INSTITUT LUXEMBOURGEOIS DE REGULATION

2016

Explanatory Note

Regulatory Cost of Capital for the fixed and the mobile network activities

March 2016

1 Introduction

(1) According to articles 28 (1) c) and 33 (2) of the law on electronic communication networks and services[1], the ILR, when setting price caps of regulated wholesale electronic communication products, should take into consideration the investments realised by the SMP operator and allow him a reasonable remuneration of the capital employed, which also reflects the associated investment risk.

(2) The cost of capital is the minimum expected rate of return necessary to attract capital to an investment. The cost of capital is also the appropriate rate of profit to allow on regulated assets. Since the cost of capital is the rate of return that just compensates investors for their opportunity costs (i.e. for forgoing their next best investment alternative), it is consistent with a normal rate of economic profit, which is what firms operating in competitive markets would expect to earn.

(3) In 2014, in the context of the development of both regulatory costing models for fixed network activities and mobile network activities, the ILR had determined for the first time a regulatory cost of capital for fixed network activities[2] and a regulatory cost of capital for the mobile network activities[3]. As the third round of market analyses has begun this year, an update of both regulatory costs of capital are necessary.

(4) The objective of the present document is to explain how the ILR has determined the cost of capital for the fixed network activities and the cost of capital for the mobile network activities for the upcoming price cap period.

(5) This document is structured as follows:

- Section 2 explains the form of the cost of capital as well as the formula used;
- Section 3 explains the rationale for calculating a common WACC for fixed network activities and mobile fixed network activities;
- Section 4 summarizes the values of the different parameters as well as the resulting cost of capital;
- Section 5 details how the different parameters of the cost of capital have been determined;
- Finally, Section 6 sets out a comparison of the WACC estimate with those from a sample of European jurisdictions.

(6) Some of parameters of the WACC have been determined in collaboration with Frontier Economics. The report delivered by Frontier Economics is set out in Annexe A.

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[1] Loi du 27 février 2011 sur les réseaux et les services de communications électroniques

[2] http://www.ilr.public.lu/communications_electroniques/encadrement_tarifaire/modele_couts_fixe/3_ILR-Model-results-and-input-data_20140303.pdf, Annexe 1

[3] http://www.ilr.public.lu/communications_electroniques/encadrement_tarifaire/M7_2007_MTR_DOC.pdf, Chapter 5.3.6.

2 Concept of the cost of capital

(7) The cost of capital is typically measured using the WACC (weighted average cost of capital). This takes into account the main sources of funding usually available to companies: debt and equity. It also takes into account the relative weight of these two sources in the capital through gearing (the proportion of debt within the capital structure). The WACC cannot be observed directly but must be estimated using empiric data on certain parameters. Some of these are specific to the market (i.e. not specific to a particular business) whereas others are business specific. The business specific parameters are usually estimated using reference data from existing comparator firms.

(8) The WACC determined by the ILR is a pre-tax nominal WACC, expressed by the following formula:

$$\text{pre-tax nominal WACC} = \frac{\text{Post-tax nominal WACC}}{1 - \text{corporate tax rate}}$$

Where:

$$\text{post-tax nominal WACC} = \big(\text{nominal cost of equity} \times (1 - \text{gearing ratio})\big) + \big(\text{nominal cost of debt} \times \text{gearing ratio} \times (1 - \text{corporate tax rate})\big)$$

(9) The WACC determined by the ILR is set on a pre-tax basis, as it is necessary to take account of the obligation of a telecommunication network operator to pay taxes.

(10) In the context of the costing obligation, it may be necessary to use the WACC in real terms, omitting in this way the impact of inflation. In such a case, the pre-tax real WACC has to be calculated on the basis of the nominal WACC fixed by the ILR.

(11) The pre-tax real WACC can be expressed formulaically as:

$$\text{pre-tax real WACC} = \frac{1 + \text{pre-tax nominal WACC}}{1 + \text{inflation rate}} - 1$$

3 Common WACC for fixed network activities and mobile network activities

(12) Some regulators in other European jurisdictions distinguish between the WACC for the fixed network business and the one for the mobile network business. Nevertheless, in practice, it can be observed that operators are typically integrated, which is also the case in the Luxembourgish market. The differentiation between the WACC for mobile network activities and the one for fixed network activities is largely due to historic reasons as mobile networks were newer and therefore perceived as riskier investments compared to fixed networks.

(13) There are three potential sources of difference in the WACC for fixed and mobile networks:

- The level of gearing;
- The asset beta and
- The debt premium.

(14) The other parameters used in the WACC estimate are not firm-specific and would therefore not vary depending on whether the WACC relates to a fixed or to a mobile network operator.

(15) In recent years regulatory WACCs for fixed and mobile networks have converged. This may mean that in practice the regulatory WACC may be the same for fixed and mobile networks because of difficulties in estimating the input parameters reliably.

(16) When estimating the asset beta and the debt premium, the ILR has analysed whether a differentiation between the WACC for mobile network activities and fixed network activities would be reasonable. The ILR came to the conclusion that there is no significant difference between the mobile and the fixed network business, which would justify such a differentiation (for the details of this analysis, please refer to Annexe A). For this reason, the ILR will set a common WACC for the regulated fixed and the mobile network activities.

(17) As it will be explained in section 5.7, an NGA risk premium will be added to fixed network WACC, when determining NGA related price caps.

4 WACC setting

(18) Following its analysis, the ILR sets a pre-tax nominal WACC of 6.86%. Regarding the WACC for fixed network activities, an NGA risk premium of 2.5% is added to the real pre-tax WACC, in case the ILR determines price caps for NGA based regulated products.

(19) The table below summarises the underlying parameters used to derive the WACC. The estimation of these parameters is described in further detail in the next sections.

Table 4-1 Estimate of the parameters used in the WACC estimate [Source: ILR, 2016]

Parameter	Value	
	WACC fixed network	WACC mobile network
Risk free rate	2.24%	
Equity risk premium	4.50%	
Equity beta	0.94	
Debt premium	1.2%	
Gearing	40%	
Inflation rate	1.8%	
Corporate tax rate	29.22%	
Nominal cost of equity	6.47%	
Nominal cost of debt	3.44%	
Post-tax-nominal WACC	4.86%	
Pre-tax-nominal WACC	**6.86%**	
Pre-tax real WACC	4.97%	
NGA risk premium	2.5%	n/a
Pre-tax real WACC + NGA risk premium	**7.47%**	n/a

5 Underlying parameters

(20) The table below summarises the approach taken to estimating each of the parameters used in the WACC setting.

Table 5-1 Approach for estimating the WACC [Source: ILR, 2016]

Parameter	Approach to estimation
Risk free rate	Average yield on Luxembourg government bonds
Equity risk premium	Long run historic averages market returns above the risk free rate at the European and global level (Dimson, Marsh & Staunton (2015), Global Investment Returns Sourcebook)
Equity beta	Average equity beta of the comparators selected
Debt premium	Average debt premium of telecommunication companies observed in the market
Gearing	Average equity beta of the comparators selected
Corporate tax rate	KPMG Global Tax Rate Survey, 2015
Inflation rate	Average inflation rate in the Euro area and in Luxembourg, ECB survey of professional forecasters (January 2016)

5.1 Comparator selection

(21) For the estimation of the gearing level (section 5.2) and the equity beta (section 5.3.3), the ILR based himself on the values observed in the market for listed telecommunications companies within Europe. The table below lists the comparators selected. As nearly all comparators are integrated operators, the table shows as well the revenue contribution of the fixed network activities and the mobile network activities. For more details regarding the comparators section, please refer to Annexe A.

Table 5-2 Comparator selection and corresponding commercial structure [Source: Frontier, 2016]

Operator	Revenue contribution			Country of domicile
	Mobile	Fixed	Other	
British Telecom	0%	99%	1%	United Kingdom
Deutsche Telekom	83%	17%	0%	Germany
Kon KPN	37%	47%	16%	Netherlands
Mobistar	82%	0%	18%	Belgium
Orange SA	39%	54%	7%	France
Proximus (Belgacom)	17%	32%	50%	Belgium
Swisscom	24%	15%	61%	Switzerland
Telecom Italia	30%	70%	0%	Italy
Telefonica	35%	65%	0%	Spain
Telekom Austria	56%	44%	0%	Austria
Telenor	75%	14%	12%	Norway
TeliaSonera	76%	24%	0%	Sweden
Vodafone	80%	20%	0%	United Kingdom

5.2 Gearing

(22) The gearing level is the level of leverage of a company, measured by the ratio of debt to total enterprise value. Gearing is used to estimate the WACC in two ways. First, it is used when transforming asset betas to equity betas (and vice versa). And second, it is used when calculating the capital structure weights in the WACC formula.

(23) The ILR estimated the gearing level based on the average gearing levels of selected comparators, listed in the previous section. The table below shows the 1-year, 3-years and 5-years average gearing level of the comparators.

Table 5-3 Gearing level of comparator companies [Source: Frontier, 2016]

Operator	Average gearing		
	1-year	3-year	5-year
British Telecom	14%	23%	19%
Deutsche Telekom	40%	45%	43%
Kon KPN	27%	51%	43%
Mobistar	30%	32%	34%
Orange SA	41%	52%	48%
Proximus (Belgacom)	14%	18%	17%
Swisscom	24%	25%	24%
Telecom Italia	59%	67%	64%
Telefonica	47%	49%	47%
Telekom Austria	40%	52%	49%
Telenor	18%	17%	18%
TeliaSonera	27%	23%	24%
Vodafone	31%	23%	25%
Average	**32%**	**37%**	**35%**

(24) This shows that the comparators' gearing levels vary between 14% - 67%, with an average range of 30 - 40%. In addition to the gearing levels observed in the market, the ILR also considered the credit rating methodology, as set out by credit rating agencies. Moody's, for example, estimates a gearing level of 45% - 60% for A-credit rated regulated energy network companies (one may not expect this estimation to be significantly different to regulated telecom companies).

(25) Based on these two pieces of evidence, the ILR believes that the adequate gearing level for a company in Luxembourg should correspond to the upper level of the average range of the gearing levels observed in the market and therefore uses a gearing assumption of 40%. This value is also in line with the value determined during the previous WACC setting.

(26) For further information regarding the gearing level assumptions, please refer to Annexe A.

5.3 Estimated nominal cost of equity

(27) The cost of equity is the rate of return required by equity investors in order to compensate them adequately for:

- The risk they bear; and
- The opportunities they forgo in order to commit funds to the firm.

(28) The cost of equity cannot be observed directly but must be estimated. The most common approach used by practitioners and regulators in the capital asset pricing model (CAPM).[4] When applied to equity capital, the CAPM can be written as:

$$cost\ of\ equity = risk\ free\ rate + \ equity\ risk\ premium \times equity\ beta$$

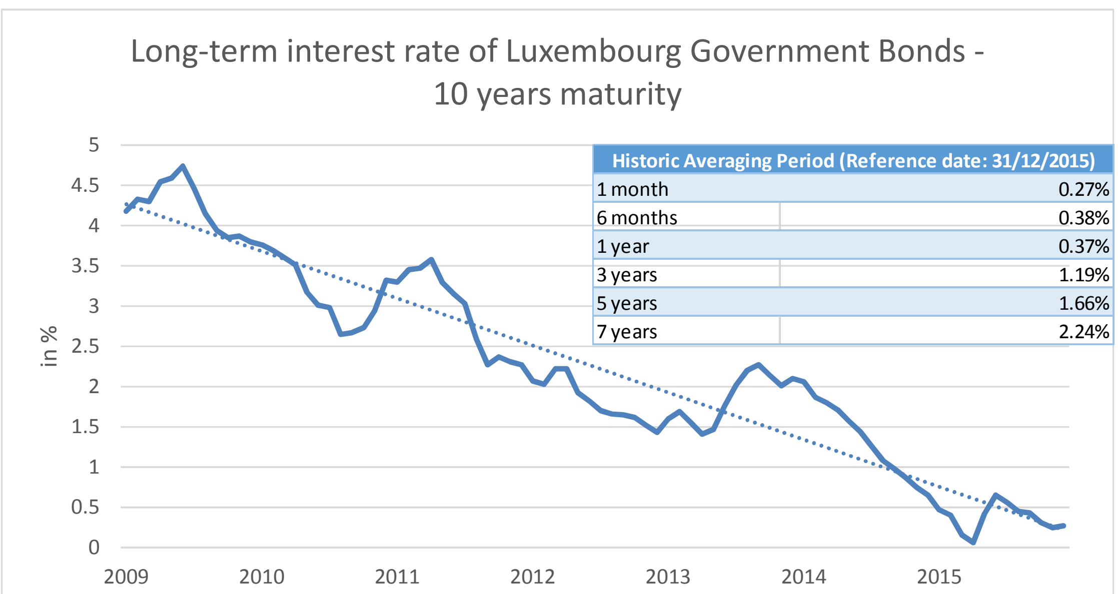
(29) These parameters are described in further detail below.

5.3.1 Risk free rate

(30) The risk free rate is the rate of return on a riskless asset. It is commonly estimated by using yields on very safe government bonds. Luxembourg government bonds are rated AAA by S&P so these provide a reasonable proxy.

(31) The figure below illustrates how nominal yields on Luxembourg government bonds have declined significantly over time.

Figure 5-1 Historic yields on Luxembourg government bonds [Source: ECB Statistical Data Warehouse, 2016]



[4] Wright, Mason and Miles (2003), ERG (2008).

(32) A similar trend has occurred with yields on securities issued by other safe governments. This has been driven by high investor demand (i.e. a 'flight to safety' as investors have sought safe haven investments during recent financial crises).

(33) As described above, the WACC and its components should be forward-looking. General expectations are that current low yields will not persist indefinitely because as the global economy recovers and market uncertainty declines, investors are likely to shift funds from safe assets towards riskier investments. This would drive up yields on government bonds. However, it is unclear when yields will recover to more 'normal' levels. Economic theory suggests that interest rates are likely to be mean-reverting. This means that it is reasonable to use historic averages to inform future risk-free rate expectations.

(34) The ILR is therefore of the opinion that a longer average of the yields of Luxembourgish government bonds should be used to estimate the risk-free rate and fixes a risk-free rate of 2.24%.

5.3.2 Equity risk premium

(35) The equity risk premium (ERP) is the return over and above the risk free rate from holding a fully diversified "market portfolio". It is typically estimated using long run historical averages of market returns.

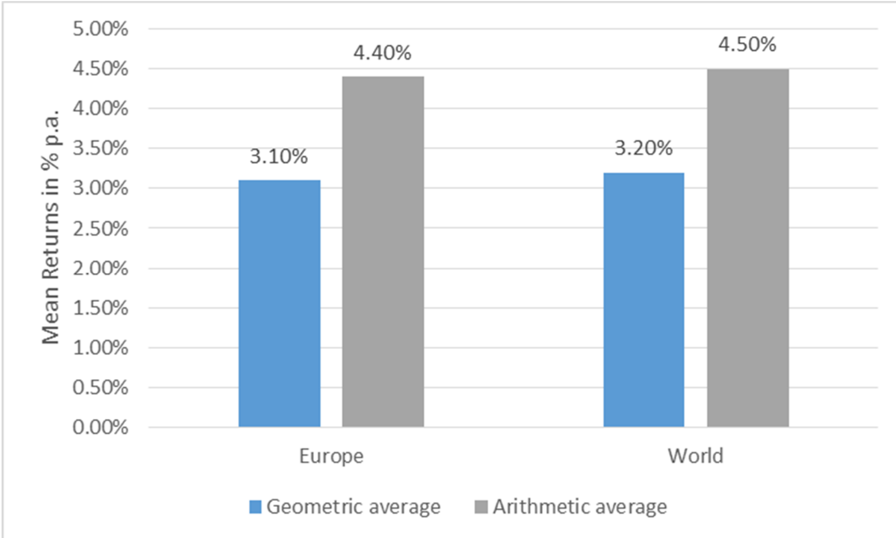
(36) The figure below shows long run historic averages of market returns of bonds in excess of the risk-free rate (from 1900 to date).

(37) The arithmetic average is the sum of growth rate in each period divided by the number of periods. On the other hand, the geometric average corresponds to the compound average return. So, for a time series of data, the geometric average calculates the average return that is assumed to be constant throughout the period considered. For this reason, the geometric average is the preferred option in case there is a correlation between the yearly returns. However, this does not apply in the present case. By using a long series of historical data, it is assumed that history provides a proxy for the probability distribution that investors face today. Each historical year is one point in this probability distribution and is independent from the others as well as equally likely. Since, from this point of view, all years are in parallel and not in sequence, the geometric mean cannot be relevant[5].

(38) Based on this, the ILR is of the opinion that the arithmetic average is the most relevant in the present context and therefore uses an equity risk premium of 4.5%.

[5] Europe Economics, 2014

Figure 5-2 Long run historic averages of market returns [Source: Dimson, Marsh & Staunton (2015), Global Investment Returns Sourcebook]



5.3.3 Equity Beta

(39) Beta reflects the risk associated with the business that cannot be diversified away, and is measured as the correlation between returns on the business and returns on the market. The ILR has obtained an estimate of equity beta by considering the equity beta of the comparators selected (section 5.1).

(40) For this, the following approach has been adopted:

- Beta estimation of the comparators;
- Bayesian adjustment;
- De-levering using the Modigliani-Miller formula; and
- Re-levering using the Modigliani-Miller formula and the gearing level estimated in section 5.2.

(41) For the details regarding the different steps of the equity beta estimation, please refer to Annexe A. The table below lists the average asset beta of the comparators over a period of 1 year, 3 years and 5 years.

Table 5-4 Asset beta of the comparators companies [Source: Frontier, 2016]

Operator	Asset beta		
	1-year	3-year	5-year
British Telecom	0.87	0.82	0.80
Deutsche Telekom	0.80	0.72	0.58
Kon KPN	0.68	0.57	0.45
Mobistar	0.44	0.41	0.49
Orange SA	0.84	0.79	0.66
Proximus (Belgacom)	0.71	0.56	0.53
Swisscom	0.70	0.52	0.48
Telecom Italia	0.62	0.52	0.46
Telefonica	0.59	0.56	0.56
Telekom Austria	0.45	0.41	0.40
Telenor	0.87	0.83	0.74
TeliaSonera	0.69	0.70	0.65
Vodafone	0.74	0.83	0.66
Average	**0.71**	**0.64**	**0.58**

(42) The estimates fall in a wide range of 0.40 – 0.87. The average of the sample varies from 0.58 in the five-year estimation to 0.71 in the one-year estimation, according to the latest data. Based on this, the ILR uses an asset beta of 0.64, which corresponds to the 3-year average.

(43) The asset beta is then re-leveraged by considering a gearing level of40% and a corporate tax rate of 29.22% (section 5.5), which results in an equity beta of 0.94.

5.4 Nominal cost of debt

(44) The nominal cost of debt is the sum of the risk free rate and the debt premium. It can be expressed formulaically as:

(45) $Nominal\ cost\ of\ debt = risk\ free\ rate + debt\ premimum$

(46) The estimation of the risk free rate is described above in the previous section. The estimation of the debt premium is described below.

5.4.1 Debt premium

(47) The debt premium is the incremental rate of return, over and above the risk-free rate, required by a company's bondholders to compensate for the additional credit risk involved in lending to the company. In the case of analysing debt premium from bonds issued in different currencies, the debt premium is estimated by subtracting the appropriate government bond yield of the currency in which the bond is issued.

(48) For the purposes of our analysis, the ILR took a wider sample than the comparator group used for the beta estimation. For further information, please refer to Annexe A.

(49) The table below shows the average debt premium of 55 bonds traded by telecommunication companies with a BBB- credit rating or above and approximately 10-year maturity.

Table 5-5 Debt premium of corporate bonds [Source: Frontier, 2016]

Group	Spot	1-year average	3-year average	5-year average
55 bonds	2.2%	1.6%	1.2%	1.6%

(50) The table above shows a range for the debt spread of 1.2% - 2.2%. In order to be consistent with the determination of the gearing level and the equity beta (for which the ILR considered each time the 3-year average), the ILR uses a debt premium of 1.2%.

5.5 Corporate tax rate

(51) The corporate tax rate is applied for the calculation of the post-tax WACC as well as the pre-tax WACC.

(52) The corporate tax rate in Luxembourg is currently 29.22%.[6] The ILR uses a corporate tax rate of 29.22% in the WACC setting[7].

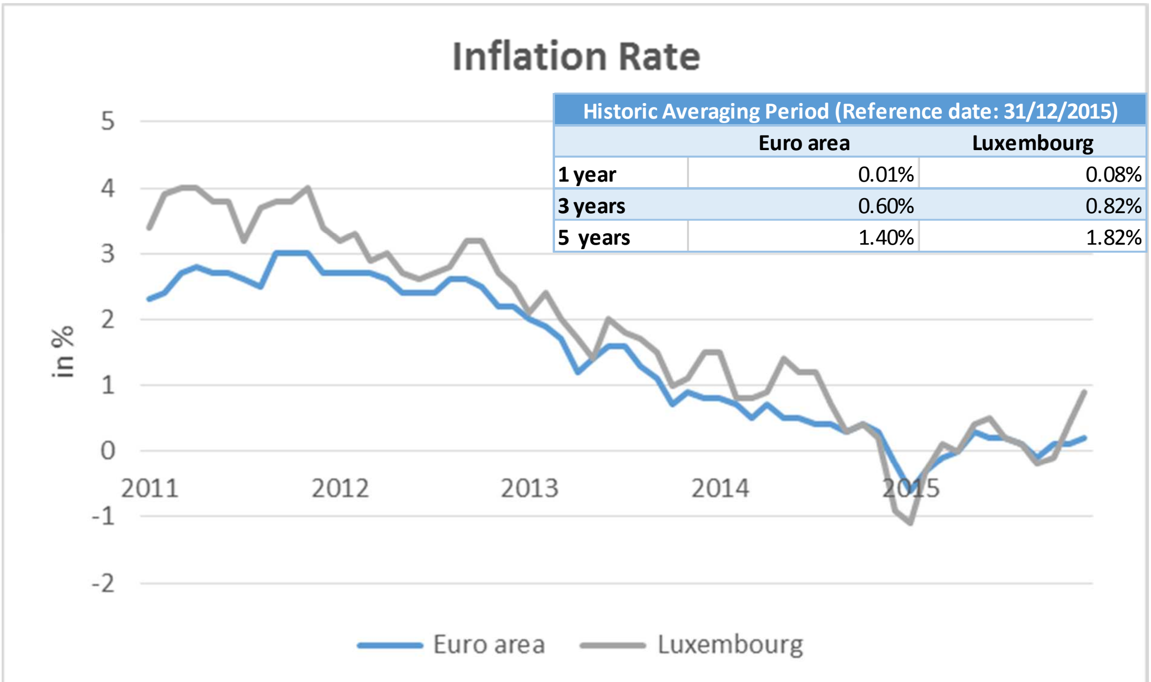
6 KPMG Global Tax Rate Survey, 2015

7 The ILR is aware of the new tax reform proposed by the Luxembourgish government at the end of February. However, as this reform has not yet entered into force, the ILR did not take it into consideration.

5.6 Inflation rate

(53) To convert the nominal WACC into a real WACC, an adjustment for inflation is necessary. The figure below shows the evolution of the inflation rate in the Euro area as well as in Luxembourg over the last 5 years.

Figure 5-3 Historic inflation rates in the Euro area and in Luxembourg [Source: ECB Statistical Data Warehouse, 2016]



(54) Over the last years, the inflation rate was at a low level. The five-year average inflation rate was 1.4% for the Euro area and 1.82% for Luxembourg. Adopting a longer-term perspective, the "ECB survey of professional forecasters" estimates an average inflation rate of 1.8% by 2020[8].

(55) Based on this, the ILR uses an inflation rate of 1.8% for the calculation of the WACC.

[8] See "The ECB Survey of Professional Forecasters", January 2016 http://www.ecb.europa.eu/stats/prices/indic/forecast/shared/files/reports/spfreport2016_Q1.en.pdf?b656180d50537f00debba8969cac763e

5.7 NGA risk premium

5.7.1 Context

(56) Investments in NGA networks are considered as risky, because on the one hand a large amount of capital is needed to finance the investments and on the other hand the returns on these investments are uncertain. This uncertainty derives from the fact that it is not yet known how many customers will switch to NGA products and what price premium they are willing to pay for a fibre access. Therefore, networks operators are tempted to “wait and see”, i.e. to delay their investment until uncertainty decreases.

(57) This investment risk related to the roll-out of NGA is also recognised by the European Commission, who states in the NGA Recommendation that: “the costs of capital of the SMP operator for the purpose of setting [NGA] access prices should reflect the higher risk of investment relative to investment into current networks based on copper.”[9]

(58) In order to estimate the risk premium, NRAs should take into account the following factors of uncertainty:

- Uncertainty relating to retail and wholesale demand;
- Uncertainty relating to the costs of deployment, civil engineering works and managerial execution;
- Uncertainty relating to technological progress;
- Uncertainty relating to market dynamics and the evolving competitive situation, such as the degree of infrastructure-based and/or cable competition; and
- Macroeconomic uncertainty.

5.7.2 Estimating an NGA risk premium for Luxembourg

(59) In 2014, in the context of the development of the fixed costing model and the determination of the WACC for fixed network activities, the ILR set for the first time an NGA risk premium. This NGA risk premium has been determined based on a benchmark and has been fixed at a level of 2.5%, to be added to the real pre-tax WACC. The following paragraphs analyse whether this NGA risk premium is still justified by considering the Luxembourgish context.

(60) The incumbent, i.e. “l’Entreprise des Postes et Télécommunications (EPT)”, has massively invested in the roll-out of NGA networks and especially in FTTH in the recent years. NGA coverage in Luxembourg has reached 89% in 2014 and the coverage of FTTH has increased from 32% in 2012

[9] Commission Recommendation of 20 September 2010 on regulated access to Next Generation Access Networks (NGA) (2010/572/EU)

to 40% in 2014[10]. Furthermore, EPT has recently announced that they have achieved 50% coverage of FTTH[11].

(61) With regard to the demand for NGA based products, it can be observed that demand for very higher speeds is slowly taking up, but nevertheless still remains marginal compared to the overall broadband demand. Therefore, it is for now difficult to foresee by when NGA will overtake copper in terms of demand, so that the investments in the roll-out of the NGA network will eventually pay off.

(62) In this context, it is also important to consider the fact that civil engineering standards in Luxembourg are quite high, which has an impact on the investment costs of the NGA roll-out. In addition, once a certain coverage has been achieved, the investment costs per line will increase, which in turn increases the riskiness of the investment[12].

(63) Considering the intention of EPT to further roll-out FTTH on the one hand and the riskiness of this investment on the other hand, the ILR believes that the maintenance of the NGA risk premium is justified. In this way, EPT is provided with an incentive to continue their investment in the roll-out of an FTTH network.

(64) The NGA risk premium determined by other regulators ranges between 1% and 4.81%[13]. Based on this, the ILR is of the opinion that it is reasonable to maintain the NGA risk premium at a level of 2.5%. This implies no change compared to the previous WACC setting, which contributes to the level of investment security.

[10] Rapport statistique des télécommunications du Luxembourg de l’année 2014, Institut Luxembourgeois de Régulation
[11] Gaston Bohnenberger, FTTH in Luxembourg, FTTH Conference 2016
[12] Benoit Felten, Rethinking how broadband regulation can extend fiver coverage at no public cost, FTTH Conference 2016
[13] Cullen International, Weighted average cost of capital, March 2016

6 International Comparison

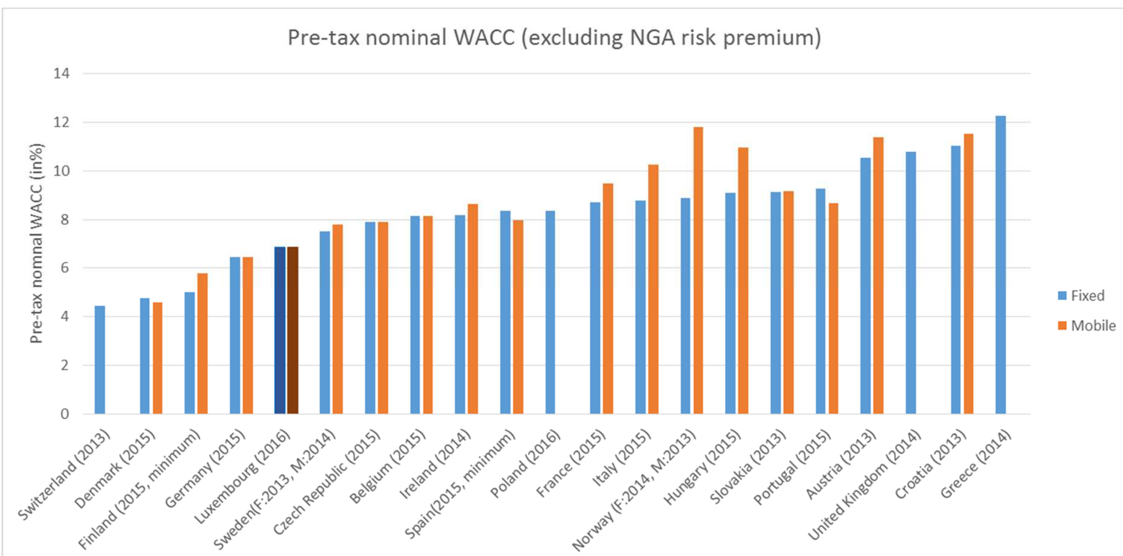
(65) In this section, we represent the WACC estimates from a range of European countries and compare them to our estimate of the WACC for a fixed and mobile network operator.

(66) There are a number of reasons why it is difficult to compare WACC estimates from different countries. It is for example important to consider that estimates are based on local data which are not necessarily comparable with operating conditions in Luxembourg (for example, because of different country specific risks). Such differences may be difficult to assess.

(67) Furthermore, regulators have determined their WACC at different points in time, which implies that operating conditions differ between the different estimates.

(68) The figure below shows the pre-tax nominal WACC estimates for fixed as well as mobile networks that have been determined by European regulators after 2012. It can be seen that the Luxembourgish estimate is at the lower bound of the range. This is mainly due to the recent strong decrease of the interest rates for the Luxembourgish government bonds, which are used for the estimation of the risk-free rate.

Figure 6-1 Pre-tax nominal WACC estimates [Source: Cullen, 2016]



Annexe A Note prepared by Frontier Economics

frontier economics

SUPPORT ON ESTIMATING THE WACC – TELECOMS SPECIFIC PARAMETERS

29 February 2016

A note prepared for ILR

INTRODUCTION

Frontier Economics has been asked by ILR to acquire data and provide support in estimating the telecoms-specific parameters to feed into the estimation of the cost of capital in the telecommunication sector as an input when determining price regulation on relevant markets where one or more operators has been found to have significant market power. The parameters to be estimated are: the appropriate level of leverage, the asset beta and the debt premium.

In this note, we present the results of our data gathering exercise as well as the relevant analysis associated with the estimation of these three parameters. This is to allow the ILR to identify the appropriate point estimates of WACC to use in the context of the Luxembourg communications markets, taking into account the methodology used for the other parameters.[1]

ASSET BETA

Theoretical background

Beta measures the correlation between a stock's return and the return of the market as a whole.[2] This can be estimated using an Ordinary Least Square (OLS) style regression of the stock return against the market return. According to the Capital Asset Pricing Model (CAPM), this beta can then be multiplied with the Equity Risk Premium (ERP), and adding on the risk-free rate gives the total cost of equity of the firm.

In the context of regulatory pricing, the aim of estimating the cost of equity is to allow the regulated company to recover the forward-looking opportunity cost of its equity capital for its investors. In this case, it may be appropriate to benchmark the cost of equity to a set of comparator companies delivering similar products and services. Using benchmark betas to estimate the cost of equity is necessary if the company's beta cannot be directly estimated as in the case of EPT, but

1 This note does not provide economic advice per se to ILR as to what an appropriate range and indeed point estimate should be for the parameters we are estimating.

2 Strictly speaking, this should be the correlation between the excess return on the stock and the excess return on the market compared to the risk-free return. In practice, because the risk-free rate is a contentious parameter in its own right, practitioners tend to leave the risk-free rate out of the equation and measure beta as the correlation between the total stock return and the total market return.

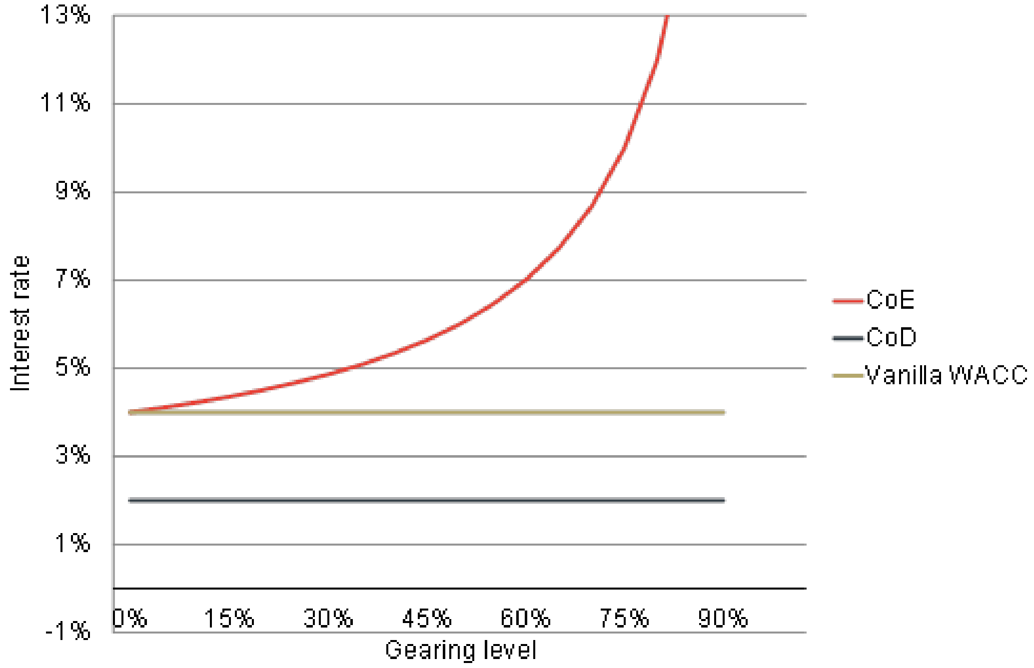
may also provide more robust results even where the equity beta can be directly estimated.

When comparing betas from different comparators, it is important to take account of the effect of leverage. According to the Modigliani-Miller (MM) theory, a firm's cost of capital does not depend on its leverage (a.k.a. gearing level), assuming that there is no tax shield provided on the debt cost and there is no bankruptcy cost.[3] This implies that with a higher level of gearing, the cost of equity increases such that the WACC stays the same. Given that the risk free rate and the ERP are market parameters, the only cost of equity parameter that changes according to gearing level is the equity beta. In fact, according to the MM theory:

$$Equity\ beta = \frac{Asset\ beta}{(1-g)},$$

where g is the gearing level, and the asset beta is a hypothetical equity beta where gearing is zero, i.e. when the company is fully equity financed. The MM theory therefore suggests that the asset beta is the fundamental beta of the company independent of its leverage. Exhibit 1 below illustrates this relationship graphically.[4]

Exhibit 1. Cost of capital and gearing for a constant asset beta of 0.4



Source: Frontier Economics (for illustration purposes only).

Note: Assumed asset beta of 0.4, 2% Risk-free rate, 5% ERP, 2% cost of debt and 0% tax.

The chart shows that as the gearing level increases, the equity beta increases, resulting in a stable WACC across the entire gearing spectrum. This is the fundamental theoretic underpinning for the methodology adopted to compare betas across different comparators. The principle is to convert any particular levered equity beta into an unlevered asset beta (assuming zero gearing). This

[3] Modigliani F. and M. Miller (1958), The cost of capital, corporation finance and the theory of investment, *The American Economic Review*, Volume XLVIII, June 1958, No.3.

[4] The vanilla WACC = Pre-tax cost of debt * Gearing + Post-tax cost of equity * (1 – Gearing)

way the betas are all on a like-for-like basis without leverage, and they still represent the same level of underlying systematic risks of the business activity (since it does not depend on gearing levels).

In order to carry out the comparator asset beta estimation, we have adopted a five-step approach:

1. comparator selection,
2. beta estimation,
3. Bayesian adjustment,
4. de-levering, and
5. significance of asset beta differential between mobile and fixed markets.

We elaborate on these steps in detail below.

Comparator selection

A suitable comparator is one that shares similar risk characteristics with the company in question, which normally implies being in the same or a similar sector/industry. Ideally, for regulated business, the comparators should have a similar regulatory environment which would affect the operational risk and regulatory risk of the company.

We begin by searching in Bloomberg for telecommunication companies similar to the Luxembourgish operators, within Europe[5]. These operators will operate under a similar market structure and regulatory framework as Luxembourg. We do not consider companies in other parts of the world, such as those in North America or Asia, to be as relevant to our study due to different regulatory and market environments. Table 1. sets out the comparator companies and the structure of each comparator based on the split of revenue reported in the most recently available annual reports.

Table 1. Commercial structure of operators' businesses

	Revenue contribution			
Operator	Mobile	Fixed	Other	Country of domicile
British Telecom	0%	99%	1%	United Kingdom
Deutsche Telekom*	83%	17%	0%	Germany
Kon KPN	37%	47%	16%	Netherlands
Mobistar	82%	0%	18%	Belgium
Orange SA	39%	54%	7%	France
Proximus (Belgacom)	17%	32%	50%	Belgium
Swisscom**	24%	15%	61%	Switzerland
Telecom Italia	30%	70%	0%	Italy
Telefonica	35%	65%	0%	Spain
Telekom Austria	56%	44%	0%	Austria
Telenor**	75%	14%	12%	Norway

5 We exclude Portugal Telecom, which was recently acquired by operator Altice NV and on which we therefore have insufficient information to be able to analyse its beta

	Revenue contribution			
TeliaSonera*	76%	24%	0%	Sweden
Vodafone	80%	20%	0%	United Kingdom

Source: Frontier Economics, based on data provided by Bloomberg.

*Note: *Deutsche Telekom and TeliaSonera fixed / mobile splits are based on subscriber numbers.*

***Swisscom and Telenor are non-EU operators, but operate in similar regulatory environment as the rest of the sample.*

Some companies operate in both mobile and fixed markets. As the relevant communications markets include both fixed and mobile markets we use the information on sources of revenues to identify any correlation between the asset beta and the type of markets.

Raw equity beta estimation

We estimate each comparator company's equity beta using data from Bloomberg, by regressing each company's returns against the returns on the broadest available local stock index.

Table 2. Raw equity betas for comparator operators

	Raw equity beta by estimation window		
Operator	**1-year**	**3-year**	**5-year**
British Telecom	0.98	0.96	1.01
Deutsche Telekom	1.16	1.08	0.90
Kon KPN	0.88	0.90	0.75
Mobistar	0.51	0.51	0.57
Orange SA	1.20	1.22	1.06
Proximus (Belgacom)	0.80	0.64	0.61
Swisscom	0.86	0.65	0.61
Telecom Italia	1.05	1.03	0.97
Telefonica	1.11	1.00	0.98
Telekom Austria	0.70	0.68	0.68
Telenor	0.83	0.88	0.79
TeliaSonera	0.88	0.87	0.81
Vodafone	1.01	1.06	0.82

Source: Frontier Economics, based on data provided by Bloomberg.

CAPM theory suggests that the market portfolio contains all risky assets in the economy. In this sense the market index should be a comprehensive world stock market index. In reality, even the largest and most diversified investors exhibit some home bias. Therefore, the consensus among practitioners is to use the broadest local index, while remaining mindful of the weighting bias and potential illiquidity of trading in the constituent stocks. For example, our preferred index for UK stocks is the FTSE All share.[6] Other examples include PAX for France and DAX for Germany.

[6] FTSE All share is code-named ASX Index in Bloomberg.

There are debates on the merits of daily data versus weekly data for the regression. The general consensus is that there is a trade-off between the number of observations (statistical robustness) and the likelihood of auto-correlation. Similarly there is a trade-off between the number of observations and the applicability of the estimate as a forward looking estimate as the estimation window widens.

Bearing these trade-offs in mind, we run the estimation for 1-year, 3-year and 5-year daily estimation windows. Below, we also present the regression with a rolling window to show the historic development of the betas.

Bayesian and other adjustments to the raw betas

Potential measurement errors in equity betas may cause concerns, particularly when the level of volatility is relatively high. The average equity beta of the entire market should be one by definition and as a result *a priori* 1 is the best central estimate of an equity beta. As random variation will result in the beta estimate for any stock to depart from 1, even if the underlying beta is 1, practitioners often apply adjustment of measured betas towards one (upward adjustment if lower than one and downward adjustment if higher than one).

There are in general two widely recognised options of adjusting raw equity betas, namely the Blume adjustment and the Vasicek adjustment.

The Blume adjustment is a deterministic adjustment on the raw equity beta towards 1. Blume (1971) found evidence that estimated betas tend to mean-revert over time: high/low values in this period seem to converge to the mean value in next period.[7] Practitioners' interpretation of Blume's result is that one can adjust the raw beta by a fixed weight (1/3) towards 1. For example, if the estimated raw beta is 0.6, the Blume adjusted beta would be 0.6*(2/3) + 1*(1/3) = 0.73.

The Blume adjustment is simple to calculate, but is a crude approach to adjusting beta as it always adjusts by the same weighting towards 1 and ignores the observed variation in the underlying data.

Vasicek (1973) proposed a Bayesian adjustment process for betas.[8] This method combines information available prior to the sampling of beta along with beta estimates to minimise sampling (estimation) error. The adjustment gives high weight to precise beta estimates and low weight to imprecise ones. The exact process is as follows:

1. When estimating the raw beta $\beta_{t,i}$ for company *i* at time *t,* record the standard errors of the estimation $s(\beta_{t,i})$.

2. Calculate the variance of the betas of the entire sample $\sigma^2(\overline{\beta}_t)$. Ideally this should be the variance of all betas estimated in the entire index. For example, if the index being used is the FTSE All share, the variance should be calculated from all betas from FTSE All share. However, if cross-country comparators are included in the sample, it would be a reasonable

7 Blume, M. E. (1971), On the Assessment of Risk, *Journal of Finance* 26(1), 1–10.

8 Vasicek, O. A. (1973), A Note on Using Cross-Sectional Information in Bayesian Estimation of Security Betas, *Journal of Finance* 28(5), 1233–1239.

compromise to just compute the variance of all estimated betas in the comparator set sample, given that the sample size is reasonably large.

3. Use the following equation to determine the weight to put on the estimated raw beta:

$$w_{t,i} = \frac{\sigma^2(\overline{\beta}_t)}{\sigma^2(\overline{\beta}_t) + s^2(\beta_{t,i})}$$

where $\overline{\beta}_t$ denotes the mean of the beta sample, $\sigma^2(\overline{\beta}_t)$ denotes the variance of the sample, and $s^2(\beta_{t,i})$ denotes the square of the standard error of the estimation of $\beta_{t,i}$.

4. The Vasicek adjusted beta is then:

$$\hat{\beta}_{t+1,i} = \overline{\beta}_t * (1 - w_{t,i}) + \beta_{t,i} * w_{t,i}$$

In practice, it is common to use the theoretic mean of beta, which is 1, to proxy $\overline{\beta}_t$ instead of using the actual mean of the sample which could be imprecise.

The intuition of this adjustment is that more weight is put on the raw beta if the standard error of the estimation is small compared with the total variance of the sample, and vice versa.

We consider that Vasicek Bayesian adjusted equity betas are the most appropriate beta estimates. We carry out the adjustment using the standard error of the individual beta estimations and the variance of all betas in the entire sample.

Additionally, when stocks are thinly traded the estimated betas tend to suffer from autocorrelation problems. In those cases, a Dimson adjusted beta can mitigate the problem to a certain extent. However, we do not apply a Dimson beta adjustment as our comparators are not thinly traded.

De-levering

As explained in the section above, it is necessary to de-lever comparators' equity betas into asset betas in order to compare them in a meaningful way. There are a number of ways to do this, which we explain in detail below.

Miller formula (practitioners' approach)

The Miller formula is the relatively simpler approach, which does not have a separate treatment for tax. The formula is as follows:

$$Asset\ beta = Equity\ beta * (1 - g) = \frac{Equity\ beta}{(1+\frac{D}{E})},$$

where D/E is the debt-to-equity ratio[9]. D+E is also termed the enterprise value (EV), and the gearing level g is equal to D/EV.

[9] D is measured by net debt, which is total debt minus cash and cash equivalents, and E is measured by the market capitalisation of the equity share and not the book value.

Market capitalisation versus book value of equity

In principle, gearing can be defined in two ways:

- market value terms (i.e. using the market value of equity and the market value of debt); or
- book value terms (i.e. using the book value of equity and the book value of debt).

Although regulators and practitioners use both approaches, finance theory is clear that the correct approach is to define gearing in market value terms. Prof. Aswath Damodaran states in his widely used book, *Corporate Finance: Theory and Practice*: [10]

"The weights assigned to equity and debt in calculating the weighted average cost of capital have to be based on market value, not book value. This is so because the cost of capital measures the cost of issuing securities — stocks as well as bond — to finance projects, and these securities are issued at market value, not at book value."

The value of a firm (or any asset for that matter) is the present value of all future streams of cashflow discounted at the appropriate discount rate. When there is uncertainty regarding these two parameters, the valuation would differ for different investors, hence encouraging potential transactions between investors. Assuming that the efficient market hypothesis holds, the market valuation of an asset can be observed from the latest transaction price of that asset. In other words, the best estimate of the enterprise value of a company is how much the market values the equity shares and existing debts.

The common measure of the market value of equity is total market capitalisation (total shares outstanding multiplied by the current stock price). This means that the market value of equity is usually straightforward to obtain for quoted companies, such as the peers used in this study. However, since debt is generally traded infrequently, obtaining market value data for debt can be difficult. Therefore, in practice it is common for the calculation of gearing to be based on the market value of equity and the book value of debt. The book value of debt will generally provide a reasonable estimate of the market value, for two reasons:

- first, the fact that corporate debt is issued with a fixed maturity limits the divergence between market and book values; and
- second, a proportion of debt is typically issued with floating interest rates, which means that the market values will fluctuate much less.

Net debt versus total debt

Net debt is equal to total debt minus cash and cash equivalents. Net debt that truly represents a company's leverage as the cash and cash equivalents can be used within short notice to repay any debt. Therefore, when the business has large cash reserves, using total debt to calculate gearing would overstate the true gearing level.

[10] Damodaran, A. (2001), *Corporate Finance: Theory and Practice*, Second Edition, John Wiley: New Jersey, p.216.

The Modigliani-Miller formula

The Modigliani-Miller formula (Hamada approach) incorporates the tax treatment in the de-levering the beta. The equation is as follows:

$$Asset\ beta = \frac{Equity\ beta}{1+(1-t)*\frac{D}{E}},$$

where *t* is the effective tax rate.

When a company pays a level of tax substantially different from other companies, this has an impact on the beta of the company, since the size of the tax shield would be affected. The MM approach takes this into account, such that all asset betas are neutral of this tax effect. This approach therefore might be useful when comparing the asset beta of companies from different countries that have different corporate tax rate. When all the comparators are from the same country, the corporate tax ratio would tend to cancel out in the de-levering and the re-levering of the betas, making the Miller formula a more practical solution than the MM formula. One exception would be where the asset betas are estimated based on a historic window with a corporate tax rate substantially different from the forward looking corporate tax rate that should be applied to re-lever the beta.

Effective tax rate versus corporate tax rate

In the MM formula the tax rate used could be the effective tax rate or the corporate tax rate. To help decide which one to choose, it is useful to understand the difference between the two.

The corporate tax rate is simply the statutory ‘headline’ corporate income tax rate.

The effective tax rate is how much tax a company actually accrues in a given fiscal year, which will depend on the tax management that the company has in place as well as its financial performance in the past (e.g. a company that has made losses in the past would be entitled to accumulated tax credit when it makes future profits).

Arguably, the expected effective tax rate is the most relevant variable for a precise de-levering of the beta, as it is the actual tax cost that would have been taken into account in the stock market’s pricing of the company’s shares.

As an alternative, one could use the corporate tax rate, assuming that all companies in the sample pay approximately the corporate tax rate in their residing country in the long run.

Summary of approach

We propose to use the Modigliani-Miller formula to de-lever the equity betas. We use the net debt and market capitalisation of the equity and effective tax rate, measured as the average of the beta estimation window, to de-lever our Vasicek-adjusted equity betas into asset betas. Where effective tax rate data is not available, we have replaced it with the corporate tax rate of the country where the stock is traded.

Table 3 below sets out the asset betas for the comparator group based on 1-year, 3-year and 5-year daily estimation windows as described previously.

Table 3. Asset betas for comparator operators

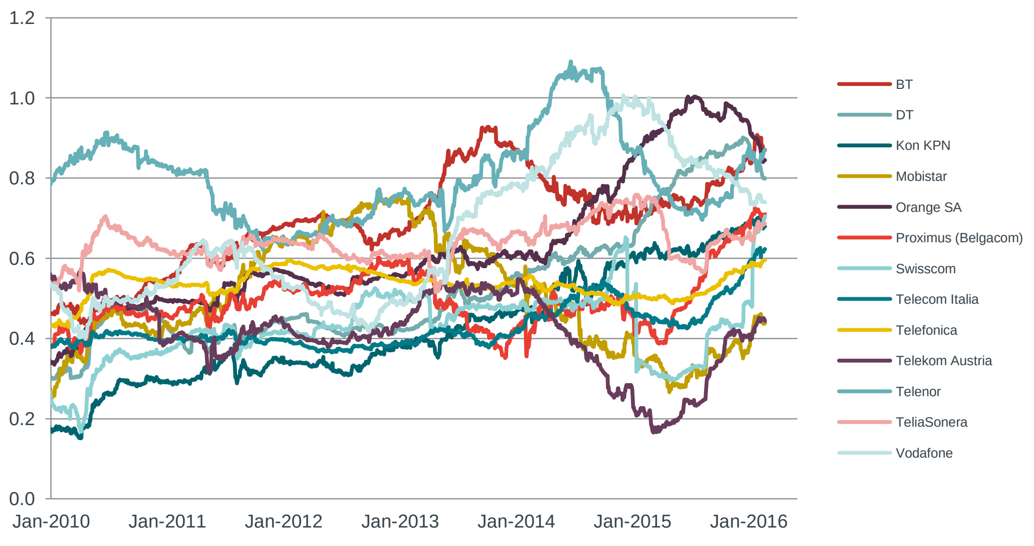
	Asset beta		
Operator	**1-year**	**3-year**	**5-year**
British Telecom	0.87	0.82	0.80
Deutsche Telekom	0.80	0.72	0.58
Kon KPN	0.68	0.57	0.45
Mobistar	0.44	0.41	0.49
Orange SA	0.84	0.79	0.66
Proximus (Belgacom)	0.71	0.56	0.53
Swisscom	0.70	0.52	0.48
Telecom Italia	0.62	0.52	0.46
Telefonica	0.59	0.56	0.56
Telekom Austria	0.45	0.41	0.40
Telenor	0.87	0.83	0.74
TeliaSonera	0.69	0.70	0.65
Vodafone	0.74	0.83	0.66
Average	**0.71**	**0.64**	**0.58**

Source: Frontier Economics, based on data provided by Bloomberg.

The estimates fall in a wide range of 0.40 – 0.87. The average of the sample varies from 0.58 in the five-year estimation to 0.71 in the one-year estimation, according to the latest data.

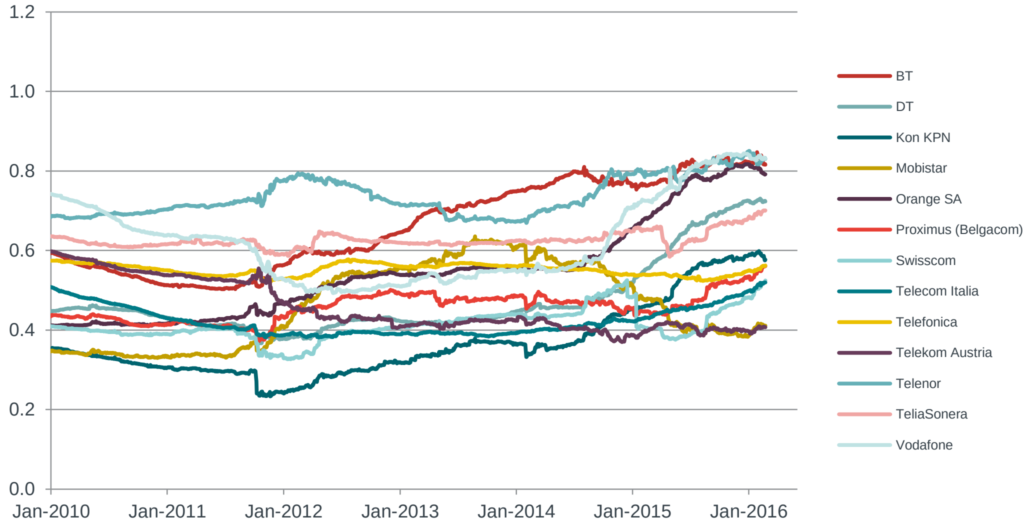
To look at the historic movement in asset betas over time in the sector, we also present the time-series of the beta estimates. Figure 1, Figure 2 and Figure 3 show the 1, 3 and 5-year rolling asset betas, which show any trends that the betas have followed in the past five years.

Figure 1. 1-year rolling asset betas for comparator operators



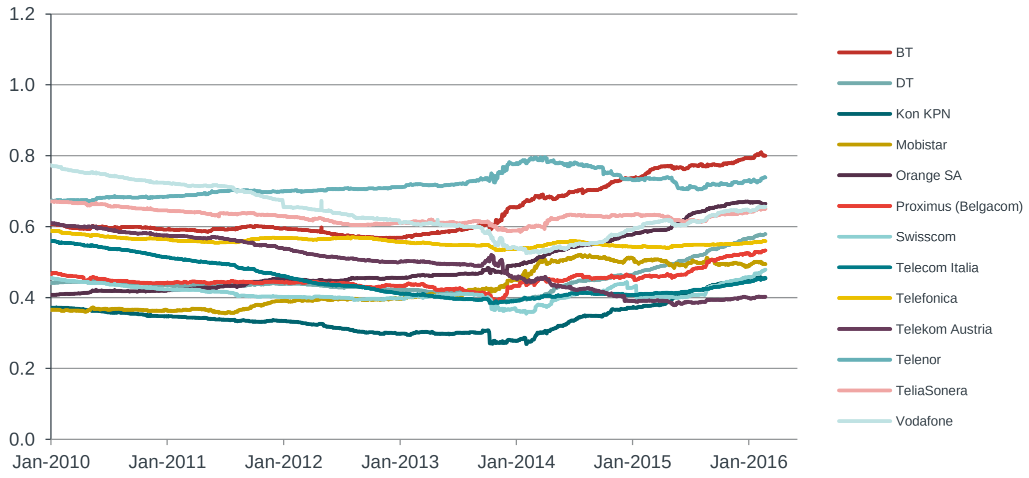
Source: Frontier Economics, based on data provided by Bloomberg

Figure 2. 3-year rolling asset betas for comparator operators



Source: Frontier Economics, based on data provided by Bloomberg

Figure 3. 5-year rolling asset betas for comparator operators



Source: Frontier Economics, based on data provided by Bloomberg

The chart above shows that, although current estimates of asset betas within the comparator group exhibit a relatively high variation (from 0.40 to 0.87), the overall envelope of the asset betas have been relatively stable over the past five years. Furthermore, to narrow down the range, one could consider the averages across the comparators for our three estimation windows and giving a range of 0.58 to 0.71.

Mobile and fixed differential analysis

The relevant communications markets under the EU framework include both fixed and mobile services. Historically regulators have set different costs of capital for fixed and mobile services, reflecting the relative immaturity of mobile services markets in the past. Recently the determined costs of capital for fixed and mobile services have converged. Therefore, it is reasonable to evaluate to what degree there is a significant observable difference between the cost of capital for fixed and mobile services.

In order to differentiate the betas for mobile and fixed services, a so-called “full information” approach can be adopted. This approach involves disentangling the different activities (such as mobile, fixed communications and other activities) within the holding groups and estimating the asset beta individually, with individual betas each representing a type of activity.

One key aspect of this approach is to be able to give weightings to different activities, estimating separate asset betas for them, and as a result the asset of the group is then the weighted average beta of all activities that the group carries out. There are various ways one could assign weighting to activities, such as accordingly to the proportion of operating income, revenue or fixed asset. In this case, we have found that data on revenue has the best coverage. We therefore used revenue proportions to assign weightings to the different activities.

Given the difficulty in obtaining the split of operators’ fixed and mobile businesses over time, this information is gathered from the latest annual reports for each operator and the regression analysis is conducted accordingly, using the 1-year asset betas for those operators.

We regress the asset beta of each comparator on the proportion of revenues derived from the fixed and mobile businesses (as set out in Table 1), with the following regression equation:[11]

$$\beta_{asset} = \beta_{fixed} \cdot \omega_{fixed} + \beta_{mobile} \cdot \omega_{mobile} + \beta_{other} \cdot \omega_{other} + \varepsilon,$$

where ω_{fixed}, ω_{mobile} and ω_{other} represent the revenue proportions of the fixed, mobile networks and other business activities in the company, respectively.

An estimation of this form could in theory provide us with estimated “pure-play” asset betas for operators whose businesses are concentrated 100% in one activity. For example, for a “pure-play” fixed network business ω_{fixed} is 100%. Its β_{asset} would be equal to β_{fixed} as both ω_{mobile} and ω_{other} would be zero. Similarly, β_{mobile} could be interpreted as the asset beta of a “pure-play” mobile network business. This analysis would also inform us whether there is a significant difference between the asset beta of the mobile and the fixed markets. Our results are set out in Table 4 below.

[11] Note that although we also considered the proportion of operators’ revenues derived from activities other than fixed and mobile telecommunications, this variable was omitted from the estimated equation to avoid introducing collinearity into the estimation, which occurs when the estimated variables are interrelated. This is the case here since they all sum to 100% and so are dependent on each other.

Table 4. Results of econometric analysis

```
. reg beta_2016_1y mobile_1y fixed_1y other_1y, noconstant
```

Source	SS	df	MS
Model	23.0338515	3	7.67795049
Residual	155.491535	10	15.5491535
Total	178.525387	13	13.732722

Number of obs =	13
F(3, 10) =	0.49
Prob > F =	0.6946
R-squared =	0.1290
Adj R-squared =	-0.1323
Root MSE =	3.9432

beta_2016_1y	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
mobile_1y	-2.729374	2.338955	-1.17	0.270	-7.940889	2.482142
fixed_1y	1.53259	2.744221	0.56	0.589	-4.581915	7.647096
other_1y	2.884513	5.008447	0.58	0.577	-8.275002	14.04403

Source: Frontier Economics, based on data provided by Bloomberg

The table shows that the p values of all three “pure play” betas failed the statistical significance test.

This result clearly shows that our betas do not support the theory that there is a significant difference between the asset beta of fixed and mobile markets. We therefore have not produced different estimates for the asset betas for fixed and mobile markets. Instead, a single range of 0.40 - 0.87 as identified above can be considered appropriate for all relevant markets.

We note that when calculating the overall cost of equity, the appropriate asset beta resulting from this analysis should then be re-levered back to an equity beta using the same MM formula we have used for the de-levering, but with the notional gearing level and corporate tax rate appropriate for the regulated business.

GEARING LEVEL

The gearing level is the level of leverage of a company, measured by the ratio of debt to total enterprise value. Gearing is used in the WACC estimation in two places: first, when re-levering asset betas to equity betas; and second, when weighting between the cost of debt and the cost of equity in the WACC formula. The gearing level used in the regulatory WACC estimation is sometimes regarded as a notional gearing, as this may or may not correspond to the actual gearing level of the regulated company. It represents what the regulator considers an optimal (or at least reasonable) level of leverage at which the regulated company should be able to raise efficient financing.

The notional gearing level can be based the average gearing level of the comparators used in the beta estimation[12]. As explained in detail in the asset beta section, we have calculated the gearing level using market capitalisation data.

Furthermore, we have used net debt when calculating gearing. It is important to recognise this when interpreting and comparing our results to those in other studies, which may have used total debt.

[12] Given that EPT is government owned, it’s gearing is unlikely to reflect an efficient market based gearing.

Comparators' actual gearing levels

When estimating the equity betas of the comparators, we have acquired estimates of their corresponding gearing levels for the same estimation window as the beta estimation. The results are shown in Table 5 below.

Table 5. Gearing for comparator operators

	Average gearing		
Operator	1-year	3-year	5-year
British Telecom	14%	23%	19%
Deutsche Telekom	40%	45%	43%
Kon KPN	27%	51%	43%
Mobistar	30%	32%	34%
Orange SA	41%	52%	48%
Proximus (Belgacom)	14%	18%	17%
Swisscom	24%	25%	24%
Telecom Italia	59%	67%	64%
Telefonica	47%	49%	47%
Telekom Austria	40%	52%	49%
Telenor	18%	17%	18%
TeliaSonera	27%	23%	24%
Vodafone	31%	23%	25%
Average	**32%**	**37%**	**35%**

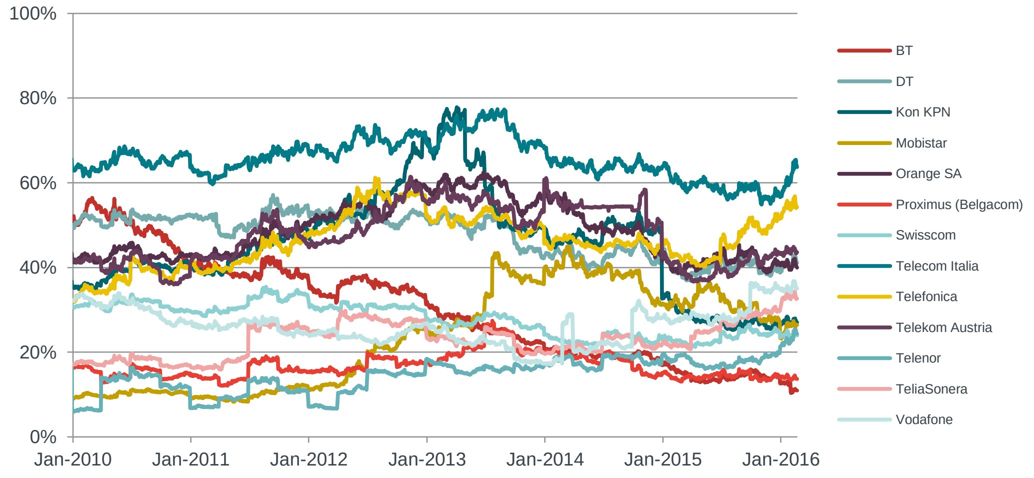
Source: Frontier Economics, based on data provided by Bloomberg.

This shows that the comparators' gearing levels vary broadly between 15% - 70%, with a range for the average of the comparators of 32 - 37%. Some of the gearing variation may be due to the degree to which companies carry out non-regulated business activities. Typically those activities can be considered riskier than regulated network business, and therefore the gearing level of the companies with a higher proportion of non-regulated businesses tend to be lower. Other factors that can explain differences in gearing levels amongst the comparators include country-specific factors such as corporate tax rates and firm-specific factors such as financial management strategies.

It may be tempting to ascertain the degree to which the gearing level is related to the proportion of mobile network business in relation to fixed networks. However, as we have not identified a statistically significant difference on asset betas, the economic rationale behind a differential in the gearing level for mobile and fixed networks would be relatively weak. This is further evidenced by our analysis of the debt premium in the next section.

In addition to the latest figures, Figure 4 presents the trend in gearing levels over time.

Figure 4. Spot gearing for comparator operators



Source: Frontier Economics, based on data provided by Bloomberg

Note that in general there is no clear trend across the comparators, even though some companies have experienced increasing gearing while some others have experienced decreasing gearing.

Credit rating methodology

As noted above, the observed gearing may be biased downwards to reflect that riskiness on non-regulated activities. When considering regulated activities it may be appropriate to take into consideration what credit rating agencies would consider as a benchmark rating for regulated telecoms networks. According to Moody's rating methodology, for example a gearing level of 45% - 60% is consistent with an A credit rating for the regulated energy networks (we do not expect the metric to be materially different for the regulated telecoms sector for the same given level of credit rating).[13]

We note that this suggests a range higher than the average gearing level in our beta estimation sample which is consistent with the fact that our beta comparators include telecoms groups that carry out other commercial activities other than regulated networks, as explained above.

In assessing the appropriate notional gearing for a regulated telecoms network, the regulator might want to put different weights on the two relevant pieces of the evidence shown above to come to an overall judgement ensuring that the rest of the determination on the WACC is consistently estimated with this gearing level.

DEBT PREMIUM

The debt premium is the incremental rate of return, over and above the risk-free rate, required by a company's bondholders to compensate for the additional credit risk involved in lending to the company. In the case of analysing debt premium from bonds issued in different currencies, the debt premium is

[13] Moody's investor service, Rating Methodology, Regulated Electricity and Gas Networks, November 2014.

estimated by subtracting the appropriate government bond yield of the currency in which the bond is issued.

For the purposes of our analysis, we took a wider sample than the comparator group used for the beta estimation. This is for a number of reasons:

- We need to focus on the spread of bonds with a particular maturity. The number of bonds issued with a maturity sufficiently close to a particular maturity date is limited.
- Since the debt premium is estimated based on bond spread, and we control for credit rating, there is good comparability between bonds issued in different countries in different currencies.

Therefore, we consider that analysing bonds issued by a wide sample of companies provides a richer base for our analysis than a narrow sample. We used Bloomberg to identify bonds that met the following criteria:

- issued by telecommunications companies;
- with a credit rating of BBB- or above;[14]
- maturing between 2024 and 2027 (approximately a 10-year maturity);
- not index-linked to inflation;
- paying a fixed (rather than floating) coupon; and
- with a bullet repayment profile.

Our sample comprises 55 bonds issued by 33 operators across 21 countries in 8 different currencies, containing a mixture of predominantly fixed and mobile operators. For each bond, we took the yield to maturity and subtracted the yield to maturity on the appropriate 10-year government bond (the theoretical measure of risk-free rate).

We have categorised bonds by credit rating into two groups, broad A (A+, A and A-) and broad BBB (BBB+, BBB, BBB-). Although we also present fixed and mobile operators separately, these categorisations are according to Bloomberg and may not be accurate given the fact that most issuing companies operate in both fixed and mobile markets. We therefore caution the interpretation of any differential between the two groups. In addition to the spot spread, we also provide a one-year, three-year and five-year average of the spreads.

Table 6 below summarises the debt premia on the sample of bonds.

Table 6. Debt premia by credit rating band (as of 23-02-2016)

Credit rating	Spot debt spread	1-year average
Fixed operators		
Broad BBB	2.2%	2.1%
Broad A	1.4%	1.2%
Mobile operators		
Broad BBB	2.6%	1.6%
Broad A	1.4%	1.1%

Source: Frontier Economics, based on data provided by Bloomberg.

[14] by S&P and Fitch, or the equivalent Baa3 and above by Moody's.

Not surprisingly, similar to the results on the asset beta analysis, there is little significant difference between fixed operators and mobile operators regarding the debt spread on their bonds.

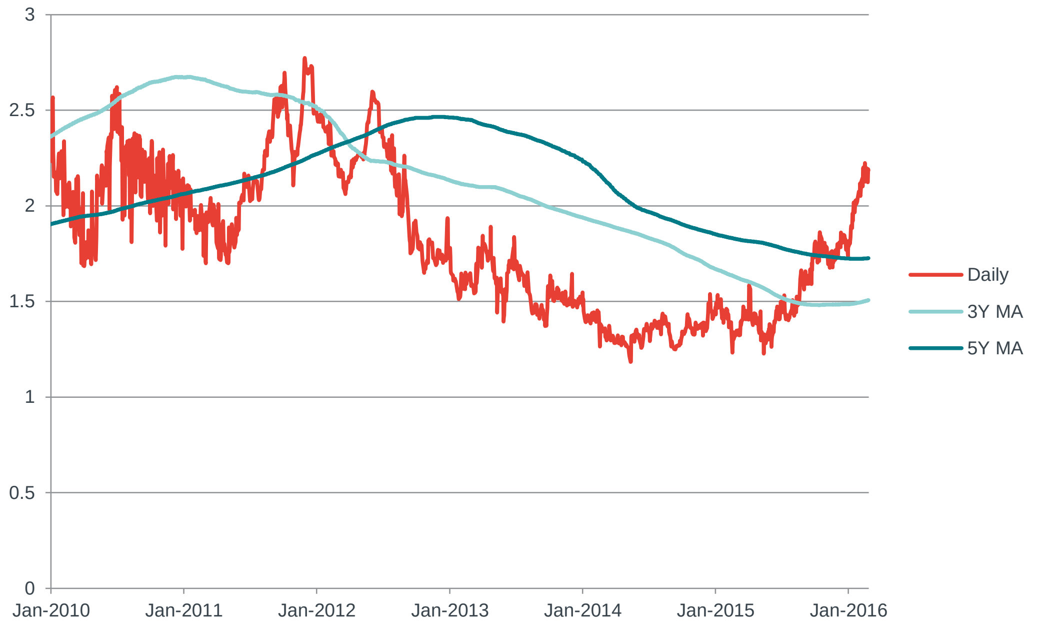
We also consider long-term averaging periods on the debt spread which may be appropriate, depending on the time period used to estimate the risk free rate. Due to the small number of bonds available in the categories, the representativeness of the estimates may be reduced.

Table 7. Debt premium for full sample (as of 23-02-2016)

Group	Spot	1-year average	3-year average	5-year average
Full sample	2.2%	1.6%	1.2%	1.6%

Table 7 above shows a range for the debt spread of 1.2% - 2.2% depending on the window used. Figure 5 shows how the debt premium changes over time, illustrated by both the spot premium and 3- and 5-year moving averages.

Figure 5. Historic average debt premium of sample (%), 2010-2016



Source: Frontier Economics, based on data provided by Bloomberg

GLOSSARY

CAPM – capital asset pricing model

CoD – cost of debt

CoE – cost of equity

ERP – equity risk premium

OLS – ordinary least square regression

WACC – weighted average cost of capital

Vanilla WACC – weighted average of a pre-tax cost of debt and a post-tax cost of equity.