



Review of approaches to estimate a reasonable rate of return for investments in telecoms networks in regulatory proceedings and options for EU harmonization

FINAL REPORT

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THE **Brattle** GROUP

*Digital
Single
Market*

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I. Abstract

National Regulatory Authorities (NRAs) for electronic communications in the EU may set maximum wholesale price caps for access to the network of operators with Significant Market Power (SMP) when certain market conditions exist. In setting these caps, the Regulatory Framework for telecommunications indicates that NRAs should allow SMP operators a reasonable rate of return on their investments. NRAs typically estimate the weighted average cost of capital (WACC) of the operator to determine this reasonable return. However NRAs often use different methodologies, so that the resulting WACCs differ for reasons other than market fundamentals. These differences may distort market participants' investment decisions and ultimately the digital single market. In this report, we develop guidelines for a common WACC methodology in the EU's telecoms sector. We highlight areas where we consider it would be appropriate to set single EU-wide values for WACC parameters. Where we conclude this is not appropriate, we recommend a common EU-wide methodology to estimate a parameter value specific to a Member State. Our report assesses the reasonable return on investments for 'legacy' copper networks and Next Generation Access (NGA) networks.

II. Introduction

The telecommunications sector is of critical importance to the economic, social and cultural development in Europe. In the early 2000s, Europe's decision-making bodies introduced the regulatory framework for electronic communications.¹ The aim of this framework was to liberalise the telecommunications sector to ensure that consumers could enjoy the benefits of a single European telecommunications market. The European Commission plays a crucial role in the application of this framework, ensuring that the rules are consistently applied across all Member States (MSs) of the European Union (EU), so as to limit any distortions arising from the different application of regulations across MS.

The Framework Directive² is a key part of the regulatory framework and aims to establish a harmonised framework for the regulation of electronic communications networks and services. It requires each MS to create a National Regulatory Authority (NRA) that periodically reviews national telecommunications markets and assesses the need for ex-ante regulatory remedies to foster competition in these markets. In particular, NRAs are required to analyse markets and to determine appropriate regulatory measures to be applied on operators having significant market power (SMP) in these markets.³

The portfolio of measures that can be introduced by NRAs include, among other things, the obligation to provide access to the network services offered by the operator with SMP and the imposition of maximum price caps on these services (so-called price controls). According to Article 13 of the Access Directive,⁴ when imposing obligations relating to cost recovery and price controls, NRAs "shall take into account the investments made by the operator, and allow him a reasonable rate of return on adequate capital employed, taking into account any risks specific to a particular new investment network project". NRAs typically determine this reasonable return by estimating the weighted average cost of capital (WACC) of the SMP operator. The WACC is therefore an important element of price control obligations, as it

¹ The regulatory framework consists mainly of five Directives, namely, the (i) Framework Directive; (ii) Authorisation Directive; (iii) Access Directive; (iv) Universal Service Directive and (v) Privacy and Electronic Communications Directive.

² Directive 2002/21/EC ("Framework Directive")

³ According to Article 14 of the Framework Directive "an undertaking shall be deemed to have significant market power if, either individually or jointly with others, it enjoys a position equivalent to dominance, that is to say a position of economic strength affording it the power to behave to an appreciable extent independently of competitors customers and ultimately consumers".

⁴ Directive 2002/19/EC of the European Parliament and of the Council "on access to, and interconnection of, electronic communications networks and associated facilities".

determines the maximum return that SMP operators can earn on the capital they employ to provide their regulated services. Hence the WACC is key in setting the tariffs other operators must pay to the SMP operator for access. In turn, the tariffs are a significant element of the retail prices consumers pay when purchasing telecommunications services.

The Directorate-General for Communications Networks, Content and Technology (DG Connect) has observed that different NRAs set the WACC for regulated telecoms activities in different ways, and that these differences may not always be motivated by fundamentals. As a result, an SMP operator may be allowed a different WACCs in different MS, simply because of underlying differences in the WACC methodology applied by the NRA. Different WACCs could then bias investment decisions, pulling investment towards high WACC jurisdictions and starving low WACC jurisdictions, ultimately creating inefficiencies and distorting the single market. Inconsistencies between WACC calculations could be particularly pronounced in respect of Next Generation Access (NGA) networks, in part because the estimate of the NGA WACC is more complex than for legacy networks, and there is more scope for subjective decision making.

Accordingly, DG Connect has commissioned The Brattle Group to develop a harmonised WACC methodology to be used in due course by EU NRAs. Specifically, we have been asked to develop a WACC methodology for:

- So-called legacy networks: copper networks used for the provision of voice and broadband services;
- Next Generation Access (NGA) networks: used for fibre-based telecoms services. We acknowledge that in practise the term 'NGA networks' encompasses a spectrum of technologies, ranging from Fibre-to-the-Cabinet (FTTC) to Fibre-to-the-Home (FTTH).⁵

In particular, DG Connect has asked us to develop a methodology that could be applied by all NRAs across the EU to set the WACC. DG Connect has asked us to select a methodology which relies as far as possible on publicly available which is available to all NRAs. In developing the methodology DG Connect has asked us to advise on whether a single parameter value should be applied across all EU MS.

⁵ In this report we will use the term FTTH, which we consider to be equivalent to the term Fibre-to-the-Premises (FTTP), unless otherwise stated.

In developing a methodology, we recognise that NRAs themselves have established methodologies and practices for estimating the WACC, and that proposing changes to the NRAs' methodologies itself has a potential cost in the form of increased uncertainty and regulatory risk. Therefore, our approach is to try to increase the consistency of existing practices and eliminate as far as possible subjective differences in the WACC methodologies, rather than to 'start from scratch'. For some parameters, in the interests of harmonisation we recommend a single methodology or data source, but recognise that other methodologies and data sources are available and could be equally valid.

We also acknowledge that the Commission's Recommendation on costing and non-discrimination states that it may not be necessary to set a price control for access to NGA if a number of conditions are met.⁶ We understand that it is common for national telecoms markets to meet these conditions, meaning that it may not be necessary to estimate a WACC for NGA in those circumstances. However, since a number of NRAs have imposed price controls on operators of NGA networks, the Commission has asked us to develop a common methodology for estimating the WACC also for NGA.

DG Connect has asked us to assume the use of the Capital Asset Pricing Model (CAPM) for the purposes of this study, since NRAs have used the CAPM almost exclusively in setting WACCs. An investigation of alternative approaches to estimate the cost of equity is outside the scope of this study.

II.A. PROCESS

In preparing this report, we have benefited from comments from the DG Connect staff involved in the project. DG Connect also organised a workshop, which took place in Brussels on January 20th 2016, and which was attended by around 80 participants. The participants included representatives from NRAs, telecoms operators and other relevant stakeholders. During the workshop we presented our initial findings, on which participants had the opportunity to comment. An academic financial economist⁷ and an analyst from an investment bank⁸ also gave their views on the estimation of the WACC for legacy and NGA telecoms networks. Where appropriate, we have incorporated the feedback we received at

⁶ Commission Recommendation of 11.9.2013 on consistent non-discrimination obligations and costing methodologies to promote competition and enhance the broadband investment environment.

⁷ Professor André Farber, Professor of Finance at the Solvay Business School & Université Libre de Bruxelles.

⁸ Mr Stephen Howard, Head of the HSBC Telecom Research team.

the workshop in this report. For a summary of the workshop discussion, see Appendix B on page 116.

II.B. ORGANISATION OF THE REPORT

In section III, we summarise our main conclusions, and indicate where the reader can find more detailed discussions of each topic in the report. In section IV, we briefly set out and define the main parameters involved in estimating the Weighted Average Cost of Capital (WACC). Readers already familiar with the concepts involved in estimating the cost of capital can skip this section. In section V we explain the motivation and purpose of the research, by describing the need for common guidelines for estimating the WACC in more detail. The bulk of the report is dedicated to a methodology for estimating the cost of capital for legacy networks in section VI, and then for NGA networks in section VII.

III. Summary of Main Findings and Recommendations

III.A. THE WACC FOR LEGACY NETWORKS

Below we summarise the main conclusions for the calculation of the parameters of the WACC for legacy networks.

Risk-Free Rate

- Deriving the risk-free rate from the yields on the NRA's 'domestic' bonds (being the government bonds for the Member State where the NRA has jurisdiction) is reasonable in most cases. A 'risk-free rate' derived in this way is in practice the sum of a true risk-free rate plus a country-risk premium (see section VI.A.1);
- Including the country-risk premium in the WACC is reasonable, since it will compensate the SMP operator for specific country and regulatory risks actually borne. A country risk 'uplift' on the WACC is the most practical way to compensate SMP operators for such risks;
- However, use of the domestic bond likely represents an upper limit to fair compensation for such country risks not otherwise compensated through cash flows. If the NRA uses the domestic bond to estimate the 'risk-free rate', no other adjustment to the WACC for other risks is required;
- Use of the domestic bond to determine the risk-free rate is not reasonable where:
 - The domestic bond is extremely illiquid;
 - The domestic bond presents a significant risk of default;
- We suggest alternative ways for the NRA to estimate a risk-free rate in such cases;
- It is likely that 'Quantitative Easing' (QE) programs have depressed country spreads, so that the country spread will tend to underestimate country risk. In this case it is reasonable for NRAs to make an upward adjustment to observed yields when estimating the risk-free rate, while the QE program is in place. An upward adjustment of up to 1 percentage point seems reasonable. The adjustment should take into account both the credit rating of the MS and the term of the QE program (see section VI.A.2).
- Deriving the risk-free rate using yields on longer term, so 10-year or 20-year bonds, seems reasonable, because:
 - It will be broadly consistent with the historical data used to estimate the Equity Risk Premium (ERP);

- Using a longer dated bond will approximate the so-called Empirical Capital Asset Pricing Model (ECAPM), and hence should lead to a more accurate estimate of the cost of equity (see section VI.A.3.b);

However, we recommend that, if NRAs estimate the ERP using data on historical returns, when using a 10-year bond as the risk-free rate they should apply an upward adjustment of around 40 basis points. This is because the standard source used by NRAs to derive historical ERP estimates (the study by Dimson, Marsh and Staunton) calculates historical return premiums relative to 20-year bonds (i.e. the equity premium over risk-free 20-year bonds), which typically have a higher yield than 10-year bonds. Hence, combining a 10-year bond as the risk-free rate with an ERP based on historical data risks underestimating the cost of equity. Alternatively, NRAs could correct for this effect by making an upward adjustment to the ERP estimate (see section VI.A.3.a).

- It is reasonable to estimate the risk-free rate based on an average yield over a period of time, but this averaging period should not exceed 12 months (see section VI.A.4).
- NRA's should use bond yield data from a reliable source including the relevant central bank, or a large data provider such as Bloomberg.

Inflation

- If necessary, NRAs should convert nominal yields to real yields using the Fisher equation (see section VI.B.1);
- NRAs should use forward-looking estimates of inflation. Ideally these estimates should be for a time period equal to the maturity of the bond from which the NRA is estimating the risk-free rate, although in practice this is not always possible because of the limited time horizon of inflation forecasts (see section VI.B.2);
- Non-Eurozone NRAs should use inflation forecasts for their currency zone. NRAs in the Eurozone should use a Eurozone-wide inflation estimate from Eurostat,⁹ unless they can demonstrate that the marginal investor in the SMP is 'local' (see section VI.B.3).

⁹ Eurostat and the national statistical institutes compile inflation forecasts based on the Harmonised Index of Consumers Prices (HICP), which is the reference inflation rate adopted by the ECB. More information can be found on the ECB website:

https://www.ecb.europa.eu/stats/prices/indic/forecast/html/table_hist_hicp.en.html

Beta

- Absent compelling reasons to the contrary, EU NRAs should use a common beta for legacy network activities. The beta should be estimated from a sample of firms based on criteria which we discuss;
- NRAs should calculate betas using daily returns over a two-year period. A two year period is an appropriate compromise between using recent data (which is likely to better reflect the expected future beta) while at the same time producing a reasonable number of observations and hence reducing statistical errors (see section VI.C.1);
- When calculating daily betas, NRAs should apply an adjustment to the calculated beta to account for the possibility that some of the reaction of the share price may occur before or after the reaction of the index (a so-called Dimson adjustment). We do not recommend that NRAs apply other adjustments such as Bayesian, Blume or Vasicek adjustments (see section VI.C.2);
- The CAPM is based on the idea that investors need only be compensated for non-diversifiable risk. At the same time, it seems unlikely that investors diversify their investments globally. We think the use of a wider European (rather than national) index is consistent with the idea that, while investors may not be globally diversified, investors in European telcos are at least diversified across Europe. It is also consistent with the use of Europe-wide data to estimate the ERP (see section VI.C.3);
- NRAs do not need to compute betas themselves, but could rely on 'off the shelf' estimates from data providers, such as Bloomberg, Morningstar, or others, or even recent beta estimates by other NRAs;
- Equity betas must be unlevered to obtain an asset beta. We present a number of reasonable unlevering formulas. The best way to minimise errors as a result of unlevering and relevering is to use a target level of gearing close to the average of the sample of firms from which asset betas are estimated (see section VI.C.5);
- Using the median of the calculated asset betas, rather than the arithmetic average, will tend to produce a beta estimate that is less dependent on the chosen comparators.
- There are no 'pure play' legacy network firms, or firms that approximate a pure play. There is no clear relationship between asset betas and revenue sources. Accordingly, there is significant uncertainty associated with the asset beta estimate for a legacy network. Based on the available evidence, an asset beta range of 0.50 to 0.67 would seem reasonable. This range reflects the upper and lower 95% confidence interval for the median asset beta based on our beta estimates for a range of suitable firms active in the European telecoms market;

- NRAs should recalculate beta for each new regulatory period, but exercise discretion in updating the beta value used in the WACC estimate. Significant variations in beta estimates from one regulatory period to another should be duly justified (see section VI.C.10).

Equity Risk Premium

- There is significant debate and uncertainty regarding predictions of the ERP, largely because it involves a prediction of the excess returns that investors expect today, and predictions are inherently uncertain. There is no academic consensus as to whether the historical data or estimates based on dividend growth models are superior. Given this uncertainty, in our view it would be wrong to be over prescriptive regarding the methodology for estimating the ERP, since this would assume that we ‘have the answer’ (see section VI.D).
- However, we do think that there is room to narrow the debate on the ERP based on a common set of principles:
 - First, NRAs could agree to estimate the ERP based on historical data on the excess return of stocks over bonds, as reported by Dimson, Marsh and Staunton (DMS). Survey data tends to be unreliable, and ERP forecasts from Dividend Growth Models tend to be sensitive to input assumptions which include analysts' forecasts of future dividends. In contrast, the historical data is stable, because it is hard for one additional year to change the average of over 100 years' worth of data. Stability, predictability and a lack of volatility are desirable in a regulatory context. The historical ERP provides a good ‘anchor’ for estimates and prevents large changes in the ERP from one regulatory period to the next.
 - Second, NRAs should base their ERP estimates on the arithmetic average of the historical excess returns. Given that there are some proponents of using the geometric average, and some arguments in favour of this approach, NRAs could also use a weighted average of the arithmetic and geometric average that take the academic research on the topic into consideration. However, we do not recommend an ERP estimate based only on the geometric average.
 - Third, NRAs could make reasonable adjustments to the historical data, informed by other sources of evidence on the ERP from, for example, Dividend Growth Models. NRAs should avoid a ‘mechanical’ application of historical data, which could for example result in an erroneously lower estimate of the ERP when stock markets have fallen.

- In our view, the final ERP estimate will often be, and perhaps should be, the result of a combination of data and judgement. At the same time, it would be desirable to have a single ERP value for the EU. This is because there is no good theoretical reason why the ERP should vary across MSs, and differences in the ERP across MSs could distort investment decisions.
- Based on the current evidence, in our view an ERP of 5-5.5% over bonds would be reasonable.

Total Returns Methodology

- We have considered the use of a total returns methodology. Rather than estimating the risk-free rate and ERP separately, a total returns methodology estimates the cost of equity by simply looking at the long-run average historic returns to equity, and reasons that equity holders would expect to earn in future the average of the returns that they have earned in the past. This would be an alternative to using the CAPM (see section VI.E).
- We do not recommend applying this methodology, for two reasons. First, equity returns are not in fact particularly stable over time. Second, the total returns method is looking at returns for the whole market, which by definition has a beta of one. Accordingly, the method will only give the correct expected return on equity for the SMP if the equity beta of the SMP is one or close to one. This is generally not the case.

Gearing

- Gearing, defined here as net debt over value, should be calculated using the market value of equity (see section VI.F.1);
- The book value of debt can be used, as long as the firm has an investment grade credit rating. If the firm does not have an investment grade rating, then it should not be used for WACC estimation;
- The value of financial leases should be included in the value of debt;
- The WACC is not highly sensitive to the choice of gearing, and the 'optimum' level of gearing will logically vary between MSs, as tax rates vary between MSs;
- In any case, the target level of gearing should not exceed 50-55%, which is the upper end of gearing observed for the telecoms sector in our sample of firms.

Debt Premiums and Betas

- The credit rating, debt premium and target gearing level should be consistent. For example, the NRA could choose a target credit rating, and then select the gearing level

and debt premium that would be consistent with that rating in the NRA's MS (see section VI.G);

- NRAs should look at yield data on bonds with the appropriate credit rating as the main input to the debt premium;
- Using a 10-year debt maturity should reflect a typical debt maturity for a large firm, and it should be possible to find yields for generic corporate bonds with this maturity;
- NRAs could calculate the debt premium by reference to a period consistent with the calculation of the risk-free rate;
- NRAs should estimate debt premia before making any adjustment to yields on government bonds to account for the effect of QE programs;
- Using 'generic' bond indices can tend to understate the required debt premium for smaller debt issuances. NRAs should give more weight to the SMP's actual bonds, providing they are consistent with the target credit rating;
- NRAs can either calculate 'bottom up' debt betas, or else use 'rules of thumb' based on credit ratings.

Taxes

- NRAs should adjust the WACC for taxes using the marginal corporate tax rate in the MS where the price control takes effect (see section VI.H);
- The MS should adjust the cost of equity for taxes by simply dividing the after-tax cost of equity by one minus the tax rate.
- NRAs should adjust the nominal cost of equity and WACC for taxes, not the real cost of equity (see section VI.H.2).

III.B. THE WACC FOR NGA NETWORKS

Consistent with the Commission's Recommendation on costing and non-discrimination, the expectation is that in most cases there will be no need to set a price control and hence WACC for NGA networks. Hence, we would expect the discussion below to apply only in a minority of cases.¹⁰

¹⁰ Commission Recommendation of 11.9.2013 on consistent non-discrimination obligations and costing methodologies to promote competition and enhance the broadband investment environment, ¶52 p.11.

III.B.1. Do NGA Networks require a 'WACC Premium'?

The second major question we address in this report is whether an NGA network requires a premium over the WACC of a legacy network. We call this the NGA network WACC premium.

We note that if there was a listed firm that only carried out NGA network activities – a 'pure play' NGA firm – then we could measure the WACC premium directly. However, at the present time no such firm exists. Therefore we have to rely on theoretical arguments to address the WACC premium.

The WACC should only compensate for systematic risk. Non-systematic risks must be dealt with, but not through the WACC. Hence, the question becomes – are there reasons to think that NGA network investments have a higher systematic risk than legacy networks? We think there are, for several reasons.

First, building an NGA network involves a commitment to make large capital investments over several years. This means that the 'capital leverage' of new NGA networks is high relative to a mature legacy network. The presence of the large capital spending commitments 'squeezes' earnings in the case of a macroeconomic shock decreasing revenues, and thereby increases the correlation between systematic events such as an economic downturn and the value of the asset. Hence, capital leverage increases the asset beta for an NGA network, relative to a legacy network, at least in the network build-out phase.

Second, NGA networks are – relative to a mature legacy network – long-lived investments with payoffs extending far into the future. This means that the value of the investment will vary more strongly with macroeconomic conditions, as the investment will be affected by uncertain macroeconomic risks over a longer period of time, in a manner analogous to a long-term bond. As a result, the value of long-lived investments like a new NGA network will be more sensitive to changes in macroeconomic conditions, and hence will have a higher beta, than a legacy network which has a shorter remaining life.

Third, demand for NGA services is likely to be more sensitive to income than the demand for legacy network services. Consumers must be persuaded to move away from legacy networks and pay more for faster services on an NGA network. In the event of a systematic downturn, as incomes fall we would expect this switching process to slow down, as consumers reduce spending. While demand for NGA services is uncertain and risky in general, it seems reasonable to suppose that a significant part of the NGA demand risk is systematic. This will increase the beta for NGA networks, relative to legacy networks.

III.B.2. Measuring the WACC Premium

NRAAs have employed a variety of methods to quantify the NGA WACC premium. While these methods may have merit, the differences between the approaches followed result in inconsistencies that could distort investment decisions within the internal market.

In our view the only way to quantify the NGA WACC premium with sufficient accuracy is through detailed financial modelling of an NGA network investment and a legacy network. We propose to use the legacy network as a benchmark from which to assess the premium required for the NGA network. In essence, the modelling exercise would reason that the asset beta for the NGA network would be proportional to the revenue volatility of the network. For example, suppose that the modelling exercise found that revenue volatility for the NGA network was 30% higher than for the legacy network, and we had estimated an asset beta for the legacy network of 0.5. We would estimate the asset beta of the NGA network as $0.5 \times (1 + 30\%) = 0.65$. This asset beta would then determine the required NGA WACC premium. We discuss how a 'beta decomposition' exercise could be a useful sense check on the value of the calculated NGA asset beta, but that this method also suffers from a number of practical difficulties. We note that the cost of debt for an NGA network investment is also likely to be higher for a given level of gearing, and discuss how an NRA can control for this.

In the previous section on legacy networks, we concluded that the default assumption is that the asset beta for legacy networks is the same across the EU, unless the NRA can provide good reasons to think otherwise. In the case of NGA networks, we reverse this conclusion. While all EU NRAs could use the same methodology to calculate the NGA WACC premium, there are reasons to believe that the value of the premium would differ between MSs. For example, the relationship between systematic changes in demand for NGA network services and changes in consumer income could differ between MSs to an extent that is not the case for legacy networks. This is largely because NGA services are a 'premium' product, so that demand for the service may be more sensitive to changes in income in some MSs than others. Capital investment costs for a given NGA network topology could also differ across the EU, for example because construction costs differ. This would result in different capital leverage in each MS. This issue is largely absent for mature legacy networks. These and other factors could lead to differences in the NGA WACC premium across the EU.

We explain that different NGA network topologies, such as Fibre-to-the-Cabinet (FTTC) Fibre-to-the-Distribution-Point (FTTD), and Fibre-to-the-Home (FTTH), could have different costs of capital, because the capital intensity and demand sensitivity of these investments will differ from one another. The WACC premium could also be different for the

wholesale and retail divisions of the company, and depending on the type of customer that the NGA network is serving.

The modelling exercise we propose could estimate the different WACC premia required for different network configurations. Indeed, only a technique based on the financial modelling of the actual network investments made will be able to identify the different risk premia required with sufficient accuracy.

IV.Measuring the Weighted Average Cost of Capital

In this section, we briefly explain the key parameters relevant to estimating the Weighted Average Cost of Capital (WACC).

The WACC combines two main components: the cost of equity and cost of debt of a given firm or project. As implied by the name, the WACC represents the weighted average of the costs of equity and debt, with weights reflecting the relative values of equity and debt.

Economic and financial literature have explored and proposed many different methodologies to estimate the cost of equity.¹¹ However, for this study DG Connect has asked us to focus on the Capital Asset Pricing Model (CAPM), which is the most common methodology EU NRAs apply to estimate the cost of equity. The CAPM – introduced in the mid-1960s by three economists, William Sharpe, John Lintner, and Jack Treynor – provides a measure of the relationship between perceived market risk and expected returns from the point of view of the market investor.¹² In essence the CAPM reasons that, to hold relatively risky equities, investors will require a return over and above the return that they could earn on a risk-free asset. This additional return is called the Market Risk Premium (MRP) or the Equity Risk Premium (ERP). The model also reasons that investors only need to be compensated for systematic risk – that is, risk that they cannot remove by holding a broad portfolio of investments. The contribution of the specific project or firm to the investor's systematic risk is measured by the parameter 'beta'. In practise, a beta of 0.5 means that if the market declines by 1%, we would expect the value of the investment to decline by 0.5%, so in this example it is less risky than the market. A beta of 1.5 means that if the market declines by 1%, we would expect the value of the investment to decline by 1.5%, so it is more risky than the market. By definition, the market portfolio has a beta of 1.0.¹³

¹¹ For review of the different methodologies in use to estimate the cost of equity see for example R.A. Morin (2006), *New Regulatory Finance*, Public Utilities Reports, Inc., pp. 28-29, and Chapter 5- 6.

¹² W.F. Sharpe, "Capital Asset Prices: A Theory of the Market Equilibrium under Conditions of Risk", *Journal of Finance* 19 (September 1964); J. Lintner, "The Valuation of Risk Assets and the Selection of Risky Investments in Stock's Portfolios and Capital Budgets", *Review of Economic and Statistics* 47 (February 1965), pp. 13-37. Note that the CAPM is also sometimes referred to as the Sharp-Lintner CAPM after the authors.

¹³ R.A. Brealey, S.C. Myers, F.Allen (2011), *Principles of Corporate Finance*, Tenth Edition, McGraw-Hill Irvin.

Mathematically, the CAPM formula is expressed as:

$$\text{Cost of Equity} = r_f + (r_m - r_f) \times \beta$$

where:

- r_f : is the expected returns of risk-free assets (Risk Free Rate) (see section VI.A);
- $(r_m - r_f)$: is expected market excess returns over risk-free assets, which is also called the Equity Risk Premium (ERP) (see section VI.D);
- β : is the equity beta, and is a measure of the specific non-diversifiable (systematic) risk of the investment (see section VI.C).

The cost of equity measured by the CAPM is a nominal after-tax value. the following formula gives the value of the after-tax WACC:¹⁴

$$WACC_{after-tax} = r_e \times \frac{E}{V} + r_d \times (1 - T_c) \times \frac{D}{V}$$

where:

- r_e : is the cost of equity as defined above;
- D/V and E/V are the relative market values of the firm's debt and equity (see section VI.F);
- r_d : is the cost of debt (see section VI.G);
- T_c : is the marginal tax rate (see section VI.H).

The cost of debt can be measured directly, but it is often expressed as the sum of the risk-free rate and a debt premium.

The debt premium measures the additional return lenders require for a borrower with a given credit risk, over and above the risk-free rate (see section VI.G).

¹⁴ The WACC formula can be expressed with different notations, we used a notation similar to the one used by Brealey, Myers, Allen in the text "Principles of Corporate Finance", p.216 (Tenth Edition).

The cost of debt is lower than the cost of equity, because debt is less risky. Because interest costs are usually tax deductible, the after-tax cost of debt is $r_d \times (1 - T_c)$, where T_c is the marginal corporate tax-rate. Adding debt to a project which was initially 100% equity financed tends to reduce the WACC.; However, as the level of debt increases beyond a certain point, the risk of bankruptcy overrides the tax advantages of debt, and the WACC will start to increase.¹⁵

The sum of debt and equity is equal to the firm value indicated by the parameter V in the formula ($V = D + E$). The relative weight of debt on the overall firm value can be called gearing or 'leverage'.

As firms usually pay taxes on their earnings, the after-tax WACC can be adjusted upward using the relevant corporate tax rate to measure the required pre-tax cost of capital:¹⁶

$$WACC_{pre-tax} = \frac{WACC_{after-tax}}{(1-T_c)}$$

The WACC, which is commonly expressed in nominal terms, can be transformed in to a real rate of return by subtracting the expected inflation rate from the nominal WACC (see section VI.B).

¹⁵ R.A. Morin (2006), *New Regulatory Finance*, Public Utilities Reports, Inc., pp. 454-455. R.A. Morin wrote: "[a]t zero debt ratio, the return on equity coincides with the return on total capital since the firm is all-equity financed at that point. Shareholders only have to contend with business risk and do not have to deal with financial risk [...]. Beyond that point, with each successive increase in the debt ratio, equity returns rise moderately at first in response to increasing financial risk to the point where the bond rating begins to deteriorate. As the debt ratio reached dangerous levels where the solvency of the firm is endangered, shareholders' required returns rise sharply", p.455.

¹⁶ See section VI.H.

V. The Need for Common Guidelines

Most EU NRAs undertaking price controls on SMP operators use the CAPM to estimate the cost of equity. They then estimate the cost of debt and produce a weighted average of the cost of debt and equity to arrive at the WACC for the relevant activity. However, the methodologies which NRAs apply to estimate the various parameters of the WACC differ widely. For example, based on a survey of five NRAs,¹⁷ we find that:

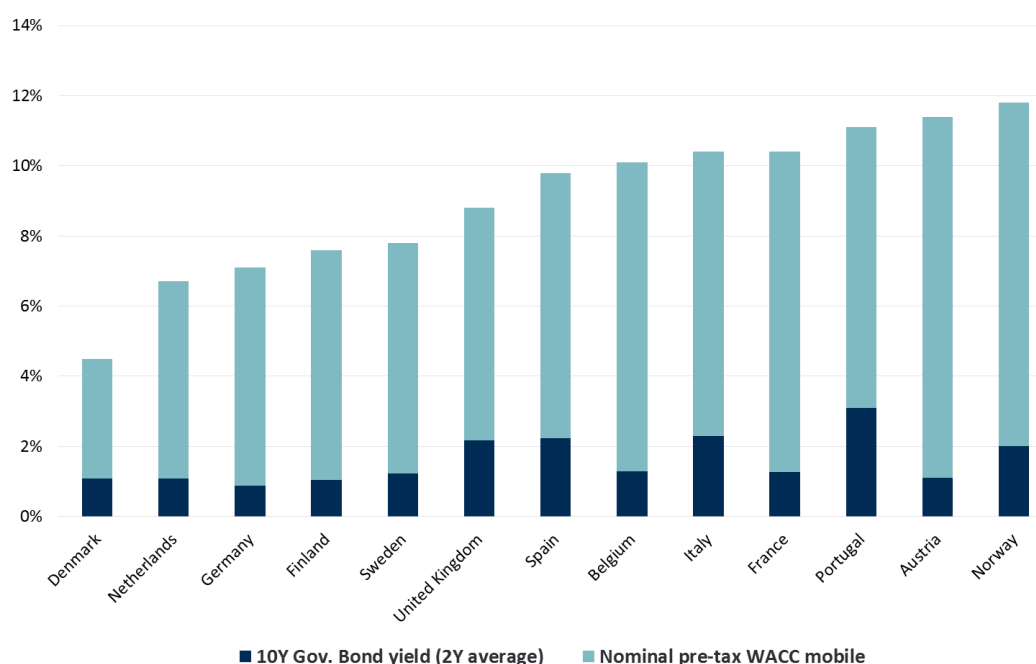
- NRAs calculate the risk-free rate by averaging yields on government bonds over a period of time. However, the averaging period varies from 10-years to 6 months;
- The Equity Risk Premium (ERP), which as we discuss in section VI.D should have a common value for all MSs, varies from 3.4% to about 7.0%;
- NRAs estimate betas based on different samples of firms;
- Some NRAs use a two-year period to estimate the equity beta and others a five year period. Some NRAs apply a Bayesian or Blume adjustment to the calculated beta while others do not; and
- With regard to the cost of debt, some NRAs base the cost on the existing or embedded debt, while others factor in the cost of new or expected debt issues.

All of the parameters have a material effect on the final value of the WACC. Figure 1 illustrates the range of WACCs determined for mobile networks, reproduced from a report by the Swedish NRA.¹⁸ As we discuss in section VI.C.9, we would expect the WACC for mobile to be broadly similar to the WACC for legacy networks. To control for differences in underlying interest rates, in Figure 1 we have added the average yield on 10-year government bonds, shown by the dark blue bars. The remaining light blue bars vary considerably from one another. It seems unlikely that all of the differences are motivated by economic fundamentals. It seems more likely that a significant amount of the difference arises because of subjective decisions taken by the relevant NRA regarding the WACC methodology.

¹⁷ Our sample consisted of Italy, United Kingdom (UK), Spain, Germany and France. We have chosen the countries in this list because they represent larger telecoms markets, and the regulators are more likely to be well resourced and therefore be able to explain and motivate any WACC decisions in more detail. We include details of the individual WACC methodologies in Appendix C.

¹⁸ PTS, “Consultation on return rates for mobile networks – an update”, April 11th 2014, available at: https://www.pts.se/upload/Rapporter/Tele/2014/consultation-on-return-rates-for-mobile-networks-wacc-pts-er-2014_17.pdf

Figure 1: Different allowed WACC for Mobile Networks



Source: PTS (Swedish NRA), Cullen International and Brattle analysis of Bloomberg data.

Differences in methodology also emerge in the cases where NRAs have estimated the WACC for NGA networks. For example:

- OPTA, now ACM (the Netherlands) allowed the SMP to earn a return up to 3.5 percentage points above the WACC, before ‘clawing back’ any additional profits, thereby giving an upside to the NGA investment.
- Ofcom (UK) has ‘disaggregated’ the SMP’s observed beta, and derived a higher beta for the non-legacy network business, a large part of which is NGA-related activity. Ofcom does not currently set a price control for fibre access.¹⁹
- Agcom (Italy) has used an option-based approach to quantify the NGA WACC premium relative to the legacy network WACC. In essence the approach tries to compensate the SMP for the loss of the option to ‘wait and see’ how the market develops when it makes the decision to invest in an NGA network.
- ARCEP (France) recognizes a premium for NGA networks to guarantee the adequate remuneration to investors. To estimate the premium – defined on a case by case basis – ARCEP compares the expected Internal Rate of Return (IRR) of the project with the regulated WACC used for fixed legacy networks. As per standard techniques in

¹⁹ See Box 1 on page 46 for a full description of Ofcom’s methodology.

financial analysis, the project IRR is calculated on the cash flows of the project on a business plan with a minimum length of 25-years.

- CNMC (Spain) applies a Discounted Cash Flow (DCF) model of an NGA network combined with a Monte Carlo analysis which varies demand for NGA services and the operator's market shares. CNMC models a low uncertainty case and a reference (higher) uncertainty case, and uses the difference in the IRR between these two cases as the basis for the NGA WACC uplift, relative to the legacy network. In essence, CNMC aims to compensate NGA investors for the additional risks of NGA demand and market share.

As a result of these differences in methodology, the WACC for the same activity will differ between MSs for reasons that do not reflect market fundamentals, but rather reflect apparently subjective differences in the WACC estimation methodology. This could distort market participants' investment decisions and create inefficient outcomes. Capital may not be invested where it is most required, and investors may not be compensated for the risks they actually bear.

In the remainder of the report we analyse each component or parameter of the WACC calculation and discuss:

- Whether it would be appropriate to apply a single value across the EU, and if so how that value should be determined;
- If it is not appropriate to apply a single value across the EU for a parameter, we consider whether it is possible or desirable to recommend a standardised methodology for estimating the parameter, so that differences in parameter values will reflect fundamentals rather than differences in the calculation methodology.

We first consider the cost of capital for legacy networks, and then consider how the WACC for NGA investments might differ from the legacy network WACC.

VI. Cost of Capital for Legacy Networks

VI.A. THE RISK-FREE RATE

Most NRAs determine the risk-free rate by reference to a yield on a traded government bond, and we assume here that this is the methodology that will be applied. However, there remain three key considerations in determining the risk-free rate:

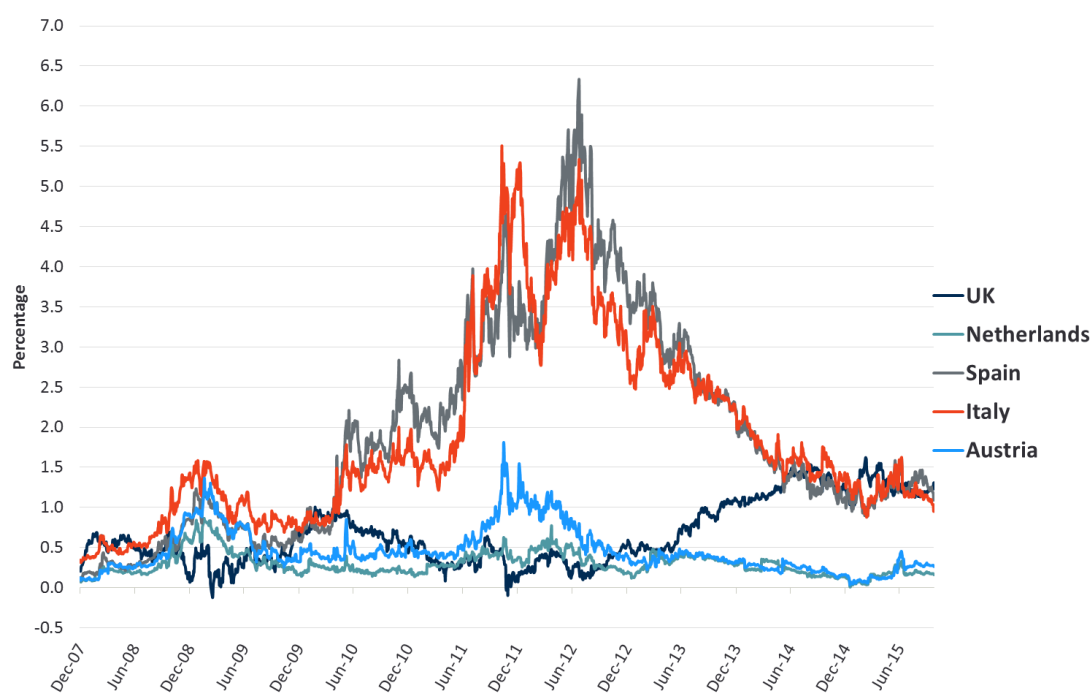
- Which country-bond should be used – a true risk-free rate, or the bond of the country where the SMP operator is located?
- Which bond maturity – for example, a six-month bond (bill), a five-year bond or a 20-year bond?
- Over what period should we measure yields? For example, should we take the bond yield on the day of the WACC decision, an average yield over the last month or an average yield over the last two years?

We discuss these issues in turn below.

VI.A.1. Choice of Country Bond

Most NRAs estimate the ‘risk-free rate’ using the bond yields of their own MS. In this discussion we will refer to these as the ‘domestic’ bonds of the NRA. Prior to the Eurozone sovereign debt crisis, Eurozone government bond yields were very similar, and indeed yields were similar across the EU – Figure 2 illustrates this. Most bonds appeared to be approximately ‘risk-free’, and it was not controversial for an NRA to use yields on its domestic bonds. However, since 2010 sovereign yields have diverged significantly from each other and the best approximation of a Euro-denominated risk-free rate: the German bund. The divergence in nominal yields reflects the variation in the risk of sovereign default across the Eurozone, and different inflation and interest rate expectations in non-Eurozone MSs.

Figure 2: Spreads of EU 10-year Bond yields over German bonds for a selection of countries



Source: Brattle analysis of generic 10Y Government bond yields data from Bloomberg.

The divergence between MSs' bond yields raises the question: is it reasonable for NRAs to estimate the risk-free rate using the yields on their MSs' bonds, even though this may not be a risk-free rate? We think the answer is 'yes' for non-Eurozone MSs, because the domestic bond reflects interest rate and inflation expectations for the domestic currency. We also think the answer is 'yes' for most Eurozone countries, for the following reasons.

First, SMP operators, and all firms subject to price regulation, need to be compensated for regulatory risk. One textbook defines regulatory risk as follows:

“Regulatory risk is another risk factor facing regulated firms that can increase both business and financial risk. Regulatory risk can encompass failing to adhere to Good Regulatory Practice that we defined in Chapter 2, for example by implementing ex-post changes in regulations. But it can also encompass ex-ante changes in how firms are regulated on a going-forward basis. For regulated firms that must make significant capital investments in long-lived assets to meet their obligation to serve, frequent changes in how those firms are regulated leads to greater uncertainty and greater risk. Regulated firms rely on consistency from regulators and assurance that existing regulation will be applied in a fair and reasonable way. Regulatory risk occurs whenever changes in existing regulations or applications of those regulations are perceived by investors to be arbitrary and capricious and, as a consequence, viewed as

jeopardizing the opportunity to earn risk-compensatory returns on their investments.”²⁰

Put another way, regulatory risk is the risk that regulation, and in particular price-cap regulation, creates for the firm. Regulatory risks include the risk that the regulator will disallow investments from the rate base,²¹ set an allowed return that does not reflect the firm’s actual cost of capital, or fail to update allowed costs to reflect the firm’s actual costs in a timely manner (so-called regulatory lag).²²

Regulatory risk means that there is always a possibility that the firm may not actually earn the revenues that the regulator promised. To earn a fair return on its investment, the regulated firm may have to earn more than a fair return in ‘good’ times – so when regulatory risk does not materialise – to compensate for negative regulatory events in ‘bad’ times.

Second, SMPs face other risks which vary between Member States, and which are unlikely to be fully accounted for in the level of the price cap. These include for example the risk of increased non-payment, bad debt and network abandonment in the event of a systematic economic downturn or crisis.

How to compensate firms for these risks depends in large part on whether they are diversifiable – that is, to what extent the risks are correlated with the wider market. Financial theory states that, if the risk is diversifiable, it is not correct to account for it by increasing the required return.²³ This is because investors only require compensation for systematic or non-diversifiable risks. Instead, we should account for non-systematic or diversifiable risks in the cash flows. For example, the regulator could increase the allowed tariffs slightly, to allow for the possibility of a tariff reduction or increased non-payments in the future.

²⁰ Giacchino, Lesser, *Principles of Utility Corporate Finance*, First Edition, p.190.

²¹ For example, the regulator could not allow an investment or part of an investment to be included in the rate base by alleging that the investment was unnecessary or was not carried out in an efficient way.

²² For further discussion of regulatory risk, see ‘Regulatory Risk, Economic Principles and Applications to Natural Gas Pipelines and Other Industries’, Kolbe, Tye and Myers, Kluwer, 1993.

²³ For example, in their seminal textbook Professors Brealey and Myers note that they “suspect that managers mark up the required return for foreign investment to cover the risk of expropriation, foreign exchange restrictions, or unfavourable tax changes. A fudge factor is added to the discount rate to cover these costs. We think that managers [valuing firms] should leave the discount rate alone and reduce expected cash flows instead.... [A]djusting cash-flows brings management’s assumptions about “political risks” out in the open for scrutiny and sensitivity analysis.” *Principles of Corporate Finance*, Brealey & Myers, Fifth International Edition, p.972.

In practice, there are a number of problems with the idea of compensating these risks through cash flows. First, it is not clear if these risks are truly diversifiable. For example, a widespread economic shock could tempt regulators to relieve financial pressures on consumers by cutting tariffs on regulated services, including telephony. Hence, to a certain extent regulatory risk is probably systematic.²⁴ At least part of the risk of increased non-payment, bad debt and network abandonment is also systematic.

From a practical perspective, it would be very difficult for the regulator to assess the chance that it may in future behave in some 'unreasonable' way, or that there might be an economic shock in the future. Clearly, from the regulator's point of view all of its decisions appear reasonable, even if investors in the regulated firm do not agree.

Hence, it does not seem practical to require NRAs to attempt to adjust the regulated firm's tariffs so as to compensate for these risks. Rather, NRAs tend to compensate regulated firms through the allowed rate of return, and specifically by using the NRA's 'domestic' MS bond yield to calculate the 'risk-free' rate, which is in fact higher than a true risk-free rate.

By using their domestic bond, the NRAs' are allowing the regulated firm an additional return equal to the difference in the yield between the true risk-free rate – which at present is the yield on a German bund – and the yield on the domestic bond. In most cases this difference or spread, also known as the country-risk premium – mainly reflects the additional default risk or country risk of the domestic bond.²⁵

The question then becomes: is the default risk, as measured by the country spreads, a reasonable way for NRAs to compensate the firm for regulatory and other country specific risks? The answer in our view is again 'yes', at least for most cases, because there are theoretical and empirical reasons to believe that regulatory and country specific risks are closely, if imperfectly, related. From a theoretical point of view, countries which get into financial difficulties and face the possibilities of defaulting on their debt often resort to reducing regulated tariffs to 'balance the books'. For example, Argentina reduced tariffs in US dollar terms for regulated electricity and gas businesses in response to the 2001 economic

²⁴ See further discussion of whether regulatory risk is diversifiable see for example Principles of Utility Corporate Finance, Giacchino, Lesser, Public Utilities Reports Inc. 2011, p.222.

²⁵ At least within the Eurozone. the differences in Eurozone Sovereign yields could also stem from the differences in liquidity and the consequent presence of liquidity premia, but in most cases we would expect liquidity effects to be relatively small. Liquidity effects are likely to be more significant for smaller Sovereign bond issuers

crisis.²⁶ More recently, Spain has been accused by investors of reducing tariffs and subsidies in the renewables sector in an attempt to reduce its expenditures in the case of the economic crisis and declining credit ratings.²⁷

On the other hand, the Iberian Peninsula also provides some evidence that the country spread can overstate regulatory risk, to the extent that investors see regulators as more reliable than the government. The Iberian Peninsula is an interesting example, because long-term collection rights granted by energy regulators in both Spain and Portugal to repay historical tariff deficits have been securitised and sold in the form of bonds. These bonds have been rated, and have observable yields which can be compared to Government bonds. This enables us to compare how investors view long-term regulatory promises as opposed to the promises made by Sovereigns to repay debt.

In Spain, the tariff deficit securities have been rated at a similar level to the Spanish government itself. In contrast, the securities issued in relation to the Portuguese tariff deficit consistently enjoyed a superior debt rating to that of the Portuguese government, for much of the time reaching the maximum three-notch uplift to the sovereign allowed by Fitch and Moody's. The three-notch uplift in Portugal reflects ratings agency confidence in the independence of the regulator and the relative stability of the regulatory regime. Fitch discussed the differences between the Spanish and Portuguese tariff deficit securities, and attributed the ratings differences to the stability of the Portuguese regulatory regime and the independence of its regulator.²⁸

To sum up our conclusions so far:

- Investors in a regulated business must be compensated for regulatory and other country-specific risks not otherwise compensated in the price cap;

²⁶ One book notes that “Government switched electricity prices to pesos from dollars (a process known as pesofication) and prohibited rate increases following the devaluation, a move to keep inflation at bay. As a result, generators and utilities could not raise prices to compensate for losses caused by any devaluation. Instead, the depreciating peso wiped out their revenue in dollar terms and nearly tripled the cost of running their plants and servicing their debts.” Vedavalli, Rangaswamy. *Energy for Development: Twenty-first Century Challenges of Reform and Liberalization in Developing Countries*. Anthem Press, 2007. Fitch, the rating agency notes even in 2015 “Capex's ratings are also impacted by the high regulatory risks associated with operating in the electricity sector in Argentina”. See Fitch Affirms Capex's Foreign and Local Currency IDRs at 'CCC' and 'B-', 30 July 2015.

²⁷ We do not comment on the legal validity of these claims here – we simply use the example to illustrate the relationship between financial distress or reduced credit ratings and regulatory risk.

²⁸ See Fitch Ratings, “Portuguese Tariff Deficit Plan More Credible than Spain's”, 10 September 2013.

- NRAs could compensate SMPs for these risks by adjusting tariffs, but in reality this is often complex and impractical for NRAs to do;
- These risks vary across MSs. To avoid distorting investment decisions, MSs with higher risks must allow a higher rate of return than countries with lower risks;
- The country risk premium, as reflected by bond yields relative to Germany, are in many cases related to regulatory risk and other relevant risks;
- Compensating investors for these risks by offering a premium on the return equal to the country-risk premium seems reasonable, as the relevant risks and default risk are closely, if imperfectly, related;
- What the NRAs are really applying in the CAPM is a risk-free rate plus a country risk premium. The latter component approximates a premium for regulatory risk and other risks;
- The risk premium calculated in this way is likely to represent the upper limit for fair risk compensation. For example, we can see examples where investors regard regulatory risk as lower than country risk;
- If NRAs account for regulatory and other country specific risks by using their domestic bonds as the 'risk-free rate', no other upward adjustment for these risks should be required. For example, NRAs should not include an arbitrary 'uplift' on their estimated WACC in addition to a WACC estimated taking into account country risk through the use of domestic bonds as the risk-free rate;

VI.A.1.a. *When is it not correct to use MSs' bond yields to estimate the risk-free rate?*

Importantly, the justification for using a MS-specific bond yield assumes that country risk – as measured by the spread over German bunds – is closely related to regulatory and other country related risks for that MS. However, there are three cases where that relationship breaks down.

First, if the NRA's domestic bonds are not very liquid, then a significant part of the country spread may relate to an 'illiquidity premium', rather than default risk. Generally, investors will demand a higher return for holding an illiquid asset which they cannot easily sell, and this additional return is referred to as an illiquidity premium. There is no reason to think that the illiquidity premium is related to regulatory risk, or that investors in the regulated firm should be compensated for it. Using the yield on a relatively illiquid domestic bond would over compensate investors in the regulated firm.

One way to overcome the issue of using a relatively illiquid bond for the calculation of the risk-free rate would be for the NRA to refer to the Credit Default Swap (CDS) rate instead of the yield on the domestic bond. The CDS rate measures only the cost of insuring against the risk of default, and is less affected by general illiquidity. By adding the CDS rate for the domestic bond to a liquid and risk-free yield for the German bund, the NRA could estimate a risk-free rate that does not compensate the SMP's for the illiquidity of the domestic bond.²⁹

Comparing the CDS rate to the difference between the domestic bond yield and the yield on a German bond could also provide a test for illiquidity.³⁰ If the CDS rate were significantly lower than the difference between the domestic bond yield and the yield on a German bond, this would indicate the presence of an illiquidity premium. The NRA could then opt to estimate the risk-free rate based on CDS rates.

CDS rates are generally only available from a financial data provider such as Bloomberg. If the NRA does not have access to such a data source, then an alternative could be to compare yields on the domestic bond with the yields on a more liquidly traded bond with the same credit rating.³¹ Credit ratings are generally available for free, and many MS central banks publish yields on the domestic bond. Professor Damodaran of NY Stern University also publishes country risk premiums and average sovereign spreads by credit rating.³² Of course other features of the bond would also have to be similar, including the time to maturity and currency. For example, an NRA with a domestic bond that was not liquidly traded and was rated A3 could calculate the average yield on other larger A3 bond issues.

The second case in which it would not be correct for the NRA to use its domestic bond yields to calculate the risk-free rate is if the NRA's MS had a significant risk of default. In this case, it is no longer reasonable to estimate the risk-free rate using the domestic bond yield. Doing so will typically overestimate the return that the SMP operator requires, because the risk of

²⁹ This exercise would require assumptions about the term structure of default risk.

³⁰ The CDS and bond yields would need to be term-matched. Otherwise differences in term could distort the comparisons.

³¹ Credit ratings indicate the chance of default on a bond, with bonds with a high rating having a very low probability of default and vice versa. Since bonds with the same rating have a similar probability of default, then the yields on the bonds should be similar. Credit ratings are issued by credit rating agencies such as Moody's, Standard and Poors and Fitch. For details on how the agencies arrive at a given credit rating, see for example the Moody's Rating Methodology, Global Telecommunications Industry, December 28 2010.

³² Downloadable from <http://www.stern.nyu.edu/~adamodar/pc/datasets/ctryprem.xls> (Damodaran online). While the site offers useful data, we would caution against NRAs adopting Professor Damodaran's country risk methodology.

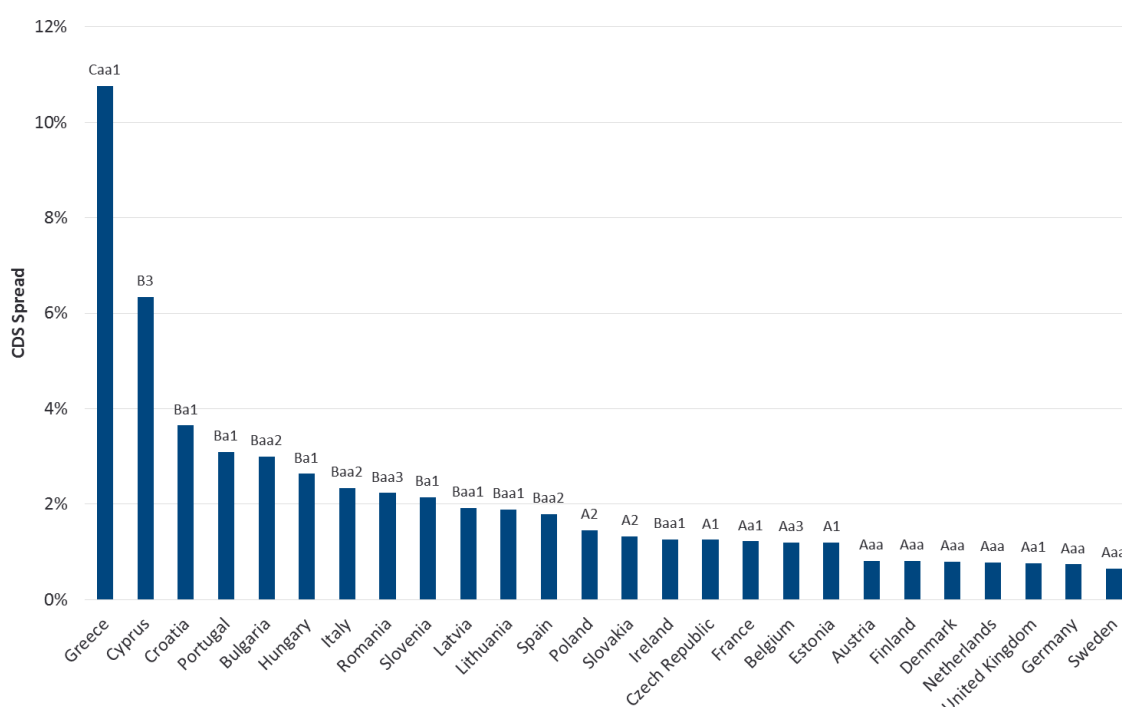
default – and hence the yield premium required – is higher than the risk of a ‘regulatory default’, being an event which reduces the SMP operator’s return below a reasonable level.

It is difficult to be prescriptive about precisely when NRAs should not use the yields on their MS bonds to estimate the risk-free rate. However, as a general guideline the MS bonds should not be used in the risk-free rate calculation if:

- The bonds have a credit rating below investment grade, for example in the range Baa3 or below;
- Yields on the bonds are above the yields on bonds issued by large firms operating in the country, and which earn most of their revenues in the country. If the SMP operator itself has listed bonds, then this would be the best benchmark. If the MSs' sovereign bond yields are higher than yields on bond which are largely dependent on revenues from the same MS, then this indicates that bond holders are concerned specifically about default on the sovereign bond issue rather than country risk more generally.

For example, as of the beginning of 2015, the criteria that bonds should have a Moody’s rating (or equivalent) of at least Baa3 would only rule out Greece, Cyprus, Croatia, Portugal, Hungary and Slovenia. As Figure 3 illustrates, there is a significant difference between the country-risk premia for Cyprus and Greece – as measured by the Credit Default Swap rate – relative to the other MS. A minimum rating of Baa3 is reasonable, since it would mainly exclude MSs which had a significantly higher country-risk premia, indicating a significantly higher risk of default.

Figure 3: 10 year Credit Default Swap (CDS) rate for EU Member States



Source: Damodaran online. Ratings and CDS rates are as of January 2015. Note that CDS rates are not available for Luxembourg and Malta, but these countries had ratings of Aaa and A3 respectively, and so would not be excluded under the proposed criteria.

If the NRA cannot use its domestic bonds because they do not have a good enough rating, how should it estimate the required regulatory risk premium? It is difficult to suggest a full proof method, because almost by definition the cases are somewhat exceptional. MS NRAs in this situation should be given fairly broad discretion to determine the appropriate cost of capital. However, one possibility is to proceed as follows:

- The NRA could identify when the domestic bond became an unreliable indicator of the regulatory and country-specific risks relevant to SMP operators, by looking at when yields rose above the yields on either the SMP operator's bonds (if available), or another company's bonds in the same MS with a similar credit rating to the SMP operator.
- In the period when the domestic bond was still reliable, we would expect that the SMP operator's bond yields would be above the sovereign (MS) yields. That is, the SMP operator was more risky than the MS, because it faces regulatory and country risks (comparable to investors in the Sovereign bonds) but also business risks which investors in Sovereign bonds do not face.
- The NRA could measure the average difference or spread between the SMP operator's yields and the MS yields in the period when the domestic MS bonds were still reliable. This difference, which we will call here the 'business spread', represents business risk specific to the SMP operator.

- For the unreliable period, the NRA could estimate the regulatory risk premium by taking the yield on the SMP operators bonds, less the business spread.

For example, suppose that yields on the MS bonds were 4%, and on the SMP operator bonds were 5%. However, at a certain point the MS bond yields jump to 8%, because the MS has been downgraded and investors are worried the MS may default on its debt. Yields on the SMP operator bond also increase, to 6%, but are lower than the MS yields. In this case the NRA would estimate the risk-free rate as 6%, being the SMP operator bond yield, less the 1% difference which represents business risk. Hence the 'risk-free' rate would be 5%, not the 8% indicated by the MS bond yields.³³

The final factor which could distort the relationship between country risk and regulatory risk is the role of 'quantitative easing'. We discuss this in a separate section below.

VI.A.2. Quantitative Easing

In January 2015 the European Central Bank (ECB) announced an expanded asset purchase programme of bonds issued by euro area central government, agencies, and European institutions, so called Quantitative Easing (QE). The program, started in March 2015, was initially intended to be in place until September 2016 but was subsequently extended. It will now run until at least March 2017.³⁴ Similarly to other previous ECB asset purchase programs launched in the last four years, QE has temporarily increased the prices of government bonds directly involved, and reduced the yields.³⁵ However, regulatory and country risks have arguably not decreased. If so, estimating the risk-free rate from bonds yields depressed by QE programs will tend to underestimate the return SMP's require. We recommend NRA's apply

³³ We applied this methodology when estimating the cost of capital for the Greek pipeline company DESFA in 2010 in the context of a tariff review, when the yields on Greek government bonds had reached very high levels.

³⁴ Through the QE program the ECB intends to fulfil price stability and to address the risks of an extended period of low inflation. The Quantitative Easing program extension to March 2017 was announced by the president of the ECB Mario Draghi during a press-conference in December 2015. The foreseen asset purchase, which at the beginning of the program amounted to about € 60 billion per month, has been increased by the ECB to € 80 billion after April 2016 (ECB, Press Release, 10 March 2016).

³⁵ Namely, the other two relevant programmes of the ECB launched since the economic crisis to rescue the European countries from the negative effects of the economic downturn are: (i) the Securities Market Programme (SMP) launched in May 2010, which mainly implied asset purchase of Italy and Spain, and (ii) Outright Monetary Transactions (OMTs) started in September 2012, with implications for short term government bills (1-3 years) of European countries most affected by the crisis.

an upward adjustment to the risk-free rate as measured by bond yields, to account for the effect of QE programs.

Recent literature and regulatory decisions provide some tools to try to estimate the overall effects of QE programs on bond-yields, and suggest that adjustments to the risk-free rate are justifiable when the regulatory period spans over the QE monetary policy timeframe and reflects a long-term view:

- The Bank of England started a quantitative easing programme in March 2009 and continued purchasing government assets until October 2012, for a total amount of about £ 375 billion. The Bank of England estimates that its asset purchase program reduced UK Government bond yields by about 100 basis points.³⁶ Ofgem has recently decided to make an adjustment for the risk-free rate for about the same amount, pointing to evidence of the Bank of England's quantitative easing policy effects on yields and to provide consistency between the estimate of the risk-free rate and the equity risk premium;³⁷
- The Federal Reserve launched a QE programme in November 2008 consisting in asset purchases of about \$3.7 trillion until October 2014, whose effect has been empirically estimated to result in a yield reduction of about 100 basis points.³⁸
- More recently, the European Central Bank (ECB) has published a paper about the effects of the QE program on European financial markets, distinguishing between “stocks” (or announcement), and “flow” (or portfolio rebalancing) effects.³⁹ Focusing on the first kind of effects, the authors measured that QE announcements by the ECB affected 10 year government bond yields between 16 basis points (measured on

³⁶ Bank of England (Q3 2011), “The United Kingdom’s quantitative easing policy: design, operation and impact”, chart 5, p.205. Joyce M., Lasaoa A., Stevens I., Tong M. (2010) “The financial market impact of quantitative easing”, Bank of England, Working Paper No. 393.

³⁷ Ofgem (2014), “Decision on our methodology for assessing the equity market return for the purpose of setting RIIO-ED1 price controls”; Ofgem (2013), “Strategy Decision for the RIIO-ED1 electricity distribution price control. Financial Issue.”, p.21. Also Ofwat in the 2014 decision adjusted the estimate of the risk-free rate for forward-looking expectations, given the current yields on ten-year index-linked gilts were close to zero at the time of the decision. For more details see Ofwat (2014), “Setting price controls for 2015-20 – risk and rewards guidance”, p.15.

³⁸ Gagnon, J, Raskin, M, Remache, J and Sack, B (2010), “Large-scale asset purchases by the Federal Reserve: did they work?”, Federal Reserve Bank of New York, Staff Report No, 441; Meaning J., Zhu F. (2011), “The impact of recent central bank asset purchase programmes”, BIS Quarterly Review, December 2011; Joyce M., Miles D., Scott A., Vayanos D. (2012), “Quantitative Easing and Unconventional Monetary Policy – An Introduction”, The Economic Journal 122 (November).

³⁹ European Central Bank (2015), “Asset Purchase programmes and financial markets: lessons from the euro area”, Working Paper Series, No.1864/November 2015.

German 10-year government bond yields) and -80 basis points (measured on Spanish 10-year government bond yields), with an average effect on the 10-year government bond yields for the Euro Area of about – 40 basis points.⁴⁰

- The Italian Regulatory Authority for Electricity Gas and Water, has recently taken into account an adjustment of about 50 basis points on the real risk-free rate of regulated services for electricity and gas sectors.⁴¹

This evidence suggests that QE programs have a measurable downward effect on yields of government bonds of somewhere between 20 and 100 basis points. The literature reviewed seems to show that the absolute reduction in yields as a result of QE programs is larger for countries with lower credit ratings, and during financial and economic distressed conditions. Finally, we observe that the overall effects of the European QE program cannot be fully measured at the time of writing, because the program is ongoing.

On balance we recommend that European regulators increase the estimate of depressed risk-free rates estimated from bond yields after January 2015 while the QE program is in place up to 100 basis points, taking into account:

- On the one hand, the ECB paper indicates that the adjustment will vary by credit rating, in a range between 16 and 80 basis points, provisionally estimated for Germany and Spain respectively;
- On the other hand, that in the longer-term the overall cumulative effect of the QE program – once concluded – on European government bond yields would likely be higher than that provisionally estimated by the ECB study, and may be more in

⁴⁰ Stocks or announcement effects on 10-year Government bond yields have been empirically tested by the authors through an event study, which takes into account a broad set of official communication announcements done by the ECB on the QE program, event windows of 1 and 2 days, and controls for other macroeconomic releases. The analysis is limited to short-term effects measured during the days around the ECB announcement and do not address long-term perspectives of the overall effects of QE on assets prices and yields that will be fully measurable only at the end of the QE program. In fact, the preliminary results of the ECB paper have been estimated before the announcement of the ECB in December 2015 which extended the QE program until at least March 2017.

⁴¹ In December 2015 the Italian “Autorità per l’energia elettrica il gas e il sistema idrico” (AEEGSI) published a directive (n.583/2015/R/com) which defines the methodology to determine and update the WACC for regulated services of electricity and gas sectors. The AEEGSI’s new methodology estimates the real risk-free rate using the average government bond yields in real terms for European countries rated at least double-A, adjusts the ‘raw’ risk-free rate to get a minimum level of 0.5%, which approximates an upward adjustment of 50 basis points.

line with long-term estimates released for UK and the United States, where the respective programs ended several years ago.

VI.A.3. Bond Maturity

For the bond maturity or term, there are a number of factors to consider including:

- Matching the bond term to the regulatory period;
- The volatility of the bond yields;
- The liquidity of the bonds – for example for some MSs 10-year bonds may be more liquid than 5 year bonds, and so the yields reflect only risk rather than a liquidity premium;
- The consistency of the bond yield data with the measured Market Risk Premium;

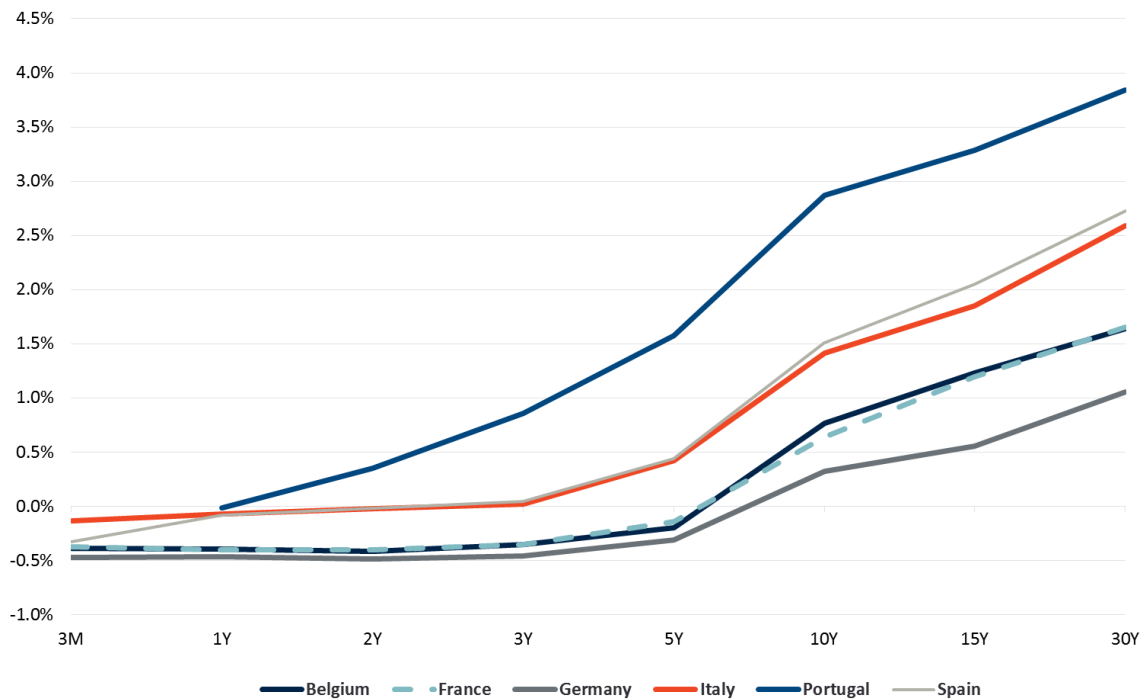
VI.A.3.a. Consistency between the ERP and the risk-free rate

One basic issue in the choice of the bond duration is the need for consistency between the choice of ERP and the risk-free rate. The ERP is a premium over a bond – usually either a long-term or a short-term bond.⁴²

Bond yields tend to increase with increasing maturity. That is, the yield curve tends to increase with increasing term, because investors bear more default and inflation risk with longer dated bonds. The slope of the yield curve will also depend on expectations regarding future interest rates.

⁴² In the context of historical ERP calculations, a short-term bond typically refers to something like a 6-month bond, sometimes also called a T-bill in the US. A long-term bond would typically be a 20-30 year bond. In practise the exact length of long term and short-term bonds will vary between countries.

Figure 4: Yield Curves as of January 2016



Source: Brattle analysis of Bloomberg data as of 29/01/2016.

Figure 4 shows that the current yields increase with the maturity of the underlying bonds, from zero or even negative values for the 3-month bills up to above 3.5% for Portuguese 30-year bond yields. Countries with a lower rating, such as Portugal, Spain and Italy, exhibit higher yields across all maturities with respect to countries with higher ratings, such as Belgium, France and Germany. However, the yield curves are steep at present, mainly because current interest rates are very low, and markets expect these to increase to more 'normal' long-run levels in the future.

Accordingly, subtracting the (higher) yield on a longer term bond from the historical return on equity gives a lower ERP than if the same calculation were done by subtracting the (lower) yield on a shorter-term bond. For example, suppose the observed average return on equity is 10%, the average yield on a 10-year bond is 4% and the average yield on a 20-year bond is 5%. Subtracting the 10-year bond yield from the market return would give an ERP estimate of 6%, while subtracting the 20-year bond yield would give a lower ERP estimate of 5%.

The risk-free rate chosen should be consistent with the ERP used, otherwise the cost of equity will be miscalculated. This consideration means that the ERP could be calculated with respect to either long-term or short-term bonds, as long as there is consistency. As a practical matter, Dimson, Marsh and Staunton (DMS), which is the most commonly used source of the

historical, outturn ERP, has measured the ERP with respect to either short-term (so roughly 6 months) bills, or long-term bonds, with a maturity of around 20-years. Considering the need for consistency, this means that if we choose to estimate the ERP based on the historical DMS data (an issue we discuss in section VI.D), then we need to use either a short-term bill, or a relatively long-term bond.⁴³

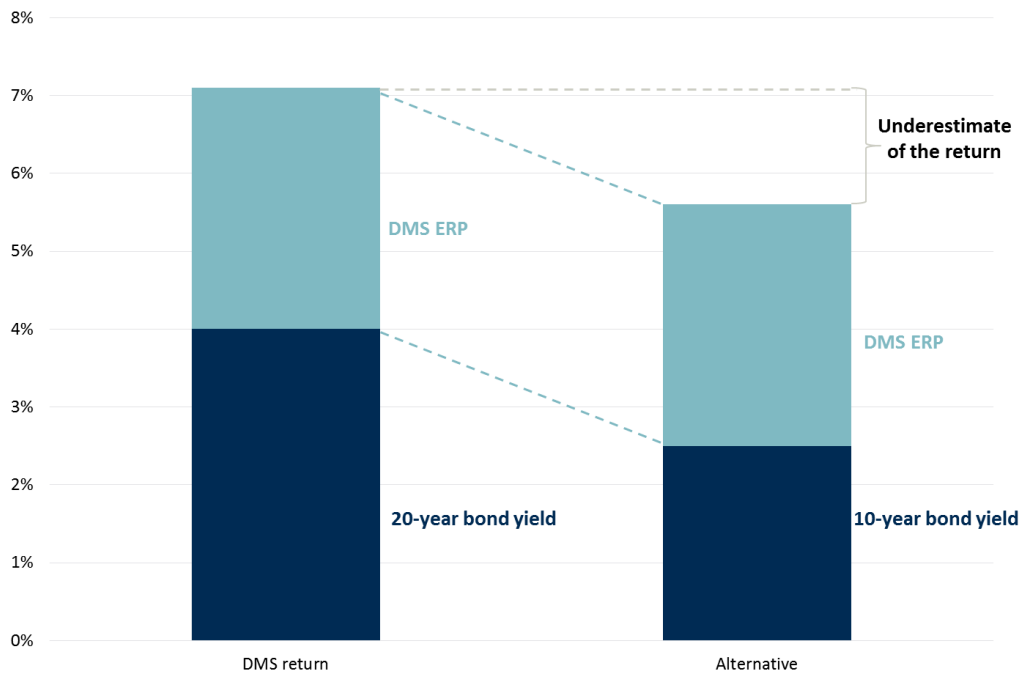
Figure 5 illustrates what can happen if we are not consistent, and use a shorter-term bill combined with the DMS estimate of ERP using long term bonds. On the left hand side, we estimate the ERP (the light blue bar) based on the difference between observed market returns (the total height of the bar) and the average yield on 20-year bonds (the dark blue bar). On the right hand side, we then add the estimated ERP to the yield on a 10-year bond, which as we noted above tends to have a lower yield. As a result, the total estimated cost of equity will be too low.⁴⁴ To be consistent, we should have estimated the ERP by subtracting the lower average yield on a 10-year bond, which would have resulted in a higher ERP. Since we do not have an estimate of the long-run returns on a 10-year bond, the best thing is to use a bond yield that will be similar to the bond yields used in the DMS data.

Above we noted that DMS target a 20-year bond in their data series. Accordingly, consistency with the available ERP estimates means that we should use a 20-year bond for the risk-free rate. However, a 10-year bond tends to be more commonly issued and more liquidly traded than 20-year bonds (see discussion in section VI.A.3.c below).

⁴³ We would not recommend computing the WACC based on only the 6-month bond yield for a long-lived asset. The risk-free rate should reflect the expected evolution of risk-free rates over the entire life of the asset. The use of a short-term bond rate would fail to reflect the expected path of interest rates over time.

⁴⁴ Note that in practice applying the CAPM we would multiply the ERP by the equity beta.

Figure 5: Using 10-year bonds and DMS' estimate of ERP could underestimate the cost of equity



Because we are proposing to base the ERP on a long-run data series (see section VI.D.2), what is relevant in this case is the long-run difference between the yield on 10-year and 20-year bonds – or term premium – in the countries from which ERP is being measured. Experience in the US indicates that the long-run term premium between 10-year and 20-year bonds is 50 basis points, though it is slightly lower in Canada at 40 basis points, and lower still in Australia at 20 basis points. At the time of writing we do not have an estimate for the term premium for Europe.

Accordingly, we recommend that NRAs using a 10-year bond as the risk-free rate either:

- Apply an upward adjustment of around 40 basis points to the risk-free rate to account for the difference in the average term premium of 20-year bonds with respect to 10-year bonds; or
- Adjust the ERP upwards.

VI.A.3.b. The Empirical CAPM

Short-term bonds are the best approximation of a truly risk-free rate assumed by the CAPM. For example, an investor who really wanted to minimise risk would buy a series of three-month government bonds. In contrast, long-term government bonds are not risk-free, even if held to maturity. Imagine an investor in 2012 who wants to invest for 10 years (until 2022). If she buys a 10-year government bond, she will receive €1,000 for certain in 2022. However, the purchasing power of that €1,000 in 2020 is unknown ahead of time. If inflation over the 10-year period is higher than anticipated in 2012, the €1,000 will buy less than anticipated. Interest rate changes in the meantime also add risk.

The ERP calculated with respect to short-term bonds will normally be higher than the ERP relative to long-term bonds, since investors require an additional premium to incur the risk of holding long-term bonds.⁴⁵ Using the smaller premium over *long-term* bonds could either over or underestimate the cost of capital according to the CAPM, depending on beta.

To see this, suppose that the true equity premium over the risk-free rate was 7% compared with a premium over long-term bonds of 6%. Suppose also that the expected total return on the market was 10%: the true 7% premium over the risk-free rate plus a 3% risk-free rate, or alternatively the 6% premium over long-term bonds plus a 4% long-term rate. While the overall expected market return obviously remains unaffected by our choice of true premium over risk-free or the premium over long-term bonds, our choice affects the cost of capital for individual assets (equity, short-term or long-term bonds) within the market portfolio. Figure 6 illustrates how the choice of risk premium would affect the cost of capital for two projects, one with an equity beta of 0.5, and another with an equity beta of 1.5.

⁴⁵ In unusual circumstances such as, for example, the current debt crisis in Greece, the yield on Greek short-term bonds is higher than the yield on Greek long-term bonds.

Figure 6: Cost of capital for two hypothetical assets

		Hypothesis 1 [A]	Hypothesis 2 [B]	Average [C] Average [A] and [B]
		Notes	Notes	
Premium over long-term bonds				
Beta	[1]	0.5	1.5	
Risk premium over long-term	[2]	6.00%	6.00%	
Long-term rate	[3]	4.00%	4.00%	
Cost of capital	[4] [1] x [2] + [3]	7.00%	13.00%	10.00%
Premium over short-term bonds				
Risk premium over short-term	[5]	7.00%	7.00%	
Short-term rate	[6]	3.00%	3.00%	
Cost of capital	[7] [1] x [5] + [6]	6.50%	13.50%	10.00%
Difference	[8] [7] - [4]	-0.50%	0.50%	0.00%
Notes:				
[A],[B]: Illustrative numbers.				

In the example in Figure 6, use of the equity premium over long-term bonds would *overestimate* the cost of capital for a project with an equity beta of 0.5, but *underestimate* the cost of capital for a project with beta of 1.5. Indeed, the use of long-term bonds *overestimates* the cost of capital for the project with beta of 0.5 by exactly the same amount that it *underestimates* the cost of capital for the project with beta of 1.5, thereby leaving the overall cost of capital across both projects unaffected.

If betas of SMP operators are less than one, then using the combination of long-term rates and the ERP over long-term bonds may slightly over estimate the cost of capital. However, this is only true if the standard CAPM accurately captures the empirical relationship between the individual stock and the market. As we explain below, there are reasons to believe that this is not the case, and that the standard CAPM actually underestimates the required return for firms with a beta of less than one.

Early papers by Black, Jensen and Scholes (1972) and Fama and MacBeth (1972) were among the first to look at whether the empirically observed relationship between company-specific returns and the market – the Securities Market Line or SML –was as steep as indicated by the CAPM.⁴⁶ Although the realized market returns demonstrated a remarkable linearity in the

⁴⁶ F. Black, M.C. Jensen, and M. Scholes, “The Capital Asset Pricing Model: Some Empirical Tests,” *Studies in the Theory of Capital Markets*, Praeger Publishers, 1972, pp. 79-121 and E.F. Fama and J.D. MacBeth, “Risk, Returns and Equilibrium: Empirical Tests,” *Journal of Political Economy* 81 (3), 1972, pp. 607-636.

CAPM beta, the empirical research demonstrated that the CAPM tends to overstate the actual sensitivity of the cost of capital to beta: low-beta stocks tend to have higher risk premiums than predicted by the CAPM and high-beta stocks tend to have lower risk premiums than predicted. In other words, the SML is ‘flatter’ than predicted by the standard CAPM. Several subsequent studies confirmed the robustness of this result and proposed explanations revolving around market frictions, such as different borrowing and lending rates, and the role of taxes.

The Empirical Capital Asset Pricing Model, or “ECAPM” attempts to correct for this defect in the CAPM. The ECAPM estimates the cost of capital as set out in equation 1.

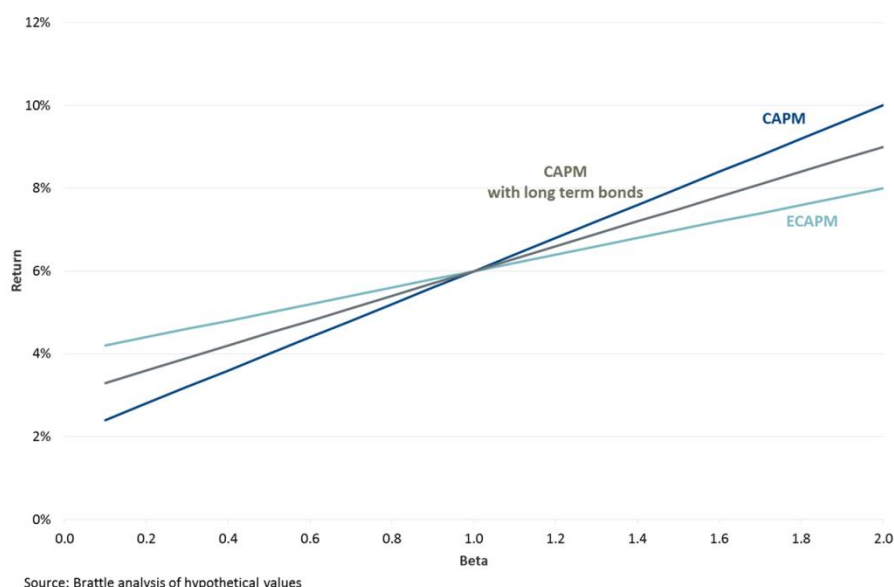
Equation 1: ECAPM

$$r_s = r_f + \alpha + \beta_s \times (MRP - \alpha)$$

Where α is the “alpha” adjustment of the risk-return line, a constant, and the other symbols are defined as above. The alpha adjustment has the effect of increasing the intercept but reducing the slope of the security market line which results in a security market line that more closely matches the results of empirical tests.

That is, if we imagine a chart with beta plotted on the x-axis and realized market returns on the y-axis, then the actual straight line we see would have an intercept higher and a slope less steep than predicted by theory.

Figure 7: Effect of Empirical CAPM on the predicted return



Using a long-term bond has a similar effect as using the empirical CAPM. Because investors demand a higher yield on the long-term bond, the long-term bond raises the intercept with the vertical axis relative to the use of a short-term bond in Figure 7. This is equivalent to adding an 'alpha' in equation 1 above. Because the ERP over a long-term bond is lower than over a short-term bond, the slope of the line is flatter. This is equivalent to subtracting 'alpha' from the ERP in equation 1 above. Hence, using a long-term bond approximates the effect of the ECAPM, which should result in a more accurate estimate of the cost of equity.

VI.A.3.c. Other considerations

In our experience long-term bonds, and in particular 10-year bonds, are one of the most common bonds issued by sovereign states. Hence the bonds tend to be liquidly traded. This has the advantage of making the calculated yields on the bonds more reliable.

Measuring the liquidity of various bond issues can be difficult, since data on the volume of each bond issue traded is not always easy to obtain. However, in general, bonds issued in larger volumes will tend to be more liquidly traded than bonds issued in smaller volumes. Data on the volume or total value of bonds by maturity is more readily available from the Treasury or Finance Ministry websites of MSs. In general, NRAs should favour a long-term bond issue that is issued in a large volume, because this is more likely to be liquidly traded and hence have more reliable yields.

A further issue is whether the NRA should measure the risk-free rate by reference to a bond with a maturity which matches the regulatory period. Arguably, the yield on a bond with a three year maturity will give the best indication of the average interest rate over a three-year regulatory period.

Consistency with the ERP estimate would be an immediate concern with any focus on the length of the regulatory period, since the typically available ERP estimates are measured with reference to either 6-month or 20 year yields, and not the length of the regulatory period. In theory, the NRA could examine the term structure of interest rates to uncover a forecast of short-term rates for the length of the upcoming regulatory period and then combine the average of the expected short-term rates as the risk-free measure, with an ERP estimate measured relative to short-term bills. However, an examination of the term structure would appear to add needless complexity.

It appears preferable for the NRA not to attempt to estimate the interest rate and cost of equity for the upcoming regulatory period alone, but instead to estimate the long-term cost of equity – since the underlying assets are long-lived – and then to update this estimate of the

long-term cost of equity in every regulatory period. As argued above, deriving the risk-free rate from a long-term bond is the best way to achieve such an estimate.

VI.A.4. Averaging Period

The risk-free rate NRAs' apply to the CAPM should be the best prediction of the risk-free rate for the upcoming price control period. In theory, the most recent rate or yield available will give the best prediction of the future rates, because the latest yield will internalise all of the latest information available to the market regarding future rates. In contrast, the yield from a month ago, or six months ago, will contain out-of-date information, so that those yields are not the best predictor of future yields.

In practice, many regulators do not simply apply the prevailing yield on the day they make their WACC determination. Most regulators instead take the average yield over a significantly longer period.

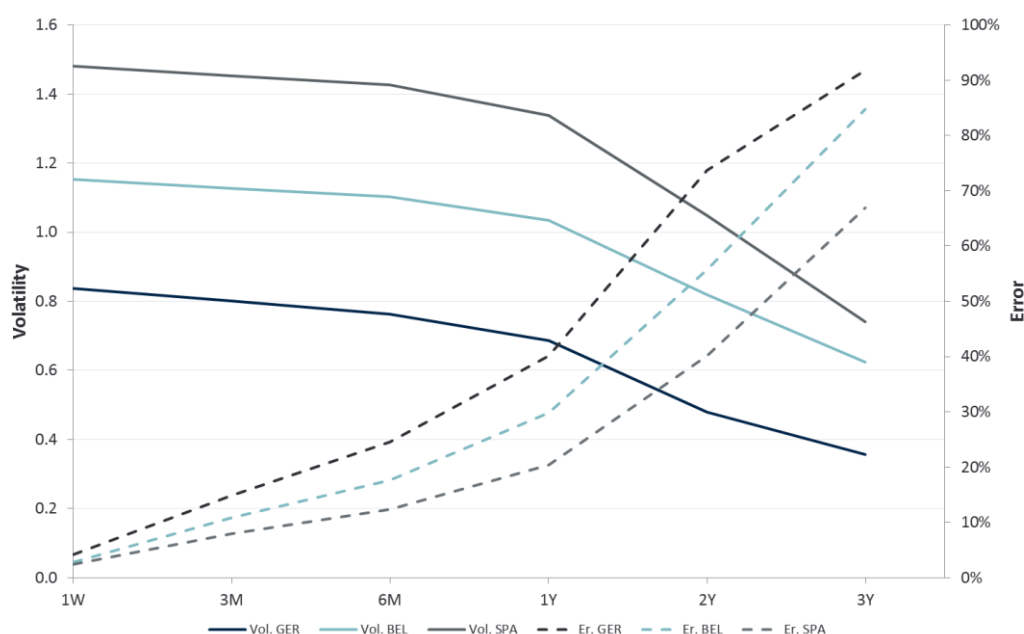
In our view the use of longer-term averaging is defensible from a policy perspective. Relying on the yield on only a single day to set the risk-free rate would introduce an element of 'randomness' and volatility into the WACC decision. This is because it is perfectly possible that the yield could be 20 basis points higher a week later, so that the exact timing of the WACC decision could strongly influence the risk-free rate and hence the WACC. Most NRAs consult on a draft WACC decision at least several months before the WACC will come into effect, so as to give time for market participants to comment and the NRA time to respond to the comments. If the NRA used a spot rate to estimate the risk-free rate, the WACC could change quite significantly between the consultation and the final decision. This would undermine the usefulness and validity of the consultation prices. Using a longer-term average yield 'smooths' changes in the yields, and makes the WACC less dependent on timing issues. It means that changes in the WACC are easier to predict, which is desirable from the perspective of regulatory stability and minimisation of regulatory risk.

However, the use of longer term average yields risks using out-of-date information. For example, in 2010 the use of a two-year average yield would have picked up high pre-crisis interest rates from 2008, even though it was very clear in 2010 that these rates were unlikely to re-occur within the regulatory period.

Hence, there is a trade-off. Use of 'spot' rates would result in volatile WACC values which are hard to predict, while using 'excessively long' averaging periods risks including too much information that is out of date.

In Figure 8 we investigate this trade-off in more detail. We have calculated an average yield on 10-year government bonds on a daily basis for the period January 2010 to October 2015. This is our estimate of the ‘risk-free rate’. We calculate these averages for a series of different averaging periods – being one week, three months, six months, 1 year, two years and three years. We then take the standard deviation of the series of risk-free rate estimates – this is the measure of volatility. We do the calculation for three different government bonds, being Germany, Belgium and Spain.

Figure 8: Error and volatility in risk-free rate as a function of the averaging period



Source: Brattle analysis of Bloomberg data.

As expected, Figure 8 illustrates that as the averaging period increases, the volatility reduces. With a long averaging period, the estimate of the risk-free rate will change very little from one day to the next, and so the volatility of the estimates will be low. This is the ‘smoothing’ effect from using a longer averaging period. From a regulatory policy perspective, this is desirable, because the risk-free rate will not be heavily dependent on the exact date of the WACC decision or when the analysis was carried out.

However, the longer the averaging period, the larger will be the difference with the current spot yield, which is arguably the best estimate of the risk-free rate over the regulatory period. In this example, we define the error as the absolute difference between the spot yield on the day and the risk-free rate calculated as an average yield over a given period. Figure 8 shows that as the averaging period increases, the average error also increases. For example, in Figure 8 an error (on the right-hand axis) of 50% means that, on average, the risk-free rate is 50% different from the best estimate of the future risk-free rate (i.e. the spot rate).

Based on the above analysis, it seems that the error starts to increase at a greater rate when the averaging period exceeds one year. On the other hand, an averaging period of one year has already achieved a reasonable reduction in the volatility of the estimate. Hence, in our view a reasonable balance is for an NRA to set the risk-free rate by taking an average yield over a period of up to one year. Use of a longer averaging period risks including data that is no longer relevant, while there is no significant advantage in terms of 'smoothing' and regulatory predictability.

We have also heard arguments justifying a longer averaging period on the basis of 'consistency' between the averaging period and the regulatory period. In our view this is not a basis to justify a longer averaging period. Using an averaging period which differs from the regulatory period does not introduce any inconsistencies. This is because there is no basis to think that the average of the risk-free rate of, for example, the last five years will be the best predictor of the risk-free rate over the next five years. The best predictor of the future risk-free rate is the current yield. Taking a longer averaging period risks including old and out-of-date information that is not relevant to the future.

VI.A.5. Conclusions on the Risk-Free rate

- Deriving the risk-free rate from the yields on the NRA's 'domestic' bonds is reasonable in most cases. A 'risk-free rate' derived in this way is in practice the sum of a true risk-free rate plus a country-risk premium;
- Including the country-risk premium in the WACC is reasonable because it should reflect regulatory and other risks for which the SMP operator should be compensated. This 'uplift' on the WACC calculation is the most practical way to compensate SMP operators for these risks;
- However, use of the domestic bond likely represents an upper limit to fair compensation for risks not otherwise compensated in the cash flows. If the NRA uses the domestic bond to estimate the 'risk-free rate', no other adjustment to the WACC for other risks is required;
- Use of the domestic bond to determine the risk-free rate is not reasonable where:
 - The domestic bond is illiquid;
 - The domestic bond is at significant risk of default;
- We suggest alternative ways for the NRA to estimate a risk-free rate in such cases;
- It is likely that 'Quantitative Easing (QE) programs have depressed country spreads, so that the country spread will tend to underestimate country risk. In this case it is reasonable for NRA's to make an upward adjustment to observed yields when estimating the risk-free rate, while the QE program is in place. An upward adjustment of up to 1 percentage point seems reasonable, taking into account both the credit rating of each MS, and the overall duration and scale of the monetary program.
- Deriving the risk-free rate using yields on long term, so 10-year or 20-year bonds, seems reasonable, because:
 - It will be broadly consistent with the historical data used to estimate the Equity Risk Premium (ERP);
 - Using a longer dated bond will approximate the so-called Empirical Capital Asset Pricing Model (ECAPM), and hence should lead to a more accurate estimate of the cost of equity;
 - 10-year bonds tend to be more liquidly traded and hence the yields are more reliable and less volatile.
- We recommend that NRAs using a 10-year bond as the risk-free rate apply an upward adjustment of around 40 basis points to account for the term premium of 20-year bonds with respect to 10-year bonds.
- It is reasonable to estimate the risk-free rate based on an average yield over a period of time, but this averaging period should not exceed 12 months.
- NRA's should use bond yield data from a reliable source including the relevant central bank, or a large data provider such as Bloomberg.

VI.B. INFLATION

Some NRAs calculate a ‘real’ WACC, by subtracting inflation from the estimated nominal WACC. The choice of inflation has an important effect on the estimated real WACC and the resulting tariffs.

VI.B.1. Converting nominal WACC to real WACC

NRAs should convert the nominal WACC to the real WACC using the following so-called ‘Fisher’ equation.

Equation 2: The Fisher equation

$$WACC_{Real} = \frac{(1 + WACC_{Nominal})}{(1 + \pi)} - 1$$

Where $WACC_{Real}$ is the real WACC, $WACC_{Nominal}$ is the nominal WACC and π is the inflation rate. Simply subtracting inflation from the nominal WACC is not correct, and will tend to overestimate the required real rate, although the error will be small when interest rates and inflation are relatively low.⁴⁷

NRAs should also perform any uplift or adjustment for taxes - discussed in section VI.H – on the post-tax nominal WACC first, before converting it to a real WACC. This is because firms pay taxes on nominal income, not real income.

VI.B.2. Forward or Backward Looking Inflation?

In our view NRAs should apply a forward looking view of inflation, because this is what is implicit in the bond yields that are used for the risk-free rate. In other words, when pricing a bond investors will consider expected inflation over the life of the bond, not historic inflation. Converting a nominal 10-year bond yield to a real rate using historic inflation rates would be inconsistent. Therefore, the forecast period for inflation should approximately match the maturity of the bond used to estimate the risk-free rate. For many MSs this may not be possible, but in any case the NRA should use the longest term inflation forecast available that is closest to the maturity of the bond used to estimate the risk free rate. We discuss data sources for inflation in Appendix A.

⁴⁷ For a further explanation of the Fisher equation, see for example Principles of Corporate Finance, Tenth edition, Brealey, Myers, Allen, McGraw-Hill Irwin, Ch.3 p.63 and Fisher, Irving (1977) ‘The Theory of interest’ Philadelphia: Porcupine Press ISBN 0-87991-864-0.

VI.B.3. Local or Regional Inflation?

Clearly, different currency areas have different inflation rates, and so for a given currency zone a specific inflation rate should be applied. For example the UK would need a different inflation rate than the Eurozone.

The more interesting question is whether NRAs should apply a single inflation rate for the Eurozone, given that inflation differs between Eurozone members. To answer this question, we must consider who is the representative or ‘marginal’ investor in the legacy network.⁴⁸

If the marginal investor holds a broad Europe-wide, if not global, portfolio, they are unlikely to consider MS specific inflation as the most relevant to calculating their real return. For example, an international investor holding Spanish government bonds would not necessarily care primarily about Spanish inflation when considering the real returns on the bonds, because there is no reason to think that the investor would be reinvesting his or her returns in Spain. Rather, the investor would be concerned about Eurozone inflation as a whole.

On the other hand, if the marginal investor is ‘domestic’, then they may well be more interested in the real return relative to their domestic market. This would indicate the application of a rate of inflation specific to the MS.

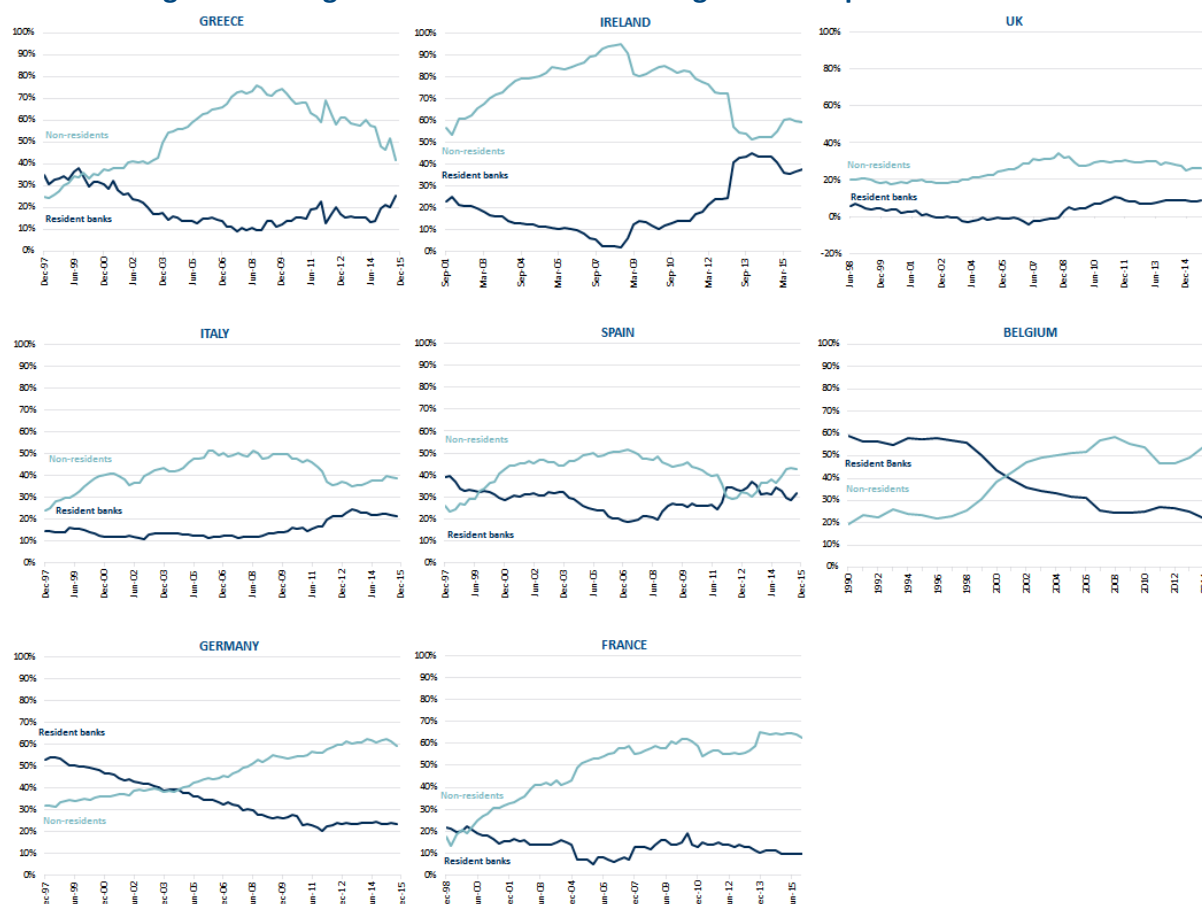
In practise, it may be hard to assess whether the marginal shareholder and bond holder in fixed-line telcos in the EU is ‘European’ or ‘domestic’. We have performed some research on this issue based on an analysis of government bond holdings of 12 MS produced by Bruegel, an independent ‘think-tank’.⁴⁹ While this data only indicates the average investment holdings, and not the marginal investor, it would be reasonable to assume that if a majority of the bonds are held by ‘foreign’ investors – that is, investors located outside of the MS for which the bonds are issued – then the marginal investor is also foreign. The Bruegel study confirms that all 12 MS have the majority of their bonds held by non-residents. With the exception of Spain, the percentage of bonds held by non-residents exceeds that held by residents by some margin, and that the general trend is for an increase in holdings by non-residents over time. The exception is some countries particularly affected by the economic

⁴⁸ The ‘marginal investor’ is a representative investor whose actions reflect the beliefs of those people who are currently trading a stock. It is the marginal investor who determines a stock’s price.

⁴⁹ “Bruegel database of sovereign bond holdings developed in Merler and Pisani-Ferry (2012)” Updated August 2015. The 12 countries are: Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain, UK and the US.

crisis such as Ireland, Spain and Greece, where the percentage of foreign bond holders decreased since 2009. Nevertheless, foreign investors remain in the majority.

Figure 9: Foreign and domestic bond holdings for a sample of EU countries



Source: Reproduced from "Bruegel database of sovereign bond holdings developed in Merler and Pisani-Ferry (2012)" Updated February 2016

Note: The percentages in the charts do not sum to 100% because they only show the holdings for residents and non-residents. Other categories of bond holders not shown in the charts include central banks and financial institutions.

However, we also note two factors:

- The composition of the bond holders has changed quite rapidly over time. This means that it is possible that it could keep changing in future;
- We lack data from other MSs, particularly those in Eastern Europe whose investment markets may be less developed. Experience shows that in less developed markets there tends to be more home-bias, that is domestic investors may hold the majority of the bonds. This is because foreign investors may be more reluctant to spend the time required to understand the risks associated with smaller bond issues.

Based on this evidence, we conclude that the default assumption should be that Eurozone NRAs should apply a Eurozone inflation rate⁵⁰. However, NRAs within the Eurozone could apply a local, MS-specific inflation rate, if they can demonstrate that the marginal investor in the SMP is located in the relevant MS and therefore may be sensitive to the inflation rate in that MS. This could occur because, for example, the fixed-line telco is largely state-owned. NRAs outside of the Eurozone would apply an inflation rate specific to their currency.

VI.B.4. Conclusions on Inflation

- NRAs should convert nominal yields to real yields using the Fisher equation;
- NRAs should use forward-looking estimates of inflation. Ideally these estimates should be for a time period equal to the maturity of the bond from which the NRA is estimating the risk-free rate, although in practice this is not always possible because of the limited time horizon of inflation forecasts;
- Non-Eurozone NRAs should use inflation forecasts for their currency zone. NRAs in the Eurozone should use a Eurozone-wide inflation estimate from Eurostat, unless they can demonstrate that the marginal investor in the SMP is 'local'.

VI.C. EQUITY BETA

In this section we address issues relating to the estimation of equity betas and the calculation of asset betas:

- What time horizon and sampling period should be used?
- Which market index should be used?
- Do we need to make adjustments to observed betas?
- Which debt betas and unlevering formulae should be used?
- Will betas vary across the EU (due to e.g. differences in regulation)?
- Which firms to use to estimate a beta for a legacy network?

We address these issues below.

⁵⁰ Eurostat regularly publishes one-, two- and five-years ahead inflation forecasts based on the Harmonised Index of Consumers Prices (HICP), which is compiled by Eurostat and the national statistical institutes and is the reference inflation rate used by the ECB. More information about HICP inflation forecasts can be found on the ECB website:
https://www.ecb.europa.eu/stats/prices/indic/forecast/html/table_hist_hicp.en.html

VI.C.1. Time Horizon for Beta Calculations

Choosing a ‘time horizon’ over which to estimate beta – in other words, over how many years we measure beta – involves a trade-off. As we extend the time horizon we will add more observations of returns to the calculation of beta, which will reduce the statistical error of the beta estimation. On the other hand, if the beta is changing over time – which is to say that the systematic risk of the legacy network is changing – then the older data on the relationship between the returns of the firm and the return of the market index may no longer be relevant to the estimate of the future beta.

For legacy networks, there are reasons to believe that systematic risk and hence betas are changing over time. As we discuss elsewhere in this report, the EU telecoms market continues to evolve, driven by successive technological innovations. This means that the systematic risk of legacy networks, as well as mobile and NGA networks, is also changing over time. For example, the way in which a systematic economic crisis is likely to affect the returns of a legacy network is likely to change depending on competing technologies. Perhaps ten years ago, a legacy network would have looked more like a conventional energy utility, with little risk of losing customers. Today, legacy networks face competition from, among others, NGA and mobile networks, and this in turn affects the systematic risk. We discuss these issues in more detail in the following sections.

The rapid technological evolution of the telecoms sector suggests that calculating betas based on a relatively short time horizon is more likely to give the best estimate of future betas. Therefore our recommendation is that NRAs estimate betas using daily returns over a two-year time horizon. The relatively short time horizon implies the need for a daily sampling period so as to generate sufficient observations for the beta estimate to be statistically robust.

However, when calculating betas using daily returns, there is a risk that the firm’s share price on day D may appear to react to changes in the market index from either the previous day ($D-1$) or the following day ($D+1$). This could occur because of differences in market opening times and trading hours, or differences in the liquidity of the firm’s shares compared to the average liquidity of the market. If such an effect is present, it could affect a beta which is calculated using only the return on the firm’s share on day D and the return on the market index on the same day.

The “Dimson” adjustment is a standard test which deals with this effect. The Dimson adjustment estimates betas by performing the same regression against the market index as for a standard beta, but uses the company returns from either one day ahead or one day before the day used for the value of the market. If the market is perfectly efficient, then all

information should be dealt with on the same day, so that a beta measured using the company returns from either one day ahead or one day before that of the market index return should be uncorrelated, giving a beta of zero. A beta significantly different from zero suggests that information about the true beta may be contained in trading the day before or after the day for which the market return is calculated.

The Dimson beta adjustment combines the beta estimates from the day ahead and day before with the original beta estimate to give an overall beta which includes the information provided in the adjacent days. We recommend that NRAs estimate equity betas using daily returns and include a Dimson adjustment to deal with the effect described above.

VI.C.2. Possible Adjustments to Equity Betas

Above we discussed the use of a Dimson adjustment. Regardless of the time period chosen to estimate beta, other possible adjustments include a so-called Bayesian/Blume adjustments, or a Vasicek adjustment. These types of adjustment reflect the idea that beta estimates are inherently ‘noisy’ and inaccurate, and so adjusting the beta by using a ‘prior expectation’ of beta could improve the accuracy of the beta. The Blume adjustment ‘pushes’ the observed betas closer to 1.0,⁵¹ on the basis that the average market beta is 1.0, and so absent any other information this is also likely to be the best estimate for a beta. Blume⁵² documented empirically that if we observe a ‘low’ beta estimate for a firm in one period, on average we are likely to observe a ‘higher’ beta estimate for that firm in the next period. Hence, pushing the beta towards 1.0 makes a ‘one-period’ beta estimate a better predictor of the future beta.

However, in the case of a fixed line legacy telco, there are reasons to think that the beta could be structurally different from 1.0, so that moving the beta towards 1.0 would not improve the accuracy of the beta estimate. For example, profits from the fixed-line telco’s regulated business may be permanently less sensitive than the average firm to changes in the market index and economy more widely. This is because the regulated prices are stable, and fixed-line telcos do not have particularly high financial leverage (see for example Figure 12 on page 84). These two factors indicate that there is no reason to believe that pushing the beta toward 1.0 will improve the accuracy of the estimate, or that any sampling error when estimating beta is asymmetric around the estimated beta. In other words, if the estimated beta is for

⁵¹ The Adjusted beta = $\frac{2}{3}$ the observed beta + $\frac{1}{3}$. For example, if the observed beta is 1.5 then the adjusted beta will be 1.33. If the observed beta is 0.5 then the adjusted beta will be 0.66. In both cases the adjusted beta moves closer to 1.0.

⁵² Blume, M.E., 1971. “On the assessment of risk,” *Journal of Finance*, 26, 1–10.

example, 0.7, then the true beta is equally likely to be greater or lesser than 0.7. Therefore we would not recommend a Blume adjustment in the methodology.

The Vasicek adjustment is similar to the Blume adjustment, except that it does not assume a tendency of the beta to go to 1.0 – rather it will tend to the industry average or some other prior expectation of beta, and the extent of the adjustment depends on the standard error of the observed beta. However, in this case we are already taking an industry average beta. The Vasicek adjustment is more useful when we are estimating the beta for a single firm, rather than estimating the beta for a specific activity represented by a sample of firms).

However, as discussed below we do recommend using the median (rather than average) beta, since this gives less weight to more extreme beta values. While not an adjustment to beta, the use of the median has a similar effect in that it will avoid giving too much weight to more extreme beta values that may well be erroneous or transient.

VI.C.3. Choice of Index

Beta measures systematic risk – that is, risk that cannot be diversified away by the investor. Hence, beta is the relationship between the share price of the firm and a market portfolio, which represents the investors' other investment opportunities. In theory the market portfolio should include all other investment opportunities (including for example real estate and fine art), but in practice financial practitioners limit it to a stock market index. This begs the question: which market index to choose?

We could calculate betas against, for example, a world index, since in theory investors could invest anywhere in the world. However, in practice there tends to be some 'home bias', in that investors will tend to invest closer to home markets which they know well (for example, a European market rather than across the world). There are several possible reasons for home-bias. For example, it could be hard to fully understand 'foreign' markets, including investment and political risks in distant markets.⁵³ This suggests that capital markets are not fully integrated, and that there is regional segmentation. Therefore using a more limited index of European stocks (rather than a world index) to calculate beta would be reasonable. We discuss this issue with respect to the equity risk premium in section VI.D.1.

⁵³ See for example The Limits of Financial Globalization, Stulz R.M., *The Journal of Finance*, Volume 60, Issue 4 pp.1595–1638, 12 August 2005, and What Determines the Domestic Bias and Foreign Bias? Evidence from Mutual Fund Equity Allocations Worldwide. Chan, Kalok, Covrig, Vincentiu and Ng, Lilian. 3, June 2005, *The Journal of Finance*, Vol. 60, pp. 1495-1534.

A further issue is currency risk. For example, suppose we calculate the beta of a UK firm, whose shares are priced in Pounds sterling (GBP) and which earns most of its profits in GBP, against an index denominated in Euros. Large changes in GBP-EUR exchange rates, such as occurred in 2014, would reduce the beta. This is because, in Euro terms, the depreciation of the Euro would cause the returns of the UK firm to increase, while the Euro-denominated index has not changed. This reduces the covariance between the returns on the index and the return on the UK firm, which results in a lower estimate of beta. While firms may hedge some of their currency risk, which would mitigate the effect of currency movements, it is unlikely that they would hedge the entire value of their overseas investments, and in any case the time horizon for the currency hedge may be limited.

From the perspective of a Eurozone investor, the lower beta represents the diversification benefits of investing in another currency. However, it would not be correct to then apply this beta for a Eurozone investor investing in a fixed line telco in the Eurozone, which does not have the same diversification benefit, or for a UK investor investing in a UK firm. Hence, there is an argument that it would be reasonable to use an index which is in the same currency as the listed shares of the fixed-line firm, at least for a period which includes relatively large exchange rate movements such as 2014. Put another way, we would assume that, because financial markets are regionally segmented, the marginal investor is located in the same currency zone as the fixed-line telco.

On the other hand, using a local index to estimate beta is inconsistent with the idea that investors are at least diversified across Europe, if not the world. In section VI.D we recommend a European-wide Equity Risk Premium, based on diversification arguments, but estimating beta based only on a local index would be inconsistent with the idea of a European ERP.

In practise, this issue only affects non-Eurozone telcos. In Table 1 we have estimated recent two-year betas for non-Eurozone telcos using both the local index and a wider European index.⁵⁴ Table 1 illustrates that:

- As we expect, non-Eurozone firms have a higher beta when calculated against the local index as opposed to a European index. The average asset beta for non-Eurozone firms is 0.63 when calculated against a local index, and 0.52 when calculated against the European index. This is consistent with the effect observed above – that currency

⁵⁴ Specifically, we use Stoxx Europe 600 Index. When calculating the beta against the European index denominated in Euros, we first convert the share price of the non-Eurozone firm to Euros.

movements reduce the covariance between the returns denominated in the local currency and the Euro denominated index, and thus reduce the beta;

- Overall, using local indices for non-Eurozone firms reduces the median asset beta – our recommended measure – of the sample from 0.58 to 0.54.

On balance, we think the use of a wider European index is more consistent with the assumptions on the ERP, and the idea that investors in European telcos are at least diversified across Europe. For consistency, we recommend that NRAs use the Stoxx Europe 600 index.

Table 1: Beta estimate with alternative index assumptions

Company	2Y Asset beta	
	Full sample	
	Local Index [A]	Eurozone Index [B]
British Telecom	0.67	0.54
KPN	0.53	0.53
Proximus	0.61	0.61
Deutsche Telekom	0.76	0.76
Telefonica	0.57	0.57
Telenet	0.51	0.51
TDC	0.49	0.43
Telia Sonera	0.61	0.53
Elisa	0.70	0.70
Kabel Deutschland	0.36	0.36
Telecom Italia	0.50	0.50
Telenor	0.75	0.56
NOS	0.58	0.58
Tele 2	0.65	0.58
Swisscom	0.39	0.42
Telekom Austria	0.28	0.28
Orange	0.66	0.66
Pharol	0.41	0.41
PJSC Telesystems	0.88	0.59
Median	0.58	0.54
Average	0.57	0.53
Average Non-EU	0.63	0.52

Source:

Brattle analysis of Bloomberg data.

Notes:

The underlying equity betas have been computed over the period from 20/10/2013 until 20/10/2015.

Different debt betas in the range of 0 - 0.3 have been assumed, depending on the rating of each company.

[A]: Betas based on equity betas obtained regressing the company's stock price returns in national currency against the returns of the reference national market index.

[B]: Betas based on equity betas computed by regressing the company's stock price returns in EUR against the returns of

VI.C.4. Bottom-up or off-the-shelf beta estimates

Some data providers, such as Bloomberg, offer pre-calculated or ‘off-the-shelf’ betas. In our view these betas are reliable, and so we would have no objection to NRAs using them, providing that they were calculated on the same bases as the recommended ‘bottom up’ beta. That is the beta is calculated:

- Using two-year daily data;
- Using a Dimson adjustment
- Against the appropriate index (e.g. Eurostoxx).
- Without any other adjustments such as a Blume adjustment, as this does not seem required for the telco industry.

In practise it may be hard to find a data provider that can provide such a beta ‘off the shelf’. NRAs could of course use the recent beta estimates that other NRAs have used in regulatory decisions, providing that those decisions are relatively recent (see section VI.C.10 for a discussion on updating beta estimates over time).

VI.C.5. Asset Beta and Unlevering

The equity beta will depend on the financial leverage or ‘gearing’ of the firm – that is, the relative financing from debt to equity. In section VI.C.7 below, we discuss that NRAs should estimate beta based on a sample or peer group of suitable firms. When estimating an ‘average’ beta from this peer group, we must first control for gearing by calculating an unlevered or asset beta from the observed equity beta (or ‘levered beta’). This will ensure that we are averaging betas on a like-for-like basis. Failing to unlever before calculating an average risks incorporating differences in financing decisions, rather than actual differences in underlying business risk.

The conversion of the equity betas to asset betas involves a measurement of the levels of debt and equity (discussed in section VI.F) and the choice of the unlevering formula. When considering the appropriate unlevering formula, the first consideration is whether we assume a constant ‘rebalancing’ of debt, so that the leverage or gearing of the firm is constant, or a fixed level of debt in absolute terms (so that gearing changes over time).⁵⁵ In our view an assumption of constant leverage over time is the more realistic assumption for a fixed-line

⁵⁵ For a full discussion off this issue see B&M Tenth Edition pp484-485.

telco business. It is also the assumption most consistent with the application of a single WACC in a price control.

An examination of the literature reveals that there are a multitude of other unlevering formulas available, all of which apply in slightly different circumstances and have different advantages and disadvantages.⁵⁶

While there is more than one unlevering formula consistent with the assumption of a constant rebalancing of debt, it would be reasonable for NRAs to use the ‘simple’ formula for calculating the asset beta from the observed equity beta. The ‘simple’ formula is:

$$\beta_{asset} = \beta_{debt} \cdot \left(\frac{D}{V}\right) + \beta_{equity} \cdot \left(\frac{E}{V}\right)$$

Where β_{asset} is the asset beta, β_{debt} is the debt beta, β_{equity} is the equity beta, D is the value of net debt, E is the value of equity and V is the value of the company, computed as the sum of D and E.

Other unlevering formulae are available, but it would be advantageous for NRAs to apply a common formula to different unlevering formulae generating arbitrary differences in the WACC.⁵⁷

Note that it would not be consistent to use the often cited ‘Hamada’ formula, because this formula assumes a constant dollar amount of debt, rather than a constant level of gearing.

More generally, the choice of unlevering formula will be less critical where the average level of debt or gearing of the peer group being used to estimate beta is similar to the gearing that will be used to re-lever the asset beta. Intuitively, if the average gearing of the peer group is the same as the gearing assumed for the final cost of equity, and tax rates are similar, then there is no need to unlever and relever. We could simply calculate our final equity beta from

⁵⁶ For a general discussion of gearing formulas, a useful reference is ‘Beta levered and beta unlevered Pablo Fernández, PricewaterhouseCoopers Professor of Corporate Finance IESE Business School, WP No. 488 January 2003 (revised May 2006).

⁵⁷ For example, a second more complex formula is the so-called Miles & Ezzell formula (Miles, J.A. and J.R. Ezzell, (1980) “The Weighted Average Cost of Capital”, Perfect Capital Markets and Project Life: A Clarification,” *Journal of Financial and Quantitative Analysis* (September), pp. 719–730). This formula is appropriate when the company adjusts to its target debt ratio once a year, rather than continuously, which seems a realistic assumption for a telco, and indeed most real-world firms, which are not constantly engaged in re-financing activity.

the average of the observed equity betas. In practice, the average gearing of the peer group will not be the same as the final ‘target’ gearing, but the smaller the difference between the average gearing of the sample and the target gearing, the less critical the choice of unlevering formula will be.

The two formula described above assumes a positive value for the debt beta. We discuss the debt beta in section VI.G.1, but here note that the formula can be applied assuming a debt beta of zero.

The NRA will need to re-lever the calculated asset beta to reflect the target level of gearing. The NRA should apply only the same ‘simple’ re-levering formula throughout its calculations. It would be inconsistent to apply one formula when unlevering the observed betas of sample firms to compute asset betas, and then to apply another formula when relevering the average asset beta of the sample to reflect a target level of gearing. What we also know is that the potential error in all of these formulae will grow as gearing becomes more extreme.

VI.C.6. A Common EU Asset Beta?

The asset beta:

- Is specific to a given line of business, for example, the operation of a legacy network;
- Reflects only systematic, so non-diversifiable, risk;⁵⁸

These two points suggest that, unless an NRA can demonstrate that its network faces a different systematic risk than the benchmark networks used to derive the beta, there should be a common asset beta for legacy networks. In the section below we discuss on what grounds an NRA might argue that their SMP’s legacy network faces materially different systematic risk from the ‘average’ EU network, and the difficulties in quantifying such differences.

However, the default assumption for most of the discussion below is that NRAs should use the same asset beta for legacy networks, unless they can make a case that this is not appropriate in their case.

⁵⁸ See Handbook of Finance, Financial Markets and Instruments, Vol. 1, by Frank J. Fabozzi, John Wiley & Sons, 2008, p. 12: “Beta measures the sensitivity of an asset’s return to changes in the market’s return. Hence, beta is referred to as an index of systematic risk due to general market conditions that cannot be diversified away”.

VI.C.7. Use of a Sample of Firms vs. a Single Firm

Should the NRA estimate beta from the SMP they are regulating (assuming it has publicly traded shares) or should the NRA estimate beta be based on data from a larger sample of suitable firms (a 'peer group')? We think the answer is to use a sample of firms, for two main reasons.

First, the NRA should be estimating a cost of capital for a line of business, being the provision of fixed-line telecoms services over a legacy network. They are not estimating a cost of capital for the specific SMP they are regulating. The SMP may have lines of business other than fixed line telephony on copper networks, which would influence its beta. Accordingly, unless the incumbent happens to be a 'pure-play' fixed-line provider, it will not provide the best estimate for the beta of the fixed-line business.

Second, the beta from a single firm's shares will have a larger statistical error than a beta derived from a larger sample of firms. Therefore, even if the SMP does derive significant revenue from fixed-line telecom, and so should be included in the peer group sample, including some other firms in the sample will improve the accuracy of the beta estimate.⁵⁹

We also note that when calculating a single average asset beta from the sample, we recommend using the median asset beta, rather than the average asset beta. This is because there typically tends to be a large spread of beta values, with some very high and very low values. Using the median gives less weight to more extreme beta values, which are less likely to be a good estimate of the true beta. Using the median also makes the final beta estimate less sensitive to the choice of the peer group, in that removing one comparator firm will tend to have less effect on the median beta than it does on the average. This can help reduce the debate on which comparators to include, if the presence or absence of a given comparator makes relatively little difference to the outcome.

The only reason why using a beta derived from the national SMP would be preferable than the approach described above is if there is compelling evidence that the SMP operator has a significantly different systematic risk than other EU fixed line operators, an issue we discuss in section VI.C.9 below. These differences would have to outweigh the increased statistical error which would result by estimating the beta based on a single firm, rather than a sample of firms.

⁵⁹ See Principles of Corporate Finance, Eleventh edition, Brealey, Myers, Allen, McGraw-Hill Irwin, Ch.5 p.490.

For example, the NRA would have to show that:

- The asset beta of its incumbent firm lies outside of the 95% confidence interval of the estimated asset beta for the sample of EU fixed-line firms. That is, there is good statistical evidence that the beta for the NRA's incumbent's beta is truly different from the beta of the wider EU sample, and the difference is not only due to estimation uncertainty and errors. Another possibility is to calculate a 'z-score' for each value of the sample and to detect outliers by selecting those observations that have a standard score equal to ± 2.5 or beyond;⁶⁰
- For at least 90% of a significant period of time, for example two-years the estimated asset beta of the SMP lies outside of the confidence interval of the asset beta derived from the peer group;
- That the incumbent firm derives at least as high a proportion of its revenue from a legacy fixed line activity as the wider EU sample, so that the difference in beta cannot be explained by an absence of fixed line activity – that is, the NRA can confirm that the difference in betas does not arise because of the incumbent's activities outside of legacy fixed line services;
- The NRA can provide convincing evidence of the regulatory, legal or market factors which have resulted in this different asset beta. For example, that demand for legacy network services are significantly more sensitive to changes in consumer income than for other EU legacy networks, perhaps because of unusually strong competition from mobile networks. This claim could be supported by the statistical analysis of historical demand data.

These criteria are 'cumulative' in the sense that the NRA should be able to show that they are all met to justify its use of a beta estimated only using the national incumbent's share price data.

VI.C.8. Criteria for the peer group firms

Once we have established the need to estimate beta based on a sample of suitable firms or a peer group, the question is which firms to include in the group? We propose a number of screening criteria for the choice of firms:

⁶⁰ The z- or standard-score is measured by $= \frac{(x-\mu)}{\sigma}$, where μ is the mean (or the median) of the population and σ is standard deviation.

- The shares of the firms must be liquidly traded. That is, the shares are traded frequently and in high volumes, so that the observed share price always incorporates all of the available information available at any time. The reason for this criterion is that if the shares are not liquid, then there is a risk that they do not react to market information as quickly as the index. This will reduce the covariance between the returns on the market index and the returns on the SMP's stock, which will result in an underestimate of the equity beta. There are a number of tests for liquidity, but common benchmarks include that:⁶¹
 - The share is frequently traded, meaning that it trades on more than 90% of days in which the market index trades;
 - The average daily values of shares traded, and the average volume of shares traded as a percentage of shares issued, exceed certain thresholds.
- Should not make up a large share (e.g. not more than 10%) of the relevant index against which beta is being calculated. This is to avoid the analysis becoming 'circular', so that the beta is measuring the covariance of the SMP's shares with its own shares in the index. This would lead to an incorrect overestimation of beta;
- The comparator firms should have an investment grade credit rating. This is because the share prices of firms with lower credit ratings could be more reactive to company specific news, which will tend to lower their beta in a way that is not representative of an efficient SMP;
- The firms should not be involved in any substantial mergers and acquisitions (M&A) or other activity that could cause the beta estimates to be biased during the period for which data is used to calculate the beta. M&A activity will affect the firm's share price in ways that are unrelated to the market index, causing a reduction in the estimated beta. We define substantial M&A as involving more than 30% of the market capitalisation of the firm, while other activities are rare but could include accounting fraud or other unique events.
- The comparators should have shares trading at the time of the price control, so that beta can be calculated using the most up-to date data. Using older data – for example

⁶¹ In a previous WACC study on Dutch regulated metering activities commissioned by the Netherlands Authority for Consumers and Markets (ACM), The Brattle Group employed a methodology including tests for the liquidity of the stocks of electricity and gas distribution system operators. Stocks were considered liquid enough if traded on at least 90% of the days when the reference index was traded. See The WACC for Regulated Metering Activities, The Brattle Group, January 13th, 2014, p. 7.

for firms that stopped trading several years ago – risks using an out-of-date beta, which may not capture changes in systematic risks in the industry.

- The firms must obviously be active in the telecoms industry, but also they should own and invest in telecoms infrastructure, rather than simply rent it. This is because renting infrastructure presents distinct systematic risk. Rental costs may be more variable than straight ownership, since an operator may be able to scale back the amount of infrastructure rented in the face of an economic downturn. In practise nearly all the firms we considered make investments in telecoms infrastructure, either mobile, fixed line or NGA. Companies that do not own infrastructure should not be considered in the analysis.

The final criteria – that the firm earns the majority of its revenue or profit (EBITDA) from the relevant activity, in this case provision of telecoms services over legacy (copper) networks – is the most difficult to meet in the case of EU telecoms firms. We discuss the criteria and the difficulty in applying it in the following section.

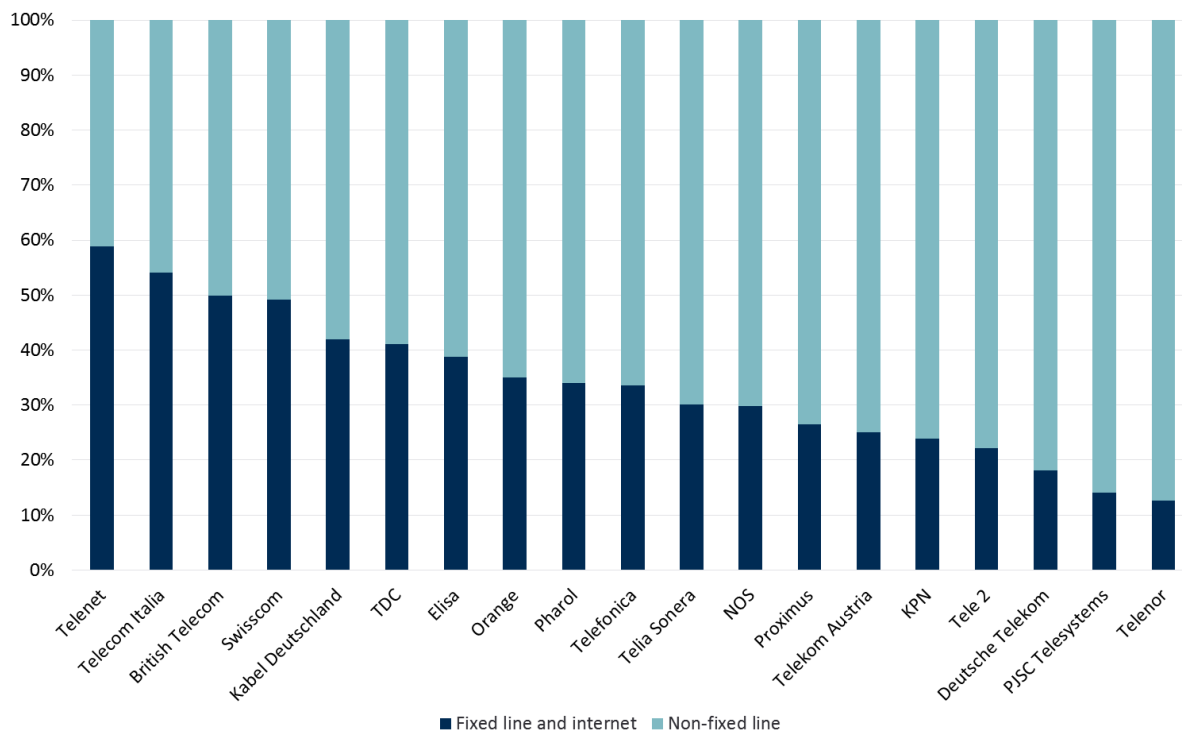
VI.C.9. Finding a ‘Pure Play’ legacy network

Ideally, we would like to base the estimate of beta on a ‘pure play’ legacy network firm. That is, a firm that only earns its revenues from the provision of telecoms services over a legacy (copper) network. To try to identify a pure play legacy network firm, we have analysed the revenue sources of the listed EU telecoms firms⁶². Figure 10 illustrates the results, dividing the revenues for each firm into non-NGA fixed line voice and ADSL services, and all other revenues.⁶³ In practice, the majority of the ‘other revenues’ relate to income from mobile. It becomes rapidly apparent from Figure 10 that there are no pure play legacy network firms in the EU, or anything that is close to a pure play firm. Only one firm earned more than 60% of its revenues from legacy network activities, and most firms earn less than half of their revenues from legacy network activities.

⁶² The telecom operator Colt has been excluded from the analysis due to its acquisition by the financial company Fidelity Investment on September 29th, 2015.

⁶³ We have performed this analysis based on the Annual Reports of the firms. However, many firms report revenues under different categories and using different definitions, and so inevitably some judgement is involved in allocating revenues.

Figure 10: Revenues of listed EU telecoms firms



Source: Brattle analysis of companies' annual reports.

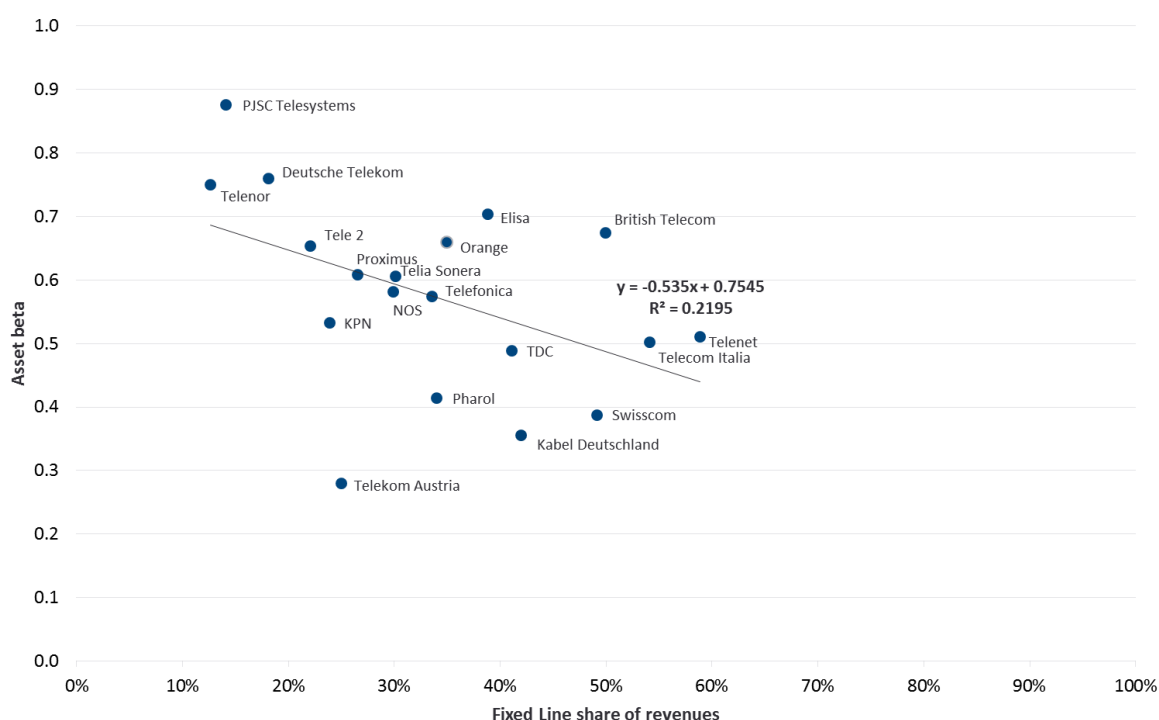
The lack of a pure play legacy network firm reflects the rapid development of the European telecoms market. Many operators offer fixed line broadband, voice and internet services, and several are now offering 'quad play' services, meaning that they offer customers fixed-line voice, mobile, broadband internet and TV. While this may be beneficial for EU consumers, it significantly complicates the issue of estimating a beta for the legacy network activity.

We have checked that the firms in Figure 10 all have liquidly traded shares, and that they meet the other criteria listed above. We estimate equity betas using daily returns over a two-year sampling period. To control for differences in financing which would affect the equity betas, we unlever the betas using the simple formula discussed in section VI.C.5, so produce a set of asset betas.

A typical technique to estimate the beta for a pure play firm, when no such firm is available, is to conduct a 'beta decomposition' exercise. This involves plotting the asset betas of the sample against the percentage of revenue earned from the activity of interest. In this case, we have plotted the calculated asset betas against the percentage of revenue earned from legacy network activities. Ideally, we would hope to see a linear relationship between the asset beta and revenues from the activity of interest, so that we can extrapolate the line to estimate the beta for a firm that earned 100% of its revenue from the relevant activity.

Unfortunately Figure 11 reveals that no such statistically reliable linear relationship between the asset betas and revenue from legacy network revenues exists in this case. The figure essentially shows a cloud of points, with a maximum asset beta of 0.88 and a minimum of 0.28. The median asset beta is 0.58.⁶⁴ For the sake of illustration we have fitted a straight line to the points, and the line seems to slope down from right to left. If we extrapolated this line all the way to the vertical right-hand axis – representing a firm that earns 100% of its revenue from legacy network activities – then the line indicates an asset beta of 0.22. But any such conclusions would be spurious, as the slope of the line is not statistically different from zero. That is, we cannot be sure that the true ‘line of best fit’ through the points in Figure 11 is actually a flat, horizontal line. In this case there would be no relationship between the asset beta and the percentage of revenue from legacy network activity.

Figure 11: Beta Decomposition Exercise



Source: Brattle analysis of annual reports and Bloomberg data.

One of the reasons that we do not see a good relationship between asset betas and revenue sources is that, while the telcos in the sample are all notionally EU operators, many in fact derive a large portion of their revenue from outside of the EU. However, it is not possible to control for this effect, given the available public data.

⁶⁴ We calculate asset betas using the debt beta values shown in section VI.G.1.

We conclude that we are unable to derive an asset beta for a legacy network specifically based on the available data. However, we explain below that there are good reasons to think that the systematic risk, and hence the asset beta for a legacy network, would be lower than the observed asset betas for the 'portfolio' of mobile, NGA and legacy networks.

Systematic risk relates to risk that investors cannot diversify. In considering the systematic risk of legacy networks it is helpful to consider how the legacy network business could be affected by a systematic economic downturn.

Generally, legacy network businesses risk abandonment as:

- Customers adopt mobile only services for both voice and internet, abandoning any form of fixed line connection;
- Customers switch to higher speed fibre-based NGA services.

In an economic slowdown, with contracting incomes we would expect:

- Switching from legacy networks to mobile to accelerate, as consumers attempt to save costs by abandoning their subscription to the fixed line. This would clearly reduce the legacy networks revenues and profits;
- Switching from legacy networks to NGA networks to slow down, on the basis that high-speed but more costly NGA services are a 'luxury' product, demand for which would fall as incomes decline.

These effects also perhaps partly explain the popularity of the tri-play or quad play business models. Holding mobile, NGA and legacy networks is a 'natural hedge'. Customers may switch from copper to NGA, or from copper to mobile, but at least they may stay with the incumbent. Conversely, a failure of customers to switch to NGA networks will at least be partly compensated by higher than expected revenues on the legacy network.

Based on the logic above, the effect of an economic slowdown on the value of the legacy network is ambiguous. It depends on the relative magnitude of the two effects described above: switching away to mobile and less switching to NGA.

However, the effect on the NGA business is likely unambiguous – an economic downturn would reduce switching rates and the value of the NGA network. From this we can conclude that the systematic risk, and hence the asset beta, should be higher for an NGA network than for a legacy network.

The analysis of asset betas above also suggests that the betas for mobile and fixed line activities are likely to be similar. As noted above, the beta decomposition exercise is essentially between fixed line legacy networks and mobile, and there is no clear influence of the proportion of revenues from mobile networks on the beta. Hence, if:

- The observed betas in Figure 11 represent a mix of legacy network, mobile and NGA (with the latter being a relatively small part for most telcos) and;
- The betas for mobile and legacy networks are similar; and
- NGA networks have a higher systematic risk and beta than legacy networks;

Then legacy networks are likely to have a lower beta than the observed beta of the portfolio. This implies that NRAs could reasonably make a downward adjustment to the observed betas. However, as Figure 11 shows, we tend to lack any good statistical basis on which to make such an adjustment. In Box 2 we illustrate an interesting approach adopted by Ofcom, the UK NRA. Ofcom in essence decomposed the observed beta of the SMP – in this case BT – by first estimating a beta for a legacy network activity, and then backing out the beta for the remainder of BT's activities by reasoning that the average of the estimated legacy network beta and the 'rest of BT' beta must equal the observed beta. The Ofcom exercise yielded an estimated legacy asset beta of 0.5, as compared to a 'rest of BT' beta of 0.83. Ofcom's approach accords with our conclusions above – that the legacy network beta is likely to be lower than the observed beta – and also provides an interesting and unconventional approach to estimating a beta for a legacy network beta.

Box 1: Ofcom's Beta decomposition exercise⁶⁵

Ofcom has disaggregated British Telecom (BT)'s asset beta since 2005 into two parts: (i) BT Group's copper and access services (the 'Openreach' asset beta), and (ii) the rest of BT Group's activities (the 'Rest of BT' – RoBT- asset beta), including business services, ultrafast broadband, and TV rights. The approach followed by Ofcom for the beta decomposition consists of four main steps: (i) estimating the asset beta for BT Group on the basis of available market data; (ii) estimating the beta for the copper business based on a group of peers; (iii) defining relative weights for each of Openreach (i.e. legacy/copper network business), and RoBT activities; (iv) backing out RoBT's asset beta based on the copper business asset beta, the BT Group's asset beta and the relative weights of each business (i.e. the BT Group's asset beta should be equal to the weighted average of the copper business asset beta and RoBT's asset beta, where the weights reflect the relative weight of each business in the BT Group).

Specifically, to estimate the two betas in the 2014 decision:

- a. Ofcom has calculated an overall asset beta for BT equal to 0.72, based on market data and taking into account a debt beta equal to 0.15;
- b. To estimate the asset beta of the legacy/copper network activities, Ofcom – in line with previous decisions – looked at the asset beta of: (i) UK non-telecom network utilities, (ii) Chorus, which is the unbundled copper network operator in New Zealand, (iii) alternative UK telecom operators, (iv) EU telecom operators. After considering specific issues about demand risk for telecommunication network services and differentials in regulatory regimes across countries, Ofcom found that the asset beta for BT's copper activities could lie between the average asset beta of UK network utilities, who carry less systematic risk than telecoms operators, and that of alternative telecom operators, who make wide use of wholesale services provided by BT, between 0.34 and 0.45. However, in order not to deviate too much from the asset beta of 0.60 determined in previous consultations in early 2013, Ofcom set the asset beta to 0.50, which was also close to the asset beta range for Chorus equal to 0.47-0.51;
- c. Ofcom set the weights of Openreach and RoBT to respectively 1/3 and 2/3, taking into account BT Group's economic value generated by the two businesses; the split is representative of Openreach and RoBT respective shares of total EBITDA and their net replacement cost share of the total enterprise value.
- d. Ofcom then calculated an asset beta for the RoBT activities equal to 0.83.

BT's asset beta overall increased since the last consultation in July 2013 from 0.67 to 0.72; according to Ofcom mostly driven by an increase in the systematic risk of the RoBT activities. Ofcom noticed that since 2010, the asset beta of BT systematically diverged from that of other UK network utilities, driven mainly by investments in NGA networks, whose demand is highly correlated with the overall economy.

⁶⁵ Ofcom, "Fixed access market reviews: wholesale local access, wholesale fixed analogue exchange lines, ISDN2 and ISDN30 – Annexes", June 2014.

While we find Ofcom's approach creative, it is not without potential controversy. For example, some of Ofcom's analysis relies on the beta of Chorus, a pure-play legacy network firm which is located in New Zealand. While Ofcom relied on other benchmarks, considering Chorus as a benchmark for Openreach raises questions regarding the equivalence of the regulation and risk, as well as currency and index issues discussed above. Ofcom also used betas of regulated UK electricity and gas networks as a benchmark. While we can see Ofcom's logic in using these betas as a reference point, it is also clear that energy networks face different, and likely lower, systematic risks than a legacy network. For example, energy networks in the EU are almost exclusively subject to revenue, rather than price controls, which mean they have no volume risk. Energy networks also face relatively little threat of abandonment for alternative technologies. We understand that Ofcom shared these views, and for this reason treated the energy networks as very much a lower bound for the beta estimate of Openreach. However, Ofcom's methodology relies, inevitably, on good judgement and thus such a methodology would not necessarily remove the subjective differences in WACC estimates which this study aims to eliminate.

VI.C.10. When to adjust Beta?

A determination of the WACC must balance two, sometimes conflicting, factors:

- On the one hand, regulatory stability and predictability are desirable. A stable and predictable WACC reduces regulatory risk and the risk of making investments under regulated conditions;
- On the other hand, the WACC should reflect the best estimate of the cost of capital at the time the estimate is made. Otherwise, distortions in investment decisions could arise.

Beta is an important determinant of the cost of equity and hence the WACC. If the beta changes significantly, then the WACC will also change significantly. As we have discussed above, estimating the beta for legacy networks confronts significant data problems. Therefore the question arises as to whether and when an NRA should periodically update their beta estimate for legacy networks for subsequent regulatory periods.

Given the large statistical errors generally associated with beta estimates, from a statistical point of view it is unlikely that an NRA could show that a new, updated beta estimate represents a true change in the beta. For example, our median asset beta estimate is 0.58. The

upper and lower 95% confidence intervals for this median asset beta are 0.50 and 0.67 respectively⁶⁶. This means that if an NRA, in three or four years from now, estimated a new median beta of 0.65, we could not be sure that the true beta had really changed.

On the other hand, the most recent median beta estimate is still the best point estimate because the errors are typically symmetric. In other words, there is a wide margin of error, but the best estimate is still to take the middle of a wide band of possible values.

Given the wide range of the confidence interval, by the time an NRA's beta estimate falls outside of the 95% confidence interval, the new median estimate of beta will be very different from the previous estimate. The beta would be 'frozen', but may eventually be subject to a large and sudden change. In our view large and sudden changes in beta are to be avoided if possible, because they increase regulatory risk.

Moreover, there are good reasons to believe that betas for legacy networks can change over time, largely due to technological changes, and changes in consumer behaviour. For example mobile has evolved from a 'luxury' product with a high beta in the early 2000s to a 'utility' or 'commodity' product with a lower beta today. Similarly, it seems reasonable to suppose that the beta for legacy networks may have or will increase over time, if they face a growing risk that consumers switch to mobile and NGA networks, and that this risk has a systematic element. It seems unlikely that there is another industry subject to price regulation which faces such rapid change. Betas for legacy networks are likely to be changing faster than in any other regulated industry.

Explaining observed changes in betas, and tying them to specific industry developments and events, is difficult given the statistical error in the beta estimate. It is hard to know if a change in the observed beta reflects a fundamental change in the industry, or is simply a statistical anomaly. However, in our view it would be incorrect to assume that legacy networks betas are now somehow 'fixed' and will no longer change. Hence, in our view NRAs should continue to update legacy network beta estimates over time. However, given the effect on the WACC, and the desire to minimise regulatory 'shocks', NRAs should exercise caution in updating betas in an overly formulistic or mechanical way. NRAs should consider if the directional change in the measured beta makes sense, given the changes that

⁶⁶ The confidence interval for the median reported in the text has been obtained with 200 bootstrap replications. Application of the binomial method would yield a confidence interval of 0.47 – 0.64 instead. By construction, the binomial method does not guarantee a symmetric confidence interval, as the boundaries of the interval are represented by actual observations.

are occurring in the industry. For example, NRAs should consider what changes have occurred in the industry that have influenced the systematic risk of the legacy network business – that is, risks that we would expect to be correlated to the wider economy. For example, if the NRA observes an increase in the asset beta, does this correspond to increased competition from mobile networks? Such an increase in competition could make it more likely that, in the events of a negative shock, more customers could switch away from the legacy network causing revenues to fall. Similarly, if the calculated beta increases slightly, while the evidence suggests a decrease in systematic risk, the regulator could opt to make no adjustment to beta, or move only partially to the new value. Changes in parameters that are not correlated with the wider economy – for example changes in the firm's fixed costs could not generally explain a change in the firm's beta.

However, to be clear we are not suggesting that the NRA should have to justify a change in the estimated beta. It can be very difficult to understand and explain all of the factors which contribute to a change in beta, and NRAs should be careful not to engage in excessive 'second guessing' of the data. Rather, the NRA should take the starting point that the new beta is likely to be correct, so that the 'burden of proof' is for the NRA to explain why the new beta estimate may not be correct, or why the NRA proposes to adopt a beta value closer to the 'old' value than suggested by the more recent beta calculation.

VI.C.11. Conclusions on Beta

- Absent compelling reasons to the contrary, EU NRAs should use a common beta for legacy network activities. The beta should be estimated from a sample of firms based on criteria which we discuss;
- NRAs should calculate betas using daily returns over a two-year period. A two year period is an appropriate compromise between using recent data (which is likely to better reflect the expected future beta) while at the same time producing a reasonable number of observations and hence reducing statistical errors;
- When calculating daily betas, NRAs should apply an adjustment to the calculated beta to account for the possibility that some of the reaction of the share price may occur before or after the reaction of the index (a so-called Dimson adjustment). We do not recommend that NRAs apply other adjustments such as Bayesian, Blume or Vasicek adjustments;
- The CAPM is based on the idea that investors need only be compensated for non-diversifiable risk. At the same time, it seems unlikely that investors diversify their investments globally. We think the use of a wider European (rather than national) index is consistent with the idea that, while investors may not be globally diversified, investors in European telcos are at least diversified across Europe. It is also consistent with the use of Europe-wide data to estimate the ERP;
- NRAs do not need to compute betas themselves, but could rely on 'off the shelf' estimates from data providers, or even recent beta estimates by other NRAs;
- Equity betas must be unlevered to obtain an asset beta. We present a number of reasonable unlevering formulas. The best way to minimise errors as a result of unlevering and relevering is to use a target level of gearing close to the average of the sample of firms from which asset betas are estimated;
- Using the median of the calculated asset betas, rather than the arithmetic average, will tend to produce a beta estimate that is less dependent on the chosen comparators.
- There are no 'pure play' legacy network firms, or firms that approximate a pure play. There is no clear relationship between asset betas and revenue sources. Accordingly, there is significant uncertainty associated with the asset beta estimate for a legacy network. Based on the available evidence, an asset beta range of 0.50 to 0.67 would seem reasonable. This range reflects the upper and lower 95% confidence interval for the median asset beta of a range of suitable firms active in the European telecoms market;
- NRAs should recalculate beta for each new regulatory period, but exercise discretion in updating the beta value used in the WACC estimate. Significant variations in beta estimates from one regulatory period to another should be duly justified.
- In section VII.C on the NGA WACC, we discuss financial modelling techniques that may be able to refine the downward adjustment of the asset beta for legacy networks.

VI.D. EQUITY RISK PREMIUM

In this section we address two key questions for the ERP:

- Whether there should be a world-wide ERP, or a European ERP? Either way, there would be a single ERP for all MS NRAs;
- Whether to estimate the ERP using historic returns, survey data or evidence from Dividend Growth Models or some mixture of these methods;

VI.D.1. Geographic Scope of the ERP

If investors were perfectly diversified over the world, it would make sense to try and measure a 'worldwide' ERP. In practise, as we discussed in section VI.C.3, economists have found evidence of 'home bias'. That is, investors have a tendency to invest in markets which are geographically closer, and often with which the investor shares a common language. At the same time, in our view it would be too extreme to suppose that investors only concentrated on their own MS, and did not make investments outside. In practice, many large SMPs are partly owned by multinational investment funds, underlining the point that the investors are not only local.

Therefore in our view it seems reasonable to apply a 'European ERP'. That is, there is likely to be home bias at least within Europe, and so the relevant excess return is that for European stocks. To allow a common ERP for all EU NRAs, the ERP estimate should be based on evidence from all EU MS.

An ERP estimate based on historical data from a wide sample of countries will have a much lower statistical error than an ERP estimated from only a handful of countries. 'High' or 'low' estimates of the ERP, based on data from a single country, are more likely to reflect statistical errors rather than a reliable basis for the ERP estimate.

However, we also note that there is unlikely to be a separate and distinct European ERP. While there is likely to be a European home-bias, an assessment of the ERP should account for investment opportunities in other major markets such as the US. Hence, while we recommend that European data is the anchor for the ERP estimate, data from the US can also be considered relevant.

VI.D.2. Methodology for Estimating the ERP

There are multiple methods that are commonly relied upon to determine the ERP. However, the methods can broadly be characterized as falling in the following categories based on the data they rely on:

- Historical data;
- Estimates based on forecasts;
- Survey results;

We discuss the pros and cons of each method below.

VI.D.2.a. Historical data

Using historical data to estimate the ERP implicitly assumes that the past is the best guide to the future. The standard data source for ERP estimates based on historical data is the work of Dimson, Marsh and Staunton (DMS). The DMS data set calculates the average excess return of stocks over bonds over more than 100 years, for a large group of world markets. When using the raw historical data the key issue becomes what time period to use to estimate the ERP, whether to use a long-term or a short-term ERP measure and exactly how to measure the ERP.

There is of course no guarantee that long-run historical averages exactly match the expected *future* ERP that investors demand now. In their work, DMS note a number of unexpected and positive factors that might have led the realized ERP to be higher than the ERP that investors would have demanded or expected. They suggest several downward adjustments to the historical ERP, to account for events which happened in the past but, in the view of DMS, are unlikely to occur in the future.

For example, DMS argue that advances in technology have made investment diversification cheaper and easier than it was 100 years ago. A more diversified investor has lower risk and so should be content with a lower expected ERP than in the past. If risk premiums have declined, say over the last 50 years, the decline would have reduced investors' required rates of return and generated higher stock prices, other things equal. According to this line of argument, historical-average ERPs could therefore be upward-biased forecasts of future ERPs.

Symptoms of a declining ERP could include an upward trend in stock prices relative to dividends or earnings. Price-dividend ratios have indeed increased over the last 50 years, and DMS argue that this upward trend is unlikely to continue. They therefore adjust average

ERPs downward to remove the return contributed by the increasing price-dividend ratios we have seen in the past.

DMS's proposed adjustments to the historical data are not without controversy. For example, adjusting the historical averages for trends in price-dividend ratios may seem plausible, but DMS ignore other reasons why price-dividend ratios have increased. Corporations' cash payout has shifted from dividends to other channels, including share repurchases and payments to selling shareholders in takeovers. Repurchases are now "the dominant form of payout" in the U.S.⁶⁷ These changes have generated higher price-dividend ratios (other things equal) simply because dividends now account for a much smaller fraction of total payout. Therefore the trend of increasing price-dividend ratios does not necessarily imply that the expected ERP is lower than historical averages. Looking only at dividends understates the total payout to investors. Moreover, when overall payout decreases, reinvestment and growth should increase. DMS make no adjustment for additional growth from increased reinvestment.

Another potential criticism of historical data to estimate the ERP is that it does not react in a coherent way in the face of an economic crisis. After the 2008/09 financial crisis low levels of stock returns depressed the historical ERP, producing the counterintuitive result that large falls in the stock market lead to reductions in the expected return. It would be more logical to expect that, as volatility and risk-rises, the rate of return demanded should increase.

The notion that market volatility increases the ERP is consistent with the academic literature which finds a positive relationship between the ERP and volatility. For example, Kim, Morley and Nelson (2004) find a positive relationship between stock market volatility and the equity premium,⁶⁸ while Bansal and Yaron (2004) demonstrate that economic uncertainty plays an important role in explaining the ERP.⁶⁹ In their model, higher uncertainty (measured in their paper by volatility of consumption) leads to higher conditional ERP.

There are also a number of papers that argue that the ERP is variable and depends on a broad set of economic circumstances. These are generally referred to as 'conditional estimates' of

⁶⁷ D. J. Skinner, "The evolving relation between earnings, dividends, and stock repurchases," *Journal of Financial Economics* 87 (2008), p. 584.

⁶⁸ C-J. Kim, J.C. Morely and C.R. Nelson (2004), "Is There a Positive Relationship Between Stock Market Volatility and the Equity Premium," *Journal of Money, Credit and Banking*, vol. 36.

⁶⁹ Bansal, R., and A. Yaron (2004), "Risks for the Long Run: A Potential Resolution of Asset Pricing Puzzles", *Journal of Finance*, Vol. 59 (4): 1481-1509.

the ERP. For example, Mayfield (2004) estimates the ERP in a model that explicitly accounts for investment opportunities. He models the process that governs market volatility and finds that the ERP varies with investment opportunities which are linked to market volatility. Thus, the ERP varies with investment opportunities and about half of the measured ERP is related to the risk of future changes in investment opportunities. Based on this approach, Mayfield estimates the U.S. ERP to be 5.6 percent measured since 1940.⁷⁰ However, the problem with such an approach is determining when the ERP has changed and by how much. Another version of the conditional ERP is found in French, Schwert, and Stambaugh (1987),⁷¹ for example, who find a positive relationship between the expected ERP and volatility of stock returns. Put differently, the conditional ERP varies with the volatility in the stock market.

Regardless of whether we use a 'raw' historical estimate or a conditional estimate based on historical data, an important issue to address is whether NRAs use the arithmetic mean or the geometric mean of the historical return. The historical return series shows a significant difference between the arithmetic mean and the geometric mean of the equity risk premium. For example between 1900 and 2014 the arithmetic mean world ERP relative to bonds was 4.5% while the geometric mean was only 3.2%. The geometric ERP for Europe was 3.1%, while the arithmetic mean was 4.4%, while the geometric ERP for the US was 4.3%, while the arithmetic mean was 6.4%.⁷²

The geometric mean is a considerably different concept than the arithmetic mean. The geometric mean of n numbers is the n^{th} root of their product. For example, the geometric mean of 3 and 12 equals 6 (the square root of 3×12). In the context of historical returns, the geometric mean is the single figure which, if compounded over time, would explain the cumulative total return difference of the stock market relative to government bonds.

For any data series, the arithmetic mean is greater than the geometric mean except when there is no variability in the data and they are equal. Because stock market returns are variable, the arithmetic mean of past returns will always be greater than the geometric mean.

⁷⁰ E. S. Mayfield, "Estimating the market risk premium," *Journal of Financial Economics* 73, 2004, pp. 465-496.

⁷¹ K. French, W. Schwert and R. Stambaugh, "Expected Stock Returns and Volatility," *Journal of Financial Economics* 19, 1987.

⁷² DMS 2015 Table 10.

Financial experts have explained that the correct approach is to use the arithmetic mean of historical returns to estimate the ERP. For example, Annin and Falaschetti note that “[o]ne area regarding the equity risk premium that is not disputed in academic circles is whether the arithmetic or geometric mean equity risk premium should be used. The arithmetic mean should always be used in evaluating projected cash flows.”⁷³ Financial experts agree that the ultimate aim is to derive an estimate of the arithmetic mean return, because this corresponds to investor’s true expectation. However, there is some debate as to whether the historic arithmetic mean or the historic geometric mean provides the best forward looking estimate of the arithmetic mean.⁷⁴ However, we find the balance of the evidence recommends the use of the arithmetic average of the historical excess return to estimate the ERP.⁷⁵

While we favour the use of the arithmetic mean, we note that some regulators also use the geometric mean ERP. NRAs could also use the average of the arithmetic and geometric average. However, we do not recommend an ERP estimate based only on the geometric average or assigning a weight to the geometric average above what is merited by mean reversion in markets.

VI.D.2.b. Supply-side estimates of the ERP

The supply-side estimate of the ERP is based upon the observation that the “supply” of market returns is generated by the productivity of businesses in the real economy. Investors should not expect to have returns much higher or much lower than those produced by businesses in the real economy. A paper by Professors Ibbotson and Chen (2003) adopts a supply-side approach to estimate the forward-looking long-term sustainable equity returns and equity risk premium based upon economic fundamentals. The primary difference between the supply-side estimates and historical realized estimates of the ERP is that the supply-side model notes that the increase in the average price-earnings ratio for stocks cannot continue. Therefore, the growth in the average price earnings ratio is subtracted from the other factors that generate returns in the market. Ibbotson and Chen’s supply-side estimate of the U.S. equity risk premium over the long-term risk-free rate is updated annually and reported in the Morningstar Ibbotson SBBI 2012 Valuation Yearbook, but as far as we are aware no equivalent number is available for European markets.

⁷³ See Annin M and Falaschetti D, “Equity Risk Premium”, Valuation Strategies, January/February 1998.

⁷⁴ For discussion on this issue see for example ‘A Study into Certain Aspects of the Cost of Capital for Regulated Utilities in the U.K.’ Smithers & Co. February 2003, Section 2.4.2.

⁷⁵ For further discussion of this issue see Jacquier E., Kane A. Marcus A. J. (2005). Optimal Estimation of the Risk Premium for the Long Run and Asset Allocation: A Case of Compounded Estimation Risk, *Journal of Financial Econometrics*, 2005, Vol. 3, No. 1, 37-55.

VI.D.2.c. Survey Data

In theory, since the ERP is a forward-looking estimate, simply asking people what they expect the ERP to be seems like an appealing idea. In practice, the use of survey results to estimate the ERP is problematic. As one recent paper noted:

“The consensus [i.e. survey] method might appear to be a very good approach; when using this method, one attempts to obtain the estimates from the market participants themselves (i.e., the very investors who are setting the market prices). But there are a number of problems with this approach. Most of these investors have no clear opinion about the long-run outlook. Many of them have only very short-term horizons. Individual investors often exhibit extreme optimism or pessimism and make pro-cyclical forecasts, and so following a boom, they can have ERP estimates that exceed 20 percent or 30 percent. Following a recession or a decline in stock market prices, their estimates of the ERP might even be negative. Academics and institutional investors may be more thoughtful, but any survey of their opinions would have to be very carefully designed. I have seen surveys, however, that do not seem to even clarify whether the questionnaire refers to arithmetic mean returns or geometric mean returns. Many surveys also do not make clear whether the ERP to which they refer is the excess return of stocks over government bonds or Treasury bills or some other type of bond. This lack of clarity makes the surveys very difficult to interpret.”⁷⁶

For example, a 2014 survey of the ERP in 88 countries included estimates for the ERP in the Netherlands. Based on 48 responses, the survey came up with a low estimate of about 2.5% and the highest estimate was about 12%.⁷⁷

The variability of survey results is not new. In a 2000 paper concerning the ERP, Professor Brealey of the London Business School⁷⁸ cites widely varying results from four surveys as evidence of their unreliability.⁷⁹ From the surveys he considered, estimates for the ERP varied between 16% and 3% over short-term US Treasury bills. The highest estimates occurred in a 1997 Montgomery Asset Management survey in which US mutual fund managers desired as

⁷⁶ The Equity Risk Premium, Roger G. Ibbotson Professor in Practice, Yale School of Management Chairman, Zebra Capital Management p.20, published in ‘Rethinking the Equity Risk Premium’, *Research Foundation of CFA Institute*.

⁷⁷ Based on Table 1 of Fernández, Pablo, Javier Aguirreamalloa, and Luis Corres. 2014. “Market Risk Premium Used in 88 Countries in 2014: A Survey with 8,228 Answers.” Working Paper WP-920, IESE Business School June 2014.

⁷⁸ Professor Brealey also consults exclusively with *The Brattle Group*. With Professor Stewart Myers of the Massachusetts Institute of Technology (who is a partner of *The Brattle Group*), Professor Brealey has written *Principles of Corporate Finance*, which for the past twenty years has been the world’s best-selling textbook in corporate finance.

⁷⁹ Brealey RA, “The New Economy and the Cost of Capital”, London Business School, September 2000.

high as 16% over short-term Treasury bills. An August 1997 poll by Paine Webber indicated a premium of only 9% over Treasury bills.

Survey results are also subject to changing market sentiment. Professor Ivo Welch has produced two interesting surveys of financial economists concerning the ERP. His surveys would seem to command more weight than surveys of fund managers, who might be more prone to influence by prevailing market sentiment. However, it appears that financial economists are also influenced by market sentiment. Professor Welch's 1998 survey of financial economists estimated the equity risk premium at just over 7%. A following survey in September 2001, in contrast, came at a time of greater pessimism. The audience estimated the equity risk premium at only 5%.⁸⁰ If the audience had analysed recent stock performance objectively, one would have expected them to raise their estimates of the ERP rather than lower them. The poor performance of stocks since March 2000 indicated significant market risk, which is associated with a higher ERP. If the audience provides high estimates of the ERP at times of rising stock prices, and low estimates at troubled times, it seems that the survey does little more than reflect short-term optimism or pessimism. For these reasons we do not recommend the use of survey data in estimating the ERP.

VI.D.2.d. ERP Estimates Based on Dividend Forecasts

An alternative method to estimating the ERP is to use dividend-discount models, which forecast dividends and dividend growth and back out the rate of return consistent with observed stock prices. Dividend-discount models typically give ERP estimates higher than historical averages. For example, the latest ERP forecasts from Bloomberg's dividend discount model are between 9% and 10% for Europe.⁸¹

Some financial practitioners argue that the use of a DGM to estimate the ERP has a more solid theoretical grounding, because the ERP is a forward-looking estimate, the DGM will give a better answer than using 'backward looking' historical data. However, we do not think it is correct to characterize the use of historical data as 'backward looking'. Rather, as we note above, the premise is that the past is the best guide to the future. Moreover, the ERP estimate will only be *based* on the historical data. As we discuss above, economists have recognized that there are a number of events that have taken place in the past that may affect the

⁸⁰ Welch I, "The Equity Premium Consensus Forecast Revisited", 8th September 2001.

⁸¹ Bloomberg uses a three-stage dividend-discount model, which allows a high near-term growth rate of dividends and earnings, but requires convergence to a relatively low, sustainable long-term growth rate.

historical ERP and that some of these events may not be repeated, thus, the historical data can be adjusted to account for these events and make a better forward-looking ERP estimate. We discuss some of the potential changes to the historical ERP in the section above. Accordingly, dismissing the historical data altogether, rather than simply trying to make some adjustments, seems unfounded.

In our view dividend-discount models give interesting support to the historical data. But the results are volatile and rather subjective. Since ERPs estimated from Dividend Growth Models are in essence based on the views of analysts, they suffer from some of the same flaws as survey data, discussed above. As one 2011 paper noted:

“consensus long-term earnings growth estimates routinely exceed sustainable GDP growth. The current consensus growth rate for earnings on the S&P 500, according to the Zacks Investment Research survey, is 10 percent, which, if we assume a consensus inflation expectation of 2–3 percent, corresponds to 7–8 percent real growth. Real earnings growth of 8 percent is six times the real earnings growth of the past century, however, and three times the consensus long-term GDP growth rate. This growth is not possible.”⁸²

⁸² Robert D. Arnott, *Equity Risk Premium Myths*, published in ‘Rethinking the Equity Risk Premium’, *Research Foundation of CFA Institute*, December 2011.

VI.D.3. Conclusions on the ERP

There is significant debate and uncertainty regarding predictions of the ERP, largely because it involves a prediction of the excess returns that investors expect today, and predictions are inherently uncertain. There is no academic consensus as to whether the historical data or estimates based on dividend growth models are superior. Given this uncertainty, it would in our view be wrong to be overly prescriptive regarding the methodology for estimating the ERP, since this would assume that we 'have the answer'.

However, we do think that there is room to narrow the debate on the ERP based on a common set of principles.

First, NRAs could agree to estimate the ERP based on historical data on the excess return of stocks over bonds, as reported by Dimson, Marsh and Staunton (DMS). Survey data tends to be unreliable, and ERP forecasts from Dividend Growth Models tend to be sensitive to the input assumptions which include analysts' forecasts of future dividends. In contrast, the historical data is relatively stable, because it is hard for one additional year to change the average of over 100 years' worth of data. Stability, predictability and a lack of volatility are desirable in a regulatory context. The historical ERP provides a good 'anchor' for estimates and prevents large changes in the ERP from one regulatory period to the next.

Second, NRAs should base their ERP estimates on the arithmetic average of the historical excess returns. Given that there are some proponents of using the geometric average, and some arguments in favour of this approach NRAs could also use a weighted average of the arithmetic and geometric average that take the academic research on the topic into consideration. However, we do not recommend an ERP estimate based only on the geometric average.

Third, NRAs could make reasonable adjustments to the historical data, informed by other sources of evidence on the ERP from, for example, Dividend Growth Models. NRAs should avoid a 'mechanical' application of historical data, which could for example result in an erroneously lower estimate of the ERP when stock markets have fallen.

In our view, the final ERP estimate will often be, and perhaps should be, the result of a combination of data and judgement. At the same time, it would be desirable to have a single ERP value for the EU. This is because there is no good theoretical reason why the ERP should vary across MSs, and differences in the ERP across MSs could distort investment decisions.

Given that:

- The historical arithmetic average ERP over bonds for Europe is 4.5%, and the corresponding figure for the US is 6.4%;
- Current Dividend Growth Models give ERP values in the range of 9-10%;

In our view an ERP of 5-5.5% over bonds would be reasonable.

VI.E.A TOTAL RETURNS METHODOLOGY

The methodology we have discussed above is based on the CAPM. As set out at the introduction, a discussion of alternative methods of estimating the cost of equity is outside of the scope of this study. Nevertheless, at the stakeholder workshop organised with this project (see section II.A) the possibility of using a ‘total returns’ methodology, as an alternative to the CAPM, was discussed.

The total returns methodology simply looks at the long-run average historic returns to equity (being in effect the risk-free rate plus the ERP), and reasons that equity holders would expect to earn in future the average of the returns that they have earned in the past.

For example, a prominent 2003 report by Smithers & Co., commissioned by the U.K. economic regulators and the Office of Fair Trading noted the problems with measuring the ERP and the historic risk-free rate, and that “we summarise a range of evidence that the equity return [risk-free rate plus ERP] has, over reasonably long samples, been fairly stable both over time, and across different markets.”⁸³

However, we note that the Smithers & Co. report did not actually recommend using a total market returns methodology in place of the CAPM. Moreover, the study actually notes that:⁸⁴

“While there has been a reasonably wide range of experience in the countries covered, the range of historic mean equity returns is not actually all that wide: all but three countries had geometric (i.e., compound) average stock returns in the range of 4% to 8%, and arithmetic average returns in the range 6% to 10%.”

In our view, this is still a fairly wide range. Hence, it is not clear that applying a total returns methodology would really deliver a more stable and predictable estimate of the cost of equity.

Given that equity returns are not in fact particularly stable over time, there are reasons to object to the use of a total returns methodology on theoretical grounds. As Professors Brealey, Myers and Allen put it in their best-selling corporate finance text book:

“One way to estimate r_m [the return to equity] is to assume that the future will be like the past and that today’s investors expect to receive the same “normal”

⁸³ A Study into Certain Aspects of the Cost of Capital for Regulated Utilities in the U.K., Smithers & Co. February 2003, p.4.

⁸⁴ Ibid p. 30.

rates of return revealed by the averages shown in Table 7.1. In this case, you would set r_m at 11.1% the average of past markets returns.

Unfortunately, this is not the way to do it; r_m is not likely to be stable over time. Remember that is the sum of the risk-free interest rate r_f and a premium for risk. We know that r_f varies. For example, in 1981 the interest rate on Treasury bills was about 15%. It is difficult to believe that investors in that year were content to hold common stocks offering an expected return of only 11.1%.

If you need to estimate the return that investors expect to receive, a more sensible procedure is to take the interest rate on Treasury bills and add 7.1%, the average risk premium shown in Table 7.1”⁸⁵

The second grounds for objection is that, the variation in returns notwithstanding, by definition the total returns method only gives the correct return for the average market portfolio. Also by definition, the beta of the market portfolio is 1.0. However, if the beta of the legacy network activity is less than 1.0, then the market returns methodology will overestimate the return that investor’s in these projects require. This is because a beta of less than 1.0 indicates that the legacy network project contributes less than the average level of systematic risk to the investor’s portfolio, and so the investor will demand a lower return than the market average.

In the case of the legacy networks it seems likely that true beta is less than 1.0. For example, the median equity beta for our sample of telcos in section VI.C is 0.85. In effect, using the total returns methodology would set the beta to one, regardless of the actual gearing of the SMP. This could lead to an overestimate of the WACC, with no obvious benefits for stability.

For the reasons set out above, we do not recommend that NRAs depart from the CAPM by applying the total returns methodology for estimating the cost of equity.

VI.F. GEARING

By gearing, we mean the ratio of net debt (D) to the value of the firm (V). We also refer to this as ‘leverage’. Gearing is relevant to the beta unlevering procedure – calculated equity betas should be unlevered using the average gearing of each firm over the period that the beta was measured. Gearing is also determines the relative weighting of debt and equity in the WACC.

⁸⁵ R. A. Brealey, S. C. Myers and F. Allen, *Principles of Corporate Finance*, 10th Ed., 2011, p.160.

The first issue related to gearing is how to measure it, and the second issue is whether there should be a common ‘target’ level of gearing for determining the WACC for SMP operators. We discuss these issues below.

VI.F.1. Measuring Gearing

Gearing clearly varies between telcos. However, it is important that NRAs arrive at a common methodology to calculate gearing, so as to avoid arbitrary differences distorting WACC estimates. We recommend that NRAs measure gearing by reference to the market value of equity⁸⁶ – where available – rather than the book value. This is because it is the market value of equity which measures the future earnings potential of firms, and their ability to sustain debt. For example, if a firm’s share price declined sharply, then the debt as a percentage of the value of the firm could increase significantly, as would the risk of default. Calculating gearing using the market value of the firm would capture this effect, whereas using the book value would not.

In theory one should measure the value of the debt at market value as well. In practise such an exercise can be difficult, and for debt issues which are not close to default, or more broadly have an investment grade credit rating, the book value of the debt is a good approximation of market value. If the firm does not have an investment grade credit rating then it seems doubtful that it should be used for the estimation of the cost of equity or as a benchmark for target gearing.

‘Debt’ should include the cost of long-term financial leases. This is because a long-term financial lease, which commits the firm to making regular repayments, is equivalent to debt in financial terms. Omitting the value of financial leases could give the incorrect impression that SMPs that chose to build a mobile network by leasing equipment were significantly less levered than firms that chose to borrow the money to build a network. In practise the two approaches are the same, from a financial economic perspective. NRAs should estimate the present value of future lease commitments by discounting future payments at the cost of debt.⁸⁷

⁸⁶ In other words, the market capitalisation of the firm equal to the share prices multiplied by the number of shares.

⁸⁷ In some cases, firms take on significant long-term operating lease commitments. These commitments do not appear on the balance sheet but are analogous to financial leases and other financial debt. NRAs do not need to consider operating leases explicitly so long as all relevant firms have similar levels of commitments. A need for further analysis would arise if some sample firms had many more operating

In general, it is reasonable to include only long-term debt in the gearing calculation, since short-term loans and liabilities are likely to be offset by short term assets, such as cash and cash equivalents. However, where it appears that ‘short-term’ debt is really a long-term source of financing, the short-term debt that is not offset by short-term assets should be included in the debt for the purposes of the gearing calculation.

VI.F.2. Target Gearing

The second issue is whether NRAs should all assume the same ‘target’ gearing when calculating the WACC, or whether NRAs should use the gearing of the SMP they regulate or their own MS-specific target value of gearing.

When choosing the target level, the NRA is estimating the efficient level of debt for the SMP’s regulated activity. On the one hand, because interest is tax deductible, more debt increases the value of the interest tax shield. Hence, starting from 100% equity financing, adding more debt will lower the WACC, because less of the value of the firm goes to the government in the form of taxes. However, at a certain point the level of debt causes the risk of bankruptcy, with its associated costs, to increase. Hence the choice of gearing by the NRA is about allowing consumers to enjoy a lower WACC and tariffs due to the presence of a ‘reasonable’ amount of debt without incurring an excessive risk of bankruptcy.

Within the context of this framework, we note that a common EU-wide target gearing is only desirable if we think that the same gearing is optimal for all MSs. But since tax rates vary across the EU, and the tax benefits of debt depend on the tax rates,⁸⁸ then the optimal gearing will not be the same across the EU.

We also note that, if a common EU gearing level was selected, and this varied significantly from the SMP’s actual gearing, then this could introduce measurement difficulties. For example, the NRA could be faced with the task of estimating the cost of debt for a firm with a 20% gearing, when the actual SMP has a 70% debt level. Estimating the correct cost of debt in these circumstances could be challenging.

Continued from previous page

lease commitments than others. We would expect the operating lease commitments to raise leverage and equity betas, all else equal.

⁸⁸ The optimal gearing will also vary with the costs of bankruptcy, which may also vary across the EU. However, we doubt that bankruptcy costs vary materially across the EU, since the EU’s Regulation on insolvency Proceedings ensures a level of uniformity to bankruptcy costs across the EU.

One argument for a common level of debt is that NRAs might choose an apparently inefficient gearing level – for example an unrealistically high level of debt which lowers the WACC but would not be achievable for the SMP without risking bankruptcy. Generally, we note that it is difficult to identify with precision what an inefficiently low or high level of debt amounts too, and the effect of gearing on the WACC is relatively modest in any event.

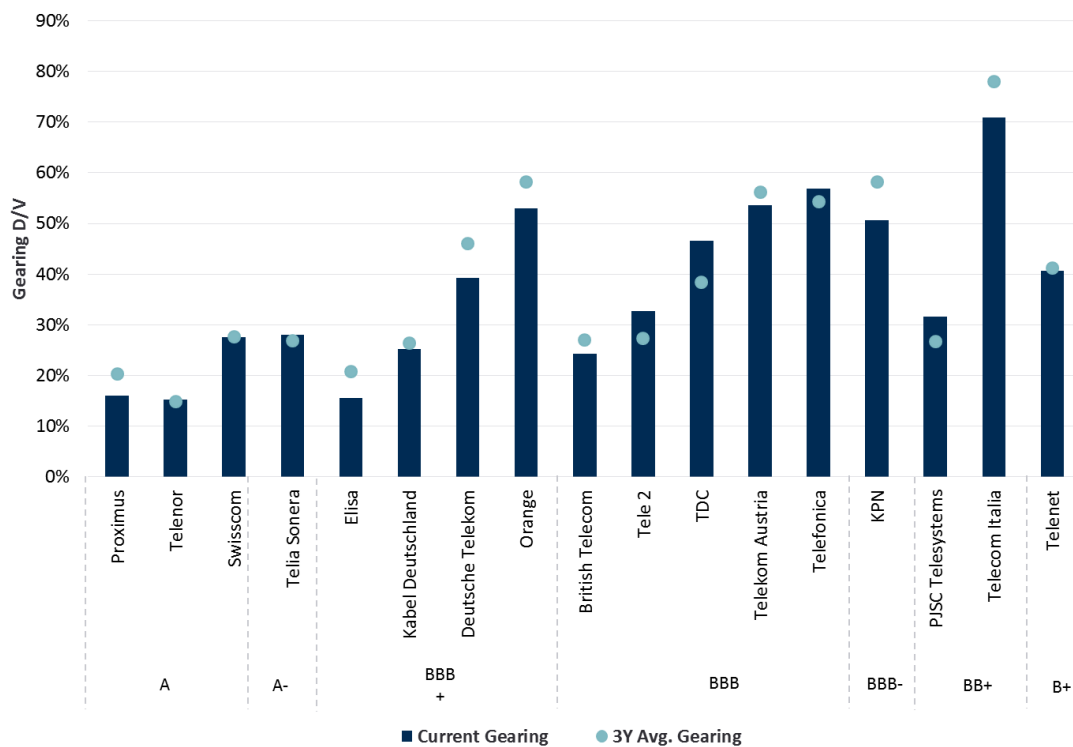
On balance, we recommend that NRAs are free to choose their own level of target gearing, but with two caveats:

- The target level of gearing should not be more than 10 percentage points higher or lower than the average gearing of the peer group used to estimate beta, without some justification as to why the NRA has chosen such a level of gearing;
- Notwithstanding the first point above, there should be an absolute maximum level of gearing.

Figure 12 illustrates gearings levels of EU telcos, calculated over a three year period⁸⁹ and the gearing as of September 2015. Figure 12 shows that less than one-third, or five out of eighteen firms, had a three-year average gearing above 50%. Hence, in our view the target gearing assumed by the NRA should not exceed a range of 50-55%. In our view setting a lower limit is not required. This is because choosing a ‘low’ target gearing would increase the WACC and the tariffs, which is something that the NRA is unlikely to want to do.

⁸⁹ The period is 20/10/2012 to 20/10/2015, which is also the time range for the calculation of betas discussed in section VI.C.

Figure 12: Gearing and Credit Ratings for EU Telcos



Source: Brattle analysis of Bloomberg and companies' data.

VI.F.3. Gearing Summary

- Gearing, defined here as net debt over value, should be calculated using the market value of equity;
- The book value of debt can be used, as long as the firm has an investment grade credit rating. If the firm does not have an investment grade rating, then it should not be used for WACC estimation;
- The value of financial leases should be included in the value of debt;
- The WACC is not highly sensitive to the choice of gearing, and the 'optimum' level of gearing will logically vary between MSs, as tax rates vary between MSs;
- In any case, the target level of gearing should not exceed 50-55%, which is the upper end of gearing observed for the telecoms sector (See section VI.F.2).

VI.G. DEBT PREMIUMS AND BETAS

The cost of debt is often expressed as the sum of the risk-free rate plus a debt premium:

$$\text{Cost of debt} = \text{risk-free rate} + \text{debt premium}$$

NRAs typically calculate the debt premium by analysing the historical differences between yields on corporate debt and the risk-free rate, as measured by yields on government bonds, over a given period.

The consideration of the debt premium is closely linked to the target gearing level discussed above. An important point is that firms with similar gearing may have very different ratings depending on which MS they mainly operate in. For example a telecoms firm with a 40% gearing operating in Spain will currently have a lower rating than a telecoms firm with a 40% gearing operating in Germany.

It is important that NRAs identify a credit rating and cost of debt consistent with their target gearing level for their jurisdiction. We recommend that NRAs proceed as follows:

- If the NRA's target gearing differs from the SMP's actual gearing, then the NRA will have to estimate the credit rating at the target gearing level. This would be most easily done by taking the incumbent's existing rating, and then re-calculating it for the assumed target gearing. Ratings agencies publish rating methodologies which would help the NRA to do this;
- Alternatively, the NRA could chose a target credit rating, and then work back to choose a gearing that is consistent with that rating. This could be done using the rating methodologies of the major credit rating agencies for example;⁹⁰
- The NRA would then estimate debt yields for the given credit rating. This could be done:
 - using yields on traded bonds with the appropriate credit rating; and/or
 - yields on 'generic' bonds with the appropriate credit rating (discussed below);
- If there is no target rating, so that the NRA will use the incumbent's actual gearing, and the incumbent has traded bonds, then the NRA could estimate the debt premium directly from using the yields on the incumbents bonds;⁹¹
- The NRA could supplement this estimate using yields from bonds with the same rating as the incumbent.
- The NRA would then calculate the average spread or difference between the debt yields and the risk-free rate (in practice a government bond) for the same historic period for which the risk-free rate is calculated;

⁹⁰ See for example Moody's Rating Methodology, Global Telecommunications Industry, December 28 2010.

⁹¹ However, the actual debt yields of the SMP may be influenced by the presence of non-legacy investments. In particular, as we discuss in section VII.C.4, NGA investments could attract higher debt yields. In the presence of substantial NGA investments the NRA should be careful to control for the influence on debt yields, by for example re-rating the debt based on a pure legacy investment.

- The NRA would add the spread to the risk-free rate to estimate the cost of debt.

As discussed in section VI.A.3, yields on bonds vary according to the maturity of the bond. Hence, the debt premium will vary with the assumed average debt maturity for the SMP. NRAs could choose a debt maturity which matches the SMP's average debt maturity. While this may reflect the SMP's actual cost of debt more closely, it may be difficult to find liquidly traded bonds of the appropriate rating with the required maturity. Using a 10-year debt maturity should reflect a typical average debt maturity for a large firm, and it should be possible to find yields for generic corporate bonds with this maturity.

Debt premia can change over time – for example, they reached historically high levels for bonds of all ratings in the immediate aftermath of the global financial crisis. More recent debt premia should give a more accurate estimate of future premia than debt premia calculated using longer averaging periods.

On the other hand, and in contrast to considerations for the cost of equity, firms typically have a legacy of old debt, which may have a different cost than new debt. For example, a firm may have average debt duration of 10-years, and aim to re-finance 10% of its debt every year. Debt policies vary between firms, but in any case it is unlikely that the SMP's actual cost of debt will reflect the current cost of debt. There will be a legacy of older debt, and the SMP will likely refinance debt over the price control period. At the time of writing, older debt arranged before the financial crisis will have a significantly higher cost than more recent debt.

One could argue that the cost of debt should reflect the SMP's actual cost of debt, or a mix of old and new debt costs. On the other hand, this policy would not allow consumers to benefit as quickly from reduced debt costs from refinancing.

On balance, for telecoms regulation, we recommend that NRAs give more weight to the current cost of debt. This is because the WACC should ultimately reflect the costs of an efficient operator, which given current interest rates would be financed with new debt.

Therefore, NRAs could calculate the debt premium by reference to a period consistent with the calculation of the risk-free rate (see section VI.A.4), which would be a period of at most one year.

In section VI.A.2 we discussed that it would be reasonable for NRAs to make an upward adjustment on the risk-free rate calculated from government bond yields, to account for the effect of QE programs. We recommend NRAs calculate the debt premia before making any

adjustment for QE programs on yields. Corporate bond yields will also have fallen as a result of QE programs, as corporate bonds and government bonds are investment substitutes, at least to some degree. Hence, if an NRA made an upward adjustment to government bond yields to account for the effect of QE programs, and then calculated the debt premia without taking into account any adjustment to the corporate bond yields, it is likely the resulting premia would be very low and even negative. This would clearly be unrealistic.

Above we discuss using yields on generic bonds vs. yields on individual bonds. Data providers such as Bloomberg publish data on generic bond yields, for example Corporate A rated bonds. In practise the data providers calculate these yields by averaging yields on individual A-rated bonds. However, in our experience the generic bond yields can be lower than yields on some individual bonds. This is because the generic bonds tend to be estimated using the largest and most liquid bond issues. In contrast, some individual bonds of telecoms incumbents may be less liquid, and as a result investors demand a higher illiquidity premium, which increases the yields. Hence, it may give fairer and more accurate results to put more weight on yields on the actual bonds issued by telecoms incumbents, where this data is available.

Some NRAs also give an ‘uplift’ on the cost of debt – for example 20 basis points – to account for the issuing costs of debt. We would not recommend this practice, unless it is shown that the issuing costs are incurred continuously. This is because issuing costs tend to be fixed one off costs incurred at the time the debt is arranged. Hence, giving an uplift on the debt cost will tend to undercompensate debt costs for shorter term debt and overcompensate for longer term debt. It would be more efficient to allow for some issuing costs along with the other operating costs.

VI.G.1. Debt Beta

Regardless of the exact unlevering formula used, conceptually the asset beta is some form of weighted average of the equity beta and the debt beta. Hence, the questions to address are:

- Can we apply a single debt beta for EU NRAs?
- How should NRAs estimate the debt beta?

With regard to the first question, we note that the debt beta will vary with the risk of default of the debt. This is because at least some of the default risk is systematic, which is what the debt beta is measuring. Figure 12 above shows that debt ratings for EU telcos currently vary from A to B+ (the latter being significantly below investment grade). Accordingly, the debt beta will vary for different EU telcos, and it would not be correct to assume a single debt beta for all EU telcos.

With regard to the second question, we note that estimating debt betas confronts significant practical difficulties. While in theory debt betas can be measured in the same way as an equity beta, in practise the illiquidity of many traded bonds mean that such an exercise gives unrealistic results. Put simply, bond prices do not react as quickly to market news, and so the correlation of the returns to the market index can look unrealistically low, and/or produce large errors.

It is possible to estimate the beta of debt using financial theory. For example, Berk and De Marzo set out a methodology for using option pricing theory to back out a debt beta, once the equity beta is known.⁹² However, the theory is relatively complex to apply, especially for NRAs with more limited resources.

An alternative approach to estimating the debt beta for the peer group firms is to apply some simpler ‘rules of thumb’. First, the beta for debt with a low chance of default – so with a good credit rating – will be zero or close to zero. Hence, it would be a reasonable approximation to say that debt with a higher credit rating has a zero or very low debt beta. Second, we have seen debt betas reported around 0.1 for debt rated around BBB (S&P) or Baa (Moody’s).⁹³ Based on these observations, in our view the debt betas set out in Table 2 represent a good guide, which avoids the complexity of estimating debt betas from first principles.

Table 2: Debt beta as a function of credit rating

Moody's rating		S&P Rating		Assumed debt beta
From:	to:	From:	to:	
Aaa	Baa1	AAA	A-	0.05
Baa2	Baa3	BBB+	BBB-	0.1

⁹² J. Berk and P. DeMarzo, *Corporate Finance: The Core*, 1st Ed., Pearson, 2009, pp. 765-767.

⁹³ See for example J. Berk and P. DeMarzo, *Corporate Finance*, 3rd Ed., Pearson, 2014, Table 12.3 p. 413 and ‘Explaining the Rate Spread on Corporate Bonds’, Edwin J. Elton, Martin J. Gruber, Deepak Agrawal, and Christopher Mann, *The Journal of Finance* • Vol. Lvi, No. 1 • February 2001.

VI.G.2. Conclusions on Debt Premiums and Debt Betas

- The credit rating, debt premium and target gearing level should be consistent. For example, the NRA could choose a target credit rating, and then select the gearing level and debt premium that would be consistent with that rating in the NRA's MS;
- NRAs should look at yield data on bonds with the appropriate credit rating as the main input to the debt premium;
- Using a 10-year debt maturity should reflect a typical average debt maturity for a large firm, and it should be possible to find yields for generic corporate bonds with this maturity;
- NRAs could calculate the debt premium by reference to a period consistent with the calculation of the risk-free rate;
- NRAs should estimate debt premia before making any adjustment to yields on government bonds to account for the effect of QE programs;
- Using generic bond indices can tend to understate the required debt premium for smaller debt issuances. NRAs should give more weight to the SMP's actual bonds, providing they are consistent with the target credit rating;
- NRAs can either calculate 'bottom up' debt betas, or else use 'rules of thumb' based on credit ratings.

VI.H. TAX RATE

CAPM measures an after-tax cost of equity, whereas debt yields are pre-tax. In general, NRAs will set a price control based on a pre-tax WACC, since the SMP must pay tax on any revenues earned from the network, and these taxes should be accounted for. Hence the NRA will have to convert the measured after-tax cost of equity into a pre-tax cost of equity, using the appropriate tax rate.

The key points to note with respect to this issue are that:

- Different MSs have different tax rates;
- Investors look at the after-tax rate of return. That is, it is the level of after-tax returns that will drive investment decisions.

These facts imply that the pre-tax WACC must be adjusted according to the tax rate specific to the MS, so that the after-tax returns are consistent across MSs. Using a single EU tax rate for the WACC, when actual tax rates differ, will result in variations in after-tax returns that would distort investment decisions.

VI.H.1. Allowing for taxes

The issue is then how should NRAs adjust the cost of equity to account for taxes. There are broadly two choices:

1. Provide an uplift (sometimes called a “tax wedge”) for the cost of equity based on the applicable corporate tax rate – that is divide the cost of equity by $1-T$ where T is the applicable tax rate. The uplift is commonly calculated using the marginal tax rate, but detailed modelling can derive the appropriate effective tax rate.
2. Treat tax as a ‘pass through’, so in other words give the firm an explicit allowance for taxes, in the same way as there is an allowance for operating costs. The allowance would be based on an estimate of the actual taxes that would be paid on the return on equity over the price control.

Both methods produce similar results, if the tax uplift is computed using the effective tax rate, but not the marginal tax rate.

Note that taxes will depend on the gearing level and debt costs assumed, since in general interest on debt is tax deductible. Hence, any ex-ante allowance for tax, whether a tax uplift or an explicit cash flow allowance, will necessarily make an assumption about future gearing levels, and the regulated firm will therefore have an incentive to increase its actual gearing above the assumed level, so as to reduce its actual tax bill below the tax uplift or explicit cash flow allowance. An explicit tax allowance may lower the incentive somewhat, since it reflects detailed modelling of actual tax liabilities and would consider a firm’s actual gearing level rather than an industry-wide target for example. However, computing an explicit tax allowance is complex, in the sense that it requires the NRA to make a much more detailed overview of the firm’s tax liabilities than computing a tax uplift to the WACC.

In any event, we do not consider that the presence of an incentive to increase gearing to be particularly problematic in telecoms. Regulated revenues generally make up only a minor proportion of the total revenues of integrated telcos, such that tax treatment in the WACC is not therefore likely to have a material effect on firm-wide financing decisions.

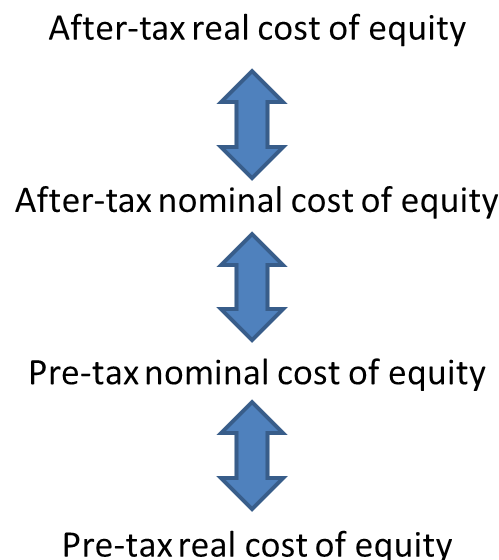
We also note that, given many EU telcos are active in multiple jurisdictions, attempting to calculate and forecast the actual tax for inclusion in the tariffs could be very challenging.

VI.H.2. Converting Between Pre and Post Tax WACC

The observed cost of equity is always after-tax, since the returns on which the cost of equity is calculated are after-tax returns. Hence, if the NRA compensates for taxes through the WACC, it must convert the after-tax cost of equity into a pre-tax cost of equity (see section IV for an explanation of how to make these conversions).

NRAs may also choose to use a real WACC, rather than a nominal WACC, discussed in section VI.B. NRAs should always convert the after-tax cost of equity to a pre-tax cost of equity based on the nominal WACC, not the real WACC. This is because taxes are always paid in nominal terms, not real terms. Figure 13 illustrates the correct order of the conversions between real, nominal and pre and post-tax cost of equity.⁹⁴

Figure 13: Order of conversions for pre and post-tax cost of equity



⁹⁴ Calculating the tax uplift to the WACC before stripping out inflation will produce the exactly correct result – an NPV of resulting cash flows equal to the costs of investment – where the accounting/tax depreciation profile follows the depreciation profile assumed in the regulatory regime.

VI.H.3. Conclusions on the Tax Rate

- NRAs should adjust the WACC for taxes using the marginal corporate tax rate in the MS where the price control takes effect;
- The MS should adjust the cost of equity for taxes by simply dividing the after-tax cost of equity by one minus the tax rate.
- NRAs should adjust the nominal cost of equity and WACC for taxes, not the real cost of equity.

VII. The WACC for NGA Networks

In the previous part of this report we discussed the WACC for legacy networks. In this part of the report we discuss how NRAs could estimate a WACC for NGA networks, and specifically the ‘WACC premium’ required. In general, throughout this report when we discuss a NGA network investment premium, NGA risk premium or NGA premium, we mean the increase in the WACC for an NGA network relative to a legacy network, required to compensate the SMP operator for any additional systematic risk of NGA investments relative to legacy networks.

We note that, consistent with the European Commission’s Non-Discrimination and Costing Methodologies Recommendation, the expectation is that in most circumstances a price control on NGA networks, and hence a calculation of the NGA WACC, would not be required. Specifically, the Non-Discrimination and Costing Methodologies Recommendation notes that:

“where [Equivalence of Inputs] EoI is applied and NRAs consider that the above competitive safeguards are in place, they should not impose a regulated access price for those NGA wholesale inputs.”⁹⁵

The competitive safeguards referred to are that there is a demonstrable retail price constraint resulting from infrastructure competition or a price anchor stemming from cost oriented wholesale copper access prices, the *ex-ante* economic replicability test is in place and there is an obligation of providing wholesale access services on the basis of EoI.⁹⁶ Hence, we expect that the discussion in this section – on the NGA WACC – would be relevant only to a minority of cases where the conditions listed above do not apply.

In practice, the term ‘NGA network’ encompasses a broad spectrum of technologies and configurations, such that it is hard to define precisely what we mean by an NGA network. The EC defines NGA Networks as “wired access networks which consist wholly or in part of optical [fibre] elements and which are capable of delivering broadband access services with enhanced characteristics (such as higher throughput) as compared to those provided over already existing copper networks. In most cases NGAs are the result of an upgrade of an

⁹⁵ Commission Recommendation of 11.9.2013 on consistent non-discrimination obligations and costing methodologies to promote competition and enhance the broadband investment environment, ¶52 p.11.

⁹⁶ *Ibid.*

already existing copper or co-axial access network.”⁹⁷ We adopt this definition in this work, but also add that an NGA networks require substantial capital investment in new equipment. We also acknowledge that the term ‘NGA networks’ encompasses different technologies and configurations, including FTTC and FTTH. We discuss how the WACC might differ for different NGA configurations in section VI.C.9.

We first discuss whether and why NGA networks need a higher WACC than legacy copper networks. We then discuss examples of how NRAs have estimated a WACC for NGA networks. We then set out our own methodology for estimating the WACC for NGA networks, and explain how this methodology could deal with alternative NGA network configurations.

VII.A. LACK OF A ‘PURE PLAY’ NGA NETWORK

If there is a difference in investment risks for NGA networks relative to legacy networks, the difference should be reflected in the associated betas. There is no reason why the risk-free rate or ERP would be different for an NGA network investment. To the extent a ‘pure play’ NGA network firm existed,⁹⁸ we would not need to discuss whether and why an NGA network faced additional risks and needed a higher WACC than a legacy network. We could simply measure the beta of the pure play NGA network firms and derive the cost of equity for NGA networks directly. Unfortunately, this is not possible because we know of no ‘pure-play’ NGA networks. At present, NGA networks make up a fraction of the revenues and profits of listed telecoms operators.

Telecoms firms do not even tend to split out NGA network revenues and profits in their accounts. But even if they did, the relatively rapid growth in NGA network revenues would not allow the calculation of a stable beta, since the mix of the firm’s earnings would change too quickly over time. This means that techniques such as ‘beta decomposition’ – discussed in section VI.C.9 – will not be reliable.

Instead, we must evaluate whether NGA networks need a higher WACC, and if so by how much, from more fundamental reasoning.

⁹⁷ Article 11 of the EC’s Recommendation on Regulated Access to Next Generation Access Networks (NGA), (2010/572/EU).

⁹⁸ By ‘pure play’, we mean a firm that derives most of its revenues and profits from NGA network activity.

VII.B. THE PREMIUM FOR NGA NETWORKS – THEORY

The European Commission Recommendation on regulated access to Next Generation Access Networks recommends that NRAs should include a higher risk premium when setting access prices to the unbundled fibre loop than for the legacy network. The extra premium should reflect any additional and quantifiable investment risk incurred by the incumbent operator in respect of NGA network investments.⁹⁹

The European Commission also set out the principles that NRAs should follow in defining the adequate risk premium. Investment risk should be rewarded by means of a risk premium incorporated in the cost of capital:¹⁰⁰

“NRAs should estimate investment risk inter alia by taking into account the following factors of uncertainty:

(i) uncertainty relating to retail and wholesale demand; (ii) uncertainty relating to the costs of deployment, civil engineering works and managerial execution; (iii) uncertainty relating to technological progress; (iv) uncertainty relating to market dynamics and the evolving competitive situation, such as the degree of infrastructure-based and/or cable competition; and (v) **macro-economic uncertainty**...

...Criteria such as the existence of economies of scale (especially if the investment is undertaken in urban areas only), high retail market shares, control of essential infrastructures, OPEX savings, proceeds from the sale of real estate as well as privileged access to equity and debt markets are likely to mitigate the risk of NGA investment for the SMP operator”.

In our view it is appropriate to distinguish the following possible reasons for giving a WACC premium for NGA network investments:

- Compensation for systematic risk – that is, risk that is correlated with the broader macroeconomic environment, and which investors cannot address by diversifying their investments.
- Compensation for non-systematic risk – these are project specific risks such as cost and technical risks;
- A ‘policy premium’ – this is a premium granted to encourage or accelerate NGA investments for the purposes of achieving various policy goals, such as a minimum level of NGA network penetration.

⁹⁹ Commission Recommendation of 20/09/2010, SEC 1037, par. 4.

¹⁰⁰ Commission Recommendation of 20/09/2010, SEC 1037, par. 6.

As a matter of financial economic theory, the WACC should only compensate for systematic risk. Non-systematic risks must be dealt with, but in careful modelling of project cash flows rather than the WACC. For example, a number of demand and cost scenarios should be modelled to account for the risks associated with these parameters. The final return for the project should be calculated using data that has fully accounted for the spread of possible outcomes, from those better than the base case assumptions to worse. Similarly, if NRAs decide to give a premium on the NGA WACC for policy-related reasons, this premium should be identified explicitly rather than being ‘bundled’ with other parameters. This will provide clarity as to the sources of the return for both investors and consumers.

If the WACC should compensate NGA networks for systematic risk, the next question to address is: do NGA networks face higher systematic risk than legacy networks? We think the answer is yes, for three main reasons.

VII.B.1. Capital Leverage

An NGA network project involves a commitment to make large capital investments over several years.¹⁰¹ This commitment must be made regardless of revenues. The presence of the capital spending commitment shrinks the gap between expected earnings and costs. As a result, a fall in expected revenues can create a large drop in expected earnings. Figure 14 gives a simplified example. On the left hand side, we illustrate a “financial balance sheet” for an NGA investment. The financial balance sheet is analogous to the actual balance sheet, but focuses on financial assets and liabilities (cash flow assets and liabilities) instead of accounting entries. The financial balance sheet focuses on the present values of the financial assets and liabilities.

The financial asset of an NGA network project is its ability to attract customers and generate revenues and a margin over variable operating costs. These benefits are risky, because more or less people may show up, and pay higher or lower prices than expected. Much of the

¹⁰¹ We understand that in practice the capital spending of fixed network operators has been stable or even decreased, despite the general trend of investment in NGA networks. This could be because reductions in capital spending on the legacy network have offset increases in capital spending on NGA networks, and/or because NGA investments have proceeded at a relatively slow pace in some MSs. Note that here we are considering the WACC for a stand-alone NGA project, where decreases in legacy capital spending would not provide an offset. The European Commission estimates that €180-270 billion will need to be invested for Europe to meet its Digital Agenda targets (see The State of Broadband 2014: broadband for all, A Report by the Broadband Commission, Table 3 p.73). For FTTH in Europe, the cost per home passed lies between €150-540 in urban areas but increases to €2700 per home passed in rural areas (Ibid, p.74).

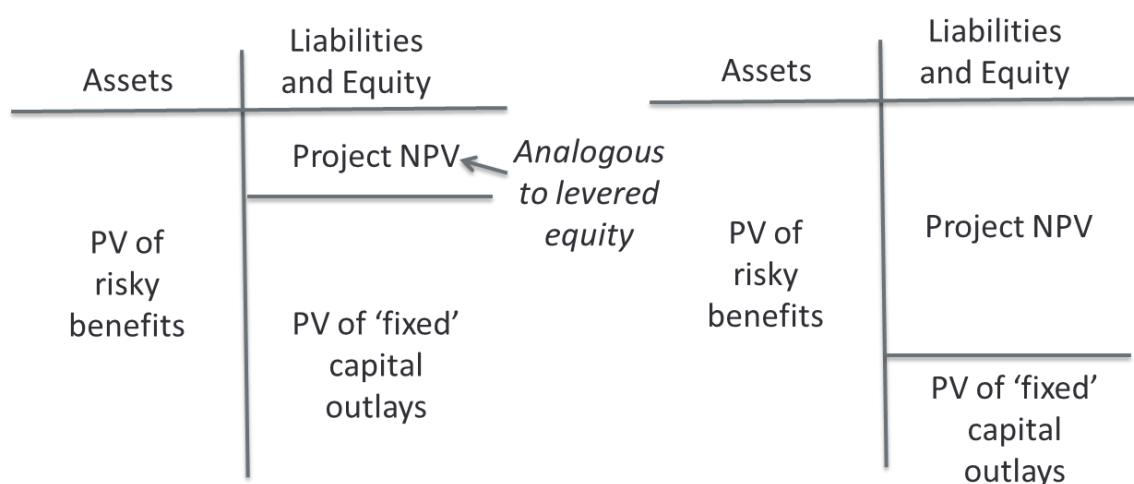
financial liabilities are taken up by the present value (PV) of the capital spending commitments, or fixed capital outlays. The fixed capital outlays are not as risky as the expected benefits, since most of the capital outlays will still need to be incurred even if less customers show up and pay lower prices than expected. The project NPV represents the surplus remaining after netting out the PV of the fixed capital outlays from the PV of the expected risky benefits. The project NPV is analogous to the equity on a normal accounting balance sheet.

Because of the presence of sizeable and relatively fixed capital obligations, a fall in the value of the project's financial assets (the PV of the risky benefits) will prompt a disproportionately larger fall in the project NPV, in much the same way as the presence of debt causes a fall in the value of an asset to prompt a disproportionately larger fall in the value of equity. To the degree that systematic risk is attached to the financial asset of an NGA project, then these risks are magnified onto the project NPV by the presence of fixed financial liabilities, such as the need to spend to build out the network. The larger the PV of the fixed capital outlays relative to the PV of the project benefits, the larger will be the risk magnifying effect. The risk magnifying effect ultimately will be reflected in a higher beta, and a higher cost of equity and WACC, for projects during the early stages of development.

The right hand side of Figure 14 then illustrates the situation for a mature legacy network. In this case, the network has already been built, and we expect the network to operate without the need for significant capital investment. This implies that the PV of fixed capital outlays is low relative to the PV of the expected project benefits. Any fall in asset values therefore will prompt a comparatively smaller change in the returns for investors, relative to the situation for a new network which faces the prospect of significantly larger build-out investments.¹⁰² As a result, we would expect the asset beta for a mature legacy network to be lower than for a new NGA network in the early stages of development.

¹⁰² Of course, the absolute change in the project NPV is the same on both the left and right hand sides, but for beta the relevant measure is the returns on the investment. Hence, the important factor is the percentage change in the value of the investment for any given fall in asset value.

Figure 14: Capital Leverage Example



- **Initial (e.g. NGA)** – prospective investment commitment magnifies risks onto NPV
- **Mature (e.g. Legacy)** – investment in past, so no more magnification of risks

Capital leverage is separate and distinct from financial leverage. Financial leverage considers the way in which the presence of debt financing magnifies project risks onto equity holders. Capital leverage considers the way in which the presence of debt like investment obligations magnifies the risks attached to project benefits onto the ultimate profits or NPV of a project. The two effects are analogous but separate. Financial leverage results from the financing choices made by the project sponsors. In contrast, capital leverage reflects fundamental economic considerations about the project and its business risk, and the capital leverage effect would still occur even if a project were entirely equity financed. Capital leverage therefore cannot be addressed through the use of the unlevering formulas discussed in section VI.C.5. Put another way, even if all projects were financed with an identical mix of debt and equity, we would observe higher equity betas for the projects with higher capital leverage.

Because NGA networks have higher capital leverage than legacy networks, they will have higher assets betas, and hence a higher cost of equity and WACC.

The extent of risk magnification due to capital leverage will depend in part on the extent to which operators can vary capital investments if demand turns out different from expectations. Less flexibility to respond to demand outcomes implies the presence of greater risk magnification upfront due to the inherent capital leverage effect. The degree of capital leverage for NGA projects will also vary depending on the type of area – for example rural

areas will involve a larger NGA investment per household passed than an investment in a densely populated city.

VII.B.2. Long-term payoffs

The second reason that NGA networks have higher systematic risks is because they are long-lived investments with payoffs extending far into the future. This means that the value of the investment is more volatile, and will vary more strongly with macroeconomic conditions. For example, suppose that a legacy network has a stream of cash flows expected to last for a further 15 years, and an NGA network has the same stream of cash flows extending for 40 years. Suppose also that the initial cost of capital was 7%. If the cost of capital increases to 8%, then the value of the legacy network falls by about 6%, but the value of the NGA network falls by over 10%. This is because more of the value of the NGA network comes from more distant future cash flows which are affected by the change in risk. As a result, the value of long-lived investments like a new NGA network will be more sensitive to changes in macroeconomic conditions, and hence will have a higher beta, than a legacy network.

VII.B.3. Systematic demand risks

The third reason to believe that NGA networks have a higher systematic risk than legacy networks is that demand for NGA services is likely to be more sensitive to income. As we discussed in section VI.C.9, it seems reasonable to view NGA services as a 'luxury' product, similar to mobile in the late 1990s and early 2000s. In most cases consumers must be persuaded to move away from legacy networks and pay more for faster services on an NGA network. In the event of a systematic downturn, as incomes fall, we would expect this switching process to slow down, as consumers reduce spending. Conversely, the downturn could be good for the legacy network, as it retains more customers than it expected to do.¹⁰³ While demand for NGA services is uncertain and risky in general, it seems reasonable to suppose that some of the NGA demand risk is systematic. This will increase the beta for NGA networks, relative to legacy networks.

¹⁰³ Although we expect that in the event of a downturn switching to mobile networks from legacy networks could accelerate.

VII.C. QUANTIFYING THE WACC PREMIUM FOR NGA

VII.C.1. Approaches Applied by NRAs to Date

In Table 3 we summarise the approaches applied by several EU NRAs to estimate the WACC, or WACC premium, for NGA networks.

Table 3: Summary of NGA WACC Approaches Applied by NRAs

Regulator's Decision	Country	Risk Premium (FTTH)	Methodology
AGCOM (2015)	[1] Italy	3.20%	The Authority recognizes a risk premium for investments in NGA networks with respect to copper/legacy business, due to: uncertainty about the demand for wholesale and retail services, market dynamics, and sunk costs. To estimate the risk premium of NGA networks, AGCOM followed real option theory, taking into account the "option premium" relative to respectively the "wait and see" and "flexibility" alternatives. The "wait and see" option rewards the investor for the uncertainty about future market dynamics, while the flexibility option rewards the incumbent for being obliged to guarantee open access to the network (once built) to alternative operators in case of high demand rates. According to AGCOM, these risks are not measurable through the beta, and the two option premia cannot be summed up together. To price both options, AGCOM has used standard financial techniques, such as the Black-Scholes model, the Cox model, and the Market Asset Disclaimer (MAD) technique, which allows to simulate the value of an asset that has not been realized yet and therefore cannot be exchanged on the market. The assumptions made to use these pricing techniques include: take-up rates, average revenues by client, the technology used, capital costs, and the probability distribution for each variable. Taking into account different scenarios for the length of the option contract and the payment method, AGCOM has estimated an NGA premium of 3.2%, including both options (i.e. wait and see, and flexibility).
OFCOM (2014)	[2] UK	2.2%	In its 2014 decision, Ofcom estimated different rates of return for copper network activities, broadband, and ultra-fast broadband services based on the decomposition of BT Group's asset beta into two parts, representing different risk profiles. The beta decomposition approach consists of four main steps: (i) estimating the asset beta of BT Group based on market data, (ii) estimating the asset beta of copper activities taking into account the asset beta of peers (such as Chorus in New Zealand, UK, and EU telecom), and other UK utility networks, (iii) defining relative weights of copper and new generation networks in BT's economic value, (iv) backing out the asset beta of broadband business from the BT's asset beta using the asset beta for copper activities and the relative weights. The two values of the WACC (nominal pre-tax) estimated in the 2014 decision, taking into account the two values of the beta and everything else equal are respectively 8.6% for copper and 10.8% for NGA.

Sources:

[1] Annex B to Resolution n. 42/15/CONS

[2] Review of wholesale broadband access network, June 2014

Regulator's Decision	Country	Risk Premium (FTTH)	Methodology
CMT (2013)	[3] Spain	4.81%	CMT has estimated the risk premium for NGA networks by using a Discounted Cash Flow (DCF) model and taking into account two different scenarios, with respectively high and low uncertainty about demand take-up and the market share of operators. The DCF is used to estimate the internal rate of return (i.e. project IRR) of investments in a fiber network, and subsequent operation of the network by the operator (the CMT has made assumptions about investments and operating costs, and consumers prices that are equal in the two scenarios). To estimate the NGA risk premium, CMT has been running a Monte Carlo simulation of the two scenarios with different rates of uncertainty and calculated the difference between the minimum IRR for each of the two scenarios at the 90% of the confidence interval.
ARCEP (2015)	[4] France	2.50%	ARCEP recognises a risk premium to reward investments in FTTx networks due to higher demand uncertainty compared to legacy networks. The premium defined by ARCEP is equal to the difference between the regulated WACC used for fixed legacy networks and the expected project IRR of a broadband network. To evaluate the project IRR, ARCEP uses a DCF model and it considers a 25-year economic and financial plan, whose length may vary according to the specific nature of the project considered. The risk premium is not defined ex-ante and it is evaluated on a case by case basis, due to the specificities of each broadband technology regarding costs, and the different kind of services provided.
ACM (2015)	[5] Netherlands	-	ACM uses a financial model of the NGA investment, and allows the incumbent to earn a return on the investment (IRR) up to 3.5 percentage points higher than the WACC, before the ACM will lower the price cap. Hence, the incumbent is allowed to keep some of the upside in the event of a 'high case' scenario.

Sources:

[3] Resolution n. MTZ 2012/2155

[4] Modèle générique de tarification de l'accès aux réseaux mutualisés en fibre optique en dehors des zones très denses, document d'accompagnement, October 2015

[5] ACM, Study into the cost of capital (WACC) of KPN, July 2015.

The approaches in Table 3 have interesting and creative elements. However, two related problems exist:

- The NRAs have not applied a consistent methodology to estimating the NGA network WACC. This leads to different NGA WACC premia in different MSs;
- Some NRAs, perhaps encouraged by the Commission's guidelines, have included in the WACC compensation for both systematic and non-systematic risks. For example, the risk of a cost overrun on a given NGA project is a non-systematic risk that should not be included in the WACC. Some NRAs also seem to have increased the WACC to give incentives to invest in the NGA networks.

VII.C.2. Proposed Approach

In our view the only way to quantify the effects discussed above is through detailed financial modelling of an NGA network investment and a legacy network. The legacy network would be used as a benchmark from which to assess the premium required for the NGA network.

As we discussed above, macroeconomic shocks could cause incomes and demand for NGA services to fall. Hence revenues for NGA networks could be relatively more volatile than for legacy. The associated betas for revenues will be higher, reflecting the increased sensitivity of NGA network revenues to macroeconomic shocks compared with the legacy network. In turn, higher revenue betas will translate into higher asset betas according to Equation 3, which expresses the asset beta of a project as the weighted average of its constituent parts (a revenue beta and a cost beta).

Equation 3: Revenue and Asset Betas

$$\beta_{asset} = \beta_{revenue} \times \left\{ \frac{PV(revenues)}{PV(asset)} \right\} + \beta_{costs} \times \left\{ \frac{PV(costs)}{PV(asset)} \right\}$$

Where:

$$PV(asset) = PV(revenues) + PV(costs)$$

The relevant analysis would need to relate systematic changes in income sensitivity to changes in systematic risk, which ultimately reflects the covariance of investment returns with movements in the stock market. Inevitably, this involves making some subjective assumptions and the application of judgement.

Our proposal is to proceed as follows:

- 1) This first step would be to construct a financial model of a mature legacy network. This would include:
 - a) ongoing and future capital costs;
 - b) operating costs;
 - c) revenues;
 - d) taxes.
- 2) The 'legacy network model' would include all of the steps to predict after-tax cash flows from a given set of revenues and costs.
- 3) The 'legacy network model' should identify and separate out revenue streams and cost streams, so that revenues and costs can be discounted at different discount rates. The revenues would have a higher discount rate, since they are more risky, and the costs would have a lower discount rate, because they are more certain.
- 4) The NRA would use Equation 3 above to identify the combination of revenue and cost betas that result in the estimated asset beta for a legacy network.
- 5) The next step is then to determine how potential changes in income could impact the revenues predicted by the 'legacy network model'. The NRA would need to:
 - a) Assume a distribution of changes in potential consumer income. Typically the assumption would be that incomes follow a standard distribution such as a normal or 'triangular' distribution. Analysis of historical income data could establish the most realistic distribution to use;
 - b) Establish the relationship between income and revenue changes for legacy networks. This would most likely be done through survey evidence – for example asking consumers how their spending on telecoms services would change as a function of household income. NRAs could also apply statistical analysis to historical income changes, to try and determine a relationship. However, we are not optimistic that such an analysis would lead to robust results, because it would require looking at a relatively long history – perhaps 10 years – while many other factors could be changing over the period which influence the relationship between income and spending on telecoms. Controlling for these changes would be difficult and would inevitably introduce significant 'noise' into the statistical relationship between income and spending on telecoms.

- c) Using a 'Monte Carlo' analysis to draw from the distribution of possible consumer income changes, and determine the corresponding impact on the PV of revenues in the 'legacy network model'.¹⁰⁴ In other words, a draw would involve a simulation of potential income changes over the life of the investment, and the use of the 'legacy network model' to simulate the corresponding path of revenues over time, and the resulting PV of revenues over the life of the investment. This process ('a draw') would then be repeated numerous times and results recorded. The ultimate aim of the Monte Carlo simulation would be to determine the distribution of PVs of revenues resulting from the assumed simulations of potential income changes over the life of the investment.
- 6) As a result of this exercise, the NRA could establish the distribution and volatility of network revenues as a function of income volatility.
- 7) The next step would be to build a similar financial model, but this time for an NGA network. The organisation of the 'NGA network model' would be the same as for the legacy network, except that the input values would be different, in particular, for the level of capex and revenues.
- 8) The NRA would again need to establish the relationship between changes in consumer income and demand for NGA services (so repeat step 5 for NGA revenue). This would most likely require a survey of consumers, since insufficient historical data would be available.¹⁰⁵ The NRA would then carry out a similar Monte Carlo simulation exercise to that described above for the legacy network – i.e. using a Monte Carlo simulation to determine the potential volatility of the PV of NGA network revenues based on an assumed distribution of potential income changes.
- 9) At this point the NRA would have calculated the volatility of the PV of the:
 - a) Legacy network revenues;
 - b) NGA network revenues.
- 10) The NRA can then calculate the ratio of the legacy network volatility to the network volatility. The revenue beta for NGA network should be equal to the revenue beta for the

¹⁰⁴ The NRA should discount expected revenues at the discount rate for revenues based on the revenue beta computed in step 4.

¹⁰⁵ To properly reflect demand uncertainty for the NGA network, it would be best for the NRA to assume a distribution of demand (and hence NGA revenue) for any given level of income. The shape of this distribution could again come from the range of responses in the survey data.

legacy network (calculated in step 4 above) multiplied by the ratio of volatilities for the PV of revenues for the 'legacy network model' and the 'NGA network model'.

- 11) Having obtained an estimate of the revenue beta for the NGA network, the NRA can then use the 'NGA network model' and Equation 3 to derive the corresponding asset beta, which reflects the extra income sensitivity of NGA investment through the revenue beta, and the extent of capital leverage through the shape of the cash flows and Equation 3.

Note that the financial modelling exercise for both NGA networks and legacy networks should be careful to account for any asymmetries in the revenue scenarios. For example, for an NGA network the 'upside' potential for the investor could be limited by the risk that, in the event that demand for NGA is higher than expected, price caps could be adjusted downward to account for the higher volume. However, in the event of very low demand for NGA, attempting to increase revenues by increasing the price cap would not be practical, since it would likely lead to demand diminishing further. Similarly, for the legacy network the upside is also capped by price controls, but in the event that NGA is very popular, the legacy network could face early abandonment. NRAs should ensure that the relationship between incomes and network revenues reflect these possibilities in the modelling.

In various places in this report, including the previous paragraph, we note the relationship between demand for legacy networks and the demand for NGA. In essence, we expect that demand for these two services will be mirror images of one another –if customers do not switch to fibre, they will remain on the incumbent's copper network. This will mitigate the effect of slower rates of switching to fibre, relative to a new entrant investing in NGA only. In section VI.C.9 we noted that legacy networks were a natural hedge for NGA network investments.

However, in this exercise we are assuming that NGA and legacy investments are 'stand-alone' investments. That is, the NGA investment is not made by an incumbent with the existing legacy network. This is consistent with the general theme of telecoms regulation – that prices and rates of return are set with a view to allowing efficient new entry, rather than from the perspective of the SMP.

We also note that investing in an NGA network involves the sacrifice of a 'wait and see' option – in that the investor loses the possibility to see how demand for NGA will develop. The valuation of this option was a major focus of AGCOM's approach to NGA pricing for example (see Box 1 above).

To a large extent, the modelling exercise we describe should capture the loss of the wait and see option, if the range of revenue scenarios is properly modelled. For example, earlier investments for NGA will logically face a much wider range of demand uncertainty and hence revenues, relative to NGA investments made later when demand for NGA services as a function of income is known with more certainty (based on the previous experience). By allowing for a wide range of demand in earlier NGA investments and narrowing the range over time, then the NRA would in effect be recognising the loss of the ‘wait and see’ option for earlier NGA investments.

Moreover, NRAs could reduce the loss of optionality by allowing SMPs to make staged NGA investments, so that they could establish demand for NGA services before making larger NGA investments.

If the NRA felt that these approaches were still insufficient to capture the cost of the loss in optionality from making an NGA investment, then they could attempt to model the remaining (uncompensated) optionality. For example, the NRA could develop a detailed binomial tree and explicitly consider the potential reduction in risk over time, similar to the approach employed by AGCOM. However, the construction of such a tree could be complicated and is likely to require numerous assumptions. The NRA should also be careful to avoid double counting the cost of the optionality loss.

VII.C.3. Use of Decomposition Analysis

In our view the modelling exercise we describe above is a rigorous way to quantify the WACC premium for NGA networks. However, we also acknowledge that it is a complex and highly technical exercise, which requires multiple assumptions.

In section VI.C.9 we discussed an alternative method of estimating betas for specific activities using beta decomposition. In particular we described the method used by Ofcom (see Box 1 above). In the context of the telecoms sector, we noted that the beta decomposition method suffers from a number of problems (also discussed in section VI.C.9). However, the fundamental idea behind beta decomposition is that the observed beta should be the ‘sum of the parts’ of the underlying betas of the different businesses. This could be a useful ‘reality check’ for the calculated beta for NGAs. That is, an appropriately weighted average of the legacy network beta and the NGA beta should approximate the observed betas from market returns.

However, we also note several potential drawbacks with such a reality check. Primarily, the observed betas are in practice a mix between legacy network betas, NGA betas, but also

mobile betas (which as we discuss we expect to be similar to legacy network betas, but may not be identical) and betas for activities unrelated to the provision of telecoms services. The observed betas also encompass activities from a wide range of countries, including non-Eurozone countries. Telecoms businesses in these non-EU countries may face different systematic risks than telecoms businesses in the EU. Therefore the presence of these non-EU revenues could ‘contaminate’ the beta estimates.¹⁰⁶ This contamination likely is one of the reasons we see significant divergence of asset betas in Figure 11. It also would reduce the accuracy of any beta decomposition exercise.

Nevertheless, we agree in principle that the weighted average of the legacy beta and estimated NGA beta should approximate the observed beta of the operator estimated using market returns. This is a sensible, if rather broad, ‘sense check’ on any estimate of a NGA network beta.

VII.C.4. Cost of Debt

Above we discussed how the beta parameter captures the difference in risk and hence the cost of equity for NGA and legacy investments. However, the risk characteristics we describe above – such as for example demand uncertainty – also suggest that the cost of debt may be higher for NGA investments. That is, we would expect an NGA investment to have a lower credit rating and a higher cost of debt relative to a legacy network, even if both had the same financial leverage.

We are unaware of any bonds with publicly available yield data linked to NGA investments. Hence, measuring an NGA debt premium directly from market data is not possible, at least at the time of writing. As a result, we recommend that NRAs use credit rating guides – such as issued by Moody’s¹⁰⁷ – to estimate the credit rating for a NGA network with the NRAs assumed level of gearing, given the financial and risk characteristics of the NGA network. The NRA can follow a similar approach as described in section VI.G.

VII.C.5. A Common EU NGA Premium?

The methodology we describe above for quantifying the NGA WACC premium – by using financial modelling to estimate the asset beta value for an NGA investment – could be applied

¹⁰⁶ The range of geographic

¹⁰⁷ See for example Moody’s Rating Methodology, Global Telecommunications Industry, December 28 2010.

by NRAs across the EU. However, there are good reasons to think that the actual *value* of the NGA premium could differ between MSs.

For example, the relationship between demand for NGA network services and consumer income could differ between MSs, with demand perhaps being more sensitive in MSs where incomes were generally lower. Also the specifics of NGA network investment projects may vary between MSs. Capital investment costs could be higher in one MS than in another, perhaps because labour and other local material costs differ.

The use of a common methodology to estimate the NGA investment premium, based on financial modelling, would enable NRAs to identify and quantify the fundamental reasons as to why NGA investment premia may be higher or lower in their MS relative to others. The methodology would eliminate arbitrary differences in the WACC between MSs.

In contrast, trying to impose a single EU wide NRA network premium would risk missing some of the differences in systematic risks that exists between MSs. This could exacerbate, rather than solve, the issue of investment distortions across the EU. Similarly, trying to estimate a NGA network premium based on a common model that is overly simplistic would risk misestimating the NGA network premium, which again would lead to the distortion of investment decisions.

VII.D. DURATION OF THE PREMIUM

Above we discussed how several factors, including capital leverage and the systematic relationship between demand for NGA services and income, could lead to a higher asset beta for NGA investments. During the January workshop, one question that was raised was: for how long should an NRA apply a premium for NGA investments, and would the premium change over time? Once again, the financial modelling exercise described above would provide the answer to this question. But in essence, we would expect the premium to fall over time. This is because the capital leverage effect that we discuss above would diminish, as the NGA network is completed and becomes a ‘mature’ asset, and also demand uncertainty would also be resolved over time, as SMPs and NRAs gained a better understanding of demand outcomes for NGA services and how demand and take-up vary systematically with consumers’ income.

Accordingly, we would expect the NGA WACC premium to fall over time. Whether the premium would ever vanish entirely remains debateable. For example, demand for NGA services may always retain a higher systematic risk than that for legacy networks, at least until the point where the legacy network is ‘switched off’.¹⁰⁸

A related issue is, given that we expect the NRA premium to fall over time, whether an NRA should apply a variable premium which starts out high and declines during the life of the NGA network, or a constant premium for the entire life of the NGA network. In theory, the NRA could design a constant premium to give the same expected net present value over the entire life of the NGA network, as the application of a declining variable premium. The constant premium would start out lower than the variable premium during the early years of the network, but end up higher than the declining premium in later years. In practice, this gives rise to a potential risk that an NRA could start out with a constant premium (because it would imply a lower NGA premium in the early years) but then face pressure to reduce the effective premium in subsequent reviews since the prospective risks then faced by the NGA network would have reduced and the constant premium would now exceed a recalculated variable premium. The combination of the constant premium for the early years and a recalculated variable premium in later years would provide insufficient compensation for the investment risks run throughout the term of the investment, and reflect the opportunistic appropriation of subsequent benefits arising due to the successful resolution of risks. To avoid the ex post appropriation of legitimate investment remuneration, in our view, the NRA should compute a premium for the upcoming regulatory period based on the information available at the time of the review, and then update the calculation of the premium at subsequent reviews based on the updated information available parameters.

VII.E. DIFFERENCES FOR DIFFERENT NGA NETWORK TOPOLOGY

As we noted above, in practise the term ‘NGA network’ captures a spectrum of technologies. Two typical network topographies are Fibre-to-the-Cabinet (FTTC), and Fibre-to-the-Home (FTTH) or equivalently Fibre-to-the-Premises (FTTP).

Based on the logic laid out above – which explained why we would expect higher systematic risk for ‘NGA networks’ in general – FTTC, FTTH and other variants will have different systematic risks and require different WACC premia from one another.

¹⁰⁸ Or, more specifically, it becomes uneconomic to serve the customers remaining on the legacy network, and they are transitioned over to the NGA network.

Above we noted that increased capital leverage was one reason we would expect to see higher asset betas for NGA networks relative to legacy networks. It follows that the less intense the capital investment program, the closer the asset beta would be to a legacy network. Hence, we would expect lower asset betas for FTTC – which involves only investment up to and within the cabinet – relative to an FTTH network.

We would also expect demand for NGA delivered over FTTC to be less sensitive to systematic changes in consumer income than FTTH, on the basis that FTTC may be priced somewhere between legacy and FTTH, and is less of a premium or luxury product relative to FTTH. Hence, the systematic risk of FTTC due to demand should be lower than for FTTH, which would be reflected in a lower asset beta and WACC premium. The financial modelling exercise that we propose above would capture both of these differences.

The specific differences in network configurations, that are likely to give rise to varying WACC premia, is another reason to support the use of financial modelling to estimate the WACC. Even with a broader universe of NGA pure play companies than in existence today, it would remain challenging to determine the WACC premium for a specific NGA network configuration based on the betas of other telcos. This is because, among other things, the statistical error in the beta estimate could well ‘drown out’ the real differences in the asset betas, and because traded telcos are likely to invest in a range of different NGA technologies depending on the countries and geographies where they are active.¹⁰⁹ Only a technique based on the financial modelling of the actual network investments made will be able to identify the risk premia required with sufficient accuracy.

VII.F. INFLUENCE OF CUSTOMER AND BUSINESS TYPE ON THE NGA PREMIUM

Above we discuss how the WACC premium could differ according to the technical characteristics of the NGA network. However, the WACC premium could also differ because of the type of business undertaken.

For example, there could be a different WACC premium for NGA services aimed at residential customers (FTTH) and NGA services aimed at large business – so-called Fibre-to-the-Office (FTTO). This is because, in many cases, FTTO networks are built upon a specific request received directly from the business customer willing to receive the NGA services.

¹⁰⁹ For example, a telco more employ FTTH networks in cities, but opt for variants of FTTC in less densely populated areas.

In contrast, FTTH is largely rolled-out on the basis of ‘demand bundling’. Hence, FTTH could be a more risky and speculative investment than FTTO, because operators invest ‘pre-emptively’ in FTTH based on *anticipated* demand. This means that in an economic downturn demand may not be realized, or materializes more slowly than anticipated. This would raise the beta of FTTH activities, relative to FTTO. On the other hand, while FTTO would not suffer from unrealized demand, it would be more vulnerable to businesses closing down in a recession, and hence losing volumes that way. It seems less likely that households would switch back to legacy networks during a recession to save money, since we would expect them to be relatively sticky.

In either case, NRAs applying the financial modelling discussed above should be careful to distinguish between the different types of customers, and the different systematic risks involved in serving them. Specifically, there may be more scope to reduce capital expenditure in the event of a downturn when providing FTTO services. This again relates to the ‘optionality’ issues we have discussed above. FTTO will tend to have more optionality, since investments are made ‘on demand’.

There could also be differences in the risk and therefore WACC premium required for wholesale and retail activities. For example, the SMP may have different abilities to hedge systematic risk by signing longer term contracts for NGA services at either the wholesale or retail level. Systematic demand risk may also vary at the retail and wholesale levels. It could be that there is more competition at the retail level, so that the SMP faces more volatile demand if customers react to an economic downturn not by abandoning the NGA network, but by switching to a cheaper (but perhaps lower quality) retail provider. Conversely, wholesale demand could be relatively stable. NRAs should be careful to consider these factors when quantifying the NGA premium, by for example modelling different relationships between incomes and NGA demand at the retail and wholesale level.

VII.F.1. Concluding Remarks on Quantifying the WACC Premium for NGA

Above we conclude that financial modelling is the only way to capture the difference in systematic risk, not only between NGA and legacy networks, but between different types of NGA network configurations, technologies and customer types. However, we also acknowledge that the task is highly technical, challenging and complex, and may be beyond the resources of some NRAs.

We discuss above that the inputs for the NGA modelling will differ between NRAs. However, the modelling methodology should be similar for all NRAs. Therefore one possibility would

be for NRAs to join forces to develop a common quantitative model, into which individual NRAs could input their own specific parameters. For example, BEREC could be a vehicle to co-ordinate this kind of modelling exercise.

Appendix A. Data Sources

Data type	Source	Country	Frequency	Time span	Link
Bond yields	European Central Bank (ECB)	Europe	Monthly	1970-2016	https://www.ecb.europa.eu/stats/money/long/html/index.en.html
	National Bank of Belgium (NBB)	Belgium	Daily	1987-2016	http://stat.nbb.be/?lang=en
	Deutsche Bundesbank	Germany	Daily	2001-2016	http://www.bundesbank.de/Navigation/EN/Statistics/Time_series_databases/Macro_economic_time_series/its_list_node.html?listId=www_s140_it02f
	Bank of England	United Kingdom	Daily	1993-2016	http://www.bankofengland.co.uk/boeapps/iadb/NewInterMed.asp
	Banca d'Italia	Italy	Daily	1991-2016	https://infostat.bancaditalia.it/inquiry/#
	De Nederlandsche Bank (DNB)	Netherlands	Daily	1986-2016	http://www.dnb.nl/en/statistics/statistics-dnb/financial-markets/interest-rates/make-table/day/index.jsp
	Banco de España	Spain	Daily	1987-2016	http://www.bde.es/webbde/en/estadis/infoest/tipos/tipos.html
	Suomen Pankki	Finland	Daily	1992-2016	http://www.suomenpankki.fi/en/tilastot/korot/Pages/tilastot_arvopaperimarkkinat_velkapaperit_viitelainojen_korot_en.aspx
	Banque de France	France	Monthly	1999-2016	http://webstat.banque-france.fr/en/browse.do?node=5384394
	Norges Bank	Norway	Daily	1982-2016	http://www.norges-bank.no/en/Statistics/Interest-rates/Government-bonds-daily/
Yield curve	Banco de Portugal	Portugal	Daily	1993-2016	http://www.bportugal.pt/Mobile/BPStat/DominiosEstatisticos.aspx?SW=1903
	Sveriges Riksbank	Sweden	Daily	1987-2016	http://www.riksbank.se/en/Interest-and-exchange-rates/search-interest-rates-exchange-rates/
	National Bank of Belgium (NBB)	Belgium	Daily	1987-2016	https://stat.nbb.be/Index.aspx?DataSetCode=IROLOBE2
	Deutsche Bundesbank	Germany	Monthly	1972-2016	https://www.bundesbank.de/Navigation/EN/Statistics/Time_series_databases/Macro_economic_time_series/its_list_node.html?listId=www_s140_it03a
	Bank of England	United Kingdom	Daily	1979-2016	http://www.bankofengland.co.uk/statistics/Pages/yieldcurve/archive.aspx
	Banco de España	Spain	Daily	1987-2016	http://www.bde.es/webbde/en/estadis/infoest/tipos/tipos.html
	Norges Bank	Norway	Daily	1982-2016	http://www.norges-bank.no/en/Statistics/Interest-rates/Government-bonds-daily/
	Banco de Portugal	Portugal	Monthly	1993-2016	http://www.bportugal.pt/Mobile/BPStat/DominiosEstatisticos.aspx?SW=1903
	Sveriges Riksbank	Sweden	Daily	1987-2016	http://www.riksbank.se/en/Interest-and-exchange-rates/search-interest-rates-exchange-rates/
	Oesterreichische Kontrollbank Aktiengesellschaft	Austria	Daily	Actual	http://www.oebk.at/en/capital-market/government-bonds/Statistics/Pages/benchmarks.aspx
Data type	Company	Source	Currency	Reference year	Link
Share prices	BT	Yahoo finance	GBP	1988-2016	https://uk.finance.yahoo.com/q/hp?s=BT-A.L
	KPN	Yahoo finance	EUR	2000-2016	http://finance.yahoo.com/q/hp?s=KPN.AS
	Proximus (Belgacom)	Yahoo finance	EUR	2004-2016	http://finance.yahoo.com/q/hp?s=PROX.BR
	Deutsche Telekom	Yahoo finance	EUR	2000-2016	http://finance.yahoo.com/q/hp?s=DTE.DE
	Telefónica	Yahoo finance	EUR	1987-2016	http://finance.yahoo.com/q/hp?s=TEF
	Iliad	Yahoo finance	EUR	2004-2016	http://finance.yahoo.com/q/hp?s=ILD.PA
	Telenet	Yahoo finance	EUR	2005-2016	https://uk.finance.yahoo.com/q/hp?s=TNET.BR
	TDC	Yahoo finance	DKK	2000-2016	http://finance.yahoo.com/q/hp?s=TDC.CO
	TeliaSonera	Yahoo finance	SEK	2000-2016	http://finance.yahoo.com/q/hp?s=TLSN.ST
	Elisa	Yahoo finance	EUR	2006-2016	http://finance.yahoo.com/q/hp?a=&b=&c=&d=1&e=19&f=2016&g=d&s=EIA.F%2C+&q=1
	Kabel Deutschland	Yahoo finance	EUR	2010-2016	http://finance.yahoo.com/q/hp?s=KD8.DE
	Telecom Italia	Yahoo finance	EUR	2000-2016	http://finance.yahoo.com/q/hp?a=&b=&c=&d=1&e=19&f=2016&g=d&s=TLIT.MI%2C+&q=1
	Telenor	Yahoo finance	NOK	2000-2016	http://finance.yahoo.com/q/hp?s=TEL.OL
	NOS (Sonaecom)	Yahoo finance	EUR	2000-2016	http://finance.yahoo.com/q/hp?s=NOS.LS
	Tele2	Yahoo finance	SEK	2000-2016	http://finance.yahoo.com/q/hp?s=TEL2-B.ST
	Swisscom	Yahoo finance	USD	1998-2016	http://finance.yahoo.com/q/hp?s=SCMWY
	Telekom Austria	Yahoo finance	EUR	2000-2016	http://finance.yahoo.com/q/hp?s=TKA.VI
	Orange	Yahoo finance	EUR	2000-2016	http://finance.yahoo.com/q/hp?a=&b=&c=&d=1&e=19&f=2016&g=d&s=ORA.PA%2C+&q=1
	Portugal Telecom	Yahoo finance	EUR	2000-2016	http://finance.yahoo.com/q/hp?s=PTC.LS
	Mobistar	Yahoo finance	EUR	2007-2016	http://finance.yahoo.com/q/hp?a=&b=&c=&d=1&e=19&f=2016&g=d&s=MOS.SG%2C+&q=1
	PJSC Mobile Telesystems	Yahoo finance	RUB	2011-2016	http://finance.yahoo.com/q/hp?s=MTSS.ME

Data type	Company	Country	Currency	Reference year	Link
Revenues, revenue break down, gearing of peer companies	BT	United Kingdom	GBP	2015	http://www.btplc.com/Sharesandperformance/Annualreportandreview/index.cfm
	KPN	Netherlands	EUR	2014	https://corporate.kpn.com/annual-report-2014/downloads.htm
	Proximus (Belgacom)	Belgium	EUR	2014	http://annualreport.proximus.com/
	Deutsche Telekom	Germany	EUR	2014	http://www.annualreport.telekom.com/site0215/en/
	Telefónica	Spain	EUR	2014	https://www.telefonica.com/en/web/about_telefonica/publications/annual-reports
	Iliad	France	EUR	2015	http://www.iliad.fr/finances/2015/CP_120315_Eng.pdf
	Telenet	Belgium	EUR	2014	http://investors.telenet.be/phoenix.zhtml?c=241896&p=irol-resultcenter
	TDC	Denmark	DKK	2014	http://investor.tdc.com/annuals.cfm
	TeliaSonera	Sweden	SEK	2014	http://www.teliaSonera.com/en/investors/reports-and-presentations/annual-reports/
	Elisa	Finland	EUR	2014	http://elisa.com/investors/financial-information/annual-reports/
	Kabel Deutschland	Germany	EUR	2015	https://www.kabeldeutschland.com/en/investor-relations/veroeffentlichungen/finanzberichte/kd-holding-ag.html
	Telecom Italia	Italy	EUR	2014	http://www.telecomitalia.com/tit/en/investors/reports-results.html
	Telenor	Norway	NOK	2014	https://www.telenor.com/investors/reports/
	NOS (Sonaecom)	Portugal	EUR	2014	http://www.nos.pt/institucional/EN/investors/financial-information/Pages/financial-reports.aspx
	Tele2	Sweden	SEK	2014	http://www.tele2.com/investors/reports/
	Swisscom	Switzerland	CHF	2014	https://www.swisscom.ch/en/about/investors/reports.html
	Telekom Austria	Austria	EUR	2014	http://www.telekomautria.com/en/ir/annual-reports
	Orange	France	EUR	2014	http://www.orange.com/en/Individual-shareholders/Shareholders-meeting/Annual-reports
	Portugal Telecom	Portugal	EUR	2014	http://web3.cmvm.pt/sdi/emitentes/docs/CONV55325.pdf
Mobistar	France	EUR	2014	https://corporate.mobistar.be/en/financial-information/annual-report	
PJSC Mobile Telesystems	Russia	RUB	2014	http://www.mtsgsm.com/resources/annual_reports/	
Data type	Company	Country	Reference year	Link	
Rating of peer companies	BT	United Kingdom	2015	http://btplc.com/Sharesandperformance/Fixedincome/index.htm	
	KPN	Netherlands	2015	http://ir.kpn.com/phoenix.zhtml?c=69978&p=irol-creditratings	
	Proximus (Belgacom)	Belgium	2015	https://www.proximus.com/en/investors/financial-position	
	Deutsche Telekom	Germany	2015	https://www.telekom.com/investor-relations/Debt+Market/ratings/64178	
	Telefónica	Spain	2015	https://www.telefonica.com/en/web/shareholders-investors/debt-ratings/credit-ratings	
	Telenet	Belgium	2015	https://www.standardandpoors.com/en_EU/web/guest/article/-/view/type/HTML/id/1394799	
	TDC	Denmark	2015	http://investor.tdc.com/credit.cfm	
	TeliaSonera	Sweden	2015	https://www.teliaSonera.com/Documents/Reports/2015/Q1/TeliaSonera%20Q1%202015%20Eng.pdf	
	Elisa	Finland	2015	http://corporate.elisa.com/attachment/content/Elisa-SP-RatingsDirect_Research-Update_Mar-18-2015.pdf	
	Kabel Deutschland	Germany	2015	https://www.kabeldeutschland.com/en/investor-relations/nachrichten/ir-mitteilungen/february-5-2014.html	
	Telecom Italia	Italy	2015	http://www.telecomitalia.com/tit/it/investors/financial-profile/rating.html	
	Telenor	Norway	2014	http://www.telenor.com/wp-content/uploads/2014/11/SP-Telenor-Research-Update-Nov-19-2014.pdf	
	Tele2	Sweden	2015	http://www.danskebank.com/en-uk/ci/Products-Services/Markets/Research/Documents/WeeklyCreditUpdate_210415.pdf	
	Swisscom	Switzerland	2015	https://www.swisscom.ch/en/about/investors/indebtedness.html	
	Telekom Austria	Austria	2015	http://www.telekomautria.com/de/ir/ratings	
	Orange	France	2015	http://www.orange.com/fr/Investisseurs/Financement	
	Portugal Telecom	Portugal	2015	http://www.standardandpoors.com/en_US/web/guest/article/-/view/type/HTML/id/1394129	
	Mobistar	France	2015	http://www.orange.com/fr/Investisseurs/Financement	
	PJSC Mobile Telesystems	Russia	2015	http://www.mtsgsm.com/bondholders/debt_market/	

Appendix B. Notes from January Workshop

Legacy Network Debate

1. Most of the comments were related to the parameters of the cost of equity. Capital structure, the cost of debt, and tax issues were given in general less attention by the audience. We summarize comments on each parameter of the cost of equity, without necessarily reflecting the chronological order of the comments:

- a. Risk Free Rate (risk-free rate):

- i. Averaging period: the Brattle presentation indicated the use of a 12-months averaging period to estimate the Risk Free Rate; some stakeholders raised concerns about the consistency of the averaging period for the risk-free rate with the length of the regulatory period, which typically lasts 3 years. According to this view, in unstable economies such as European markets following the economic and financial crisis of 2008 the risk of using short-period averages to measure the risk-free rate is to temporarily “lock” risk-reward parameters to values that will not properly represent market conditions in the medium-, long-term. The nominal risk-free rate may be less stable than the other WACC parameters. A regulator pointed out that in a quite influential study on the cost of equity, they would estimate the return on equity by looking at the Total Market Returns (TMR) as the sum of the risk-free rate and the Equity Risk Premium (ERP). According to this regulator's representation, the TMR estimated by Dimson, Marsh and Staunton tends to be more stable over the long-run; this representative observed that as companies become risky as the market (i.e. with an equity beta equal to one), TMR might be taken into account to estimate the cost of equity, and to back out the risk-free rate.

DG Connect reported same concerns about the instability of the risk-free rate and endorsed “stabilization” measures, noticing that regulators in other sectors have done the same. We will address both issues – i.e. proper averaging period to measure the risk-free rate, and the use of a TMR methodology – in our draft final report.

- ii. Country and Regulatory Risk: slide 8 of the Brattle presentation shows that Government bond yields of each MS consist of the risk-free rate, plus the country-risk premium for the MS. According to analysed evidence the country risk implicitly takes into account the regulatory risks that regulated revenues will be lower than expected when the MS turns into bad economic/financial conditions. Not all stakeholders understood the link between country and regulatory risks, providing examples on how the two risks may differ among each other: for example, a regulator asked how strong is the relationship between low level of Government bond yields and low regulatory risk; another

regulator pointed out that regulatory risks may vary among different sectors within the same country.

DG Connect agreed regulatory risk may currently be different in telecoms with respect to other sectors due to explicit political actions in some MS for broadband deployment and digital development. Such public efforts may not be directly tracked into MS's government bond yields. On the other hand, regulatory risk may be taken into account in different ways than the WACC, for example investors may be rewarded for that risk in tariff setting rules. In our draft final report we will provide further reasoning about why the use of MS specific bond yields is a reasonable approach to capturing regulatory risk.

b. Equity Risk Premium (ERP):

- i. a regulator noticed that with low risk free rates, temporarily depressed by unconventional macroeconomic policies such as the Quantitative Easing (QE), the projections of private investors on expected returns take into account higher levels of the ERP than in normal market conditions. To provide the right signals to the market, the ERP should be consistent with the risk-free rate in terms of: (i) maturity of the instruments (i.e. treasury bonds, vs. bills), and (ii) averaging periods.

c. Beta:

- i. Peer Group: One participant pointed out that the peer group shown in the Brattle presentation combined companies that own the network with companies that only use it; other stakeholders asked how it is possible to take into account geographical aspects of revenues distribution and wondered if some companies should be taken out from the group because they implicitly convey risk that is not totally related to the European context; other comments referred to the definition of a 'pure play' legacy network in context of increasing diversification of activities for the incumbent, and when customers use almost indistinctly fixed and mobile services. One operator suggested that - where possible - the definition of legacy networks should stick to the physical aspects of the assets and consequently restrict the sample to companies that still own copper networks. In the draft final report we will take into account and explore the differences among the average asset beta of firms that own the network and firms that only use it, as suggested during the workshop.
- ii. Market Index: Several stakeholders agreed that the beta parameter should take into account the single market perspective alleged by the EC, and suggested the use of global indexes (for example the All Worlds FTSE Index) to estimate the beta for each company, independently from currency effects. By using a global market index, stakeholders see alignment also with the ERP global perspective

presented in Brattle's slides. Finally, according to Professor Farber, internationally exposed investors must be able to hedge against exchange rate risks and therefore it would be correct to use a global market index for all peers. In the draft final report we will investigate the effect of using alternative indexation assumptions on the final asset beta, and on the basis of this make a recommendation on which indices to use when calculating betas.

- iii. Beta ranges: Finally, some attendees mentioned the broad range of asset beta estimates presented in the slide; in the draft final report we will consider all the aspects mentioned above and propose a final range.

d. General Issues/Concerns:

- i. Stability of the WACC: the methodology described by the Brattle Group raised attention over the general predictability of the WACC and the stability of the parameters among different regulatory periods. On one hand, stakeholders recognized the need to define robust financial rules, and methodological harmonisation, on the other they raised concerns on how it is possible to take into account the macroeconomic context, and market shocks to adjust the WACC. To this end, it should be clarified to what extent the proposed adjustments for the effect of unconventional macroeconomic policies such as the QE should be taken into account and what is the best way to hedge the risk of unexpected market changes into the WACC.

Next Generation Network Debate

- 2. The presentation on the WACC for EU NGA Networks was split in two parts: (i) risk assessment for NGA relative to legacy, (ii) measurement of NGA risk premium. The debate covered both topics; next paragraphs summarize main concerns/comments by topic, not necessarily reproducing the chronological order of the interventions:

a. Risk assessment for NGA relative to legacy:

- i. Systematic vs. non-systematic risk: stakeholders in general raised concerns about the distinction between systematic and non-systematic risks for NGA networks, for example noticing that demand and income-elasticity risks can be both considered non-systematic risks and therefore not necessarily taken into account in the WACC. Brattle explained that for NGA networks part of the demand risk is systematic being correlated with macroeconomic fluctuations (i.e. take-up rates would be influenced by macroeconomic future expectations). On the overall risk perception of investments in NGA networks some stakeholders argued that there is not such a risk premium over legacy networks justified by investors' behaviors (i.e. investor would not

invest at all if NGA networks are perceived much riskier than legacy). One stakeholder pointed out that assessing too high return rates for NGA projects would “kill” the value of long-term projects, discouraging new investments. We find these views difficult to rationalize from an economic perspective, but in our final draft report, we will present our analysis supporting the view that the risk of NGA networks is higher.

- ii. Beta: Stakeholders agreed that higher systematic risk of NGA networks with respect to legacy should be reflected in the beta. Lack of market evidence on ‘pure play’ NGA networks operators force to explore methodological alternatives: DG Connect suggested that estimates of the NGA beta can be backed-up by noting that the combination of the legacy and NGA betas should approximate the observed beta. Brattle agreed, but pointed out a number of practical issues that would complicate such an analysis. We will discuss the use of this kind of beta decomposition exercise as a check on the estimated asset betas for NGA networks in our final report. DG Connect observed that NGA take-up rates and legacy network demand are negatively correlated, supporting the idea that legacy networks provide a hedge for NGA networks.
- iii. Non-discrimination and Costing Methodology: setting the right risk reward for NGA networks with the WACC may be really difficult due to several aspects, including assumptions on demand take-up, financial gearing, and the size of asymmetric risk. The risk of setting the wrong parameters is to produce under-investment, or to distort investment decisions favoring certain technologies over others (i.e. there are differences in terms of capital costs for FTTH and FTTC platforms). The HSBC presentation fostered the idea that the legacy network anchor product (e.g. ADSL) already provides the necessary protection for investors and gives operators flexibility to price differentiate and to invest in the technologies requested by the market. A regulator agreed on the “anchor pricing” approach, however it recognized the benefit of a view on the cost of capital for NGA networks for forward-looking purposes in evaluating downstream activities, and economic replicability tests. On downstream, a regulator added considerations about the potential differences in risk rewards for NGA networks among wholesale and retail activities, noticing some companies are vertically integrated. We will address in the report the differences in risk rewards for upstream and downstream activities, but would like to discuss this point further with DG Connect.
- iv. Additional Regulatory Risk: One stakeholder disagreed with the idea in Brattle’s presentation that uncertainty in NGA networks creates a risk for asymmetric regulatory responses, with limited upside for investors and downsides in case of volumes lower than expected. In fact, the participant claimed that the actual returns of regulated companies

show the opposite, being historically higher than regulated returns. In addition, DG Connect noted that the uncertainties surrounding regulation of NGA networks are similar to those of legacy networks, in particular, given that NGA take-up and legacy network demand are negatively correlated. Thus, according to DG Connect, it does not seem correct to consider that there is an additional regulatory risk on NGA networks on top of the potential regulatory risk for legacy networks.

- v. Duration of the premium: regulators raised concerns on defining the right time-frame for applying a premium to NGA network, and asked for clarifications about periodic reviews. We will discuss in the report the duration of the premium and reviews.

b. Measurement of NGA risk premium:

- i. Capital Leverage: it should take into account a changing risk profile over time due to high capital costs at the beginning of the project and uncertainties about the take-up. To this end the risk premium for capital leverage measures the average difference between the WACC of mature networks and the WACC of NGA over time. A stakeholder claimed that additional systematic risk related to capital leverage seems to be nailed down in traditional WACC parameters (i.e. the gearing), with no need for additional rewards. Brattle Group clarified that there is a distinction between capital leverage and financial leverage, and that gearing does not represent capital leverage. Capital leverage implies fixed obligations for investors that are analogous to financial debt; however, capital leverage is further up in the project risk, before taking financial choices.
- ii. Real Option: was included in Brattle presentation as a reward for uncertainty about consumer willingness to pay and technology development. Some argued that in competitive markets companies would not have that real option, and it should be clarified that “the wait and see option” pertains to regulated firms. Brattle clarified that real option is the net effect between risk of waiting and the fact that competitors will enter later into the market.

Appendix C. Details of WACC Methodologies for Selected Member States

Table C-1: WACC methodology comparison

Regulator's Decision		Country	WACC	Methodology
AGCOM (2015)	[1]	Italy	9.18%	The value is pre-tax nominal and it is computed using a bottom-up CAPM approach. The rate is calculated for the incumbent operator (Telecom Italia SpA).
OFCOM (2014)	[2]	UK	8.60%	The value is pre-tax nominal and it is computed using a CAPM approach. The rate is computed for the incumbent's (BT) copper network assets and services; other WACCs are computed for the rest of the BT group and for BT as a whole.
CNMC (2014)	[3]	Spain	9.60%; 9.09%; 9.00%	The value is pre-tax nominal and it is computed using a bottom-up CAPM approach. The Authority computes a rate for each SMP (Significant Market Power) operator: Telefonica SA (9.60%), Vodafone Group PLC (9.09%) and Orange Espagne SA (9.00%).
BnetzA (2015)	[4]	Germany	6.44%	The value is pre-tax nominal and it is computed using a CAPM approach.
ARCEP (2013)	[5]	France	9.5%	The value is pre-tax nominal and it is computed using a bottom-up CAPM approach.

Sources:

[1] Appendix B to Resolution n. 42/15/CONS

[2] Fixed Access Market Reviews 2014, Annex 14

[3] Resolution n. 'WACC/1819/14/WACC 2014 Op Integrados'

[4] Section 4.2.2 of BK0a-15-001

[5] Resolution n. 2013-0001

Table C-2: Risk-free rate methodology comparison

Regulator's Decision		Country	Risk Free Rate	Methodology
AGCOM (2015)	[1]	Italy	4.64%	Average daily yield to maturity of 10-year Italian Treasury bonds over a period of 5 years (April 2009 - March 2014).
OFCOM (2014)	[2]	UK	4.50%	The rate is informed by historical averages of the yields of RPI linked gilts, forward rates on those gilts and values used in other regulatory decisions. The authority does not mechanically weight the different sources of evidence to come up with a final estimate but rather uses its regulatory judgement to come to a view on the appropriate forward-looking rate. When interpreting the data, the Authority took into account the level of uncertainty that has persisted, the potential impact of temporary distortions such as quantitative easing and the relationship between the risk-free rate and the equity risk premium. The risk-free rate is 4.5% in nominal terms and 1.3% in real terms (using the assumed RPI inflation rate of 3.2%).
CNMC (2014)	[3]	Spain	4.34%	Average daily yield to maturity of 10-year Spanish Treasury bonds over a period of 6 months (July - December 2013).
BnetzA (2015)	[4]	Germany	2.71%	10-year average of effective yield to maturity of 9 to 10-year German Treasury Bonds.
ARCEP (2013)	[5]	France	3.70%	10-year average of the 10-year constant maturity rate (TEC10) calculated by the French Treasury.

Sources:

[1] Appendix B to Resolution n. 42/15/CONS

[2] Fixed Access Market Reviews 2014, Annex 14

[3] Resolution n. 'WACC/1819/14/WACC 2014 Op Integrados'

[4] Section 4.2.2 of BK0a-15-001

[5] Resolution n. 2013-0001

Table C-3: Equity Risk Premium methodology comparison

Regulator's Decision		Country	ERP	Methodology
AGCOM (2015)	[1]	Italy	3.40%	Computed using the geometric average of historical data in Dimson, Marsh and Staunton data series (as of 2013).
OFCOM (2014)	[2]	UK	5%	The value is based on the long run arithmetic average equity risk premium according to Dimson, Marsh and Staunton historical data (1900-2013 UK and global series). The authority also takes into account recent surveys, recent UK's Competition Commission decisions and the volatility of UK stock market proxied by FTSE All Share index.
CNMC (2014)	[3]	Spain	6.98%	Median of ERP taken from a selected sample of sources in 2013, which includes: Bloomberg estimated values; Dimson, Marsh and Staunton historical data; Pablo Fernandez survey data; Reports from investment banks and other financial institutions (KPMG, Deutsche Bank, UBS and Goldman Sachs).
BnetzA (2015)	[4]	Germany	3.83%	ERP obtained as $\beta_e \cdot \text{MRP}$. MRP of 4,73% computed as the unweighted average of the average long-term return for US, UK and Germany.
ACERP (2013)	[5]	France	5%	Based on long term historical data. The methodology is not specified in the Authority's resolution.

Sources:

- [1] Appendix B to Resolution n. 42/15/CONS
- [2] Fixed Access Market Reviews 2014, Annex 14
- [3] Resolution n. 'WACC/1819/14/WACC 2014 Op Integrados'
- [4] Section 4.2.2 of BK0a-15-001
- [5] Resolution n. 2013-0001

Table C-4: Comparables selection methodology comparison

Regulator's Decision		Country	Comparables	Methodology
AGCOM (2015)	[1]	Italy	France Telecom (FRA); Telecom Italia (ITA); BT Group (GBR) KON Telecom (NED); Deutsche Telekom (GER); Telefonica (ESP); Telia Sonera (SWE); Belgacom (BEL); Swisscom (SWI); Telekom Austria (AUT)	Major telecommunications operators in Europe.
OFCOM (2014)	[2]	UK	(i) UK network utilities: National Grid (Energy), Pennon Group (Water and Waste), Severn Trent (Water), United Utilities (Water), Centrica (Energy), SSE (Energy); (ii) Chorus (New Zealand vertically separated telecoms network operator); (iii) UK telecoms operators: Sky, Colt, TalkTalk, Virgin Media; (iv) EU telecom operators: Orange (FRA), Telecom Italia (ITA), KPN (NED), Telefonica (ESP), Deutsche Telekom (GER), Belgacom (BEL)	The authority considered 4 different samples of comparable firms: UK Network utilities, Chorus, UK telecom operators, EU telecom operators. The comparables are not used mechanically in the calculation of BT's copper network WACC. They are rather used as benchmarks to come up with an informed estimate of the separation of BT Group's asset beta into a copper network value and a value for the rest of BT.
CNMC (2014)	[3]	Spain	BT Group (GBR); Orange (FRA); Swisscom (SWI); Telefónica (ESP); Deutsche Telekom (GER); Telecom Italia (ITA); Belgacom (BEL); Koninklijke KPN (NED); Telekom Austria (AUT); Portugal Telecom (PRT); Mobistar (BEL); Mobile Telesystems (RUS); TeliaSonera (SWE); Telenor (NOR); Vodafone Group (GBR)	Comparables are chosen according to the following criteria: (i) homogeneous business mix (integrated fixed and mobile companies), (ii) stock exchange listing and (iii) absence of recent takeover or M&A activity that may bias the beta calculation.
BnetzA (2015)	[4]	Germany	Vodafone Group (GBR); German Telekom (GER); Telefonica (ESP); France Telecom (FRA); Telecom Italia (ITA); British Telecom (GBR); Telia Sonera (SWE); Kon. KPN NV (BEL); Telenor (NOR); Portugal Telecom (PRT)	Top ten EU telecommunications companies in terms of market value and total sales.
ARCEP (2013)	[5]	France	Sample not specified in the final decision.	A sample of European telecommunication companies active in the fixed telephony business. The companies included in the sample are not specified in the decision (Art D. 311 CPCE).

Sources:

- [1] Appendix B to Resolution n. 42/15/CONS
- [2] Fixed Access Market Reviews 2014, Annex 14
- [3] Resolution n. 'WACC/1819/14/WACC 2014 Op Integrados'
- [4] Section 4.2.2 of BK0a-15-001
- [5] Resolution n. 2013-0001

Table C-5: Gearing methodology comparison

Regulator's Decision		Country	Gearing	Methodology
AGCOM (2015)	[1]	Italy	49%	Average gearing ratio of set of comparable firms estimated using market values.
OFCOM (2014)	[2]	UK	32%	Incumbent operator (BT) average 2-year gearing ratio computed as of December 2013. The same reference period has been used for the estimation of the equity beta. The ratio is computed with reference to the face value of both long-term and short-term outstanding debt. The same gearing ratio is applied to all BT's business activities, for which the Authority computes different WACCs.
CNMC (2014)	[3]	Spain	48%	Average gearing ratio of set of comparable firms using market values. A firm is excluded from the sample if its gearing ratio (intepreped as D/E) is not within a 0-3 range.
BnetzA (2015)	[4]	Germany	54.53%	Weighted average gearing of the comparable firms using book values. No distinction is made between fixed-line and mobile operations, as a distinction would be basically impossible for many big companies offering both services.
ARCEP (2013)	[5]	France	40%	The estimation uses long term historical data. The methodology of the estimation is not specified in the final decision.

Sources:

[1] Appendix B to Resolution n. 42/15/CONS

[2] Fixed Access Market Reviews 2014, Annex 14

[3] Resolution n. 'WACC/1819/14/WACC 2014 Op Integrados'

[4] Section 4.2.2 of BK0a-15-001

[5] Resolution n. 2013-0001

Table C-6: Equity beta methodology comparison

Regulator's Decision		Country	Equity Beta	Methodology
AGCOM (2015)	[1]	Italy	0.85	The equity beta for each comparable firm is computed using the CAPM and it is then adjusted using a Blume adjustment. The Authority uses the daily returns of each of the comparable firms' stocks and the Dow Jones Euro Stoxx 600 as the market index; it does not specify the length of the time series considered but mentions that the number of observations used is in the range of 250 - 500 (i.e. 1-2 years). The final value is equal to the comparables' average asset beta, relevered using Miller's formula (with no tax rate and a debt beta of zero).
OFCOM (2014)	[2]	UK	0.69	A levered equity beta is computed for the BT Group as a whole (1.01) using daily data over the last two years (as of Dec 13) for BT's stock returns and the FTSE All Share Index. The Authority also considered the 1-year daily equity beta and the 5-year weekly beta, but considered the 2-year daily beta to provide the best balance between statistical robustness and time relevance. A number of statistical tests were run to ensure the beta estimation was robust to trading illiquidity, time distortions and standard conditions underlying OLS regressions. The equity beta was then unlevered using the assumed value of the gearing ratio and debt beta of 0.1. The unlevered beta of the BT Group (0.72) was then disaggregated into an unlevered beta for the copper networks assets (0.50) and the for the rest of BT (0.83). The final value of the equity beta of BT's copper network assets (0.69) is the re-levered asset beta computed by using the assumed levels of gearing and debt beta for BT group as a whole.
CNMC (2014)	[3]	Spain	0.84	The equity beta for each comparable firm is computed using the CAPM and is then adjusted using a Bayesian adjustment (Marshall Blume formula). The Authority uses weekly returns of each of the comparable firms' stocks over 2009-2013 (i.e. 5 years) and a local market index of the stock exchange where the company is listed. The final value is the comparables' average asset beta, relevered using Hamada's formula (i.e. inclusive of a 30% tax rate). Any equity beta outside a range of 0.3-1.7 is excluded from the sample average.
BnetzA (2015)	[4]	Germany	0.81	Computed using the last 5 years of (daily) data for STOXX Europe TMI and for the peer group stocks.
ARCEP (2013)	[5]	France	0.80	The estimation uses long term historical data. The details of the estimation methodology are not reported in the decision.

Sources:

[1] Appendix B to Resolution n. 42/15/CONS

[2] Fixed Access Market Reviews 2014, Annex 14

[3] Resolution n. 'WACC/1819/14/WACC 2014 Op Integrados'

[4] Section 4.2.2 of BK0a-15-001

[5] Resolution n. 2013-0001

Table C-7: Asset beta methodology comparison

Regulator's Decision		Country	Asset Beta	Methodology
AGCOM (2015)	[1]	Italy	0.44	Sample average of comparable firms' asset betas.
OFOMC (2014)	[2]	UK	0.50	The levered beta for BT Group is unlevered using the assumed gearing ratio and a debt beta of 0.1. The resulting BT group asset beta is then disentangled into a lower asset beta for BT's copper network assets and a higher asset beta the rest of BT's business. The separation takes into account the riskiness level of investment in BT's different business sectors and it is benchmarked against different samples of comparable firms.
CNMC (2014)	[3]	Spain	0.51	Sample average of comparable firms' asset betas.
BnetzA (2015)	[4]	Germany	-	Not reported.
ARCEP (2013)	[5]	France	-	The final decision does not report a detailed description of the assumptions used in the levering/unlevering of the estimated betas.

Sources:

[1] Appendix B to Resolution n. 42/15/CONS

[2] Fixed Access Market Reviews 2014, Annex 14

[3] Resolution n. 'WACC/1819/14/WACC 2014 Op Integrados'

[4] Section 4.2.2 of BK0a-15-001

[5] Resolution n. 2013-0001

Table C-8: Cost of debt methodology comparison

Regulator's Decision		Country	Cost of Debt	Methodology
AGCOM (2015)	[1]	Italy	5.74%	Average face value (coupon) of fixed rate bonds issued by Telecom Italia being traded in 2013.
OFCOM (2014)	[2]	UK	5.50%	Computed as the sum of the risk free rate and a debt premium estimated using market values. The debt premium is informed by the spread of BT's 2017 bond (i.e. end of regulatory period) over nominal UK government gilts in different historical time windows. BT's debt premium is also benchmarked against other UK network utilities. The authority considers a 1.0%-1.5% range and assigns the lower end (1%) to BT's copper network assets and services, the upper bound (1.5%) to the remainder of BT's Group activities and the mid-point (1.25%) to BT Group as a whole.
CNMC (2014)	[3]	Spain	4.30%; 3.23%; 3.06%	Estimated for each SMP operator with reference to the cost of debt of its group. It is computed as the arithmetic average of the yield to maturity of eligible bonds observed daily in the last 6 months of 2013. A debt issue must satisfy the following criteria to be included in the calculation : (i) it must have been issued recently (i.e. in the last 2 years); (ii) the maturity is in the 8-12 years range; (iii) the volume of the bond issue is significant; (iv) the bond issue must not be linked to a specific project not subject to the regulated activities. If the acceptable observations are not enough, the authority uses bond issues of comparable firms (i.e. groups with the same credit rating and incorporated in a country with a similar rating). Alternatively, the authority can use the interest rate swap (IRS) plus the credit default swap (CDS) of the group or the average of the CDSs of comparable firms. The final cost of debt values used for Telefonica, Vodafone and Orange are respectively 4.30%, 3.23% and 3.06%.
BnetzA (2015)	[4]	Germany	4.24%	The reference value is pre-tax and includes a debt risk premium of 1,53%, computed as the spread between 10 years peer companies' bonds and the comparable German Treasury bonds. The post-tax cost of debt is 4,40%.
ARCEP (2013)	[5]	France	5.90%	Calculated considering the cost of debt to be issued and the costs of debt already issued. The cost of debt to be issued is the sum of the risk free rate and a debt premium of 1%, computed as the spread of bonds issued by non-financial companies rated BBB+ . The Authority considers bonds with an average maturity of 10 years, using Bloomberg data. The final value is 4.7% post tax and 5.3% pre tax. When considering the cost of debt already issued, the value becomes 5.9% pre tax.

Sources:

[1] Appendix B to Resolution n. 42/15/CONS

[2] Fixed Access Market Reviews 2014, Annex 14

[3] Resolution n. 'WACC/1819/14/WACC 2014 Op Integrados'

[4] Section 4.2.2 of BK0a-15-001

[5] Resolution n. 2013-0001

Table C-9: Tax rate methodology comparison

Regulator's Decision		Country	Tax Rate	Methodology
AGCOM (2015)	[1]	Italy	27.5% and 36%	The authority uses two different rates: (i) 27.5% for the cost of debt and (ii) 36% as the general corporate tax. The difference in rates reflects the possibility of excluding part of a company's debt from the reported taxable base.
OFCOM (2014)	[2]	UK	20%	Corporate tax rate announced in Chancellor's 2013 budget.
CNMC (2014)	[3]	Spain	30%	Spanish nominal tax rate.
BnetzA (2015)	[4]	Germany	30.56%; 3.85%	A tax factor is applied to post-tax cost of equity and post tax cost of debt in order to obtain the pre-tax figures. The tax factor is 1.44 for equity and 1.04 for debt, yielding a tax rate of 30.56% for equity and 3.85% for debt.
ARCEP (2013)	[5]	France	34.30%	Rate applicable in 2014 and 2015. The rate was 36.10% in 2013 for companies with revenues higher than € 250 millions. However, in 2013 interest borrowings were deductible from the corporate tax at 85% and then at 75% in 2014 and 2015.

Sources:

[1] Appendix B to Resolution n. 42/15/CONS

[2] Fixed Access Market Reviews 2014, Annex 14

[3] Resolution n. 'WACC/1819/14/WACC 2014 Op Integrados'

[4] Section 4.2.2 of BK0a-15-001

[5] Resolution n. 2013-0001

Table C-10: Inflation rate methodology comparison

Regulator's Decision		Country	Inflation rate	Methodology
AGCOM (2015)	[1]	Italy	1.20%	Long term inflation rate (after 2 years) calculated by the Bank of Italy through a survey in December 2013. WACC to be adjusted using Fisher's formula.
OFCOM (2014)	[2]	UK	3.2%	Forecasted RPI based on evidence from: (i) HM Treasury 2016/17 forecasts (as of Feb 2014, based on analysts' survey), (ii) implied RPI on forward rates computed as the difference in yields between 5 and 10 year nominal and indexed-linked gilts in three years' time and (iii) implied long run estimated difference between RPI and CPI to the Bank of England's CPI target of 2%.
CNMC (2014)	[3]	Spain	-	No inflation rate assumptions
BnetzA (2015)	[4]	Germany	1.24%	Averaged from the last 10 years of GDP deflator data.
ARCEP (2013)	[5]	France	-	To be updated each year on the basis of the forecast reported in the annual Government budget.

Sources:

[1] Appendix B to Resolution n. 42/15/CONS

[2] Fixed Access Market Reviews 2014, Annex 14

[3] Resolution n. 'WACC/1819/14/WACC 2014 Op Integrados'

[4] Section 4.2.2 of BK0a-15-001

[5] Resolution n. 2013-0001

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