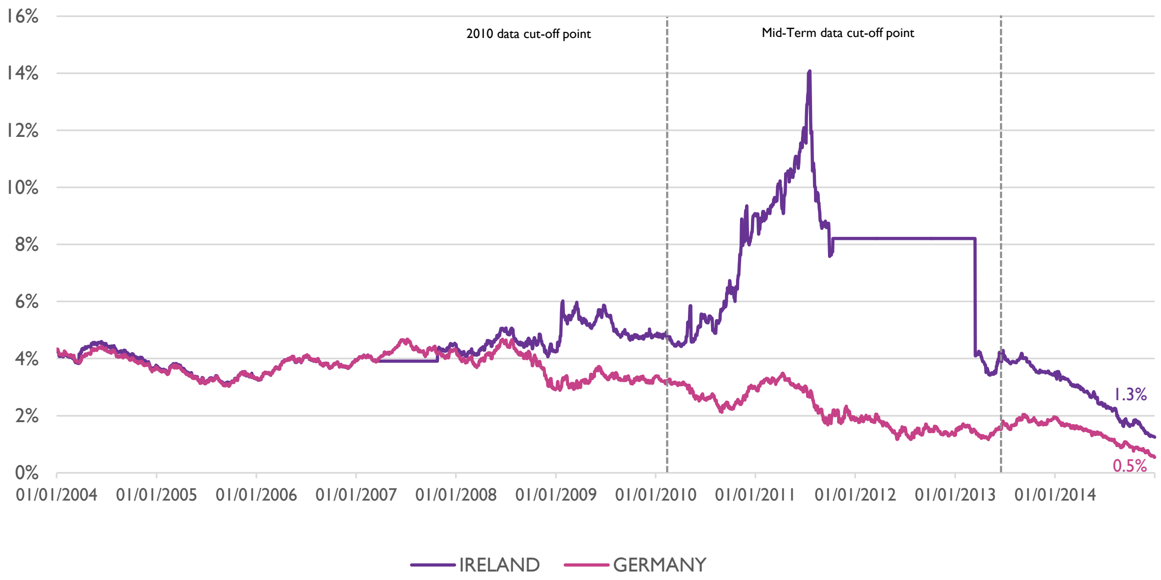
For the reasons set out above, in the context of the Mid-Term review and for PR4, our methodological recommendation was to use a Eurozone-wide risk free rate. Based on the average real yields of 10-year German bonds for the periods 2000-2013 and 2000-2007 and UK regulatory precedent for 2011-2012 (1.4 to 2 per cent) we determined that a range of 1.4-2.0 per cent was appropriate for 2011-2013 with a forward looking rate of 1.75-2.0 per cent.

2.5 Developments

Government bond yields for Eurozone countries were decreasing throughout 2014 and have decreased more since October 2014. We note that the observed levels may be distorted downwards. For example, as well as the general deterioration in the macroeconomic outlook for the Eurozone (which might induce a genuine reduction in the risk-free rate) playing an important role in this downward movement, the potential and subsequent actual introduction of quantitative easing measures by the ECB may also be a factor (creating a downwards distortion).

Figure 2.2 illustrates the movements of 10-year German and Irish government bond yields for the past 10 years. The convergence of Irish yields to Eurozone norm is becoming more evident from the decreased difference of German and Irish yields. Both countries' yields have been falling since July 2013 and reached a spot level (as of 31/12/2014) of 1.3 per cent for Ireland and 0.5 per cent for Germany.

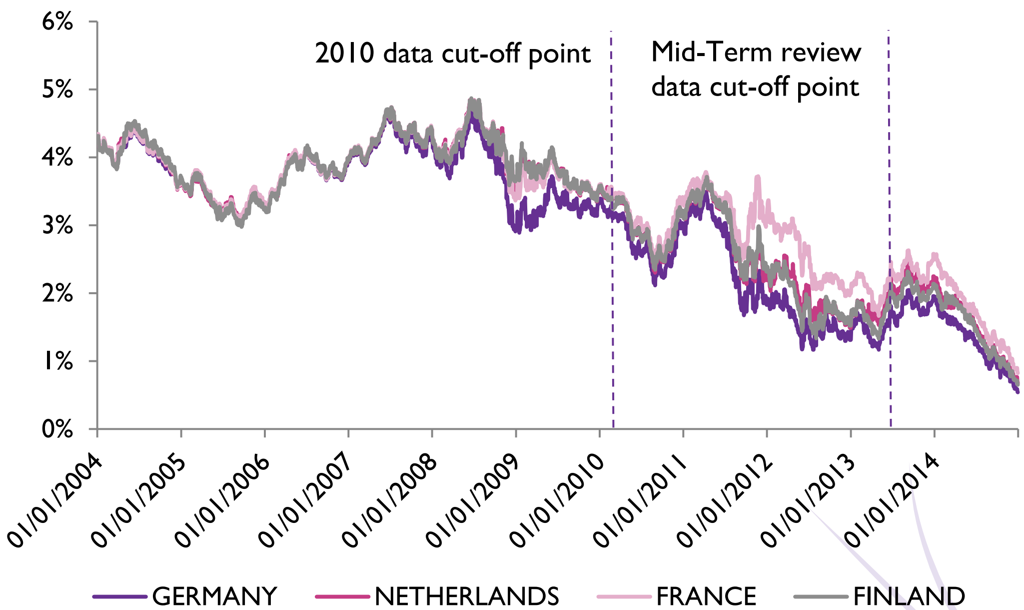
Figure 2.2: 10 year nominal government bond yields (IE and DE for 01/01/2004-31/12/2014)



Source: Bloomberg, Europe Economics' calculations.

The figure below illustrates the same point for four core European governments' bond yields (Germany, the Netherlands, France and Finland). A marked decrease in these countries' yields can be observed since the Mid-Term review and even more so since the beginning of 2014.

Figure 2.3: 10 year nominal core European government bond yields (01/01/2004-31/12/2014)



Source: Bloomberg, Europe Economics' calculations.

2.6 Conclusion

For PR4 we expect the Eurozone risk-free rate to be in the region of 1.75-2.1, with a working point estimate of 1.9 per cent. The upper bound coincides with our most recent advice to ComReg, whilst the lower bound

reflects the potential for QE and deterioration in the Eurozone's macroeconomic outlook and is also close to the 2000-2014 average yield of German 10-year bonds.

We note that the forwards-looking mid-term WACC review figure was 1.75 to 2 for 2014-2015. That was based upon the rate normalising to above 2 from late 2015 onwards, which would have implied that the late 2015-on range consistent with the mid-term WACC review would have been higher than 1.75 to 2. That means that our 1.75-2.1 should be understood as involving a reduction in the risk-free rate range for late 2015-on implied by the mid-term WACC review range, reflecting the darkening of the macroeconomic outlook since that time.

3 Debt Premium and Cost of Debt

3.1 Our approach to the estimation of the cost of debt

3.1.1 Debt premium approach

There are generally two main approaches for estimating the cost of debt.

- Estimating the all-in cost of debt directly by analysing corporate bonds' yields.
- Estimating corporate bonds spread over the risk-free rate and expressing the cost of debt by its two identifying components, i.e. risk-free rate plus debt premium.

In estimating the cost of debt, we have adopted the approach of building up the cost of debt by summing the risk-free rate (i.e. the return required by investors for investing in risk-free assets) and a company-specific debt premium. This approach will ensure consistency with the way in which the cost of equity is calculated, since the same risk-free rate assumption is being used.

Additionally, in a CAPM framework, there are conceptual differences between the movements in the debt premium and movements in the risk-free rate. Changes in the debt premium may occur due to re-evaluations of risk or changes in risk appetite for the company in question, which are distinct from the changes captured by risk-free rate variations. Separating the components of the cost of debt therefore allows for a more focused analysis of the cost of debt.

Second, with a debt premium approach, forward-looking estimates of a rise in the risk-free rate convert straightforwardly into a forward-looking cost of debt estimate. In the approach that uses the overall cost of debt this relationship is unclear. For example, loose monetary policy and quantitative easing are intended to reduce market interest rates below the cost of debt in order to enhance incentives to invest. The effect of this policy on market rates has been discussed in our analysis of the risk-free rate. An overall cost of debt approach risks under-appreciating the effects of deliberate policies upon debt costs.

Putting the point a different way, our approach to the risk-free rate can be seen as envisaging a certain scenario for the equilibrium level of sovereign bond yields. The use of a debt premium approach means that the scenarios for the equilibrium overall cost of debt involve the same rises in the cost of debt as those for the risk-free rate, if the debt premium is fairly constant (as theory and empirical evidence suggest it will be).[6]

We also note that our estimated risk-free rate is itself generated in part from a disaggregation of total market returns in their respective components. Given the advantages of a bottom-up approach to the forward-looking cost of debt, we therefore prefer this approach to direct estimation from bond yields.

[6] We note that in cases where an overall cost of debt is used, some assumption is required regarding how the overall cost of debt will change as government bond yields are expected to change (e.g. as implied by futures markets). In the debt premium approach the change is one for one. In its analysis of the overall cost of debt for the UK CAA as part of the Q6 price review, PWC found the relationship was 0.8 for one, i.e. a rise of 1 per cent in government bond yields implied a 0.8 per cent risk in the overall cost of debt. PWC does not report whether its statistical analysis suggests this 0.8 figure was statistically significantly different from 1, but we note that it rose from 0.6 to 0.8 between the interim and final reports, which suggests a range of uncertainty of at least 0.2 is plausible – see: http://www.caa.co.uk/docs/78/PwC_CAA_CostofCapital_Designated_Airports_Oct.pdf
Our view is that the use of a conversion coefficient so close to one (and potentially not statistically significantly different from 1) makes the distinction between a debt premium approach and an overall cost of debt approach rather limited in scope.

EirGrid does not have any listed euro bonds while ESB only has three outstanding euro bonds maturing in September 2017 (€600m), November 2019 (€500m) and January 2024 (€300m). There are also three sterling-denominated ESB bonds maturing in 2018 (£175m), 2020 (£275m) and 2026 (£400m). In addition, we note that there is also one outstanding Bord Gáis bond with less than three years to maturity that we consider in our analysis and present along with the ESB bonds.[7] Since there were only four Irish euro-denominated bonds available, on top of examining ESB's bonds, we informed our analysis of the debt premium for ESB Networks and EirGrid with data on spreads of European comparator companies (i.e. other electricity suppliers and utilities), and evidence from regulatory precedent. In order to ensure consistency, we have only used comparator companies that were used either in PR3 or the Mid-Term review (or both).[8]

When considering relevant comparator bonds it is more appropriate to rely on bonds in the same credit class as opposed to focusing on bonds across classes that have the same credit rating. This is partly because of the conceptual difference between the *market debt premium* (MDP) (i.e. the spread of bond yields over the benchmark observable from market data) and the *expected return from holding debt* — the relevant concept in the CAPM framework — which reflects inventors' expected returns on debt after taking into account the probability of default and the loss given default. Within the CAPM framework the probability of default and loss given default are relevant only to the extent to which they reflect systematic risks that cannot be diversified (e.g. defaults and losses that are correlated with the broader market). However, credit ratings reflect also idiosyncratic risks and therefore, for the purpose of estimating debt premium, credit ratings on bonds in different credit classes (e.g. financials as versus transport as versus utilities) should be regarded as only imprecise measures of systematic risk. When bonds of the same rating within the same credit class (e.g. utilities) are used, there is a much better chance that the debt premium reflects a fairly consistent ratio of systematic to idiosyncratic risk.

3.1.2 Use of embedded debt

An embedded debt approach involves combining estimates of companies' existing costs of debt with an estimate of their forward-looking cost of debt, and weighting these according to the companies' expected future debt requirements. A forward-looking cost of debt approach does not take into account embedded debt costs, and instead relies on estimating what would be the costs of debt for new issuances.

An embedded debt approach may be appropriate for pragmatic reasons. For example, there may be feasibility problems for existing companies in adjusting costs quickly to an efficient level or it may have been cheaper to acquire or build relevant assets in the past than is currently the case. This approach may also be used by regulators seeking to meet duty-to-finance obligations. None of these cases would necessarily require a regulator to make an embedded debt adjustment, but such an approach may represent an appropriate pragmatic response to particular circumstances.

However, in the absence of such considerations, it is preferable not to apply embedded debt adjustments. This is because the key thought experiment in a price control is that of the competitive or contestable market, the existence of the control being due to a lack of competitive constraint. An efficient new entrant would not have access to past debts obtained at rates cheaper than those at the time of entry, nor would it have legacy debt that was more expensive than the debt it could obtain at entry. An efficient new entrant would

7 We note that Bord Gáis Éireann was renamed Ervia in 2014 and that its energy part was sold to Centrica in December 2013.

8 In the stakeholder submissions, ESB's consultants Frontier use only ESBN's own bonds. EirGrid's consultants KPMG use a range of bonds including a EuroGrid bond (2020), an RTE bond (2022), an Elia bond (2028) and a Fingrid bond (2028), plus a set of UK National Grid bonds ranging in maturity dates from 2017 to 2028. RTE is a subsidiary of EDF. We have considered National Grid and EDF bonds where they satisfied our data sampling criteria, which in practice excludes the National Grid bonds KPMG quotes but EDF bonds from 2022-2026 are included in our analysis below.

therefore neither gain nor suffer due to embedded debt.[9] Thus, although pragmatic considerations may justify the use of embedded debt under some circumstances, best practice in economic regulation should be to seek to phase out embedded debt adjustments as and when doing so becomes feasible.[10]We observe that the CER's 2012 BGN decision included an allowance for embedded debt, presumably reflecting the exceptional circumstances of that very turbulent period. We do not believe that this should be regarded as establishing any precedent for the treatment of embedded debt in more stable market conditions.

Our approach for determining the cost of debt is therefore to estimate a forward-looking cost of debt and make no embedded debt adjustment.

3.1.3 Use of indexation

Some regulators (e.g. Ofgem in the UK, or CER for BGN in 2012 — though the BGN indexation method is very different from Ofgem's) have adopted an approach to the cost of debt wherein the cost of debt allowance in the price control is indexed, in a manner somewhat akin to the indexation of prices with respect to inflation.

Four main kinds of rationale are offered in defence of indexation:

a) Movements in the risk-free rate are economy-wide and, as such, would affect all firms and hence feed through into prices in a competitive market.
b) Insofar as risk-free rates are estimated directly from government bond rates, they are a reflection of macroeconomic policy measures (e.g. central bank interest rates or QE) that would affect all firms equally and as such closely analogous to (indeed, affected by the same factors as) inflation.
c) In an era of low and falling government bond yields, regulators have been cautious about reducing risk-free rate determinations in line with sovereign yield falls, perhaps fearing a reversion of yields to historic norms over the period of price controls. This has resulted in a tendency for risk-free rate determinations to include "headroom" over sovereign bond yields as a form of insurance against sudden rises in those yields. Indexation provides an alternative insurance policy, allowing regulators to set risk-free rates more closely in line with sovereign bond yields.
d) In the case of BGN, conditions were so extreme and uncertainty so high that, absent some mechanism for indexation, it would very probably have been necessary to re-open the WACC in particular or even the price control in general mid-way through the control period. Indexation was thus an alternative to a mid-term review (the approach taken by the CER in the case of electricity transmission and distribution for PR3).

In the current context, since we are not estimating risk-free rates directly from sovereign bond yields, argument (b) is straightforwardly inapplicable. Regarding argument (c) we do not regard our judgement as involving headroom[11] as such — there is no implicit forecast for bond yields or insurance against adverse movements in such yields in our recommendation. We regard this as more of an issue for regulators that have had a tradition of providing such headroom (e.g. Ofgem). As regards argument (d) we believe it is clear that current macroeconomic conditions are not remotely as turbulent as those of 2012.

As regards argument (a) we consider it unconvincing in itself and unconvincing as a rationale for the use of indexation. Firms have the scope to raise debt at various points over the price control period, and investments have an extended life. As such, it is a mistake to believe that final prices for products will

[9] These considerations do not make any presuppositions on the market share of either an entrant or existent market participants.

[10] ESBN bonds were issued in 2010 and one each year in 2011-2013. That was a period of elevated debt premia, which were reflected in the WACC determinations at PR3 and in the mid-term WACC review.

[11] We understand the term "headroom" in this context as referring to the determination of a value above one's best estimate of a WACC component to insure against an adverse movement over the price control period.

generally move in line with the point risk-free rate. Instead, they are more likely to be correlated with expected movements in the long-term risk-free rate, but even there, there is a question of which is cause and which effect — higher growth might mean higher profits and higher prices, so raising risk-free rates, rather than the reverse. But even if whole-economy prices were to move in line with risk-free rates, we would regard efficient financing as part of the incentive structure of periodic-review-based regulation. Firms manage risks, including the risk of adverse movements in the risk-free rate, over the period of the price control.

To conclude, we therefore recommend against the use of indexation.

3.2 Data sampling

As mentioned above, our preferred methodology for estimating the debt premium consists of observing the spread of corporate debt costs over the risk-free rate and not incorporating any embedded debt costs, as a hypothetical efficient firm would manage its treasury operations to achieve the lowest cost of debt possible.

For estimation purpose the debt premium is calculated as the spread between the yields of risky assets (corporate bonds) against the yields of 10-year German government bonds (i.e. a benchmark asset which is perceived as having very low risk), noting that the purpose is to identify the spread from risk.[12]

The following two sections present an analysis of outstanding bonds issued by Irish and selected European utilities. The criterial used for selection are as follows:

- All the bonds selected have a "comfortable investment grade" (i.e. they are rated above BBB- from S&P and Baa3 from Moody's).
- All bonds are denominated in euro (with the exception of UK utilities bonds which are denominated in GBP).
- For all bonds the spreads are calculated against an appropriate benchmark selected by Bloomberg. For European utilities Bloomberg selected benchmarks are German government bonds, and for UK bonds the selected benchmarks are UK Gilts.
- All bonds have a time to maturity ranging between 8 and 12 years (when rounded).

3.3 Target credit rating: PR3 and stakeholder submissions

At PR3 the target credit ratings were in the A grade for both ESBN and Eirgrid.

For PR4 ESBN has proposed a credit rating of A-. EirGrid has proposed A.

3.4 Target credit rating: Our view

In estimating the cost of debt, one of the key methodological choices concerns the credit rating which should be assumed for ESB Networks and EirGrid. When estimating the cost of debt for the 2001-2005 price control period, the CER assumed that ESB Networks would maintain an A credit rating over the regulatory period (which was deemed consistent with a notional assumed gearing of 50 per cent). In its 2006 price control review, on the other hand, the CER assumed a credit rating of A or BBB for the price control period (which was deemed to be consistent with a notional assumed level of gearing of 50-60 per cent). However, in its response to a questionnaire sent by CER, ESB Networks stated that it did not have a formal target rating.

[12] The assumption upon which this method is based is that whatever factors downwards-distort government bonds also downwards-distort yields on riskier assets.

In contrast, no reference was made in either of these price reviews to the target credit rating for EirGrid and according to its response to a questionnaire sent out by the CER, EirGrid also does not have a formal target rating.

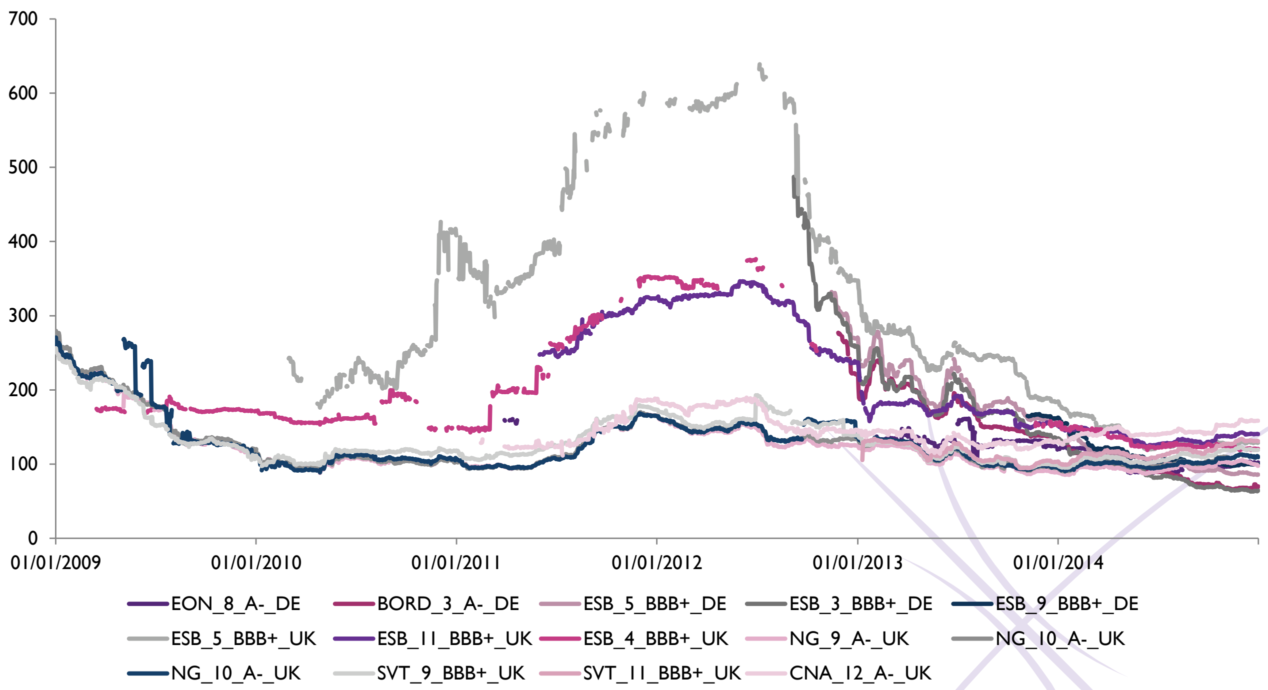
Our working assumption for estimating the cost of debt for the 2010 and the Mid-Term review, was that ESB Networks and EirGrid would be able to issue bonds with a rating between BBB and A. This was in line with regulatory practice since regulatory decisions (e.g. ComReg in November 2014) tend to regard a comfortable investment grade rating (BBB+ or above), as being sufficient for utility companies to finance their activities. However, we also note that significant changes in market environments may lead to revisions in the target credit rating. For example, in 2009 we advised Ofwat carry out its financeability analysis for both a target rating of A- and of BBB+. This decision was driven by the worsening of credit market condition at that time and was supported by the following market evidence:

- A significant increase in the yields on corporate bonds across all credit ratings (relative to 2007 values).
- A widening of the wedge between yields on BBB rated bonds and bonds with superior ratings (relative to 2007).
- Mixed views expressed by investors as to whether a credit rating of BBB+ was sufficient for water companies to access sufficient debt finance in the market at that turbulent time.

As illustrated in the figure below yields on corporate bonds of European utilities, and the spread between BBB+ and A- bonds have decreased significantly in the past two and a half years, being fairly stable for at least a year. We interpret this as evidence of normalisation in the credit markets and therefore we think it is now appropriate for the CER to target a credit rating of comfortable investment grade level, i.e. BBB+ or above.

It should be emphasized that the notional credit rating used in assessing the WACC need not be identical either to the actual credit rating of regulated entities nor to any targets regulators impose upon those entities (though the latter is likely to be desirable).

Figure 3.1: Spreads of European utilities' bonds over their respective benchmarks



Note: EON (Germany), Bord Gais (Ireland, abbreviated to BORD), ESB (Ireland), National Grid (UK, abbreviated NG), Severn Trent (UK, abbreviated SVT) and Centrica (UK abbreviated as CNA) are presented in this graph. After the name of the company, the number represents years to maturity, followed by the credit rating and lastly by the country of the benchmark index.
Source: Bloomberg, Europe Economics' calculations.

3.5 Debt premium: PR3, Mid-Term Review and stakeholder submissions

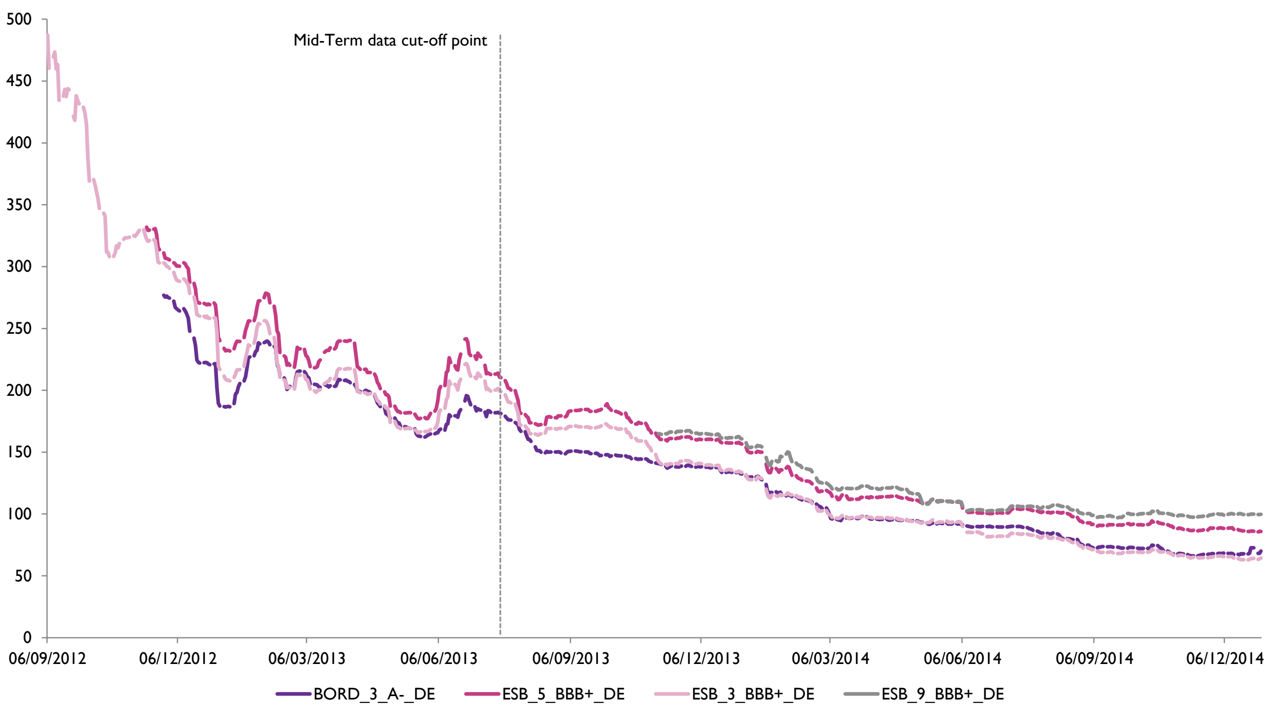
At PR3 we recommended a debt premium range of 1.0 to 1.4 with a point estimate of 1.2. At the mid-term review the range was 1.7-2.2.

At PR4, ESBN's point estimate for the debt premium is 1.75 per cent, as is EirGrid's when including "issuance" and "access to finance" uplifts of 25 bps (with a range of 1.5-2.0 per cent).

3.6 Evidence from spreads of Irish energy company bonds

Figure 3.2 illustrates how the spreads of euro denominated Irish energy bonds have steadily decreased since the cut-off date of the Mid-Term review (16/07/2013). A snapshot of this information is also presented in Table 3.1 where we observe spot rates for ESB bonds ranging from 64 (three years to maturity) up to 100 bps (9 years to maturity). These values are significantly lower than their respective one year averages, reflecting the downward trajectory that the spreads have followed.

Figure 3.2: Spread of euro denominated Irish utilities' bonds (bps) over the German benchmark bond



Numbers in the legend represent years to maturity, followed by credit rating and the country of the benchmark bond used.
Source: Bloomberg, Europe Economics' calculations.

Table 3.1: Spread of euro denominated Irish utilities' bond over the German benchmark bond (in bps, as of 31/12/2014)

Company	Sector	Years to Maturity	Rating (S&P)	Spread 31/12/2014	Average (1 year)	Max (1 year)	Min (1 year)
BORD GAIS	Gas	3	A-	70	95	142	66
ESB	Electricity	3	BBB+	64	94	151	63
ESB	Electricity	5	BBB+	86	114	166	86
ESB	Electricity	9	BBB+	100	120	167	97
Average				80	106	156	78
Average ESB				83	109	161	82

Note: Years to maturity are rounded figures. Averages are raw.
Source: Bloomberg, EE calculations.

For completeness in the table below we present also the spreads of outstanding sterling denominated ESB. We note that the spot spreads range from 121 (four years to maturity) to 140 (eleven years to maturity) and that the bonds with shorter time to maturity are currently trading at below their one year average spreads.

Table 3.2: Spread of sterling denominated ESB bond over UK gilts (in bps, as of 31/12/2014)

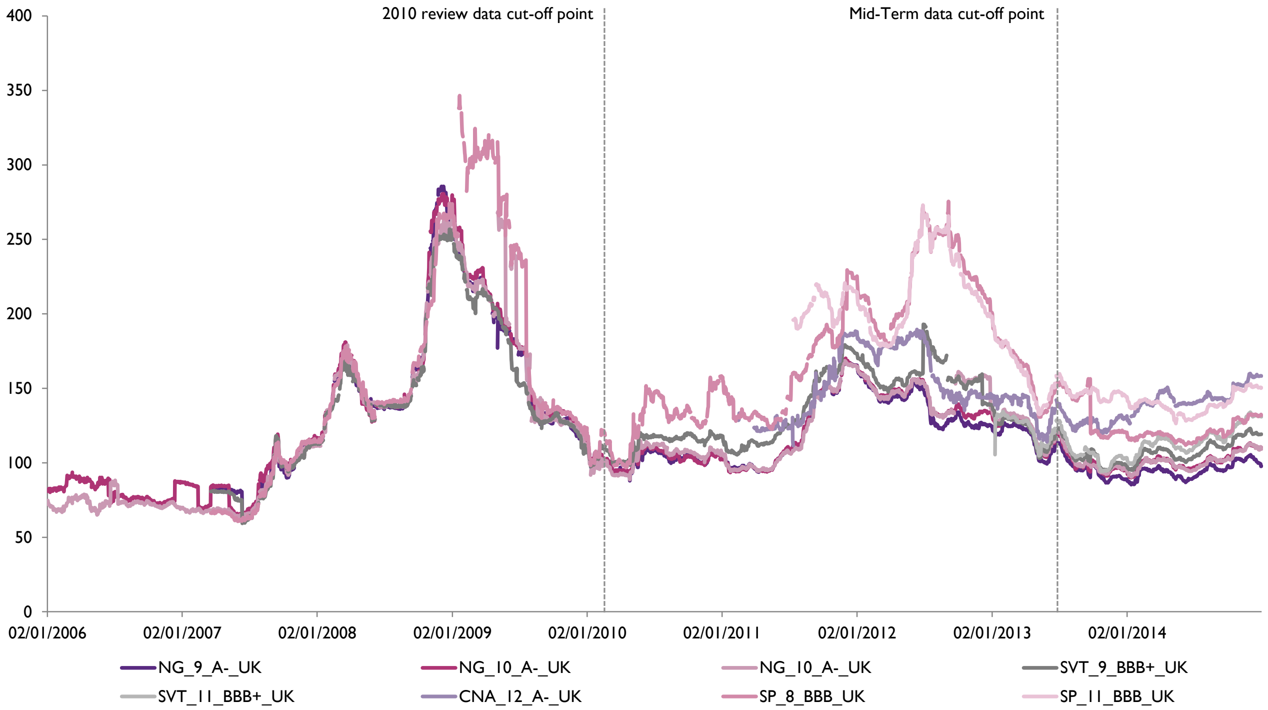
Company	Sector	Years to Maturity	Rating (S&P)	Spread 31/12/2014	Average (1 year)	Max (1 year)	Min (1 year)
ESB	Electricity	4	BBB+	121	131	157	119
ESB	Electricity	5	BBB+	129	138	184	119
ESB	Electricity	11	BBB+	140	137	152	124
Average				130	135	164	121

Note: Years to maturity are rounded figures.
Source: Bloomberg, EE calculations.

3.7 Evidence from spreads of European comparator company bonds

Below we provide figures presenting the spreads of a number of European utilities. While the spreads exhibited considerable volatility since the 2010 review and less so since the Mid-Term review, visual inspection shows that they have not moved markedlyin any direction, in the past year.

Figure 3.3: Spread of UK utilities' bond (bps) over UK gilts



Note: CNA stands for Centrica, NG for National Grid, SP for Scottish Power and SVT for Severn Trent. Numbers in the legend represent years to maturity, followed by credit rating and the country of the benchmark bond used.
Source; Bloomberg, Europe Economics' calculations.

The table below summarises the data on UK comparators' spreads over UK gilts for the last year. Interestingly, all spot spreads are above their one year averages, a situation which is not observed for bonds issued by our other European comparators. The average spot spread for our sample of UK bonds is 126 bps while the one year average is 116 bps.

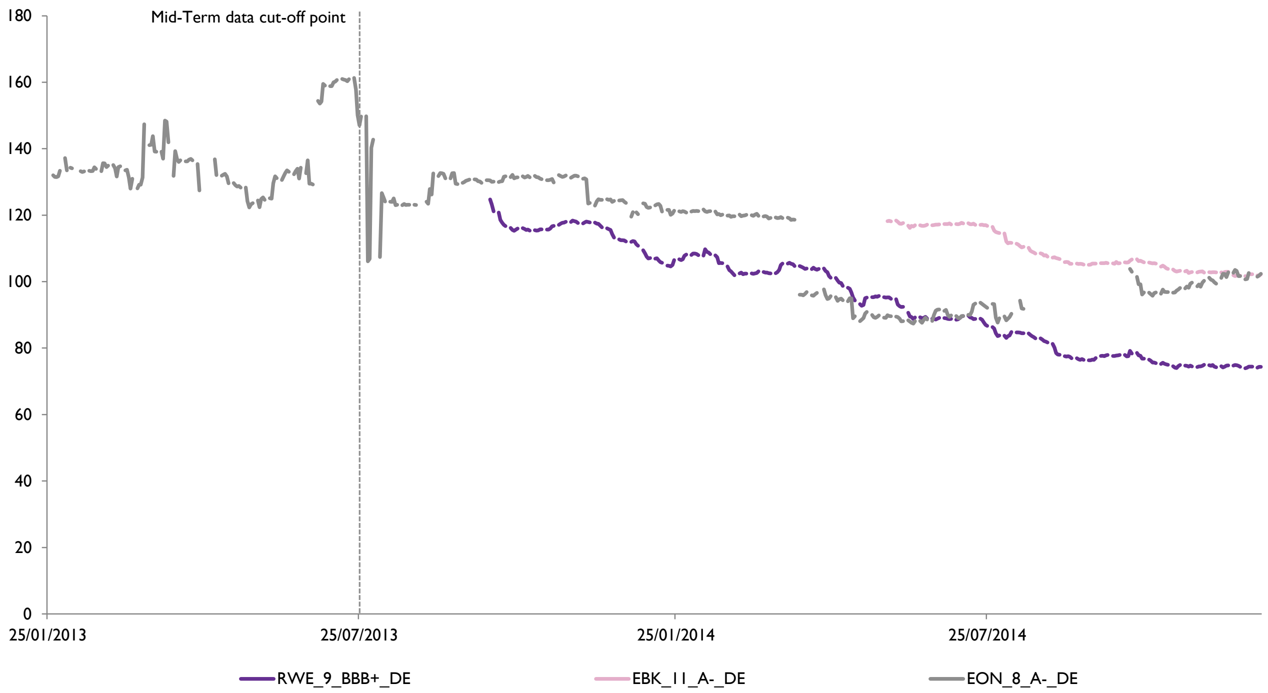
Table 3.3: Spread of sterling denominated UK utilities' bond over the UK benchmark bond (in bps, as of 31/12/2014)

Company	Sector	Years to Maturity	Rating (S&P)	Spread 31/12/2014	Average (1 year)	Max (1 year)	Min (1 year)
National Grid	Electricity	9	A-	98	95	105	85
National Grid	Electricity	10	A-	110	102	113	90
National Grid	Electricity	10	A-	109	101	113	90
Centrica	Gas & Electricity	12	A-	158	144	160	126
Severn Trent	Water	9	BBB+	119	109	123	95
Severn Trent	Water	11	BBB+	131	116	134	99
Scottish Power	Gas & Electricity	8	BBB	132	120	133	112
Scottish Power	Gas & Electricity	11	BBB	150	140	153	126
Average				126	116	129	103
Average A-				119	111	123	98
Average BBB+				125	113	129	97
Average BBB				141	130	143	119

Note: Years to maturity are rounded figures.
Source: Bloomberg, EE calculations.

The following figure serves to illustrate the decreasing spread movements for the German bonds in our sample with data from the table below serving as confirmation; spot spreads are, as with Irish bonds, lower than their one year averages (90 bps compares to 112).

Figure 3.4: Spread of German utilities' bonds (bps) over the German benchmark bond



Note: EnBW's (EBK) 10 year to maturity bond has been excluded due to observed anomalies in the historical data, particularly during June 2014. Numbers in the legend represent years to maturity, followed by credit rating and the country of the benchmark bond used.
Source: Bloomberg, Europe Economics' calculations.

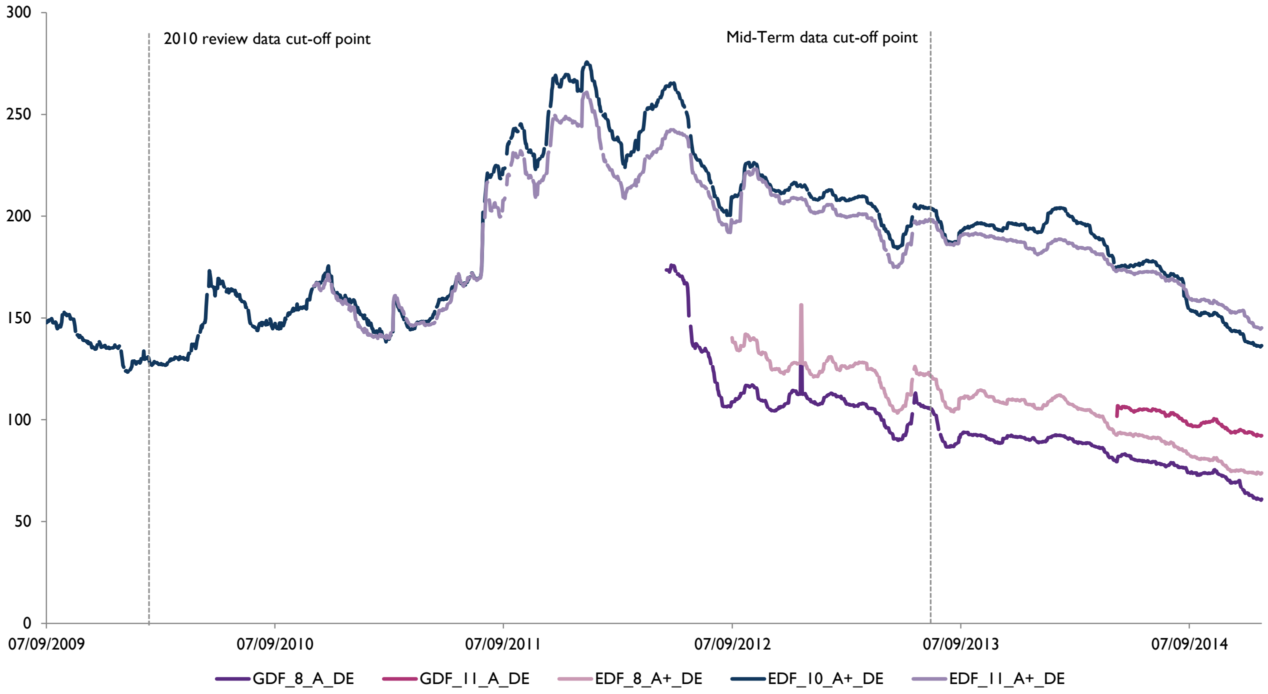
Table 3.4: Spread of euro denominated German utilities' bond over the German benchmark bond (in bps, as of 31/12/2014)

Company	Sector	Years to Maturity	Rating (S&P)	Spread 31/12/2014	Average (1 year)	Max (1 year)	Min (1 year)
EnBW	Gas & Electricity	10	A-	83	148	273	77
EnBW	Gas & Electricity	11	A-	102	109	118	102
EON	Gas & Electricity	8	A-	102	103	124	87
RWE	Energy	9	BBB+	74	90	112	74
Average				90	112	157	85
Average A-				96	120	172	89

Note: Years to maturity are rounded figures.
Source: Bloomberg, EE calculations.

The spreads of French and Italian bonds (Figure 3.5-Figure 3.6) have exhibited a more marked decrease since our mid-term review and have dropped to a spot average of 102 bps compared to a one year average of 123 bps (Table 3.5) in France and a spot average of 124 bps compared to a one year average of 134 bps in Italy (Table 3.6).

Figure 3.5: Spread of French utilities' bonds (bps) over the German benchmark bond



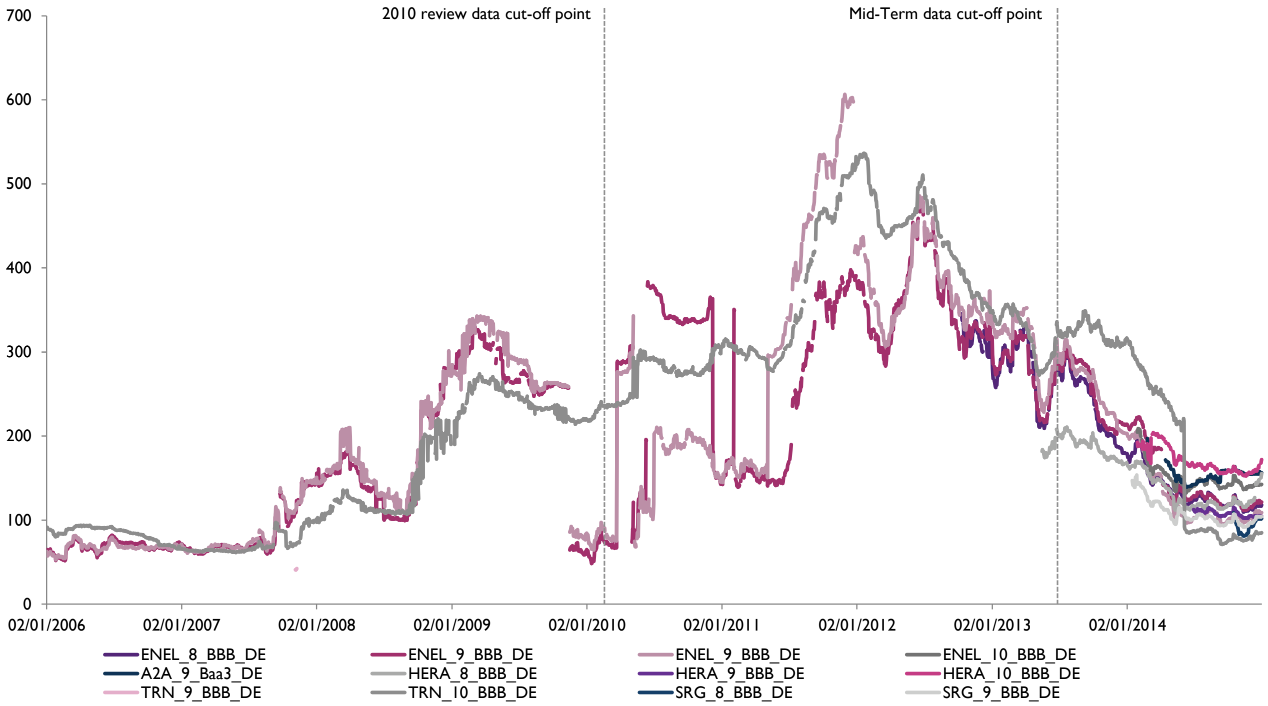
Note: Numbers in the legend represent years to maturity, followed by credit rating and the country of the benchmark bond used.
Source: Bloomberg, Europe Economics' calculations.

Table 3.5: Spread of euro denominated French utilities' bond over the German benchmark bond (in bps, as of 31/12/2014)

Company	Sector	Years to Maturity	Rating (S&P)	Spread 31/12/2014	Average (1 year)	Max (1 year)	Min (1 year)
EDF	Energy	8	A+	74	92	112	73
EDF	Energy	10	A+	136	172	204	136
EDF	Energy	11	A+	145	170	189	145
GDF	Gas & Electricity	8	A	61	79	93	61
GDF	Gas & Electricity	11	A	92	100	107	92
Average				102	123	141	101
Average A+				118	145	168	118
Average A				77	90	100	76

Note: Years to maturity are rounded figures.
Source: Bloomberg, EE calculations.

Figure 3.6: Spread of Italian utilities' bond (bps) over the German benchmark bond



Note: SRG stands for Snam Rete Gas. Numbers in the legend represent years to maturity, followed by credit rating and the country of the benchmark bond used.
Source; Bloomberg, EE calculations.

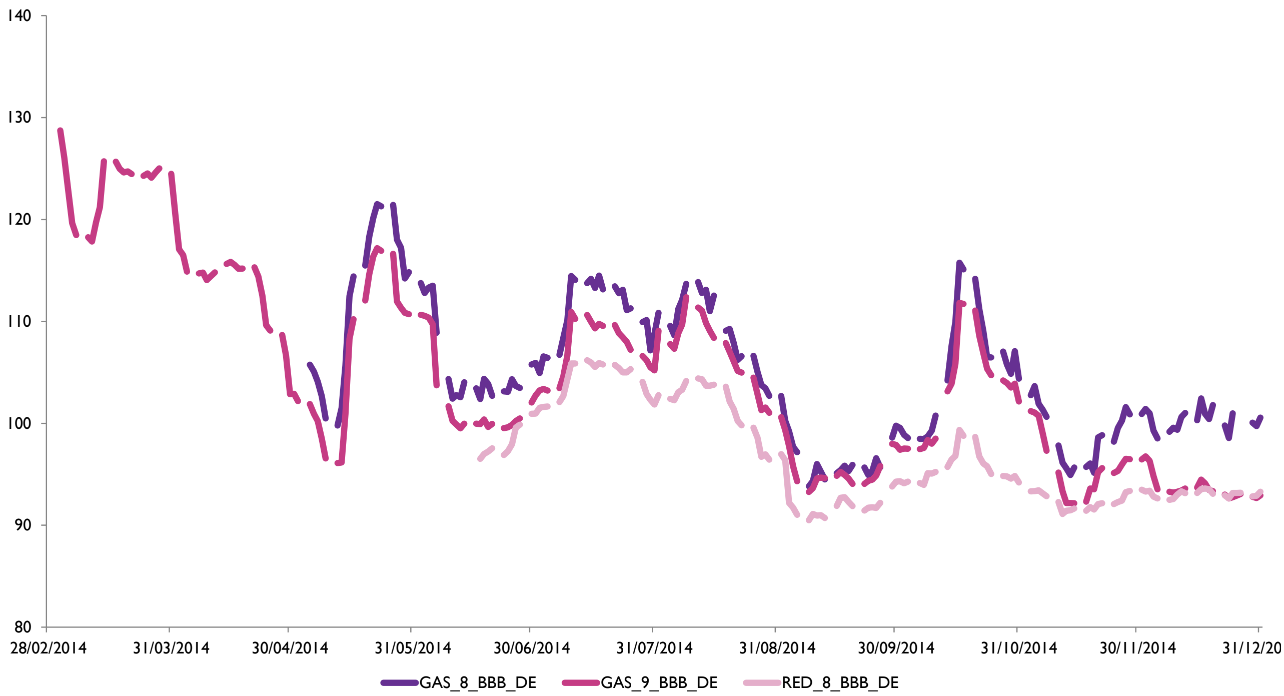
Table 3.6: Spread of euro denominated Italian utilities' bond over the German benchmark bond (in bps, as of 31/12/2014)

Company	Sector	Years to Maturity	Rating (S&P)	Spread 31/12/2014	Average (1 year)	Max (1 year)	Min (1 year)
ENEL	Energy	8	BBB	118	135	196	109
ENEL	Energy	9	BBB	121	145	222	111
ENEL	Energy	9	BBB	109	125	206	94
ENEL	Energy	10	BBB	142	150	209	132
A2A	Electricity	9	BBB	156	153	197	139
Hera	Gas & Electricity	8	BBB	155	131	170	112
Hera	Gas & Electricity	9	BBB	104	108	115	102
Hera	Gas & Electricity	10	BBB	172	170	204	152
Terna	Electricity	10	BBB	85	156	316	71
Snam Rete Gas	Gas & Electricity	8	BBB	102	92	109	81
Snam Rete Gas	Gas & Electricity	9	BBB	104	108	154	91
Average				**124**	**134**	**191**	**109**

Note: Years to maturity are rounded figures.
Source: Bloomberg, EE calculations.

Spanish utilities' bonds that made our sample were issued in 2014 and hence do not have sufficient historical data for the calculation of one year averages (see Figure 3.7). As a cross-check to other countries, we note that their average spot spread is 96 (Table 3.7).

Figure 3.7: Spread of Spanish utilities' bond (bps) over the German benchmark bond



Note: GAS stands for Gas Natural and RED for Red Electrica. Numbers in the legend represent years to maturity, followed by credit rating and the country of the benchmark bond used. Bonds matching our search criteria were only issued in 2014 for our Spanish comparators, therefore not covering the periods of the 2010 or the Mid-Term review.
Source; Bloomberg, EE calculations.

Table 3.7: Spread of euro denominated Spanish utilities' bond over the German benchmark bond (in bps, as of 31/12/2014)

Company	Sector	Years to Maturity	Rating (S&P)	Spread 31/12/2014	Max (since issue)	Min (since issue)
Gas Natural	Gas & Electricity	8	BBB	101	122	94
Gas Natural	Gas & Electricity	9	BBB	93	129	92
Red Electrica	Electricity	8	BBB	93	106	90
Average				96	119	92

Note: Years to maturity are rounded figures.
Source: Bloomberg, EE calculations.

A summary of the spot and one year average data analysed in this section is presented in the table below. In particular, we note that UK and Italian bonds, have significantly higher spot levels compared to core European bonds. Spain's bonds were all recently issued therefore not allowing the calculation of one year averages and they also have a significantly lower average time maturity compared to the other countries, justifying their average spot spread being lower than in France, and considerably lower than in Italy. Furthermore, with the exception of UK bonds, we observe a clear downward trend since the mid-term review for all other countries, reflected in both the included figures and the consistently lower spot spreads compared to one year averages.

Table 3.8: Summary of bond spread data by country (in bps, as of 31/12/2014)

Country	Average time to maturity	Average spot spread (31/12/2014)	One year average
UK	10	126	116
Germany	9.5	90	112
France	9.6	102	123
Italy	9.0	124	134
Spain	8.3	96	N/A

Source: Bloomberg, EE calculations.

3.8 Regulatory precedent

In PR3 (2010) we advised for a debt premium range of 100-140 bps and a point estimate of 120 bps. Our advice for the mid-term WACC review (2013) was for a range of 170-220. The table below presents the most recent regulatory decisions regarding the debt premium and the cost of debt in Ireland and the UK.

Table 3.9: Recent regulatory precedent for cost of capital in the UK and Ireland

Company	Ofwat (2014)	CER Irish Water (2014)	ComReg Eircom (2014)	CAR DAA (2014)	CC NIE (2013)	Ofgem NGET (2012)
Risk-free rate	1.25%	2.00%	2.30%	1.50%	1.50%	2.00%
Debt premium		1.90%	1.75%			
Cost of debt	2.59%	3.90%	4.05%	3.00%	3.10%	2.92%

Source: Various regulatory determinations.

3.9 Developments

Based on recent market evidence, the spread of euro denominated Irish utility bonds (to which we give particular weight) over the German government bond benchmark ranges from 64 bps to 100 bps (see Figure 3.2 and Table 3.1). Of these, the bond with the closest profile to our 10-year benchmark for the risk-free rate is the ESB 9 years to maturity bond issued in late 2013, with a spread of 100 bps.

3.10 Conclusion

The international bonds have average spot spreads in the range 90-126 bps. The Irish utilities bonds have a spot range of 64 to 100 basis points and a one-year average of 94-120 bps. With spreads of euro denominated bonds having moved downwards since the Mid-Term review, we place less weight on recent regulatory precedent.

We thus expect the debt premium to be in the range of 75-115 bps, with a point estimate of 100 bps — at or above current spot yields for Irish utilities and at or a little below spot yields for most other European utilities.

3.10.1 Cost of debt

Based on the above analysis the indicative range and point estimate for the cost of debt are as set below:

Table 3.10: Range and point estimate for the cost of debt

Low	High	Point estimate
2.5	3.25	2.90

4 Equity Risk Premium

4.1 PR3, Mid-Term Review and stakeholder submissions

At PR3 we recommended an Equity Risk Premium of 5.0. The same figure was used at the Mid-Term Review.

In their PR4 submissions, EirGrid used KPMG's assumption of a 5.0 per cent point estimate, while ESBN used Frontier's 4.6 per cent estimate.

4.2 The Equity Risk Premium

The CAPM equation[13] states that the expected return on a capital asset is equal to the return required on a risk-free asset plus a degree of non-diversifiable risk that is inherent to the market. The right-hand side of the CAPM equation therefore includes a term defined as the Market Risk Premium (MRP) (E(Rm)-Rf). Strictly speaking, a fully diversified portfolio might include assets such as land or gold, but no usable all-assets index exists. 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.

We note that it is sometimes asserted that stock markets do not have this property and that therefore the CAPM is not strictly correct. However, even if stock markets are not perfectly diversified, it does not follow that CAPM is incorrect — CAPM requires only that a fully diversified portfolio could, in principle, be constructed from all available assets (not merely shares). But it might follow that the ERP is an imperfect proxy, so that measured estimates of the CAPM did not perfectly capture the cost of capital. Specifically, it would mean that the risk on a maximally-diversified pure equity portfolio included risk that was specific to equities but could, in principle, be offset (diversified) in a wider asset portfolio. Hence the ERP would be greater than the MRP. Thus, the risk that stock markets do not permit full diversification is the risk that using the ERP results in an over-estimation of the cost of capital. Similarly, if periods of high stock market volatility are also periods in which stock markets temporarily function less well with the consequence that they lose some of their ability perfectly to diversify, a consequence will be that ERP estimates for those periods will over-estimate MRPs.

Standard practice for 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. 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 both data and methods used to estimate the ERP.[14] 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

[13] CAPM states that $E(R_i) = R_f + \beta_i (E(R_m) - R_f)$

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

year period (1900-2002). Their results showed that the equity risk premium has typically been lower than previous research had suggested.

An often cited survey conducted by Welch in 1998,[15] of the opinions of 226 financial economists who were asked to forecast the thirty-year arithmetic mean equity risk premium, showed that a large number of correspondents were calibrating their forecasts relative to the longest-run historical benchmark available from Ibbotson, and then altering the historical number downward based on subjective factors.

4.3 Methodological issues

4.3.1 Limitations of estimates of the risk premium based on short time periods

To find the expected future risk premium, extrapolation from the past is not sufficient; consideration has to be given to the question whether the future is likely to reveal a difference in the market preferences or institutional factors that have determined the historic risk premia. There are particular problems if extrapolation is based on a short time period.

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". The high corporate growth rates during the late 1990s, and the subsequent 'burst' of the technology bubble, is an example of extremes which cannot be relied upon for future predictions. For such reasons, Dimson et al. argue that judgements should be informed by the full extent of financial history.

Using the achieved premium in returns to forecast the required risk premium depends on having a long enough period. Even with more than 100 years of data, market fluctuations have some impact. In addition, the underlying MRP could vary over time (e.g. as tastes for risk evolve). It is, moreover, important to take into account the fact that stock market outcomes are influenced by many factors. For example, non-repeatable events (such as the removal of trade barriers) would feasibly mean projected premia should differ from past premia.

This problem can be illustrated by comparing the first and second halves of the twentieth century. Several factors may have contributed to the high returns achieved during the second half of the twentieth century. These include:

- Unprecedented growth in productivity and efficiency and great technological change have led the market outcome to exceed investor expectations. (But higher growth in corporate cash flows then became known to the market and presumably built into higher stock prices.)
- Stock prices rose relative to dividends because of a fall in the required rate of return due to diminished business and investment risk. Factors reducing business risk included increased international trade flows and the end of the Cold War. Investment risk may also have diminished through diversification.
- Transaction and monitoring costs fell materially over the century.

A major shortcoming of the Ibbotson Associates, Barclays Capital and CSFB reported premia is the historical success of the US equity market and survivorship bias, alongside bias in the index construction due to narrow

[15] Welch, I, (1998), "Views of Financial Economists on the Equity Premium and Other Issues", *Journal of Business*, Vol. 73, 2000, pp. 501-537.

coverage.[16,17] Dimson et al. point out that even when indices are constructed to account for survivor bias within countries, the very fact that certain markets did not survive through the very long run (a century) means that certain countries had to be omitted such as Poland, Russia and China. These markets would have been likely to have had smaller measured returns than those in the sample.

4.3.2 Arithmetic or geometric mean?

Discussions of the ERP explore the implications of using the arithmetic or the geometric mean of historical equity premia.[18] The arithmetic mean of a list of numbers is simply the sum of the numbers divided by the number of items in the list (n). To calculate the geometric mean the numbers in the list are multiplied and then the *n*th root of the resulting product is taken. There are reasons for using each when calculating the ERP. In theory, the arithmetic mean treats each estimate as independent of the others (consequently it is considered to be "forward looking"), and therefore corresponds to the "true" expectation. The geometric mean necessarily tracks past estimates, and will therefore always be smaller than the arithmetic mean in the presence of market volatility. The geometric mean's stickiness renders it a superior indicator of the magnitude of past returns.[19]

In this context, the arithmetic mean is preferred for the following reasons:

- investment is at the margin;
- investment is forward looking; and
- there is no mean-reversion (weak efficient markets hypothesis).

The two means are linked by volatility when returns are distributed along a lognormal distribution, which is commonly assumed in long-term equity markets.[20] 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).

The relationship between the arithmetic and geometric mean is perhaps more easily understood through a mathematical explanation, proof and example. 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.[21] To be clear, if (in the impossible scenario that) there were no volatility in annual returns, the arithmetic mean return would equal the geometric mean return. While the difference between (arithmetic) mean log returns and the geometric mean is typically very small, this relationship gives rise to the counter-intuitive result that an asset may have negative geometric mean returns but positive arithmetic mean returns (i.e. if an investor loses money over a long period of time).

As an example, Dimson, Marsh and Staunton (2001) suppose that a general estimate for the standard deviation[22] of equity market log returns (over a 102-year period) is 0.2. Let us assume that the true distribution of returns is normal. Then the difference between the arithmetic and geometric mean is

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16 Survivorship bias refers to the tendency for markets (and therefore estimates of returns) to include equity from only companies that have been successful but not account for those which have folded, thereby overestimating returns.

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

18 What is conventionally referred to as the "geometric mean" is technically the compound average return — or the geometric average of 1 + R_{jt}, minus one.

19 Abrams, Dr. Jay (1996) "Arithmetic vs. geometric means: empirical evidence and theoretical issues." www.abramsvaluation.com/pdf/Arith_geom.pdf.

20 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.

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

22 Standard deviation is the square root of the variance ($\sigma = (\sigma^2)^{1/2}$).

approximately $(0.2)^2/2$=2%. A two percentage point difference between the two mean returns is non-trivial. Moreover, as volatility increases, the difference grows more rapidly; for volatility levels of 0.3, the gap becomes 4.5 per cent.

Now let us assume that the true distribution of returns is lognormal: if $E(r)$=0.04, the geometric mean return is $\exp(0.04)-1$, or 4.08 per cent — a very small difference.

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.

4.3.3 Limitations of the historical approach

The use of the DMS methodology, which we still consider the most robust approach to infer the ERP, presents some problems in the current financial and economic context.

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".[23]

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. On the commonly-used (though not official or economically meaningful) definition of recession as meaning two consecutive quarters of contraction, Ireland has now been out of recession since the third quarter of 2012 — so 10 or 11 quarters at the time of writing and perhaps 14 quarters (three and a half years) by the time of the commencement of the price control. On the other hand, Ireland suffered two non-consecutive quarters of contraction during 2013 and thus has only had four or five consecutive quarters of growth since the last contraction. We believe it is reasonable to regard PR4 as occurring either totally or overwhelmingly in a period in which the ERP should be expected to be at a "normal level".

4.4 Regulatory precedent

In PR3 (2010) we advised the CER for an ERP of 4.5-5.4 with a point estimate of 5.2 per cent. Our suggested ERP range for the Mid-Term WACC review (2013) was between 4.6-5.0 per cent.

The table below lists Irish regulatory precedent on the equity risk premium. It can be observed that the ERP has been in the range of five to six per cent since 2000.

[23] 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)).

Table 4.1: Total market returns in Irish regulatory determinations, 2000-2014

Regulator	Subject	Year	ERP
CER	ESB PG	2000	5.4
CAR	Aer Rianta	2001	6
CAR	Irish Aviation Authority	2002	6
CER	Bord Gáis Éireann	2003	6
ComReg	Eircom	2003	6
CAR	Dublin Airport Authority	2005	6
CER	ESB PG	2005	5.25
ComReg	Eircom	2008	6
CAR	Dublin Airport Authority	2009	5
CER	EirGrid and ESB	2010	5.2
CAR	Irish Aviation Authority	2011	5
CC	NIE	2013	5
CAR	DAA	2014	5
ComReg	Eircom	2014	5
CER	Irish Water	2014	5

Source: Various regulatory determinations.

The regulatory precedents set out in Table 4.1 above suggests an equity risk premium in the range of 5.0-6.0 per cent, with determinations prior to 2005 showing a strong preference for 6 per cent and almost all determinations after 2009 picking an ERP of 5 per cent. Note that determinations in the period up to 2005 generally had higher ERPs, with a strong preference for 6.0 per cent, whereas in the period after determined risk premia have been lower. This may appear counterintuitive, but may reflect very high total market returns in Ireland during the early 2000s in a period of particularly strong growth.

4.5 Developments

The most recent (2013) figures from DMS indicate that the long term arithmetic average for the ERP in both Ireland and Europe is 4.6. This was the same figure as for 2012 for Ireland and a decline of 20 bps from the 2012 figure for Europe. Whilst it is a well-accepted regulatory practice to rely on DMS figures, we notice that, since DMS figures rely on Irish bond yields for the calculation of ERP, the extraordinary high levels that Irish bonds reached from 2010-2012 is likely to have resulted in a downward biased ERP estimate.

In light of this, some form of uplift to the DMS figure in order to reflect these distortions appears appropriate. We employ two methods in order to adjust the DMS ERP estimate for Ireland to account for the high Irish yields in the period 2009-2013. Both methods produce an estimate for every year in this period that should be added to the respective DMS estimate after being appropriately weighted.

The first method makes use of the difference between one-year average daily yields of 10-year Irish and German government bonds for every year during 2009-2013. This creates five data points that need to be weighted according to the equal historic weight that they hold in the entirety of the DMS sample (114 years). The table below illustrates how the first method is used in order to obtain a total adjustment value of 0.19 per cent. Applied to the 2013 DMS figure of 4.6 per cent for Ireland this would imply a 4.79 per cent figure.

Table 4.2: ERP Adjustment – Method 1

Year	Average Irish Yield	Average German Yield	Difference	Weight	Adjustment
2009	5.14%	3.27%	1.87%	1/114	0.02%
2010	5.74%	2.78%	2.96%	1/114	0.03%
2011	9.55%	2.65%	6.90%	1/114	0.06%
2012	8.21%	1.56%	6.64%	1/114	0.06%
2013	4.67%	1.63%	3.04%	1/114	0.03%
Total					0.19%

Source: Bloomberg, Europe Economics' calculations.

The second method accounts for the fact that German yields have been very low throughout this period by examining differences with the average yields in 2008 (which is taken as the base year for this calculation). This results in tracking relative movements as opposed to focusing on yield levels. In the table below we present the steps leading to our final adjustment figure for method 2. With a total adjustment of 0.17 per cent implied by the second method, the adjusted ERP figure would be 4.77 per cent.

Table 4.3: ERP Adjustment – Method 2

Year	Average Irish Yield compared to 2008	Average German Yield compared to 2008	Difference	Weight	Adjustment
2009	0.64%	-0.73%	1.37%	1/114	0.01%
2010	1.25%	-1.22%	2.46%	1/114	0.02%
2011	5.05%	-1.35%	6.40%	1/114	0.06%
2012	3.71%	-2.43%	6.14%	1/114	0.05%
2013	0.17%	-2.37%	2.54%	1/114	0.02%
Total					0.17%

Source: Bloomberg, Europe Economics' calculations.

4.6 Conclusion

We suggest an ERP range of 4.6-5.0 (thus, using the DMS number as a lower-bound) and a point estimate of 4¾ influenced by our proposed adjustments to the DMS estimates and by the further normalisation in the ERP, relative to our 2014 Comreg advice, entailed by an additional year having passed, by the time of the commencement of PR4, since the end of the Irish recession.

5 Equity Beta and Cost of Equity

5.1 PR3, Mid-Term Review and Stakeholder Submissions regarding asset beta

At PR3 we recommended an asset beta of 0.3, the same figure being used at the Mid-Term Review.

For PR4 the stakeholder submissions were: ESBN proposed an asset beta of 0.36 whilst EirGrid proposed an asset beta of 0.4.

5.2 Analysis of risks faced by the TAO, DSO and TSO

The applicability of a RAB-WACC approach or a margin alternative is considered in a separate document. This section explores the issues arising from the following question: if a RAB-WACC approach is methodologically appropriate and there is a correctly specified RAB, what is the right WACC?

5.2.1 The transmission and distribution networks

Transmission asset owner (TAO) – ESB networks

ESB Networks[24] is the licensed owner of the transmission system - the transmission asset owner (TAO). The role of the TAO is to ensure that the transmission system is developed and maintained in accordance with the requirements set down by the transmission system operator (EirGrid).

The TAO has responsibility for the management of the transmission capital and maintenance work programmes. This includes the building of new high-voltage substations and their associated overhead lines and underground cables. It also involves responding to network faults and carrying out planned maintenance and refurbishment works on these assets.

The TSO EirGrid is responsible for operating the network of high-voltage transmission lines and substations to transport power from the various electricity generators to where it is needed and for setting out the planned development needs of the transmission network.

There is a legal agreement in place between EirGrid and ESB Networks (the "Infrastructure Agreement") which sets out the terms under which ESB Networks provides infrastructure services to EirGrid. The agreement was approved by CER and came into effect on 1 July 2006 – the same date as the legal establishment of EirGrid as the TSO.

Transmission system operator (TSO) – EirGrid

EirGrid is the independent state-owned body licensed by the CER to act as transmission system operator (TSO).

The electricity transmission system (commonly known as the national grid) is a high voltage network for the transmission of bulk electricity supplies around Ireland. Generally the high voltage lines deliver electricity from Ireland's generation sources to the transformer stations, where the electricity voltage is reduced and taken through the distribution system to individual customers' premises.

[24] ESB Networks is a ring fenced subsidiary within ESB Group.

EirGrid is responsible for the operation, development and maintenance of the system. The TSO also offers terms and levies charges for connection to and use of the transmission system. These are regulated by the CER.

The Connection Agreement is structured in three parts: the Connection Agreement contains the specific provisions in respect of connecting both generation and demand customers; the General Conditions contains the general provisions of the Connection Agreement; and Schedule 10 contains construction and commissioning provisions.

Distribution system operator (DSO) – ESB Networks Ltd

ESB Networks Ltd is the licensed operator of the electricity distribution system – the distribution system operator (DSO).

The distribution network is the medium- and low-voltage electricity network used to deliver electricity to connection points such as houses, workplaces and street lights.

ESB Networks as Distribution Asset Owner (DAO) owns and is responsible for building, maintaining and operating the entire distribution level network infrastructure. This includes all overhead electricity lines, poles and underground cables used to bring power to Ireland's customers.

Distribution tariffs are the charges paid for using the distribution system. The tariffs are paid by the suppliers who use the system (and are ultimately passed on to customers). The CER sets the tariffs to be applied for use of the network. Distribution tariffs are reviewed annually. The CER periodically carries out full reviews of the costs that ESB Networks incurs owning, maintaining and operating the distribution system to ensure that only equitable levels of costs are collected through the distribution tariffs (the price control review).

5.2.2 Underlying business risks

We now discuss the underlying risks in carrying out the business activities of the TAO, TSO and DSO. As only systematic risks affect the appropriate cost of capital, we focus on this type of risk. However, we first include a brief outline of some of the specific risks which may affect the networks.

- Specific risks — those risks that only apply to a particular asset class and which are not correlated with the overall returns of the market portfolio. As these risks can be diversified by investors they do not affect a company's cost of capital
- Systematic risk — also known as market or non-diversifiable risk, is risk that is characteristic of an entire market. As it cannot be diversified away by investors, the extent of the systematic risk affects a company's cost of capital.[25] Examples of risks with a systematic element affecting the transmission and distribution networks are discussed below.

Systematic risk can be divided into cost risk and demand risk. Of these, in most industries the dominant form of systematic risk is demand risk.

Demand volatility

There are a number of factors that can affect the demand for the services of the TAO, TSO and DSO. Types of demand risk affecting the transmission and distribution networks are:

- the number of customers (both existing and new connections);
- the voltage transported; and
- the length of network required.

[25] As explained in section 1, exposure to systematic risk is captured in the CAPM equation by the size of company's equity beta, which is multiplied by the market risk premium and added to the risk-free rate to determine the cost of equity.

Although there would be specific factors affecting demand such as environmental legislation, there would also be systematic components to demand – for example, a country's GDP which could affect the demand for energy. Growth in the Republic of Ireland's GDP is also likely to be correlated with the number of new premises built and hence the number of new connections.

The demand for EirGrid's services is derived from demand for electricity in Ireland and thus demand from ESB and generation and load directly connected to the transmission system. But not all fluctuations in electricity demand, either voltage transported or number of customers, will induce fluctuations in demand for EirGrid's services, because the management of the transmissions assets will be fairly consistent even as output varies. It is therefore natural to assume that EirGrid's systematic demand risk exposure will tend to be less than that of ESB.

Bad debts

Customer defaults affect a company's profitability. The proportion of customers defaulting on their utility bills is likely to rise in a recession and hence bad debts can be a systematic risk for the industry, primarily affecting the suppliers of electricity

Customers are also more likely to fall behind on their bills in a recession, even if their bills are still ultimately paid. This will be costly for companies as cash will be received later rather than sooner, either requiring companies to raise working capital to cover their cash requirements (with associated financing costs), or meaning that companies forego the opportunity to earn returns on this cash during the period of delay.

Changes in input costs

Changes in input costs affect the revenues of the TAO, TSO and DSO. Input costs include the costs of construction materials as well as the costs of paying wages to staff. The networks may also be affected by changes in oil prices and related factor inputs.

Changes in inputs such as wages are systematic in nature to the extent that they affect the whole economy. However, there may be a specific element to certain inputs if only particular categories of that input are affected (for example, the wages of construction workers).

Interest rate movements

Changes in interest rates affect the whole economy and are hence a systematic risk.

Interest rates can affect the costs of raising finance, and the repayment terms of existing debt where debt has a floating rather than a fixed interest rate. Bond prices move inversely to interest rates, with bond prices being lower when interest rates are high and vice versa. This is because with a static coupon bond prices and bond yields are inversely related (the higher the price of the bond, the lower the real yield); and bond holders are prepared to accept a lower rate of return (yield) when interest rates are low; but demand a higher yield when interest rates are high.

Interest rates will have direct effects on a company's systematic risk but also indirect effects as they may have an impact on demand volatility and input costs.

Changes in inflation/ deflation

Changes in inflation affect the whole economy and therefore represent a systematic risk. The inflation rate affects the real amount which a firm ends up repaying on nominal debt. Inflation may also affect input costs.

As a result of the recent financial crisis, the European Central Bank is close to announcing its quantitative easing program in order to combat deflationary pressures. Deflation increases the real amount repayable on nominal debt, although companies may benefit from lower input costs.

Like interest rates, the rate of inflation will also have direct effects on a company's systematic risk but also indirect effects on other factors such as demand volatility. Inflation also affects revenues through indexation.

The extent to which a company is affected by interest rate movements and changes in inflation will be influenced by the amount of finance it needs to raise. Companies which have to undertake large amounts of investment may therefore face higher risks.

5.2.3 Other Factors affecting risk exposure

There are certain factors that affect a company's exposure to systematic risk. These include the regulatory framework and cost structure.

Regulatory framework

A regulatory framework can either increase or decrease a company's exposure to systematic risk when compared with an unregulated company performing similar functions.

A firm allowed full cost pass-through or with rate-of-return regulation faces no increase in systematic risk if there is cost uncertainty.

Whether the price control takes the form of a price cap or a revenue cap affects a company's systematic risk. The two alternatives work as follows:

- *Price cap* – the regulator agrees a fixed set of tariffs. The revenue which the company earns from these tariffs would depend on market volumes. Under a pure price cap approach, the company is fully exposed to the revenue consequences of any change in market volumes. In other words, its revenue would increase if market volumes increased, but would fall if market volumes decreased.
  However, price cap regulation decreases a firm's beta when compared with an unregulated firm. This is because profits rise less for the regulated firm compared with the unregulated firm when there are positive shocks to demand due to the price cap placing a limit on price rises, but profits will fall due to negative shocks in the same way as for an unregulated firm since prices can (at least in theory) fall below the cap. Overall, profits for the regulated firm are less variable (and on average lower, due to not being able to take full advantage of upside shocks) than when the firm is unregulated. This lower variability in profits leads to a lower beta for the regulated firm when compared to an unregulated firm.
- *Revenue cap* – the regulator would agree the revenues that the company should be allowed to earn. Tariffs would be calculated so as to recover these revenues on the basis of projected market volumes. However, in the event that out-turn market volumes differed from these projections, any over- or under-recovery of revenue would be taken into account in finalising the tariffs for the following year. As tariffs are changed annually (to allow a set level of revenues to be earned) the company is exposed to less systematic risk than companies with a pure price cap.

Regulators are not necessarily restricted to choosing between the pure price cap and revenue cap approaches described above, since it is also possible to employ a hybrid approach. For instance, a price control could be set such that 50 per cent of allowed revenue is fixed, with the company exposed to changes in market volumes in relation to the other 50 per cent. This type of arrangement is sometimes referred to as including a "volume driver" within the price control.

There are a number of mechanisms that a regulator can use to reduce a company's exposure to systematic risk. These include the type of price cap, cost pass through items and revenue drivers.

Cost structure

Another risk consideration is related to the concept of operation leverage. A firm's operating leverage refers to the level of its fixed costs relative to variable costs. To see how this relates to beta, first note that the present value of an asset is equal to the present value of revenues, less the present values of fixed and variable costs:

$$NPV(asset) = NPV(revenue) - NPV(fixed\ costs) - NPV(variable\ costs)$$

This can also be expressed with respect to the present value of revenue:

$$NPV(revenue) = NPV(asset) + NPV(fixed\ costs) + NPV(variable\ costs)$$

Given this expression, the beta of the present value of the asset's revenue (as distinct from the beta of the present value of the asset itself) can then be expressed as

$$\beta^{REV} = [NPV(asset) / NPV(revenue)] \cdot \beta^{ASSET} + [NPV(fixed\ costs) / NPV(revenue)] \cdot \beta^{FIXED} + [NPV(variable\ costs) / NPV(revenue)] \cdot \beta^{VARIABLE}$$

By definition, the beta of fixed costs should be approximately zero, while the betas of revenue and variable costs should be approximately equal as they both change in response to output. Noting these, and rearranging the above expression implies

$$\beta^{ASSET} = \beta^{REV} \cdot (1 + [NPV(fixed\ costs) / NPV(asset)])$$

This states, therefore, that firms with a high ratio of fixed costs to asset value have higher asset betas.

Even though it would possible in principle to assess whether a difference in operating leverage between EirGrid and ESBN leads to wedge between the asset betas of the two companies, we are unable to conduct such analysis because we lack (as illustrated in in details in a separate note) an estimate of EirGrid's asset value that would be relevant and appropriate for the purpose.

5.2.4 Conclusion

We have identified no compelling reason to believe that there is a material difference between the systematic risk exposures of the TAO, TSO and DSO. Theoretical considerations might suggest that the TSO should be expected to be subject to less demand risk that the other players. On the other hand, the impact of differences in operating leverage, which could be material, are unknown and unknowable.

Our judgment is that, if the enterprise value is specified correctly, the rate of return on total assets (as measured by enterprise value) is likely to be similar between the TAO, TSO, and DSO. However, we note that in an accompanying document we explain our view that it can be argued that EirGrid's enterprise value may not be fully reflected in its RAB.

5.3 Methodology

We discuss here, general methodological issue for the estimation of asset beta. More specifically, this subsection is organised as follows:

- Use of comparator analysis.
- Empirical specification.
- Choice of the appropriate market portfolio.
- Estimation period.
- Equity beta adjustments.
- De-levering of equity beta into asset beta.
- Gearing measures used for un-lever equity beta.
- Re-levering asset beta into equity beta.

5.3.1 Use of comparator analysis

For publicly listed regulated entities it is common practice to estimate asset beta from direct market data. Since ESBN and EirGrid are not listed, their asset betas must necessarily be inferred from a set of relevant comparators – ideally, listed companies carrying out comparable activities and subject to similar economic

regulation. Consistently with the approach used in PR3 and the mid-term WACC review, the set of relevant comparators is composed of utilities that operate in the European energy sector and own electricity or gas transmission and distribution networks. In addition, we have included comparator companies that operate in the UK water sector, reflecting the similarities between water and energy networks.[26] 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.

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. The table below lists the comparators used in this report and indicates whether they were used in 2010 and/or the mid-term Review.

Table 5.1: List of comparators

Company	Sector	Country
National Grid	Electricity	UK
Severn Trent	Water	UK
SSE	Gas and Electricity	UK
Pennon**	Water	UK
Centrica**	Gas and Electricity	UK
United Utilities**	Water	UK
Scottish Power*	Gas and Electricity	UK
Viridian*	Gas and Electricity	UK
ENEL	Energy	IT
A2A**	Electricity	IT
Hera**	Gas and Electricity	IT
Terna**	Electricity	IT
Snam rete gas*	Gas and Electricity	IT
Endesa**	Energy	ES
Gas Natural**	Gas and Electricity	ES
Red Electrica	Electricity	ES
REN*	Gas and Electricity	PT
EDP**	Energy	PT
Veolia**	Water	FR
EDF	Energy	FR
GDF Suez	Gas and Electricity	FR
RWE	Energy	DE
EnBW**	Gas and Electricity	DE
E.ON	Gas and Electricity	DE

Note: * refers to companies that were only included in the 2010 report, ** refers to companies that were only included in the mid-term review. Companies with no asterisks were included in both reports.

Beta estimates for comparators can either be taken direct from existing sources (e.g. Bloomberg or the LBS Risk Management Service), or they can be estimated from data on company and stock market returns. The advantage of the former is that it is less resource-intensive, whereas the advantage of the latter is that it gives greater control over how the estimation is carried out. We have opted for the latter approach, which is consistent with the methodology employed for the Mid-Term review.

[26] The three UK water and sewerage companies are Severn Trent, Pennon 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.

5.3.2 Empirical specification

The (raw) equity beta (β_i) measures the covariance between the company (i) return over the safe rate with the market return over the safe rate. The equation to be estimated is usually:

$$R_{i,t} = \alpha + \beta_i R_{m,t} + \varepsilon_{it}$$

where $R_{i,t}$ is the log excess return on asset *i* at date *t* (log return net of the logarithmic safe rate), $R_{m,t}$ is the log excess return on the market, α is a constant, β_i is the equity beta, and ε_{it} is an error term — the non-systematic component of the return to the asset — which may display both heteroskedasticity and autocorrelation.

The excess return $R_{i,t}$ is constructed as a data manipulation prior to estimation and is defined as:

$$R_{i,t} = ln\left(\frac{P_t + D_t}{P_{t-1}}\right) - \ln(1 + R_{f,t})$$

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 $R_{f,t}$ is the safe rate available today.

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 estimations without netting off the risk-free rate from individual share and market index returns.

5.3.3 Choice of the market portfolio

With regard to the market portfolio for calculating $R_{m,t}$, we have chosen the following domestic equity markets indices:

- Deutsche Börse AG German Stock Index (Germany).
- CAC 40 Index (France).
- FSTE MIB Index (Italy).
- PSI All-Share Index (Portugal).
- IBEX 35 Index (Spain).
- FTSE All-Share Index (UK).

As a cross-check betas were estimated also on a European wide market index (i.e. the MSCI-All Countries-Europe Index).

5.3.4 Data frequency

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. 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.

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.

5.3.5 Estimation period

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.[27]

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.

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.

We have therefore adopted the Smithers & Co (2003) recommendation and have based our analysis primarily on two years rolling betas. As an additional cross-check we also estimated betas on 1-year and 5-year windows of daily data.

5.3.6 Adjustments to estimated betas

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.

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. 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. 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.

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.

5.3.7 De-levering equity beta into asset beta

When comparing the betas of different firms, one has to take into account the different gearing levels that firms choose since — all other things being equal — a firm with higher gearing will exhibit a higher equity beta. Therefore, unless one controls for this effect, there is a danger of confusing the risk that comes from high leverage with the underlying systematic risk that a firm faces by virtue of the nature of its activities.

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[27] We note that the single point estimate for beta will embody expectations for returns over the lifetime of the assets involved. There is thus no intrinsic tension between the use of a beta point estimate and its application to a five-year price control.

Asset betas are calculated in order to control for the effect of differing levels of gearing. An asset beta is a hypothetical measure of the beta that a firm would have if it were financed entirely by equity. By comparing different firms' asset betas it is possible to isolate shareholders' perceptions of underlying systematic risk, and carry out an assessment of the relative riskiness of different companies after controlling for gearing.

De-levered asset betas are calculated using the following formula:

$$\beta_{A,i} = (1 - g_i)\beta_i + g_i\beta_i^D$$

where $\beta_{A,i}$ is a firm's asset beta, β_i is a firm's raw equity beta, g_i is the company's gearing, and β_i^D is the firm's debt beta.[28] De-levered asset betas for comparators have been calculated assuming zero debt betas.

5.3.8 Gearing measures used for de-levered asset beta

An important practical issue relates to the choice of gearing measure which is used to de-lever the equity betas in order to estimate asset betas. In particular, a choice has to be made about the measure of asset value which is going to be used in the denominator of the gearing measure.

At a conceptual level, our preferred measure of gearing would be net debt to RAB, given that the TAO, TSO and DSO are subject to RAB-based price regulation. However, many of the comparator companies include generation and supply businesses as well as network businesses, and in many cases there will not be a RAB figure available for businesses operating in these parts of the supply chain (e.g. generation and supply are not subject to RAB-based price regulation in the UK). Further, where the comparator company owns a number of network businesses, there may be no readily available RAB figure at a group level even if a RAB exists for some or all of the subsidiary companies.

We have considered two of the gearing measures available in Bloomberg:

- total debt / total assets, where asset values appear to be based on book values in statutory company accounts; and
- total debt / total capital, where total capital appears to be based on net debt and market capitalisation.

In our view, the asset values in statutory company accounts do not form a good basis for measuring gearing. They may differ substantially from asset values that would be included in a RAB for a number of reasons – for instance, unlike the RAB, asset values in statutory accounts are not indexed to inflation.

By contrast, under certain conditions (e.g. including that the regulatory WACC reflects the company's true market cost of capital, and that there is no under-performance or out-performance against regulatory assumptions on opex and capex), one would expect the market value of a company to be in line with its RAB.

While these conditions will not always hold in practice, we nonetheless consider that using a gearing measure based on the market value of a company will tend to reflect more closely our ideal measure of gearing (net debt / RAB) than one based on the book value of assets in statutory accounts.

In the light of this, we have used Bloomberg data on total debt / total capital as expressed through net debt/(net debt + market capitalisation) as our measure of gearing for most companies.

5.3.9 Re-levering asset beta into equity beta

Once, based on comparators analysis, a decision is taken on what are the appropriate asset beta values for ESBN and EirGrid, these can be expressed back as equity beta through a re-levering exercise which makes

[28] The debt beta measures the covariance between the return on a company's debt with the market return. In this work we assume a debt beta of zero (this is in keeping with a number of regulatory precedents), and also carry out sensitivity analysis assuming non-zero debt betas based on companies' credit ratings.

use a notional gearing level g (see Section 6 for a discussion on gearing), though the following formula (where, again, we assume zero debt beta):

$$= \beta_i = \frac{\beta_{A,i} - g\beta_i^D}{(1-g)}$$

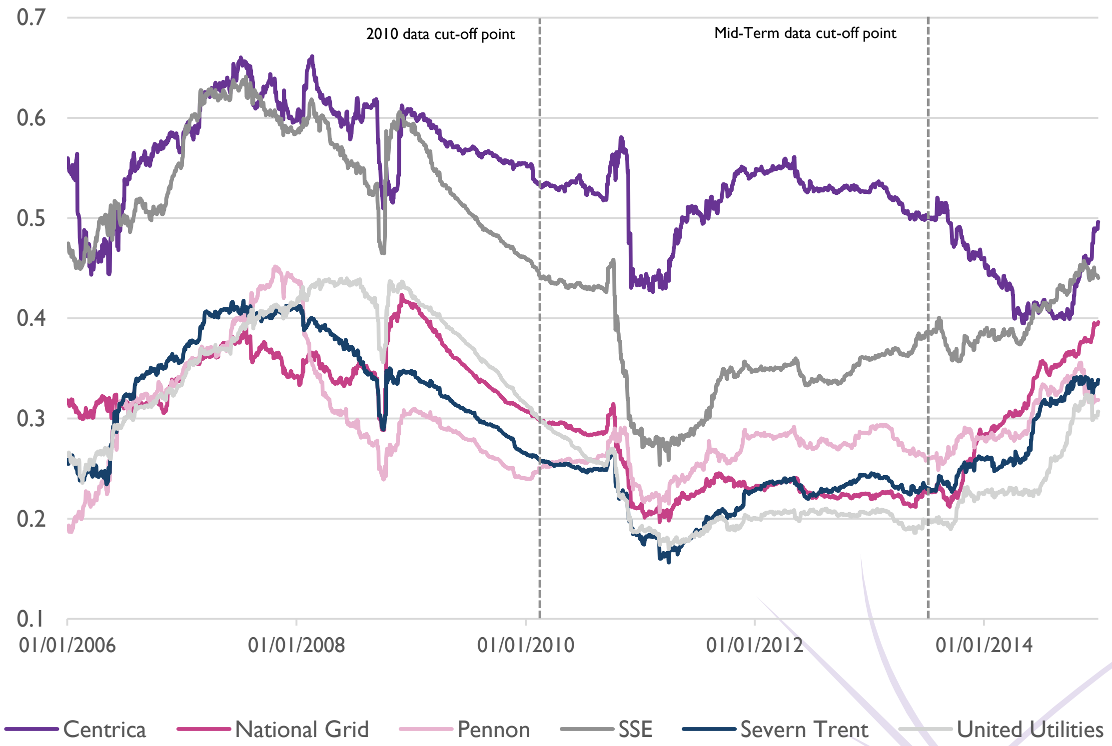
5.4 Analysis of comparators

5.4.1 UK comparators

Figure 5.1 shows the two-year rolling asset betas from 01/01/2006 to 31/12/2014 for UK utilities. These have been estimated using a debt beta of zero and by regressing individual company total returns on the FTSE All Share Index.

Asset betas for all UK utilities except Centrica have been increasing since the mid-term Review cut-off point indicating that the previously prevalent safety haven effect is now fading as the economy has normalised. This would imply that betas of companies perceived as low risk, such as utilities, can be expected to move closer to a value of 1. For Centrica, the asset beta has remained unchanged at around 0.5 which could be explained due to the different business nature of the company. Additionally, UK energy companies have higher asset betas compared to UK water companies.

Figure 5.1: Rolling 2 year asset betas of UK comparator utilities (01/01/2006-31/12/2014)



Source: Bloomberg, Europe Economics' calculations.

Table 5.2 provides a snapshot of rolling two year asset betas for UK utilities at the data cut-off points for the 2010 report, the mid-term review and the present report. The asset betas of all but Centrica decreased between 2010 and 2013, possibly reflecting the safe haven status that utilities can be perceived to have in the time of crisis. This evidently reversed in the period after the Mid-Term Review, possibly due to the perceived normalisation of the economic environment reducing the appeal of safe havens.

Table 5.2: Comparison between UK utilities' asset beta at the cut-off dates of 2010 report, Mid-Term review and current report

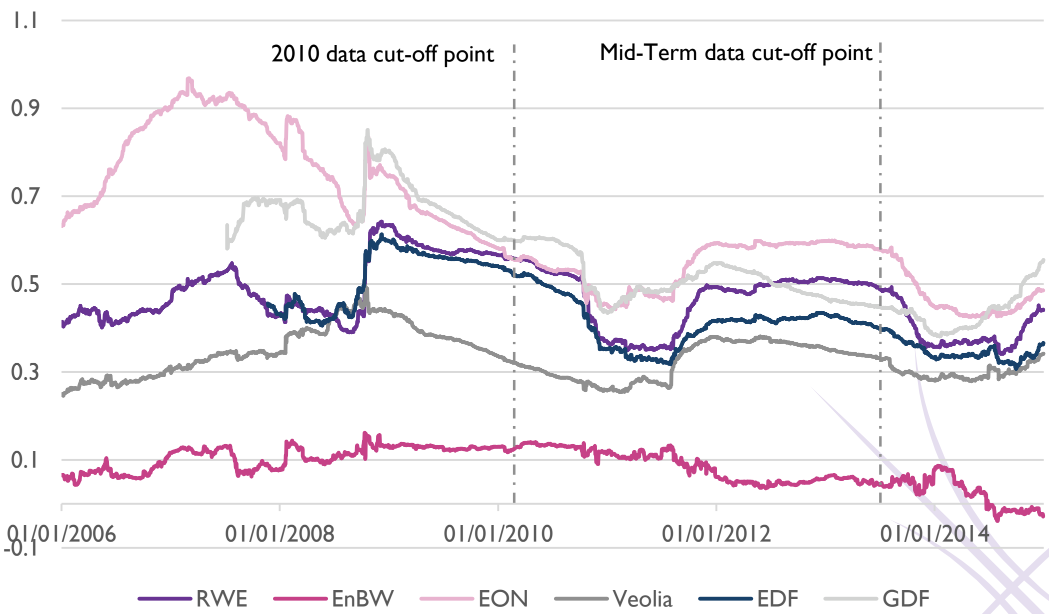
Company	Asset beta at 28/02/2010	Asset beta at 16/07/2013	Asset beta at 31/12/2014
Centrica	0.53	0.50	0.50
National Grid	0.30	0.23	0.40
Pennon	0.26	0.26	0.32
SSE	0.45	0.39	0.44
Severn Trent	0.26	0.23	0.34
United Utilities	0.30	0.20	0.31
Average	**0.35**	**0.30**	**0.38**
Average without Centrica	**0.31**	**0.26**	**0.36**
Minimum	0.26	0.20	0.31
Maximum	0.53	0.50	0.50

Source: Bloomberg and Europe Economics' calculations.

5.4.2 European comparators

The asset betas for the European comparators have been estimated using a debt beta of zero and by regressing individual company total returns on the broadest possible domestic stock indices. Figure 5.2 shows the rolling two year asset betas from the 01/01/2006 to 31/10/2014 for European utilities based in Germany and France. Asset betas decreased towards the end of 2010-beginning 2011 before rebounding and stabilising at levels broadly similar to those observed at the beginning of 2010. Since the Mid-Term Review, asset betas have been within the 0.3-0.5 range, picking up towards the second half of 2014, with GDF being the only company to exceed 0.5 as of 31/12/2014. EnBW is a notable outlier within this sample of companies, exhibiting consistently low asset beta in the region of 0-0.1 and often falling to negative values.

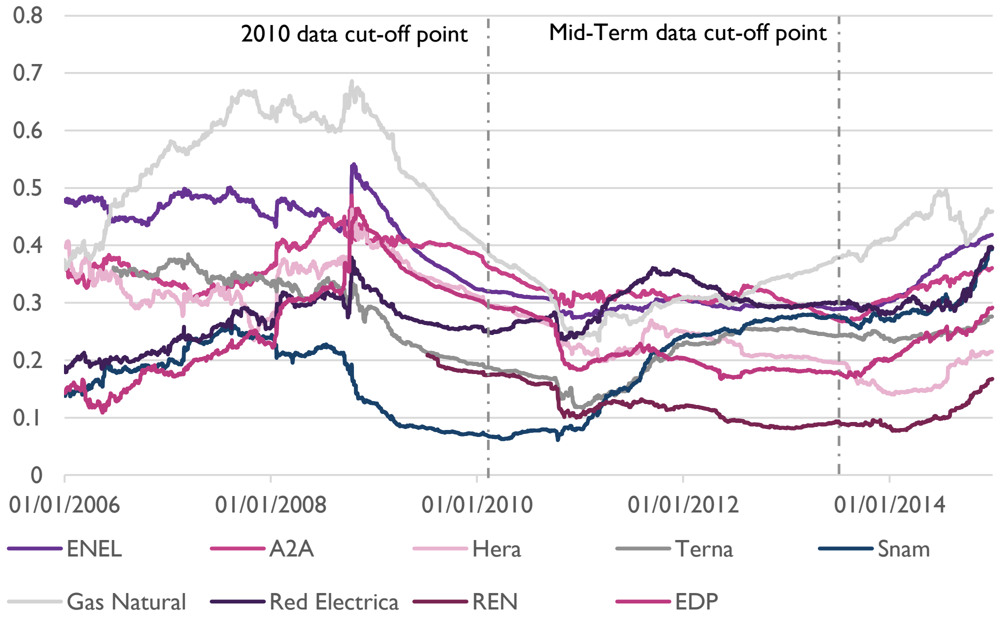
Figure 5.2: Rolling 2 year asset betas of core European comparator utilities (01/01/2006-31/12/2014)



Source: Bloomberg, Europe Economics' calculations.

The figure for peripheral Eurozone countries (Italy, Spain and Portugal) displays similar patterns. We observe a drop in asset betas towards the end of 2010 which is then counterbalanced by a further rise. Since the Mid-term cut-off data betas have decreased in value.

Figure 5.3: Rolling 2 year asset betas of peripheral European comparator utilities (01/01/2006-31/12/2014)



Source: Bloomberg, Europe Economics' calculations.

The table below presents information from Figure 5.2 and Figure 5.3 at three different dates; the cut-off date used in PR3, the cut-off used for the Mid-Term Review, and the last day of 2014. We can see that the average asset beta across all companies, excluding the outlier, EnBW, decreased between 2010 and the Mid-Term Review from 0.35 to 0.32 but has now risen up to 0.37.

Table 5.3: Comparison between European utilities' asset beta at the cut-off dates of 2010 report, Mid-Term review and current report

Company	Asset beta at 28/02/2010	Asset beta at 16/07/2013	Asset beta at 31/10/2014
Germany			
RWE	0.56	0.49	0.44
EnBW	0.13	0.04	-0.03
EON	0.56	0.58	0.49
Average	0.41	0.37	0.30
France			
Veolia	0.32	0.33	0.34
EDF	0.52	0.40	0.37
GDF	0.60	0.45	0.55
Average	0.48	0.39	0.42
Italy			
ENEL	0.32	0.29	0.42
A2A	0.36	0.27	0.36
Hera	0.29	0.19	0.21
Terna	0.18	0.24	0.28
Snam	0.07	0.27	0.39
Average	0.24	0.25	0.33
Spain			
Gas Natural	0.38	0.38	0.46
Red Electrica	0.25	0.30	0.40
Average	0.31	0.34	0.43
Portugal			
REN	0.18	0.09	0.17
EDP	0.29	0.18	0.29
Average	0.23	0.13	0.23
Total average*	0.35	0.32	0.37
Minimum*	0.07	0.09	0.17
Maximum*	0.60	0.58	0.55

Note: The average, minimum and maximum calculations excluded EnBW which was an outlier.
Source: Bloomberg and Europe Economics' calculations.

5.5 Regulatory precedent

In PR3 (2010) we recommend the CER use an asset beta of 0.2-0.4, with a point estimate of 0.3. In the mid-term WACC review (2013) we did not move away from our 2010 recommendation and confirmed an asset beta of 0.3. The table below presents recent regulatory precedent in the UK and Ireland.

Table 5.4: Recent regulatory precedent for the asset beta in the UK and Ireland

Company	Ofwat (2014)	CER Irish Water (2014)	ComReg Eircom (2014)	CAR DAA (2014)	CC NIE (2013)	Ofgem NGET (2012)
Asset beta	0.30	0.30	0.50	0.60	0.40	0.38

5.6 Companies' submissions

ESBN's estimate of the asset beta was 0.36 which translated to an equity beta of 0.8 (assuming 55 per cent gearing), resulting in a post-tax cost of equity of 5.68 per cent.

EirGrid's submission presented a spot asset beta of 0.4, an equity beta of 0.9 (with gearing at 55 per cent) and a post-tax cost of equity of 6.25 per cent. EirGrid also presented a "mid-period" asset beta of 0.30, an equity beta of 0.67 and a post-tax cost of equity of 5.47 per cent.

5.7 Recent developments

As we can see in section 5.4.1 around the time of PR3 determination the asset beta of UK relevant comparators was below but close to 0.3 (the asset betas for Centrica and SSE appeared to be outliers). By the mid-term review date, the asset betas had changed very little and, if anything, they appear to have decreased slightly (a point noted as likely in our analysis in the mid-term WACC review). However, since the time of the mid-term WACC review, we can see a material rise in asset betas for all comparators, except Centrica which remained at the same levels. This might be due to a normalisation of financial market and an increase in risk appetite with investors moving away from a flight-to-safety behaviour.

We observe similarities in the asset betas of European comparators with the average across our sample rising from 0.32 to 0.37 since the Mid-Term review.

5.8 Conclusion

For PR4 we expect the asset beta to be in the region of 0.31-0.44 (obtained by excluding the outlier Centrica from the range-generating set, owing to its business profile being relatively more different from ESBN than the other firms') with a central estimate of 0.37.

The equity beta is derived by re-levering asset beta at the notional gearing level and assuming a debt beta of zero. Given the notional gearing level we use is 55 per cent (see further below), the implied equity beta range and working estimate are respectively 0.69-0.98 and 0.82.

5.8.1 Cost of Equity

Based on the above analysis, the range and point estimate for the cost of equity (post-tax) are as set below:

Figure 5.4: Range and point estimate for the cost of equity

Low	High	Point estimate
4.92%	6.99%	5.81%

6 Capital Structure

6.1 PR3, Mid-Term Review and Stakeholder Submissions

At PR3 and the mid-term review the gearing was 0.55. At PR4 both ESBN and EirGrid propose a gearing of 0.55.

6.2 Introduction

In calculating a WACC estimate, it is necessary to make an assumption about the gearing level of the company so as to know the weight which should be placed respectively on the cost of equity and the cost of debt. However, as discussed below, the choice of gearing does not necessarily affect the vanilla WACC since both the cost of equity and the cost of debt change with gearing. The choice of gearing does, however, affect the tax liabilities which the CER has to allow for within price limits.

The notional level of gearing on which the WACC calculation is based is not intended to represent second-guessing of companies' decisions about their optimal financing structure, or to provide any guidance on the gearing level that firms should adopt.

6.3 Capital structure and CAPM

The starting point in thinking about the effect of gearing is the Modigliani-Miller insight (MMI) that the riskiness of a company depends on the riskiness of its real cash-flows — volatility in the costs and in the demand for its products. The implication is that where there are no taxes, incentive or information problems, the way a project or firm is financed does not affect its value or its cost of capital — the market value of any firm is independent of its capital structure. This is because the overall risk on the company's asset base, the asset beta, does not change with the capital structure of the firm (i.e. the chosen combination of equity and debt).

This section first explains the MMI more fully, and then investigates situations where the proposition may not apply.

6.3.1 Understanding MMI

A company can be thought of as a bundle of investment projects (installation of different physical assets, different marketing schemes, etc.). MMI is easiest to explain in terms of raising finance to undertake a project. A project can be represented by a stream of uncertain, future cash flows or (net) revenues. Each set of future revenue is equivalent to some amount of cash today; the exact amount is obtained by discounting by the cost of capital. Adding all the cash equivalents together gives the total value of the project, V, say.

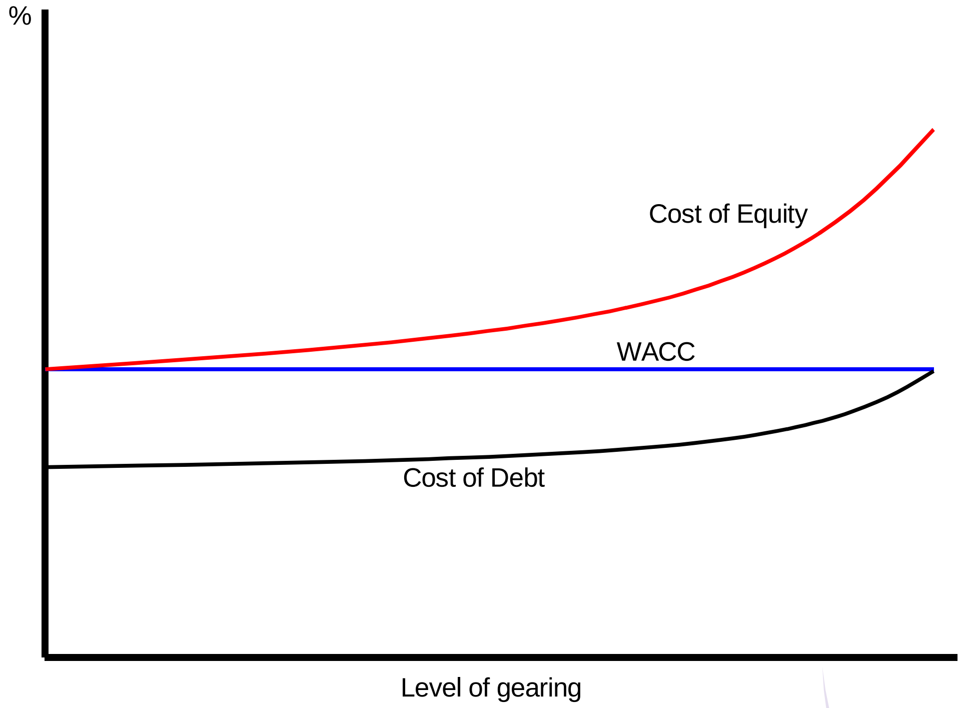
Suppose the project costs an initial amount C. Then the project is worth undertaking if, and only if, $V > C$, that is, if, and only if, it contributes positive net value. This brings us back to MM proposition I, as follows. The financiers of the project — who put up the C — have to get their C back. They can get it back in a variety of ways: they could be given a share s of future revenues, where $sV = C$, or they could get some debt (risk-less or risky) that has a present value equal to C. Regardless of the method, they must get C, and simple arithmetic tells us that the entrepreneur that sets up the project will get the remainder $V - C$. That is, from

the entrepreneur's point of view (and from the financiers') the method of financing doesn't matter. (It does not matter how the C is sliced up.)[29]

Since the riskiness of the asset is determined by its real features, not its method of financing, causality runs from the asset cost of capital to the costs of debt and equity, via the capital structure, rather than the other way around. Many people, first encountering corporate finance, have a thought along the following lines — if the cost of equity is 11 per cent, the cost of debt is 1 per cent, and the gearing level is 50 per cent, then the cost of capital will be 6 per cent (0.5 x 11 + 0.5 x 1). But (they think) if gearing rises to 75 per cent, then the cost of capital must fall to something like 3.5 percent (0.25 x 11 + 0.75 x 1). If that were so then causality would run from the costs of debt and equity to the overall asset cost of capital, via the capital structure (the cost of capital would depend on the costs of debt and equity and the gearing). The Modigliani-Miller theorem reverses this, saying that the asset cost of capital is fixed by the real nature of the asset, so, in fact, it is the costs of debt and equity that depend on the level of gearing, not the asset cost of capital.

The proposition is illustrated in Figure 8.1 below. At zero level of gearing the weighted average cost of capital is equal to the cost of equity. As gearing increases, the weight on the (lower) cost of debt increases. However, cost of equity and debt both adjust such that the combined WACC remains unaltered, until at 100 per cent gearing WACC simply equals the cost of debt.

Figure 6.1: Modigliani-Miller proposition I



Since capital structure is irrelevant according to MMI, if that were all there were to it, we might expect to see completely random capital structures of companies. But we do not. MMI then points us to the reasons

[29] Miller used to illustrate MM proposition I with one of baseball legend Yogi Berra's famous (mis-)sayings: "You better cut the pizza in four pieces because I'm not hungry enough to eat six".

why capital structures might matter for a company, particularly through noting for us the matters from which MMI abstracts.[30] These are the things the proposition abstracts from: [31]

- Taxes — differential tax treatment of equity and debt finance may imply that increasing gearing will save tax and in this way increase company value.
- Costs of financial distress — in the absence of other distortions, the expected costs of financial distress will rise with the level of gearing, at least partially offsetting the potential benefit from tax effects.
- Incentive problems — financial structure may affect incentives that, for example, the managers have to maximise the net present value of the company.
- Information problems — the information that different market participants have access to at different times might vary.
- Transaction costs — for example, in changing the level of gearing.

The figure below illustrates possible effects these factors might have on the market value of the company. The horizontal line represents the situation under the MMI – the level of gearing has no effect on company value. Once we move to a situation with taxes, however, gearing may have an effect due to the tax advantage of interest payments, as illustrated by the rising straight line. Considering only the effects of taxation would imply that the best possible capital structure involved holding no equity.[32] However, as gearing rises, so do the risks and expected costs of financial distress. Therefore there is some optimal level of gearing as illustrated by the higher of the curved lines in Figure 6.2. If in addition there are some incentive problems associated with high levels of gearing, the optimal level of gearing might be lower still, as represented by the lower of the curved lines in Figure 6.2.[33]

The same can be shown with the rate of return on the vertical axis rather than the market value of the company. Figure 6.2 shows the effects of the value of the tax shield in pre- and post-tax WACC settings. A pre-tax approach allows the company to earn a return out of which to settle tax expenses. In a post-tax approach, on the other hand, taxes are modelled separately from the return (WACC) as a cost item. Therefore, as gearing increases, pre-tax WACC falls due to the value of the tax shield, until the expected costs of financial distress begin outweighing the benefit from the tax shield.

In a post-tax setting the WACC allows only for returns to investors, after taxes have been paid. Therefore only the costs of financial distress show on the WACC diagram (we are here ignoring the other possible distortions), and it would seem there is no obvious optimal level of gearing. This is, however, more apparent than real — taxes have merely been moved out of this equation. Their effect, including the tax shield value

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30 Note that it is sometimes naively asserted that the MMI result "does not hold" — i.e. that it is not true that the cost of capital is invariant to the level of gearing — if the assumptions the MMI theorem's proof requires do not hold. That is fallacious. For example, if we take as an assumption given, that my sister is currently in my house, it follows that my house has not fallen down (there is a quasi-logical proof). But just because my sister is not, in fact, currently in my house (just because our assumption does not hold) it does not follow that my house has, in fact, fallen down. Likewise, we are not entitled to assume, upon observing a world of information asymmetry or costs of bankruptcy that *therefore* the cost of capital will vary with the capital structure. That remains to be proven one way or another. Many claims concerning conditions that, if they held, the MMI result would not hold, have turned out upon subsequent analysis not to be convincing. The MMI result, once one understands the intuition, is amongst the most compelling, elegant, and universal in all corporate finance theory, and has been recognised as such ever since its publication.

31 MM proposition I also assumes efficient well-functioning capital markets, but that is an assumption we will keep throughout this paper.

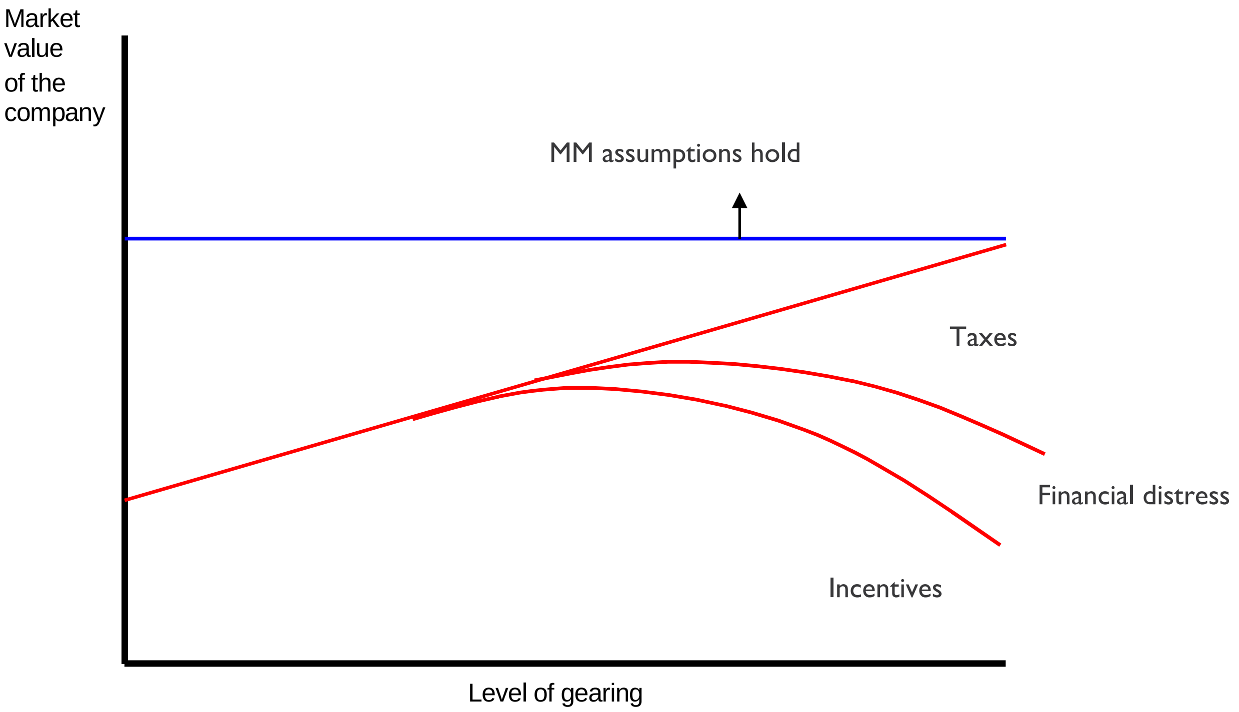
32 Taxation however introduces a distortion, such that the value in a world with taxation will never actually reach the value of the company in a world without any taxation, as in the MMI. Hence the MMI line lies above the "world with distortions" lines.

33 The drawing of the "incentive problem line" in Figure 6.2 is not intended to imply that incentive problems arise before significant effects on cost of financial distress. This does not have to be the case, and the titling of the curved lines could as easily be reversed.

that varies with the level of gearing, still exists in the separate modelling, and the company will take their value into account when selecting its financial structure.

We will turn to the effects outside of MMI after considering the basic proposition in the CAPM framework in slightly more detail.

Figure 6.2: Illustration gearing and market value of company



6.4 Implications within a WACC framework

In order for the financiers of the above project to be willing to put up the cost of the project, they must determine what level of risk they are taking on and, therefore, what level of return they require for their investment. To do this in a CAPM framework, they have to estimate the risk on all of the company's capital (shares and bonds), the asset beta. As discussed in previous sections, the asset beta is a measure of how the net returns on the asset as a whole (the relevant "asset" in this context being the whole energy transmission and distribution sectors) are correlated with changes in returns across the wider economy.

The asset beta is relevant to the total WACC of the company, as opposed to just the cost of equity:

$$WACC = r_E \cdot \frac{E}{D+E} + r_D \frac{D}{D+E} \;\; ; \;\; \beta_A = \beta_E \cdot \frac{E}{D+E} + \beta_D \frac{D}{D+E}$$

If the firm uses no leverage, then the shareholders get all the project revenues, and $\beta_A = \beta_E$. However, when the firm uses debt as well as equity, β_E overstates the risk of the company, and the equity beta must be "un-levered" to get the asset beta. This is straightforward in the well-functioning capital markets we are still assuming — we can utilise the above formula.

Recalling MM proposition I, the value of the company is determined by its future revenues, and how those revenues are split between different types of financiers does not matter. This means that the asset beta is constant — as the company gears up (D increases), the weight on the equity beta decreases relative to the weight of debt beta, and therefore something has to adjust to compensate (as typically $\beta_D < \beta_E$). Assuming

that the risk on the debt providers does not change, the risk on equity holders must increase. This in fact is the case; the risk on the firm's equity is affected by its capital structure as well as the riskiness of the underlying business.[34]

We have now illustrated MMI in the CAPM framework. In perfect capital markets, the fact that a company gears up does not matter because the risk on equity rises in proportion to exactly compensate, leaving the asset beta, and therefore the company WACC, unaffected. In fact, it is the asset beta that drives the level of equity and debt betas — the overall risk on the asset base is what matters, the cost of equity and debt only adjust to reflect this depending on their relative amounts.

However, things are not as clear as we relax the assumptions behind MMI. The most clear-cut effects are those associated with taxation, which can be directly analysed in the CAPM framework, and to which we now turn.

6.4.1 Value of tax shield in CAPM

Bringing taxation into the picture, it is now possible that a company's value is affected by its capital structure due to the tax advantage enjoyed by debt finance under many tax regimes — in many countries interest payments are tax deductible, whereas dividends and capital gains are not.

Roughly speaking, the impact of a change in the level of gearing on the WACC due to the change in the tax shield value could therefore be calculated as follows. First, estimate the values of the debt and the equity beta for the previous level of gearing, and using them construct the asset beta. Also remember that as gearing increases, the company value might be affected by the factors described in paragraph 6.3.1, such that the trade-offs imply that an increase in gearing would not be desirable above a certain point.

Second, remember that the asset beta will change only as a result of the change in the present value of the tax shield due to gearing up, which would have to be projected throughout the regulatory price review period. If there is no additional value from the tax shield compared to current gearing (i.e. current gearing is optimal), the asset beta can either only stay the same or *increase*, leading to a fall in the company valuation (as, other things being the same, the discount rate on the future income is now higher).

Aiming for an "optimal capital structure" implies equating the marginal benefit of debt financing with its marginal cost. Optimal gearing ratios are likely to vary by sector and even, in principle, by company within each sector.

6.5 Regulatory precedent

In PR3 we advised the CER for a gearing range of 50 to 60 per cent with a point estimate of 55 per cent; this was retained in the Mid-Term review. Notional gearing estimates from other regulatory determinations in the UK and Ireland are presented in the table below.

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[34] Occasionally, studies are produced in which the cost of equity appears to be invariant to issuance of new debt, with the argument offered that this is incompatible with MMI. But that is not correct — for example, something happening to reduce the company's cost of capital (e.g. greater certainty over its future revenue stream) might naturally be associated with a decision to issue additional ("securitising" those future revenue streams). It might well be natural for the amount of debt issued in such a circumstance to be that amount that leaves the cost equity as it was before the cost of capital fell. (This is particularly likely if the determinant of the capital structure operates through or has the effect of placing a cap on the cost of equity — debt issuance would continue until that cap was reached.)

Table 6.1: Recent regulatory precedent for gearing in the UK and Ireland

Company	Ofwat (2014)	CER Irish Water (2014)	ComReg Eircom (2014)	CAR DAA (2014)	CC NIE (2013)	Ofgem NGET (2012)
Gearing	62.5%	55%	40%	50%	45%	60%

Source: Various regulatory determinations.

6.6 Companies' submissions

Both EirGrid and ESBN proposed a 55 per cent notional gearing figure in their submissions.

6.7 Conclusion

We retain a notional gearing figure of 55 per cent for our WACC calculations.

7 Taxes

7.1 PR3, Mid-Term Review and stakeholder submissions

At PR3 and at the Mid-Term Review the tax rate was taken as 12.5 per cent. That same rate is proposed by ESBN and EirGrid for PR4.

7.2 Introduction

This section of the report considers issues relating to taxation and the cost of capital. In particular, we consider different options for the treatment of taxation, and the potential impact of these options on the revenues allowed for tax liabilities. We conclude our section with our recommendations.

7.3 Different Options for the Treatment of Taxation

We discuss the options available for the treatment of taxation under two headings:

- How allowed revenue is provided to allow for tax liabilities
- Treatment of tax benefits from gearing above notional level

7.3.1 How allowed revenue is provided to allow for tax liabilities

There are a number of possible approaches that can be used to provide for tax liabilities within a price control, including:

a) a pre-tax cost of capital calculated using the statutory rate of tax. This is the simplest approach and was used in setting the PR3 price control. The revenue provided for tax liabilities under this approach may be either higher or lower than the company's actual tax liabilities.
b) a pre-tax cost of capital calculated using an effective tax rate. Under this approach, tax liabilities would still be allowed for within the WACC, but the uplift to the cost of equity would be determined by an estimate of the effective tax rate faced by the company over the relevant period.
c) a pre-tax cost of capital using the statutory rate of tax, but with an NPV adjustment (e.g. for the tax benefit from accelerated capital allowances). This option could be seen as part-way between the above two options.
d) a vanilla cost of capital with an explicit allowance for tax liabilities provided separately. A number of regulators use this approach, which treats tax in a similar way to opex.

Approaches (b) and (d) can be seen as presentationally different ways of achieving the same outcome, since both aim to provide allowed revenues for tax which match actual tax liabilities over the price control period. Similarly, approach (c) can be seen as an attempt to move from (a) towards (d) by including an adjustment to align revenues allowed for tax more closely with actual tax liabilities during the price control period. For example, approach (c) might involve making an approximate adjustment in circumstances where the data required for full modelling of future tax liabilities is not available and hence it might not be practicable to implement approaches (b) or (d).

Given the above, we consider that the most useful way to approach the analysis is to compare approaches (a) and (d) as representing the two main alternatives. Hence, in what follows we compare a pre-tax cost of capital using the statutory tax rate with the use of a vanilla cost of capital and separate allowance for tax liabilities.

In carrying out this comparison, it is also important to take account of how approach (d) would be implemented in practice. In particular, (and as also noted in the past by the UK Completion Commissions) if in the future there is a switch from a using a pre-tax WACC based on the statutory rate to allowing for actual tax liabilities, then the a regulator should make adjustments related to the pre-funding that companies have received as a result of the use of the statutory rate in previous years.

We discuss below two key aspects that should be considered when deciding the specific tax regime to adopt. i.e.:

- Treatment of tax benefits from gearing above notional level; and
- Timing differences considerations.

7.4 Treatment of tax benefits from gearing above notional level

Another important aspect relates to how the tax benefits of gearing above the notional level assumed in the WACC should be treated. In particular, there are two issues which arise:

- First, if the regulated firm is known to have gearing above the notional level at the time that the price control is set, how should the tax benefits of this be treated?
- Second, if the regulated firm chooses to increase gearing during the price control period, how should the additional tax benefits from doing this be treated?

Under a pre-tax approach to the cost of capital (using the statutory tax rate), the regulator only takes account of tax shield on debt at the notional level of gearing. Hence, if the firm obtains further tax benefits from gearing up above the notional level, then (in the absence of any adjustment mechanism) the firm retains these benefits.[35]

In the case of a vanilla WACC with separate allowance for tax, what happens depends on whether the regulator uses the actual or notional level of gearing in forecasting tax liabilities. If the regulator uses the notional level of gearing (e.g. for consistency with the WACC and with other aspects of the financial modelling), then again the firm will retain any tax benefits from having higher gearing than the notional level. By contrast, if the regulator uses the actual level of gearing in modelling future tax payments, then the tax benefits of higher gearing will be passed through to customers.

In some cases, regulators have introduced explicit adjustment mechanisms to claw back the benefits from gearing up above the notional level. Hence, in addition to the choice between a pre-tax WACC based on the statutory rate and a vanilla WACC with a separate tax allowance, the regulator also has to decide whether to claw back the tax benefits from gearing above the notional level (either by use of actual gearing in modelling tax liabilities under the vanilla WACC approach, or through some other adjustment mechanism).

7.5 Timing differences

The difference between the effective tax rate and the statutory tax rate arise because of differences between depreciation and capital allowances and capitalised interest. Both of these differences can be considered as 'timing differences' in that they broadly reverse in the long-run; all other things being equal, at some time in the future the effective tax rate is likely to be greater than the statutory tax rate, and this benefit to equity will unwind if the regulated entity continues with the statutory rate. Such timing differences have two implications:

[35] There are a number of important points here regarding who bears the higher costs of financial distress if a company gears more highly and whether (and if so how) regulators should take account of this. For more detail, see http://www.caa.co.uk/docs/5/ergdocs/20100129EERegFinance.pdf

- First, when considering tax issues one needs to look beyond any single price control period. Although a pre-tax approach may provide more revenue than required to fund actual tax liabilities in one price control period, to the extent that this is driven by timing differences then the situation is likely to reverse during some future price control period.
- Second, from a regulator's perspective there is a strong rationale for consistency between regulatory periods. If the regulator consistently applies the same approach then these timing differences are likely to balance out in the long run.
- Third, if the regulator does switch from a pre-tax approach using the statutory rate to a vanilla WACC approach, then *prima facie* there is an argument (from the regulator's perspective) for an adjustment to compensate for any historic over- or under-funding of tax liabilities. For example, consider the case of a company which has been regulated using a pre-tax approach to taxation based on the statutory rate and which has historically been over-funded for tax liabilities. If the regulator were to switch to a vanilla WACC approach at the point in time when tax liabilities rise above the allowance provided by use of the statutory rate, then customers would be losing out since they would effectively have provided pre-funding for tax without receiving any benefit.

7.6 Companies' submissions

Both EirGrid and ESBN proposed using the statutory tax rate of 12.5 per cent in their submissions.

7.7 Conclusions

We see no strong advantage in CER switching treatment of tax at this point, whilst noting the complications and costs of changing. Our main view of substance is that the approaches based upon the headline rate of tax are conceptually superior to those based upon the effective rate, since they leave the discretion to change investment incentives across the economy, via tax allowances, with the tax authorities (where they should lie) instead of with the regulator.

Hence we recommend the CER to continue to calculate the WACC on a pre-tax basis using the statutory rate of 12.5 per cent.

8 WACC

8.1 Summary

Our draft estimates for the WACC for PR4, before aiming-up, are set out in the table below:

Table 8.1: Overall WACC before aiming-up

	High	Low	Point estimate
Risk-free rate	2.10	1.75	1.90
Debt premium	1.15	0.75	1.00
Cost of Debt	**3.25**	**2.50**	**2.90**
ERP	5.00	4.60	4.75
Asset beta	0.44	0.31	0.37
Equity Beta	0.98	0.69	0.82
Cost of equity (post-tax)	**6.99**	**4.92**	**5.81**
Tax rate (%)	12.5	12.5	12.5
Cost of equity (pre-tax)	**7.99**	**5.62**	**6.63**
Gearing	0.55	0.55	0.55
WACC (pre-tax)	**5.38**	**3.90**	**4.58**

8.1.1 Companies' submissions

Table 8.2: WACC submissions by EirGrid and ESBN

	EirGrid Spot estimate	ESBN estimate
Risk-free rate	1.75	2.0
Debt premium	1.75	1.75
Cost of Debt	**3.5**	**3.75**
ERP	5.0	4.6
Asset beta	0.40	0.36
Equity Beta	0.9	0.8
Cost of equity (post-tax)	**6.25**	**5.68**
Tax rate (%)	12.5	12.5
Cost of equity (pre-tax)	**7.14**	**6.49**
Gearing	0.55	0.55
WACC (pre-tax)	**5.14**	**4.98**

Source: EirGrid and ESBN submissions.

8.2 The principle of aiming up

Reaching a judgement on the likely "true" value of ESB Networks and EirGrid's cost of capital over the price control period is inherently subject to uncertainty. In the light of this, it is important to consider how this uncertainty itself should be taken into account. In particular, what would be the consequences of either over-estimating or under-estimating the WACC?

The consequence of setting the regulatory WACC higher than the market cost of capital is that investors will receive a windfall gain at the expense of electricity customers, who will pay more than necessary for their electricity.[36]

This higher payment by customers would, however, be associated with some partially-offsetting gains. Orthodox price regulation seeks to duplicate the pricing that would prevail in a competitive market. But prices being above that level increase the likelihood of new entry, enhancing actual competition and diminishing the need for regulation. Now, the presence of price regulation implies that the regulated entity has market power, so opportunities for new entry are very probably less than they would be in a competitive market. But even if the regulated entity were a well-entrenched monopolist, then as well as the standard problem of monopoly profits leading to allocative inefficiency[37] and x-inefficiencies[38], prices being occasionally above the competitive level may also create incentives to innovate and invest, producing new products and services.[39] The standard theory of price regulation suggests that the dynamic incentive gains from excess profits are less than the allocative efficiency losses from pricing being above the competitive level, but the key point for our purposes here is to recognise that the consequences of the price cap being set above the competitive level are not all one way — there are gains from excessive prices as well as losses, even though the losses outweigh the gains.

On the other hand, the consequence of setting the regulatory WACC lower than the market cost of capital are less ambiguously negative. First, when prices are below the competitive level there is inefficiently too much of the regulated product consumed. Furthermore, at the margin the return that companies make on new investment projects may not be sufficient to cover the cost of raising finance, thus reducing incentives for the companies to invest. The impact of this on customers would be mitigated by the fact that companies might have to invest anyway in order to meet licence conditions. However, if under-estimation of the WACC were serious companies could face difficulties raising the finance which they need, both in debt and equity markets.

In addition, the setting of too low a WACC might have the result that any new innovations that required investment would be under-rewarded, thereby reducing the incentive to engage in such investments. That might imply customers foregoing the gains, in later years, of new cost-reducing technologies or new ways to pay bills (say). Work by J.A. Hausman and others suggests that the consumer welfare losses from innovation foregone as a result of regulation can be quite large.[40]

While customers might benefit from lower bills in the short run if the WACC is set too low, ultimately they would be expected to suffer in the long run if investment in the electricity sector does not go ahead. Such negative consequences could potentially last for years into the future.

Hence, while there are material consequences from both over-estimation and under-estimation of the cost of capital, we consider that on balance the long-term consequences of under-estimation are worse. This

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[36] This assumes that all other elements of the price control have been set at an appropriate level. In practice, it is of course possible that errors in setting one part of the price control may be offset by errors in the opposite direction made elsewhere in the regulatory settlement.

[37] "Allocative inefficiency" here means that there will be consumers who are not purchasing the product whose willingness to pay would be above the marginal cost of producing the product.

[38] "X-inefficiencies" arise when the presence of monopoly profits allows technical inefficiencies to continue in the production process. An example might be that the monopolist is willing to over-pay for some factor of production (e.g. a raw material or unionised labour).

[39] This is a famous point made by Schumpeter. An innovator will secure an advantage over rivals by being able to increase demand or sell at a higher price. An innovator that is a monopolist will be able to garner all the gains from this, whereas an innovator that faces competition may in due course face a me-too innovating rival (a rival that produces a copy-cat innovation), bidding away the profits of the innovation.

[40] See, for example, Hausman, Jerry A., "Valuing the Effect of Regulation on New Services in Telecommunications," *Brookings Papers on Economic Activity*, Microeconomics 1997, pp. 1-54.

implies that, once one has formed a view about the "true" value of the WACC or its components, one should aim up to take account of the asymmetry of consequences from getting the decision wrong.

It should be noted, however, that the above discussion of asymmetric consequences does not mean that it is necessary to be *certain* that the estimate is not too low — given that estimates of each WACC parameter are subject to significant uncertainty this might require such a high mark-up that it would not be in consumers' interests. As an alternative to simply aiming up and leaving the gains with regulated entities, it would be possible to envisage an alternative mechanism, whereby a regulator aimed up in devising a price control but then had an ex post review of the realised WACC and clawed back all or some portion of the difference. That would, however, create a number of complex incentives the analysis of which would take us beyond our scope here.

The principle that there is an asymmetry of consequences between those of setting the cost of capital too low and those of setting it too high is now well-established by regulators (and the Competition Commission in the UK).[41] Too high a cost of capital, and consumers today pay a little more than would occur in a competitive market. Too low a cost of capital, and consumers tomorrow miss out on the benefits of investment and innovation that does not occur. The latter costs are generally recognised as significantly exceeding the former. Consequently, Europe Economics recommends that the regulatory cost of capital should be set above the central estimate of the market cost of capital.

The issue of precisely how much to aim up is debated, as is the issue of whether aiming up should take place on the basis of the overall WACC or its individual components. In its advice on the Q5 London airports price control, the Competition Commission aimed up a number of estimated parameters in the WACC calculation (such as the equity beta) to the 95th percentile.

In our advice to Ofwat in the PR09 water sector review in the UK, Europe Economics argued that the purpose of aiming up is not to eliminate all possibility that the WACC has been set too low but, rather, merely to reflect the presence of some asymmetry in the consequences of too low versus too high a value. We stress that

On this basis we disagreed with what was at that point the position adopted by the UK's Competition Commission, where it aimed up to the 95th percentile — i.e. close to two standard deviations from the mean in a normal distribution, the usual statistical measure of certainty. Instead, we proposed aiming up of the order of one standard deviation rather than two. More recent regulatory judgements on aiming up have adopted figures in the 75th-80th percentile range.[42]

8.3 Regulatory precedent

Choosing a value for the WACC that is above the regulator's expected value for the WACC has been standard practice for regulators for many years, across many regulated sectors and in particular in the communications sector, both in Europe and outside. The process by which this is done has often been implicit – via the choice of a "conservative" estimate of a particular parameter such as the beta or the equity risk premium. In other situations it is done by choosing, as a point estimate, a value above the mid-point of quoted range for the WACC as a whole or some key building block thereof.

Wholly implicit conservativeness is not straightforward to evidence, but the practice of choosing a point estimate above the mid-point can be seen in a number of determinations. How regulators choose a point

[41] For aiming up in Ireland, see the most recent Commission for Energy Regulation decision on electricity transmission and distribution networks: Commission for Energy Regulation (2014) "Mid-Term review of WACC applying to the Electricity TSO and TAO and ESB Networks Ltd for 2014 to 2015", CER/14/026.

[42] For example, see the UK Civil Aviation Authority's 2013 Q6 price control proposals.

estimate from within a range was explored by the consultancy "Economic Insights" in a recent (June 2014) report for the New Zealand Commerce Commission.[43] Of 53 decisions reviewed in that document, 35 involved choices of the point determination of the WACC at above the mid-point of the quoted range. The authors remarked that, for those cases where the point estimate used of the WACC is not explicitly above the mid-point of the range, "This often reflects adopting a conservative view of the market risk premium and equity beta that are used in the Capital Asset Pricing Model (CAPM) for determining the return on equity, where 'conservative' means erring on the high side."[44]

We note that the point estimates we have provided are, in our view, our best estimates of true forward looking values and do not represent a conservative representation. As explained above, aiming-up on our WACC estimate is best dealt with separately and in a transparent manner.

In both PR3 and the Mid-Term WACC review, our final WACC recommendation included some degree of aiming-up. We stress that, in the context of PR4, the degree of uncertainty in the WACC is less than at the Mid-Term WACC review (as noted in that review, the degree of aiming-up was amplified by the Mid-Term nature of the review and the risk that firms had under-recovered in 2011 and 2012) and potentially also less than at PR3.

The justification for such conservativeness was set out by the UK regulator Ofcom in a 2005 methodological paper.[45] Ofcom stated:

> "Traditionally, Ofcom has considered that the downside risk associated with taking too low a value for the ERP (discouraging discretionary investment) is more detrimental to the interests of consumers than taking too high a value (leading to higher prices to customers) and has tended to the higher end of the possible range. Having reviewed its approach in this area, Ofcom remains of this view".

This methodological position was confirmed in its Final Statement of August 2005.[46]

8.4 Recommended WACC range and aimed-up point WACC

Our recommendation for the degree of aiming up is based upon a Monte Carlo analysis using

- The ranges recommended for each building block of the WACC.
- An assumption of a uniform distribution of outcomes across each range.
- 1000 runs.
- Calculation of the standard deviation of outcomes across the runs.
- Application of one standard deviation as the level of aiming up to be applied to our preferred point estimate.
- Construction of the recommended range as running from one standard deviation below the best estimate to two standard deviations above it.

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43 Economic Insights (2014) "Regulatory precedents for setting the WACC within a range".

44 Economic Insights (2014) "Regulatory precedents for setting the WACC within a range", p. iii.

45 Ofcom (2005) "Ofcom's approach to risk in the assessment of the cost of capital". See paragraphs 1.13, 4.28, and 4.33 of http://stakeholders.ofcom.org.uk/binaries/consultations/cost_capital/summary/cost_capital.pdf.

46 Ofcom (2005) "Ofcom's approach to risk in the assessment of the cost of capital". See paragraph 4.73 of http://stakeholders.ofcom.org.uk/binaries/consultations/cost_capital2/statement/final.pdf. Note also that at paragraph 4.33 Ofcom again confirms that it picks points above the mid-point of its ranges: "By proposing values that are towards the upper end of a reasonable range…".

The result is that the standard deviation is 0.2 percentage points, implying a recommended WACC range of 4.4 to 5.0 per cent, and producing an overall pre-tax WACC point recommendation, after aiming up, of 4.8 per cent.

8.5 Inflation

We base our range on forecasts for CPI and HICP inflation over the coming years. Our HICP forecast was obtained from the Irish budget report for 2015 and was provided by the department of finance while our CPI forecasts were obtained from PWC's "Global Economy Watch" economic projections section. These forecasts are presented below.

Table 8.3: Inflation

Inflation measure	2015	2016	2017	2018
HICP	1.1%	1.4%	1.4%	1.4%
CPI	0.8%	1.1%	1.5%	1.5%

Source: PWC Global Economy Watch and http://www.budget.gov.ie/Budgets/2015/2015.aspx.

Based on these forecasts our point estimate for inflation is 1 per cent for 2015 and 1.4 per cent for 2016 onwards.

9 Financeability

9.1 Role of financeability

Financeability analysis has three main potential objectives:

1. It provides a consistency check. The WACC calculation involves an assumed level of gearing and assumed credit rating. If that level of gearing is not consistent with the achieving of that credit rating, that should be exposed by the financeability analysis.
2. Some regulators have the statutory duty to ensure that regulated entities are able to finance their functions. In such cases, financeability analysis tests whether this duty can be met.
3. WACC calculations, along with other elements of the price control, are based upon an assessment of a notional entity and of the actual regulated entities' capacity to enhance efficiency (operating and financial). The financeability test can be used to provide an analysis of how much is being asked of the actual entity.

For our purposes here, we focus upon objective 1 — consistency with the target credit rating.

9.2 ESB Financeability: indicative analysis

We next set out a preliminary view of ESB's financeability. Specifically, we discuss the following:

- The target credit rating.
- The financial ratios that are the most relevant ones to focus on.
- What numbers one should expect for these financial ratios in order to achieve the target credit rating.
- The projected financial ratios given ESB's forecast expenditure, and what this implies for the financeability of ESB.

It should be noted that the quantitative assessment here is based on ESB's forecast expenditure for the forthcoming price control period for the distribution network and the transmission network. This analysis would need to be revisited in the light of the CER's view on what costs will be allowed in the next price control period.

As regards EirGrid, we provide a separate note in which we consider the applicability of the RAB-WACC approach to EirGrid.

9.2.1 Actual vs target credit ratings

The first question is what target credit rating should be assumed in the analysis. ESB currently achieves the following credit ratings[47]:

- Standard & Poor's: BBB+ (stable).
- Moody's: Baa1 (Stable).
- Fitch: BBB+ (stable).

We note that these credit ratings are consistent with the "comfortable investment grade" (i.e. at investment grade, BBB, and sufficiently at or above that rating that the investment grade rating can be regarded as secure and comfortable — usually interpreted as at least one step above, i.e. BBB+ or higher) that we adopt as the target credit rating for the purposes of estimating the debt premium.

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47 http://www.esb.ie/main/about-esb/credit-ratings.jsp.

9.2.2 Most relevant financial ratios

ESB is rated by Standard and Poor's, Moody's and Fitch, and hence ideally the financeability analysis would cover the financial ratios used by all three ratings agencies. The full list of relevant financial ratios is as follows:

- Net debt / RAV
- FFO interest cover
- Post-maintenance interest cover ratio (PMICR), also known as "adjusted interest cover ratio"
- FFO / net debt
- Retained cash flow (RCF) / capex

The table below shows which of the ratings agencies uses which of these ratios:

Table 9.1: Financial ratios used by different rating agencies

	Fitch	Moody's	Standard & Poor's
Net debt / RAV (%)	✓	✓	✓
FFO interest cover (x)	✓	✓	✓
PMICR (x)	✓	✓	
FFO / net debt (%)		✓	✓
RCF / Capex (x)		✓	

Source: Ofgem, "Strategy decision for the RIIO-EDI electricity distribution price control – Financial issues", 4 March 2013, https://www.ofgem.gov.uk/ofgem-publications/47071/riioed1decfinancialissues.pdf (page 26).

The financial models which the CER has sent us calculate all of these ratios except for PMICR.[48] Hence, in the analysis which follows we consider:

- Net debt / RAV;
- FFO interest cover;
- FFO / net debt; and
- RCF / capex.

9.2.3 What numbers one should expect for these financial ratios

Below we present a table (extracted from the same recent document published by Ofgem referenced above) of the financial ratios associated with different credit ratings.

Table 9.2: Financial ratios associated with different credit ratings

	Fitch		Moody's		Standard & Poor's	
	A	BBB	A	Baa	A	BBB
Net debt / RAV (%)	50 – 65	>65	45 – 60	60 – 75	<70	>70
FFO interest cover (x)	4.0 – 5.0	<4.0	3.5 – 5.0	2.5 – 3.5	>3.5	2.5 – 3.5
PMICR (x)	>1.7	<1.7	2.0 – 4.0	1.4 – 2.0		
FFO / net debt (%)			12 – 20	8 – 12	>12	8 – 12
RCF / Capex (x)			1.5 – 2.5	1.0 – 1.5		

Source: Ofgem, "Strategy decision for the RIIO-EDI electricity distribution price control – Financial issues", 4 March 2013, https://www.ofgem.gov.uk/ofgem-publications/47071/riioed1decfinancialissues.pdf (page 26)

We emphasise the importance of noting that the above table relates to category ratings – in other words, "BBB" refers to the BBB category, covering BBB+, BBB and BBB-. This is important, because it implies that ESB's financial ratios might need to be at the upper end of the range quoted by Standard and Poor's for the BBB category in order to achieve a target rating of BBB+ (though it is unclear what precisely secures a "+" or "-" qualification — in principle that could also, perhaps, be associated with a firm that squeaks in on the

48 The full list of financial ratios calculated by the CER's financial model is: EBIT interest cover; EBITDA interest cover; Net Debt/RAV; EBITDA/net debt; operating cashflows/capex; FFO interest cover; FFO/net debt; retained cash flow/net debt; retained cash flow/capex.

ratios but seems very unlikely to have them fall). (We note as well that these metrics are for the UK – we have not at this stage considered it proportionate to investigate to what extent ratings agencies expect different ratios from companies in Ireland. That additional step will become proportionate and be pursued once we have access to a full financial model that allows for a full financeability analysis.)

The table below shows the financial metric thresholds used by Ofgem in July 2014 in the draft determinations for the RIIO-ED1 price review.

Table 9.3: Financial metric thresholds used by Ofgem

Financial metric	Threshold
Key ratios identified above	
FFO interest cover ratio	2.5 min
FFO/ Net Debt	8% min
Net Debt / RAV	80% max
RCF / Capex	0.5 min
Other ratios monitored by Ofgem	
Adjusted interest cover ratio, or PMICR	1.4 min
RCF / Net Debt	5% min
Regulated equity / EBITDA	5.5 max
Regulated equity / PAT	18 max
Dividend cover ratio	1.0 min

Source: Ofgem, "RIIO-ED1: Draft determinations for the slow track electricity distribution companies, Financial Issues, Supplementary annex to RIIO-ED1 overview paper", 30 July 2014, https://www.ofgem.gov.uk/ofgem-publications/89072/riio-ed1draftdeterminationfinancialissues.pdf.

For our indicative purposes here, and noting again that we do not at this stage have access to a financial model (including the CER's assessment of allowed costs) that would allow a more complete analysis, we proceed for now on the basis that it is appropriate to use the same ratios that Ofgem used in the UK.

9.2.4 Projected financial ratios

An important question is whether financeability testing should be applied at the level of each licensed entity (implying separate financeability testing for transmission and for distribution) or at the level of the group as a whole. We recognise that there may be pragmatic arguments in favour of doing the financeability testing at a group level, on the assumption that this is the level at which ESB will issue debt. On the other hand, however, it can be argued that it is more correct theoretically to test financeability at the level of each licensed entity, since price regulation is intended to allow each licensed entity to finance its functions as a stand-alone entity.

Assessment of financial ratios at a group level could potentially mask financeability problems in any one business. In what follows, we therefore consider the distribution and transmission businesses separately. The table below summarises the financial ratios calculated on the basis of ESB's forecast cash flows for the distribution network and for the transmission network.

Table 9.4: Financial ratios calculated on the basis of ESB's forecast cash flows

	DSO	TAO	Target
	Average for 2016-20	Average for 2016-20	
Net debt / RAV (%)	52%	46%	80% max
FFO interest cover (x)	4.7	7.8	2.5 min
FFO / net debt (%)	15%	15%	8% min
RCF / Capex (x)	1.3	0.6	0.5 min

9.2.5 Conclusion

As can be seen, if all of ESB's expenditure was allowed (as forecast), its cash flows would not pose any financeability concerns. Accordingly, at this stage we conclude that this provisional, high-level financeability analysis suggests that the WACC proposed is compatible with the comfortable investment grade credit rating recommended.

We note that ESBN has sought a higher credit rating than we have assessed here. We believe the target here to be the correct one, for the reasons set out in our cost of debt analysis section above. But we observe that, if ESBN were subject to a higher credit rating, then its debt premium would be expected to fall (higher credit ratings mean lower debt premia, *ceteris paribus*). So its actual cost of capital would fall. But if achieving that credit rating meant it failed the financeability analysis, then (absent other remedies such as demanding a lower gearing level) one option to restore financeability would be the crude one of permitting higher prices and thus higher returns. In that case, allowing ESBN a higher assumed credit rating would simultaneously reduce its cost of capital and increase its rate of return — meaning the benefits of that lower cost of capital would all accrue to the firm, with consumers losing out through higher prices.