Body of European Regulators for Electronic Communications

BEREC

BoR (20) 116

BEREC Report on WACC parameter calculations according to the European Commission's WACC Notice of 7th November 2019

(WACC parameters Report 2020)

12 June, 2020

Table of Contents

Executive Summary

In this first BEREC Weighted Average Cost of Capital (WACC) parameters Report BEREC calculates the WACC parameters following the non-binding Commission's WACC Notice on the calculation of the cost of capital for legacy infrastructure in the context of the Commission's review of national notifications in the EU electronic communications sector of 7th Nov. 2019[1]. The cost of capital is the core element of any regulatory pricing decision NRAs take. The Notice aims to ensure a consistent calculation of the WACC by NRAs thereby contributing to the development of the internal electronic communications market.

BEREC applied three general principles:

- Follow the Notice as closely as possible, which mainly refers to the methodologies to be used for the estimations;
- Be transparent, using publicly available data where possible or using data which is widely used and accepted in the financial markets, which refers to the data sources to be used for the estimations;
- Explain every step of the calculation and proceed in a straightforward manner, which refers to the calculations as such.

For each of the parameters of the WACC formula (using the CAPM approach) the Report sets out:

- the application of the methodologies according to the WACC Notice,
- the assumptions and choices made,
- the data and data sources used,
- the steps of the calculations,
- the results.

By explaining precisely and transparently how the results were derived NRAs will be able to follow the BEREC calculation steps from start to end and to fully understand the logic of the calculation process so that they can replicate the results shown in the WACC parameters Report. This ensures that NRAs are confident that the results are robust and were derived using state of the art professional standards as well as following the Notice as closely as possible taking into account also best regulatory practices where the Notice provides for NRAs' flexibility.

All results were cross checked and verified to ensure that no methodological mistakes have been made, no questionable data has been used and no calculation errors have occurred, so

[1] https://ec.europa.eu/digital-single-market/en/news/commission-publishes-notice-calculation-cost-capital-legacy-infrastructure.

that BEREC was able to exclude any systematic bias. Only after these checks were carried out, BEREC was satisfied that the results were correct and NRAs will be confident to use them in their own WACC calculations.

The following Table provides a summary of the structure of the WACC parameters Report, BEREC's calculations and (references to) the results derived from it.

Table 0 Summary of the structure of the BEREC WACC parameters Report 2020 with references to result tables

Chapter	**Parameter**	**Results**	**Reference (Table)**
Chapter 1	Introduction WACC formula		
Chapter 2	RFR	RFR for each EU member state	Table 2
Chapter 3	Peer group	BEREC Peer Group 2020 comprising 14 companies	Table 3
Chapter 4	Debt premium, Cost of debt	Debt premium, Cost of debt for each of the 14 companies of the BEREC Peer Group	Table 4
Chapter 5	Equity beta, Gearing, Asset beta	Equity beta, Gearing, Asset beta for each of the 14 companies of the BEREC Peer Group	Table 6
Chapter 6	ERP	EU-wide ERP	Table 10 + 11
Chapter 7	Summary	All WACC parameters as calculated by BEREC	Table 12 + 10

The novelty of the Notice and the WACC parameters Report is the calculation of an EU-wide ERP (equity risk premium). Based on the calculations described in Chapter 6 BEREC considers that the appropriate value of the single EU-wide ERP is in the margin of 4.18% (GM) and 5.31% (AM).

BEREC will publish the estimated WACC parameter values and NRAs are assumed to take into account those parameter values when carrying out their own calculations for their national regulatory decisions, but they do have some flexibility within this framework to take account of national specificities. For reference by NRAs the Report is to be published before 1st July 2020

when the Commission starts applying the Notice when reviewing NRA's notifications in the EU electronic communications sector.

BEREC has taken utmost care to develop this Report according to the best knowledge and technical expertise of its members. Nevertheless improvements may be necessary in the future yearly update where deemed appropriate.

1. General introduction

This Report contains the results of the calculations run by BEREC to estimate the parameters of the Weighted Average Cost of Capital (WACC) according to the non-binding Commission Notice on the calculation of the cost of capital for legacy infrastructure in the context of the Commission's review of national notifications in the EU electronic communications sector[2] and the Commission Staff Working Document (SWD)[3] accompanying the WACC Notice which describes the methodologies in more detail. Acc. to para. 6 of the Notice the scope is limited to the WACC calculation for legacy infrastructure.[4]

The following introductory chapter describes the tasks assigned to BEREC by the Notice and the general principles BEREC follows in fulfilling these tasks as assigned acc. to section 7[5] of the Notice.[6] The goal of this Report – according to the tasks – is to enable NRAs to make use of the results of the calculations when setting the WACC in their national regulatory decisions.

For this purpose it is important that the Report is as clear and as detailed as possible in describing each step of the calculation in such a manner that each NRA can replicate the results and thus rely fully on the robustness of BEREC's calculations. The Report therefore explains for each of the parameters estimated:

- the application of the methodologies according to the WACC Notice,
- the assumptions and choices made,
- the data and data sources used,
- the steps of the calculations,
- the results.

By explaining precisely and transparently how the results were derived NRAs can be confident that they meet state-of-the-art professional standards and that BEREC followed the Notice as

[2] OJ 2019/C 375/01 of 6th Nov. 2019, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52019XC1106(01)&from=EN – the Notice.
[3] SWD(2019) 397_final, https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=62834, the SWD.
[4] Legacy infrastructure means infrastructure of an SMP operator not subject to a Next Generation Access (NGA) premium.
[5] See section 1.1. below.
[6] BEREC is not taking any view regarding the Notice in this Report. BEREC provided input during the Commission's public consultation in 2018, cf. BEREC Position Paper – Input to the Commission's WACC consultation 2018, BoR (18) 67, publ. in Oct. 2018, https://berec.europa.eu/eng/document_register/subject_matter/berec/opinions/8257-berec-position-paper-input-to-the-commission8217s-wacc-consultation-2018.

closely as possible taking into account also best regulatory practices where the Notice provides for NRAs' flexibility as well as drawing on the explanations of the SWD.

At the end of the introduction the structure of the Report will be outlined for a better understanding and easy reference.

Also, for an easy reference, the standard **WACC formula** as used in the WACC Notice[7] is shown hereafter:

$$WACC = R_E \times \frac{E}{D+E} + R_D \times \frac{D}{D+E}$$

$$R_E = RFR + ß \times ERP$$

$$R_D = RFR + \text{Debt Premium}$$

$$WACC = [(\frac{E}{D+E}) \times (RFR + ß \times ERP)] + [(\frac{D}{D+E}) \times (RFR + \text{Debt Premium})],$$

Where

R_E = the cost of equity (to be estimated using the Capital Asset Pricing Model (CAPM);

ß = beta;

ERP = the equity risk premium;

R_D = the cost of debt;

RFR = the risk-free rate;

Debt Premium = the additional return that lenders require from a company with a given credit risk, over and above the RFR;

E = the value of equity, with $\frac{E}{D+E}$ being the share of equity in the company value (D+E);

D = the value of debt, with $\frac{D}{D+E}$ being the share of debt in the company value (D+E); the share of debt in the company value is also called *gearing (g)*;

V = the value of the company, which is equal to the sum of debt and equity (V = D+E).

This is the first time that this Report is being produced by BEREC. BEREC has taken utmost care to develop this Report according to the best knowledge and technical expertise of its members based on their longstanding experience of applying regulatory principles[8] when setting the WACC in pricing decisions which are reported every year in a specific chapter of

[7] As set out in section 2 of the WACC Notice.
[8] For the regulatory principles see below section 1.2.1.

the BEREC Regulatory Accounting in practice Report.[9] Nevertheless improvements may be necessary in the future yearly update where deemed appropriate. Since this report is published yearly, BEREC can, in close cooperation with the Commission, update the data sources or methodologies (incl. 'technical choices') where needed if e.g. more data becomes available or significant changes are observed deeming relevant.

1.1. BEREC's tasks according to the WACC Notice

BEREC's tasks are described in para. 64 – 67 of section 7 of the Notice "Role of BEREC and the Commission in the calculation of WACC parameters". Acc. to section 7 BEREC in close collaboration with the Commission estimates the WACC parameters consistent with the approach described in the Notice. BEREC will estimate and publish the values on an annual basis for the parameters reflecting general economic conditions and the company-specific parameters for the selected peer group.

The parameters reflecting general economic conditions described in section 4 of the Notice consist of the **RFR** which will be estimated for each EU member state and a **single EU-wide ERP**. The single EU-wide ERP follows from the assumption of ultimately reaching a common EU capital market (para 38 Notice).

The company-specific parameters described in section 5 of the Notice consist of the following parameters: **equity beta, gearing, debt premium**, and the **cost of debt** (R_D), the latter being calculated indirectly as the sum of the **domestic RFR** and the **debt premium**. Given that the calculation of the cost of debt includes the *domestic* RFR the debt premium must also be estimated using (besides the relevant corporate bonds) corresponding government bonds of the *home country* of the company as a benchmark in order to avoid inconsistencies. This assumes an investor taking a "home country" approach or, in the context of the Notice, an EU rather than a global investor's perspective. The company-specific parameters will be estimated for each company of the peer group.

BEREC will prepare a list of companies suitable for the **peer group** by following the criteria for selecting the peer group as outlined in para. 44 of the Notice. BEREC will estimate the equity beta, gearing, debt premium and cost of debt for each company included in the list. Acc. to para. 67 BEREC will also describe factors justifying the removal of one or more companies from the "BEREC peer group" to take into account national specificities.

When estimating the parameters BEREC takes into account the assumptions common to several WACC parameters as described in section 3 of the Notice, namely the length of the averaging period and the averaging method. This ensures "internal consistency" of the estimations. Also to be consistent throughout all parameters the cut-off date is set at 1st April 2020 for this Report.

[9] For an overview of current NRAs' practices when setting the WACC cf. to the latest BEREC Regulatory Accounting in practice Report, WACC chapter (ch. 5), BoR (19) 240, publ. in Dec. 2019, https://berec.europa.eu/eng/document_register/subject_matter/berec/reports/8907-berec-report-regulatory-accounting-in-practice-2019-including-wacc-chapter.

BEREC will publish the estimated WACC parameter values and NRAs are assumed to take into account those parameter values when carrying out their own calculations for their national regulatory decisions, but they do have some flexibility within this framework to take account of national specificities. The Report is due to be published before 1st July 2020.

1.2. General principles

The work of BEREC is guided by the following three main principles:

- Follow the Notice as closely as possible, which mainly refers to the methodologies to be used for the estimations;
- Be transparent, using publicly available data where possible or using data which is widely used and accepted in the financial markets, which refers to the data sources to be used for the estimations;
- Explain every step of the calculation and proceed in a straightforward manner, which refers to the calculations as such.

The three principles are set out in the following sections. Taken together they serve to ensure a robust result on which NRAs can rely.

1.2.1. Follow the Notice as closely as possible

Following the Notice as closely as possible ensures that BEREC uses the methodologies of the Notice (and detailed in the SWD), i.e. BEREC is doing what it is asked to do. By applying the methodologies foreseen in the Notice BEREC contributes to a consistent application of the regulatory framework thus promoting a competitive internal market for electronic communications networks and services. More specifically, BEREC thus contributes to NRAs using a consistent calculation method for estimating the WACC by NRAs.

In this regard it is important to recall that in line with the objectives of the EU Framework, the Notice is based on four regulatory principles laid down in para. 8: (i) consistency in the methodology; (ii) predictability; (iii) promotion of *efficient* investment taking into account the risk incurred; and (iv) transparency of the method to determine the reasonable rate of return avoiding unnecessary complexity. When calculating the WACC NRAs equally observe these regulatory principles[10].

With regard to the methodological approach the Notice follows the financial market theory known as the Capital Asset Pricing Model (CAPM)[11]. This methodological approach to estimate the cost of equity is based on a number of assumptions. Generally, the application of any methodology requires making assumptions and choices to reflect the concrete situation

[10] Cf. also BEREC Position Paper – Input to the Commission's WACC consultation 2018, BoR (18) 67, publ. in Oct. 2018.
[11] Cf. Chapter 5 below for a description.

and specific purpose of the calculation.[12] In particular this is true for the estimation of WACC parameters, which is a very complex multi-dimensional process that in some instances imply that trade-offs must be solved one way or the other.

Thus, BEREC also had to make some 'technical' choices to be able to apply the methodologies foreseen in the Notice in a meaningful and consistent manner to reach robust results applicable by all NRAs. When making choices BEREC used the margin left in the Notice mindfully to stay in line with the Notice and financial market theory in these cases. Where these choices are made, they are made objectively and the reasons are explained in detail. BEREC followed the best regulatory practice stemming from the application of the CAPM which all NRAs already currently use when calculating the WACC.[13]

1.2.2. Be transparent, using public data where possible

The second principle relates to the ensuring that only reliable data is used for the estimations. The choice of the data sources used must be made transparent and explained explicitly. Whenever possible, preference was given to the use of publicly available data, in particular official EU data sources such as Eurostat and the ECB.

However, the estimation of certain parameters required specific financial market data, namely long term historic data series from Morningstar[14] necessary to estimate the single EU-wide ERP and data derived from the Bloomberg financial system[15] to estimate certain company specific parameters. Both data sources are widely used and accepted by financial market players. Access to this data has to be procured by the BEREC Office to be able to estimate the parameters and publish the results of the calculations based on this specific data. Being proprietary the data as such cannot be published. In order to be able to rely on this type of data BEREC needs to be sure it understands exactly how the data was compiled. BEREC therefore requested and received explanations from the providers on how the data was compiled and aggregated.

1.2.3. Explain every step of the calculation and proceed in a straightforward manner

The third principle relates to the calculation process as such. To ensure that all NRAs can easily understand and replicate the results of the BEREC calculations, every step of the estimation of each of the parameters is explained in detail and in a straightforward manner. Thus, NRAs will be able to follow the BEREC calculation steps from start to end and to fully

[12] In this case to estimate WACC parameter values reflecting the cost of capital (SMP) operators face across the EU when investing in telecoms infrastructure for the WACC calculations of NRAs.
[13] Cf. BEREC Regulatory Accounting in practice Report, ch. 5, BoR (19) 240, publ. in Dec. 2019.
[14] Morningstar provides a soft copy of the latest DMS data set (which itself is compiled by Dimson/Marsh/Staunton (DMS) and published yearly in hard copy by Credit Suisse/London Business School as the *Credit Suisse Global Investment Returns Yearbook*). For the calculations in this BEREC Report the 2020 version with data from 1900 through to 2019 was used, i.e. the data source is Dimson/Marsh/Staunton, Global Investment Returns Database 2020 (distributed by Morningstar Inc.). BEREC Office acquired the DMS data distributed by Morningstar Inc. for BEREC.
[15] BEREC Office acquired for BEREC access to Bloomberg financial system, which is henceforth referred to as Bloomberg.

understand the logic of the calculation process. This ensures that NRAs are confident that the results are robust and were derived using state of the art professional standards.

All results were cross checked and verified to ensure that no methodological mistakes have been made, no questionable data has been used and no calculation errors have occurred, so that BEREC was able to exclude any systematic bias. Only after these checks were carried out, BEREC was satisfied that the results were correct and NRAs will be confident to use them in their own WACC calculations.

1.3. Structure of the Report: parameter by parameter following the WACC formula

The introduction closes with a short overview of the structure of the report which largely follows the structure of the Notice which itself follows the WACC formula:

$$\text{WACC} = [(\frac{E}{D+E}) \times (\text{RFR} + ß \times \text{ERP})] + [(\frac{D}{D+E}) \times (\text{RFR} + \text{Debt Premium})].$$

Chapter 2 describes the estimation of the RFR.

Chapter 3 sets out the peer group and provides criteria that NRAs can use to remove peer group members to take account of national specificities.

In Chapter 4 the debt premium and the cost of debt is calculated for each member of the peer group.

In Chapter 5 the beta and gearing are estimated for each member of the peer group.

Chapter 6 contains the calculation of the single EU-wide ERP which is a key parameter and certainly the most complex to calculate. Therefore it is placed at the end of the Report.

Chapter 7 summarizes all results in an overview table for easy reference. Furthermore this chapter also touches upon taxes and inflation (section 6 of the Notice). It also contains a short section on possible future effects of the corona crisis.

2. RFR

2.1. Definition and data source used

The risk-free rate (RFR) is the rate of return an investor would expect to gain from investments in financial instruments that theoretically do not carry any risk of default, such as a government bond. However, even the safest investments may carry some risk of default.

In the CAPM the risk free rate is a parameter used to calculate the cost of equity and the cost of debt:

Cost of equity = Risk Free Rate + ß x Equity Risk Premium

Cost of debt = Risk Free Rate + Debt Premium

The established practice by most NRAs to date has been to calculate the risk free rate by using yields on 10-year domestic government bonds.[16]

BEREC's calculation of the risk free rate is based on data retrieved from Eurostat as the official publicly available source for EU data and referred to in para. 36 of the Notice. The Eurostat dataset is described as follows: "Long term government bond yields are calculated as monthly averages (non-seasonally adjusted data)"[17]. They refer to central government bond yields on the secondary market, gross of tax, with a residual maturity of around 10 years. The bond or the bonds of the basket have to be replaced regularly to avoid any maturity drift. This definition is used in the convergence criteria of the Economic and Monetary Union for long-term interest rates, as required under Article 121 of the Treaty of Amsterdam and the Protocol on the convergence criteria".[18]

2.2. Methodology with reference to Notice

BEREC uses yields on domestic 10-year government bonds for each Member State to calculate the risk free rate. The approach of using long-term bonds, which are less volatile than shorter-term bonds, is in line with the longer-term nature of investments in electronic communications networks. Moreover, it follows the Notice since the Commission underlines that the use of domestic government bonds, together with a consistent methodology, will

[16] BEREC Report, Regulatory Accounting in Practice 2019, Chapter 5.2.1 Risk Free Rate, Figure 9 Methodology used to estimate RFR (fixed market),BoR (19) 240, 5 December 2019.
[17] Online data code: TEIMF050.
[18] See further information on long-term interest rate statistics and convergence criteria for EU Member States: https://www.ecb.europa.eu/stats/financial_markets_and_interest_rates/long_term_interest_rates/html/index.en.html: Annex 1.

ensure that differences in risk free rates capture specific country-risks and reflect differences in financing conditions within the Member States.[19]

Eurostat provides the following description of how it derives this data: yields of long-term government bonds are provided on a monthly basis.[20] Only bonds with an outstanding amount of at least EUR 5 billion are included in the data.[21] The European Central Bank (ECB) provides the underlying data in line with their prescribed methodology.[22] The rates/yields are calculated as monthly arithmetic averages based on daily data provided by National Central Banks' official rates. Daily values are obtained from real trade, in line with the requirements stipulated by the ECB, with the benchmark bond, or imputed values from prior trades when no transactions with the benchmark bond have been made. The monthly values are calculated as an unweighted arithmetic average of daily yields.

Each EU Member State can select between a benchmark bond and a basket of bonds, issued by Central governments. The residual maturity should be as close as possible to 10 years as the recommended residual maturity of bonds should be between 9.5 and 10.5 years. Consequently, the bonds of the basket have to be replaced regularly in order to avoid a maturity drift.[23]

The benchmark bond should be sufficiently liquid and only yields on actively traded government bonds with a maximum bid-ask spread per quote of three basis points are included. The prices and yields are taken at close of market on the trading day.[24] The yield to maturity serves as a nominal long-term interest rate without any adjustments for coupon effects, taxes, or inflation. The rates are not subject to seasonal adjustments.[25] The risk free rates have not been adjusted for any quantitative easing programs in line with the Notice[26].

The averaging period BEREC uses for calculating each country-specific risk free rate is **five-years** and is based on monthly data retrieved from Eurostat. This is in line with the Notice on the calculation of the cost of capital, which highlights that this approach would strike the right balance between predictability and efficiency.[27]

[19] Cf. Notice and SWD.
[20] See https://ec.europa.eu/ eurostat/tgm/table.do?tab=table&plugin=1&language=en&pcode=teimf050. Metadata file on Eurostat: https://ec.europa.eu/eurostat/cache/metadata/en/irt_lt_mcby_esms.htm.
[21] Eurostat metadata, Monetary and financial indicators, 10.6 Documentation on methodology.
[22] See ECB background information on the full monthly time series of long-term interest rate data.
[23] Eurostat, https://ec.europa.eu/eurostat/cache/metadata/en/ei_mf_esms.htm#meta_update1570115961737.
[24] Eurostat metadata, Monetary and financial indicators, 10.6 Documentation on methodology.
[25] European Central Bank, Convergence Report, section 6.5. Link: https://www.ecb.europa.eu/pub/convergence/html/ecb.cr201805.en.html#toc8
[26] Section 4, para. 36.
[27] Notice, para 37.

2.3. Assumptions and choices made

The data used by BEREC has been retrieved from a reliable, publicly available official source (Eurostat, based on ECB statistical data). The ECB has highlighted the following data issues that impact the calculation period for the risk free rate selected by BEREC:[28]

Greece: There is no data available for July 2015 because the market was closed. Therefore, no value has been included for the month of July.

Estonia: Estonia has not issued any 10-year government bonds that comply with the definition of long-term interest rates for convergence purposes. Neither has the ECB been able to identify any suitable proxy indicator that could be used as an alternative. Consequently Eurostat has harmonised the data series for all the Member States apart from Estonia[29].

To remedy this lack of data for Estonia BEREC has decided to apply to Estonia the same Risk Free Rate as is applied to another EU country with similar country characteristics and credit rating.

Furthermore, some additional country specific issues have been itemised in the footnote.[30]

2.4. Calculation steps – description of how the result is derived

The determination of the Risk Free Rate per country is based on data published by Eurostat[31] and calculating a five-year arithmetic average of data from 1st April 2015 to 31st March 2020.[32]

---

[28] European Central Bank, Statistical Data Warehouse, Harmonised long-term interest rates for convergence purposes.

[29] See metadata file on Eurostat: https://ec.europa.eu/eurostat/cache/metadata/en/irt_lt_mcby_esms.htm

[30] In **Cyprus** primary market yields are reported up to April 2015, which means that the interest rate on 10-year Government Bonds were 6 per cent during the period January to April 2015, and subsequently dropped to 3.96 per cent in May 2015. In **Bulgaria** the calculation of the "Long-Term Interest Rate for Convergence Assessment Purposes" (LTIR) has been developed by the Bulgarian National Bank (BNB) in cooperation with the national Ministry of Finance and in compliance with the requirements of the ECB. Bulgaria has selected a benchmark approach, because it is a small market, and the liquidity of different bonds may be very diverse. The calculation of the LTIR is based on a database of the Bulgarian National Bank (BNB). The BNB informs the Ministry of Finance when a replacement of the benchmark bond takes place, i.e. when the benchmark bond no longer meets the requirements for residual maturity and another security. Daily values are taken from real trade, in line with the requirements of the ECB with the benchmark bond or an imputed value from prior trades when no transactions with the benchmark bond have been made. Monthly values are calculated as an unweighted arithmetic average of the daily yields. For **Germany** the Eurostat data is based on a time series provided by Deutsche Bundesbank (BBK01.WT00557) which consists of yields on listed Federal securities. It only includes bonds eligible as underlying instruments for future contracts and calculated as unweighted averages with a mean residual maturity of 9 and up to 10 years, with daily data. Source: www.bundesbank.de/dynamic/action/en/statistics/time-series-databases/time-series. In **Lithuania** - according to the Central Bank of Lithuania - the yields on 10-year government bonds provided by Eurostat may not be representing actual market values correctly. As a basis for the yields on 10-year government bonds Eurostat uses trades on Nasdaq Vilnius, but since there are few trades and the last known rate is used if no further trades are registered, yields reported may be based on outdated statistical data. Source: email of 07.02.2020 by Antanas Bumblauskis, Lietuvos Bankas. In **Slovenia** the Bank of Slovenia does not change the bond underlying LTIR statistics compilation immediately upon the issue of a new 10-year bond in combination with the criteria of volume of market transactions. Source: email of 07.02.2020 by Franc Otoničar, Banka Slovenije.

[31] Source Eurostat Long term government bond yields 2015M04 to 2020M03.

[32] Notice, paragraphs 27 and 29.

As mentioned above in section **Error! Reference source not found.**., due to lack of data, the risk free rate for Estonia has to be determined based on a corresponding EU country with similar country characteristics and credit rating. A country credit rating reflects the interest premium on private loans or government bonds due to the underlying risk associated with the country in question. Thus from the perspective of an investor, it represents a risk premium. The level of the risk premium is dependent e.g. on the general economy, political stability and credit worthiness of the country. These factors are considered by Rating Agencies such as Fitch, Moody's and Standard & Poor's for establishing the country risk rating. The rating usually corresponds with the credit rating for the country's government bonds. The five-year average has been evaluated considering comparable returns in term of credit rating along the time series. The result for Estonia has been derived from the average return of countries with comparable credit rating along a five-year time-window, also taking into account the evolution of the credit rating of Estonia.

Standard & Poor's (S&P) credit rating was used for this purpose.

Table 1 Country Economic Factors (Eurostat)

Country Code	Country	Number of inhabitants[33]	GDP per capita index[34]	Unemploy-ment[35]	HCPI[36]
AT	Austria	8,858,775	114.7	4.2%	106.98
BE	Belgium	11,455,519	113.5	5.2%	107.77
BG	Bulgaria	7,000,039	125.0	4.1%	104.99
HR	Croatia	4,076,246	111.9	7.2%	103.04
CY	Cyprus	875,899	110.0	6.4%	100.78
CZ	Czech Rep.	10,649,800	122.6	2.0%	107.80
DK	Denmark	5.806.081	117.7	4.9%	102.50
EE	Estonia	1,324,820	139.7	4.1%	110.50
FI	Finland	5,517,919	109.1	6.0%	103.58
FR	France	67,012,883	112.1	8.4%	104.95
DE	Germany	83,019,213	116.6	3.1%	105.50

[33] Source: Eurostat. Total population figure on 1st January 2019. Ireland: estimated. France: provisional
https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=demo_gind&lang=en

[34] Source: Eurostat Database: Main Gross Domestic Product (GDP) aggregates, GDP and main components (output, expenditure, income) Q4 2019. Index 2010 = 100. Unadjusted data (seasonally or calendar). Provisional for Bulgaria, Greece, Spain, Cyprus, Netherlands, Poland, Romania. Estimated for Portugal
https://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do

[35] Source: Eurostat. Unemployment rate Q4 2019.
https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=lfsq_urgan&lang=en

[36] Source: Eurostat. Harmonised Index of Consumer Prices (HICP) annual average Index 2019. Index 2015 = 100. Netherlands: provisional.
https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=prc_hicp_aind&lang=en

EL	Greece	10,724,599	86.0	16.8%	102.46
HU	Hungary	9,772,756	130.1	3.3%	109.46
IE	Ireland	4,904,240	177.3	4.5%	101.70
IT	Italy	60,359,546	100.6	9.9%	103.20
LV	Latvia	1,919,968	134.2	6.0%	108.53
LT	Lithuania	2,794,184	138.7	6.4%	109.47
LU	Luxemburg	613,894	129.4	5.8%	105.93
MT	Malta	493,559	166.3	3.2%	105.54
NL	Netherlands	17,282,163	114.0	3.3%	105.78
PL	Poland	37,972,812	153.9	2.9%	104.80
PT	Portugal	10,276,617	106.1	6.8%	103.71
RO	Romania	19,414,458	141.3	3.9%	108.15
SK	Slovakia	5,450,421	127.2	5.6%	106.33
SI	Slovenia	2,080,908	117.7	4.0%	105.11
ES	Spain	46,937,060	110.5	13.8%	104.26
SE	Sweden	10,230,185	120.5	6.3%	106.93
UK	United Kingdom	66,647,112	118.0	3.6%	107.80

2.5. Results

A **Risk Free Rate** based on a five year arithmetic average (April 2015 to March 2020) has thus been determined for each EU member state.

Table 2 BEREC Risk Free Rate EU Member States

Country Code	Country	Country Credit Rating[37]	5 year arithmetic average[38]
AT	Austria	AA+	0.46
BE	Belgium	AA	0.57
BG	Bulgaria	BBB	1.41
HR	Croatia	BBB-	2.53
CY	Cyprus	BBB-	2.58
CZ	Czech Rep.	AA-	1.16
DK	Denmark	AAA	0.32
EE	Estonia	AA-	1.09
FI	Finland	AA+	0.44
FR	France	AA	0.57
DE	Germany	AAA	0.17
EL	Greece	BB-	5.67
HU	Hungary	BBB	2.96
IE	Ireland	AA-	0.75
IT	Italy	BBB	1.96
LV	Latvia	A+	0.67
LT	Lithuania	A+	0.59
LU	Luxembourg	AAA	0.29
MT	Malta	A-	1.09
NL	Netherlands	AAA	0.37
PL	Poland	A-	2.93
PT	Portugal	BBB	2.16
RO	Romania	BBB-	4.06
SK	Slovakia	A+	0.66
SI	Slovenia	AA-	0.94
ES	Spain	A	1.30
SE	Sweden	AAA	0.49
UK	United Kingdom[39]	AA	1.25

[37] Source S&P via Bloomberg; it is also possible to get a free guest account with S&P that allows credit ratings to be researched.
[38] Source: BEREC average based on Eurostat Long term government bond yields 2015M04 to 2020M03, https://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&plugin=1&pcode=teimf050&language=en.
[39] The UK was a member state of the EU until 31st Jan. 2020.

3. Peer group

3.1. Definition and data source used

The peer group is defined by selecting are companies that fit the Commission criteria – see section 5.3.2.3 of the Staff Working Document.

The data source used to check if a company is listed on a stock exchange is Bloomberg.

3.2. Criteria from the Notice

BEREC has closely followed the criteria in the Notice and the Staff Working Document when deciding on which companies to include in the peer group. Section 5.3.2.3 of the Staff Working Document lists the following criteria for selecting the companies that should be included in the peer group.

The companies in the peer group:

- are listed on a stock exchange and have liquidly traded shares;
- own and invest in electronic communications infrastructure;
- have their main operations located in the Union;
- have an investment grade (credit rating BBB/Baa3 or above); and
- are not, or have not been recently, involved in any substantial mergers and acquisitions.

BEREC has applied these criteria as well as taking into account national specificities in preparing the list of companies included in the peer group of this edition. It has also examined whether or not, based on the five criteria, there are additional companies that should be added to the peer group.

3.3. Assumptions and choices for BEREC peer group

In the Staff Working Document the European Commission presented, by way of illustration, the following companies that it considered to be consistent with the criteria[40]:

[40] Table 25 of the SWD – “Electronic companies from relevant EU Member States with investment grade (2017)”.

Figure 1 Illustrative list of peer group companies in the SWD[41]

Company	Country	S&P rating
TDC A/S	DK	BBB-
Elisa Oyj	FI	BBB+
Orange S.A.	FR	BBB+
Koninklijke KPN	NL	BBB-
BT Group plc	UK	BBB+
Telenet	BE	BBB
Tele 2	SE	BBB
Telekom Austria	AT	BBB
Telecom Italia	IT	B+
Vodafone Group plc	UK	BBB+
Telia Company AB	SE	A-
Proximus S.A.	BE	A

Where possible BEREC has followed the illustrative list of companies provided by the European Commission. BEREC has further assessed the criteria concerning national specificities and considers that two criteria require further refinement:

Companies have their main operations located in the Union

A strict application of this criterion without consideration of national specificities could result in the exclusion of companies that generate a substantial proportion of their turnover in the Union. BEREC considers that, over the five-year period on which the parameters are based, where:

(a) a company's headquarters are located in the Union and therefore major strategic decisions are taken within the Union; and

(b) a substantial proportion of a company's revenue is generated within the Union

these companies should be included in the peer group.

In addition, this will allow the home country (domestic) debt premium to be estimated for a wider range of countries. As a result NRAs will have a wider selection of companies/countries that are closer to their national specificities.

Companies have an investment grade (credit rating BBB/Baa3 or above)

A review of the company credit rating at a particular point in time could result in certain companies being included in one period's peer group and excluded from the next in case they have not at least an investment grade rating. BEREC considers that it is more appropriate to consider the investment grade status of a company over a five-year period and that if a company has had an investment grade rating in four of the five years it would qualify under this criterion. The choice of a five-year averaging period is also consistent with the averaging periods in the Notice[42]. BEREC considers that where the asset beta is to be determined it is

[41] The illustrative list of the SWD has been used as the starting point, but is subject to adjustments (as explained hereafter).
[42] Notice, para. 27.

important to get a representative sample from across the Union. Once a company's equity beta is unlevered the underlying asset beta should not be dependent on the gearing of the company but represents how the risk of its assets is assessed relative to the index being used for beta estimation.

As a conclusion from the above considerations it follows that if a company meets four of the five criteria (as modified) it is considered appropriate for inclusion in the peer group. However, a company must meet criterion 1 "*are listed on a stock exchange and have liquidly traded shares*" as a prerequisite for inclusion as otherwise no equity market data is available.

Adjustments to the peer group in the Staff Working Document

As ***TDC*** (Denmark) is no longer listed on the stock exchange it no longer qualifies as a peer group member.

Deutsche Telekom (Germany) and ***Telefónica*** (Spain) have been added to the SWD's illustrative peer group due to national specificities. While these companies have significant operations outside of the Union both have their headquarters and boards of directors within the Union. Therefore, all major strategic decisions are taken and significant proportions of their total revenues are generated within the Union. BEREC considers that this qualifies them for inclusion within the peer group.

BEREC considers that ***NOS*** (Portugal) should also be included in the peer group as it meets each of the five criteria. BEREC notes recent judicial proceedings against significant shareholders in NOS[43] but makes no further comment in this regard[44].

BT Group plc (UK) is currently included in the peer group as the United Kingdom was still a member of the EU for a significant part of the five year period on which parameters are based. Furthermore, it continues to have activities in countries who are members of the European Union[45].

Vodafone Group plc (UK) is also included in the peer group. While it is currently headquartered in the United Kingdom it continues to have extensive activities in several EU member states and derives four times the revenue from operations in the EU in comparison to its UK operations.[46]

BEREC also examined other fixed line operators for possible inclusion in the peer group. However, when applying the five criteria above (as modified) none met the minimum requirement of complying with at least four of the five criteria and were therefore excluded. While it noted that some companies in Central and Eastern Europe are publicly traded they do not have a five year trading history and therefore are not included (for example, DIGI Communications N.V. has been publicly traded since May 2017). BEREC considers that their

[43] https://www.bloomberg.com/news/articles/2020-04-05/lisbon-court-seizes-nos-stake-held-by-angola-s-dos-santos

[44] BEREC is aware that the conduct of judicial proceedings may affect the future tradability of NOS shares.

[45] https://www.totaltele.com/505423/Negotiations-for-sale-of-BT-Ireland-fall-through

[46] Vodafone Group Plc. FY10 Preliminary results of 12th May 2020, https://investors.vodafone.com/static-files/4e32c6fe-6335-49e1-904f-6808e7d42bed.

inclusion may be possible once they have a five year stock exchange trading history and debt investment grade status of at least four out of five years.

BEREC also considers that insufficient data is currently available to incorporate into the peer group companies from Central and Eastern Europe. In order to ensure that the peer group is representative of the entire EU, BEREC also examined whether or not the members of the peer group had significant investments in fixed line operators in Central and Eastern Europe (for example Magyar Telekom is majority owned by Deutsche Telekom. Furthermore, Magyar Telekom does not have a credit rating[47]). In doing so BEREC considered that where this is the case the peer group members' parameters would also incorporate some of the underlying parameters of its investments. Many members of the peer group were found to have made significant investments into Eastern European fixed line operators.[48] While BEREC notes that it does not offer a one-to-one comparison, it does offer some assurance that telecom assets in Central and Eastern European companies are included in the overall calculations of beta and also debt premiums. BEREC expects that as Central and Eastern European capital markets become more mature over time, more data will be available in the future which will allow the incorporation of companies from this region into the peer group. This will be assessed on an annual basis.

When assessed against the STOXX Europe Total Market Telecommunications index[49], which lists all possible candidates for a peer group that would be representative of the European Telecommunications Market, the BEREC peer group would represent circa 80% by market capitalisation of the STOXX Europe Total Market Telecommunications index.

3.4. Result: BEREC peer group 2020

Therefore, based on both the criteria and national specificities the **BEREC peer group 2020** is shown in Table 3.

Table 3 BEREC peer group 2020

Company	Country	S&P rating as of 22 April 2020	Rating last reviewed by S&P	Stock Symbol
BT Group plc	UK	BBB	20 Sept. 2019	BT/A LN
Deutsche Telekom-AG	DE	BBB+	01 April 2020	DTE GR
Elisa Oyj	FI	BBB+	26 March 2020	ELISA FH

[47] Magyar Telekom initiated withdrawal of credit ratings, https://bbj.hu/business/magyar-telekom-initiated-withdrawal-of-credit-ratings_33623. For more information on Central and Eastern European incumbents see also https://www.brodynt.com/incumbent-telecom-operators-in-europe/.
[48] Cf. below Chapter 7, Table 12.
[49] https://www.stoxx.com/index-details?symbol=BTEP.

Koninklijke KPN N.V.	NL	BBB	13 March 2020	KPN NA
NOS	PT	BBB-	27 March 2020	NOS PT
Orange S.A.	FR	BBB+	27 Sept. 2019	ORA FP
Proximus S.A.	BE	A	10 April 2020	PROX BB
Tele 2	SE	BBB	25 Nov. 2019	TEL2B SS
Telecom Italia	IT	BB+	28 Oct. 2019	TIT_MI
Telefónica	ES	BBB	01 April 2020	TEF SM
Telekom Austria	AT	BBB+	10 April 2020	TKA AV
Telenet	BE	BB-	29 July 2019	TNET BB
Telia Company AB	SE	BBB+	20 January 2020	TELIA SS
Vodafone Group plc	UK	BBB	01 August 2019	VOD LN

National Specificities

BEREC also considers that NRAs, in order to reflect national specificities should where necessary amend the companies included in the peer group by selecting those that are most reflective of their national specificities. In accordance with paragraph 67 of the Notice this may involve removing companies from the peer group (but not adding any).

Where possible NRAs should also maintain a peer group that is as wide as possible using the companies in Table 3 being representative of the national specificities.

According to para. 67 and in order to avoid "arbitrary" choices BEREC considers it justified to remove peer group members from the list primarily for the following reasons:

(a) Certain companies in the peer group may not reflect the size of the SMP operator in the particular member state. For example, it may be inappropriate to include a very large company in the peer group if its scale is significantly greater than the SMP operator or the member state itself has a relatively small population[50];

[50] The size of an operator could be based on Market Capitalisation. However, the use of a country specific size premium is not considered appropriate.

(b) Competition conditions within the electronic communications sector, and in particular infrastructure-based competition, may vary between member states increasing risk for both SMP and OAO operators (access seekers and wholesalers).[51] For example the presence of a significant cable operator could present particular competitive conditions in one member state that may be absent from another;

(c) The share of regulated vs non-regulated revenues of peer group members may vary. Indeed as mentioned by the Brattle report[52], regulated telecommunication activities could be seen to be less sensitive to changes in the economy than those of an average firm with non-regulated activities;

(d) The scope of segments of activity (i.e. mainly mobile, mainly fixed, mainly TV, combined, etc.) of certain companies in the peer group may differ significantly from the SMP's types of business to an extent of not being representative.

BEREC does not consider it appropriate to exclude companies from the peer group on the basis of the credit rating or risk free rate of the member state. These may not be directly comparable to conditions experienced by the SMP operator in the member state.

4. Debt premium and cost of debt

4.1. Definition and data source used

The cost of debt is defined as the interest or financial cost paid by a company on its debt. It can be expressed as the sum of the risk-free rate and a debt premium:

Cost of debt = Risk Free Rate + Debt Premium

The debt premium is the additional return lenders or investors require for a company above the risk free rate. The level of the debt premium depends to a large degree upon the perceived credit risk and credit rating. The debt premium can be estimated by using the yields on corporate bonds above the interest rate on long-term government bonds. The debt premium is calculated as:

Debt premium = Cost of debt - Risk Free Rate

In order to calculate the debt premium BEREC assesses, in line with established practice, the yield on long-term corporate bonds above the risk free rate. Although BEREC strives to use the same averaging period (five years) and maturity (ten years) as for the calculation of the

[51] See Digital agenda Scoreboard "New entrant subscription - using own infrastructure or the incumbent network" indicator, https://ec.europa.eu/digital-single-market/en/desi, Connectivity report slide 22.

[52] See Brattle report (2016), p50: https://op.europa.eu/fr/publication-detail/-/publication/da1cbe44-4a4e-11e6-9c64-01aa75ed71a1/language-en. The Brattle report "Review of approaches to estimate a reasonable rate of return for investments in electronic communications networks in regulatory proceedings and options for EU harmonization" is a study for the Commission.

risk free rate, the secondary market for corporate bonds has different characteristics compared to the market for government bonds. Companies issue corporate bonds in order to raise capital, but given that market conditions vary over time they are not necessarily issued with a regular frequency, they could use different currencies in order to respond to investor interest, and some companies use the bond market to a less extent as they use other sources to obtain capital.

The data sources used for the calculation of the debt premium are Bloomberg (Cost of Debt) and Eurostat (Risk-Free Rate). Bloomberg is extensively used in the financial and corporate sector. Eurostat provides data on the risk-free rate by using the long-term government yields.

4.2. Methodology with reference to Notice

Deducting from corporate bond yields the risk free rate with similar maturity and the same currency is the established method to calculate the debt premium. It is in line with the Notice, which states to add the domestic risk free rate to the debt premium.

Moreover, it is also commonly used among NRAs for deriving the debt premium for the WACC applicable for the SMP operator according to the BEREC report on Regulatory Accounting in Practice 2019[53].

Altogether, BEREC estimates the debt premiums for the companies in the peer group from which NRAs can select the appropriate value for their SMP or regulated operator (having regard to its characteristics) and adds this to the estimated domestic RFR to derive the cost of debt.

4.3. Assumptions and choices made

In calculating the debt premium and cost of debt, BEREC has made some assumptions in order to carry out its designated task:

- Considering that the capital market is global, companies use different currencies when they issue corporate bonds according to their needs, market characteristics, and investor interest. However, the calculations of the debt premium is limited to corporate bonds that have been issued in the domestic currency, which primarily is EUR, apart from a few exceptions, in order to be able to match domestic long term government bonds.
- The five-year averaging window, where available, will cover the period from April 2015 to March 2020, however the maturity year of the bonds must be within the period from April 2026 - March 2034. BEREC has chosen this maturity period of the bond for the following reasons:

[53] https://berec.europa.eu/eng/document_register/subject_matter/berec/reports/8907-berec-report-regulatory-accounting-in-practice-2019

- Striving to be as close as possible to a 10 year residual maturity.
- Avoiding excluding too many corporate bonds.
- Assuming a bias for the longer maturities rather than for the shorter ones in order to balance the fact that the yield curve by maturity period shows an exponentially decreasing rather than a linear form[54].

- The above takes into consideration that companies issue corporate bonds depending upon demand for capital and market conditions, which vary over time. Consequently, it is not possible to apply a strict five-year averaging window for all bonds as they have been issued at different times resulting in different periods with a maximum of five years for calculating the average bond yields.

BEREC has, based on the above-mentioned criteria, included as many corporate bonds as possible issued by the peer group companies. However, some companies only have few traded corporate bonds, or only a single one, which means that the underlying data sample varies between the different companies in the peer group[55].

All things considered, BEREC concludes that this approach is in line with the Notice.

4.4. Calculation steps – description of how the result is derived

BEREC has retrieved data for the corporate bonds from Bloomberg. The following steps have been undertaken:

1) Identify corporate bonds that have been issued in the domestic currency by the companies in the peer group that have 7-15 year residual maturity (maturity year within April 2026 - March 2034), and which are traded on the secondary market.

2) Identify government bonds that match each corporate bond, that have been issued by the respective governments, which have 7-15 year residual maturity (maturity within April 2026 - March 2034), and which are traded on the secondary market. This facilitates the establishment of pairs of bonds consisting in a corporate bond compared with a domestic government bond.

3) Provide a description of each bond pair, both the corporate and government bonds, with the following details:

[54] https://www.ecb.europa.eu/stats/financial_markets_and_interest_rates/euro_area_yield_curves/html/index.en.html

[55] In the case of NOS, it has not issued any bond which meets the criteria set in the section 4.3. That is why for that company the two corporate bonds included in the calculations mature in 2023 and 2024, respectively, as it is shown in Annex 2. At the same time in order to ensure consistency to the debt premium calculation the government bonds used for NOS have a similar maturity to the corporate ones, 4-5 years. In addition, those two corporate bonds were issued in 2018 and 2019, respectively, and subsequently the averaging window is less than two years.

a. ticker, which is the label and identifier for each bond which is used in the secondary market, including information about when the bond matures,

b. date when the bond was issued,

c. currency used for the corporate bond and its nominal value,

d. coupon, which is the annual interest payment a bond holder receives from the issuer until the bond matures,

e. ISIN (International Securities Identification Number), which is an identification number for the corporate bonds.

4) Retrieve data from Bloomberg for the maximum period 1 April 2015 up to 27 March 2020 based on weekly data for identified corporate bonds and benchmark government bonds for the following parameter:

- Mid Yield to Maturity (*YLD_YTM_MID* in Bloomberg), which is the yield of a fixed income security that will solve for the mid-price when valuing the security to maturity. It is the total return anticipated on a bond if the bond is held until it matures. Yield to maturity is considered a long-term bond yield and is expressed as annual return, which could be described as the internal rate of return (IRR) of an investment in a bond if the investor holds the bond until maturity, with all payments made as scheduled and reinvested as the same rate.

  Bloomberg provides a weekly value for the mid yield to maturity for each bond, which facilitates for BEREC for each pair to deduct the value of the government bond from the value of the corporate bond on a weekly basis. This gives a debt premium on a weekly basis.

5) Subsequently, BEREC calculates the arithmetic average of the difference between each bond pair for an averaging period up to five years.

6) The debt premium for each company is calculated as an arithmetic average of the difference between all the identified bond pairs, consisting of a corporate bond and a matching domestic government bond. All of this depends on the availability of corporate bonds that fulfill the above listed criteria.

On the whole, this gives a value for the debt premium for each company in the peer group as input for calculating the cost of debt:

Cost of debt = Risk Free Rate + Debt Premium.

In order to make the calculation complete the domestic risk free rate is added, which gives the cost of debt for each company.

4.5. Results

All in all, the results are presented in Table 4.

Table 4 Debt premium and Cost of debt

Company	Debt premium (basis point)	Domestic RFR	Cost of debt
BT GROUP PLC	167	1.25%	2.92%
DEUTSCHE TELEKOM AG	131	0.17%	1.48%
ELISA OYJ	100	0.44%	1.44%
KONINKLIJKE KPN NV	117	0.37%	1.54%
NOS	42	2.16%	2.58%
ORANGE	87	0.57%	1.44%
PROXIMUS	89	0.57%	1.46%
TELE2 AB-B SHS	178	0.49%	2.27%
TELECOM ITALIA SPA	161	1.96%	3.57%
TELEFONICA SA	45	1.30%	1.75%
TELEKOM AUSTRIA AG	81	0.46%	1.27%
TELENET GROUP HOLDING NV	302	0.57%	3.59%
TELIA CO AB	150	0.49%	1.99%
VODAFONE GROUP PLC	170	1.25%	2.95%

Remarks on results

The calculations of the debt premium are in line with the Notice and the results merit some comments in order to put them into context.

In fact, a home country approach is taken, where the corporate bonds are compared only with the respective domestic government bonds, assuming the latter in each case are the Risk-Free Rate. Therefore, in this approach the debt premium accounts for the risk associated with the country where each company is based instead of following an approach where a more speculative-oriented debt premium is reflected from diversified portfolios in different countries and sectors as commonly a financial investor does.

Given that the mid yield to maturity of the corporate bonds have been compared with the mid yield to maturity of the domestic government bonds, this could not fully reflect the international investor perspective and will be dependent on how the capital market assesses the value of the government bonds. This means that the debt premiums for international companies based on high RFR countries are significantly lower compared with what would have been if the calculations had been based on benchmark bonds regularly used by Bloomberg, this is, German government bonds.

Since the approach excludes corporate bonds issued in non-domestic currencies the results could not exactly show how companies are raising capital on the international market, which could have an effect on the estimated debt premiums. This does not apply for the Swedish companies Tele2 and Telia Company. Both have not issued corporate bonds in the domestic currency (SEK) and this is why these bonds (issued in euros) have been compared with German government bonds.

In addition, some of the peer companies like Elisa, KPN, Proximus, Tele2, Telekom Austria, Telenet and Vodafone have only a very limited number of traded corporate bonds in domestic currencies in combination with the fact that the residual maturity of some of the bonds is short. Altogether, these aspects should be born in mind when evaluating the result presented in the above table.

5. Beta and gearing

5.1. Definition and data sources used

According to Capital Asset Pricing Model (CAPM) the cost of equity considers that a particular relation holds between the level of risk of a company and the level of risk within the whole economy. The level of systematic risk[56] due to macro-economic conditions related to the increment of the interest rates as well as risk related to the demand, affecting all companies in the economy is described by the relation:

$$\text{Cost of equity } (R_E) = \text{Risk free rate } (RFR) + \text{beta\_Equity} \times \text{Equity risk premium } (ERP) \quad (1)$$

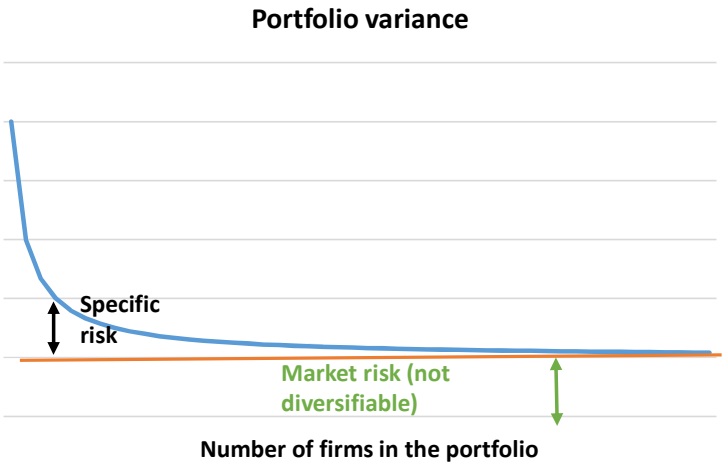
The idea behind the CAPM model is that, in a competitive market, the expected risk premium in an asset varies with respect to the risk free rate in direct proportion to “beta”. The beta is the measure of the risk contribution of an individual security to the risk of a well-diversified portfolio. Stocks with betas between 0 and 1 tend to move in the same direction of the market as a whole, but not as far. Stocks with betas greater than 1.0 tend to amplify the overall movements of the market.[57]

Formally the risk of a portfolio is described by the variance of the return and covariance of the return between each security included. If the number of the stocks (N) included in the portfolio increases with equal proportion of capital invested in each security, the level of the risk of the portfolio measured as the variance of the portfolio itself becomes mainly proportional to the covariance of the stocks between each other and not on the variance of each security included (Figure 2). If ideally the average covariance of a portfolio becomes equal to 0 all risks by holding a sufficient number of securities will be eliminated. Unfortunately, common stocks move together, not independently so a market risk is the one that cannot be diversified. So, the risk of a well-diversified portfolio depends on the market risk of the securities included in the portfolio. The market risk is proportional to the average beta included in the market portfolio. Formally this can be understood calculating the variance of the portfolio that is equal formally to:

[56] Systematic Risks are non-diversifiable market risks in contrast to non-systematic risk relating to the risk associated with individual shares. CAPM serves to measure the systematic risk.
[57] Bready, Myers, Allen, “Principle of corporate finance”, 11th Edition (2014).

$$\text{Portfolio variance} = \sum_{i=1}^{N} \sum_{j=1}^{N} x_i x_j \sigma_{ij} \qquad (2)$$

Figure 2 Portfolio variance



Where x_i x_j are the proportions of the resources allocated for each security, and σ_{ij} the covariance between the stocks "i" and "j" included in the portfolio. In other words, the contribution of stock "i" to portfolio risk is equal to the relative size of the holding (x_i) times the average covariance between stock 1 and all the stocks in the portfolio.

To evaluate the relative contribution to the portfolio risk of each security we need to divide the average covariance with the portfolio variance. This ratio formally describes the relative contribution to the risk of the portfolio and it is exactly the beta:

$$\beta_i = \frac{\sigma_{i,m}}{\sigma_m^2} \qquad (3)$$

Where $\sigma_{i,m}$ is the covariance of the stock with respect to the market portfolio and σ_m^2 the variance of the market portfolio itself.

Generally, the higher the value of the beta is, the higher the uncertainty about the returns on a firm's equity with respect to the reference market considered.

Companies with high equity betas tend to have high business risk and/or high financial risk such as:

- Non-diversified businesses with revenues, earnings and cash flows that are highly sensitive to economic factors;
- Highly geared, capital intensive businesses that have a large proportion of fixed operating costs (increasing the volatility of operating and net cash flows);
- Early stage or start-up ventures.

The average beta of the market should be equal to one and this can be effectively addressed considering a portfolio that is the wider as possible approaching the corresponding whole market. From a technical point of view the equity beta of a company/asset is estimated through

a regression analysis, i.e. by measuring the relationship between the returns of that company's shares and the returns of a market index, which is meant to approximate the whole economy.[58]

Given the above, the corresponding risk of an asset to the portfolio will depend also on the **financial leverage** or **'gearing'** of the firm.

As the Notice suggests to estimate the equity beta in the CAPM model from a "peer group" of companies it is relevant, in this case, to make reference, for fair comparison of the systematic risk, to an unlevered beta or asset beta from the observed equity beta of each peer. The use of asset beta will ensure that actual differences in underlying business risks (systematic risk) are compared between peers removing from the betas differences in financing decisions.

The main elements to estimate the equity beta are:

i) the methodology (Bottom-up/notional vs SMP operator);
ii) time horizon and sampling period for the estimation of the formula;
iii) market index;
iv) adjustment of the beta;
v) the unlevering formula to get the asset beta.

For beta estimation the return of the security of each company should be calculated with a daily, weekly or monthly sampling period. A corresponding return of a market index in accordance with portfolio theory should be chosen. For the estimation of the asset beta of each peer an unlevering formula should be considered that need also the gearing estimation of each company. So, the gearing is faced in this section of the report due the fact that it is strictly related to the asset beta estimation.

The gearing (g) is a measure of a company's financial leverage. It compares the amount of debt financing to the amount of the value of the company. This parameter is relevant in the WACC formula as it provides the weight for the cost of debt and the complement (1-g) the weight for the cost of equity, but it is also strictly related to the estimation of the final equity beta as it is used in the formula for levering and re-levering the beta as already mentioned.

The "gearing" (g), in accordance with the Notice, is formally considered as the relative weight of debt on the overall firm value, in formula as:

$$g = \frac{D}{D + E}$$

This measures the company's **financial leverage** and shows to what extent its operations are funded by lenders as opposed to shareholders.

The main points for the gearing estimation are the following: i) kind of approach for the estimation of the debt and equity component (market vs book values); ii) kind of debt that can be considered in the debt component; iii) time windows and sampling period of the estimation as for the other main parameters (RFR, beta, cost of debt) of the WACC.

[58] See Notice, para. 45.

5.2. Methodology with reference to Notice

Following the Notice the approach to estimate the equity beta should be the following:

- Estimate the equity beta for each company in the group of EU companies, which form the peer group;
- Estimate the gearing level for each company in the peer group;
- Derive the asset betas from each company in the peer group, including the SMP operator (using the equity beta and gearing level for each company);
- Relever the asset beta to obtain the final equity beta.

BEREC will provide the data for asset beta and gearing for each company of the peer group, from which the corresponding ranges of values for each parameter can be used for estimating the final equity beta in the WACC formula by each NRA.[59]

The Notice states that the equity beta calculation should use weekly data, a sampling period of, and a time windows of five years, which is in line with the time window used for the calculation of the risk free rate (RFR).

Moreover, the Notice highlights that no adjustments to the equity beta calculation should be done with methods such as Blume,[60] Dimson[61], Vasicek[62]. The Commission doubts that these adjustments would improve the efficiency of the beta estimator and are likely to make the regulator's approach more complex and less transparent.[63]

The Commission, in line with portfolio theory, suggests to use a wide index[64] which in this case is an EU index rather than a domestic market index and favours the STOXX Europe TMI also in line with the provision regarding the EU-wide Equity Risk Premium.

Moreover, for the estimation of the beta the levering and unlevering formula is crucial.[65]

A company's financial structure, in fact, has an effect on its equity beta. In particular, financial leverage increases the risk of company's share. For this reason, and in order to be able to compare a company's equity beta to that of other companies, it is common to estimate an asset beta from the company's equity beta. When estimating the equity beta in the WACC

[59] See SWD, page 86.
[60] The adjustment of the Blume formula relies on the idea that over the long term companies should tend towards a beta of 1 (e.g. firms that survive in the market tend to increase in size over time, become more diversified and have more assets in place, which should push betas towards 1) and adjusts the estimated company beta towards 1.
[61] Dimson corrects for distortions in the beta estimation when using daily returns due to the potential for mismatch between the changes in the market index and the reaction of the company's stock to these.
[62] The Vasicek formula is similar to the Blume adjustment, except that it does not assume a tendency of the beta to go to 1, but rather towards an industry average or some other prior expectation of beta, and the extent of the adjustment depends on the standard error of the observed beta.
[63] See SWD, page 80, and BEREC Regulatory accounting in practice 2019, page 28.
[64] In the CAPM framework the market portfolio includes all risky assets, in proportions defined by their relative market values.
[65] Most NRAs unlever and re-lever the beta to take into account financial leverage in the final estimation of the beta, see WACC chapter of the "BEREC regulatory accounting in practice report 2019", page 28, https://berec.europa.eu/eng/document_register/subject_matter/berec/reports/8907-berec-report-regulatory-accounting-in-practice-2019.

formula from the peer group, one must first assess the effect of financial leverage on the observed equity betas (so-called 'levered betas') by calculating the unlevered (or asset) betas.

The Notice suggests to use the formula known as "Miller Formula"[66]:

$$\beta_A = \beta_E \frac{E}{D+E} + \beta_D \frac{D}{D+E}$$

With reference to the beta debt the Notice considers that it entails significant difficulties to be estimated. The reason is the illiquidity of the biggest part of the traded bonds, which means that an estimation of debt betas as the covariance between bond yields and market returns can give incorrect results). For this reason, the Commission suggests to lever and re-lever the beta including a beta debt of 0.1.[67]

With respect to the gearing the Notice provides the following: the Equity component should be measured considering the market value obtained as the product of the price of the share and the number of outstanding shares for each company. The motivation behind this is related to the fact that it is the market value of equity that measures the future earnings potential of firms and their ability to sustain debt.

As the level of liquidity of corporate bonds could be low, the book value of the debt is a good approximation of the market value of the debt. With respect to the kind of debt to be considered to be consistent with a market value evaluation the Notice suggests using only long term debt as all the short term debt are generally netted off by the cash. As long-term debt the Commission considers it relevant to also include capital lease obligation.

5.3. Assumptions and choices made

BEREC estimates the asset beta and corresponding gearing of the 14 peer group companies that fulfill the Commission's selection criteria as reported in chapter 3 above. In this section the equity beta, gearing and asset beta are evaluated from raw data on equity prices of shares obtained on weekly basis of each peer and the corresponding price of the STOXX Europe TMI. The raw data have been obtained from Bloomberg.

The equity beta for each peer of the group is estimated regressing the variation of the shares price on a weekly basis with the corresponding variation of the price of the market index, the beta is obtained using OLS estimator.

The asset beta is derived applying the Miller formula including a beta debt of 0.1 as suggested by the Notice. The gearing is derived from the spot gearing evaluated on a weekly basis using a five years' time window.

A standard statistical test has been carried out and liquidity merit figures have been calculated to provide transparency on the data consistency for the equity beta estimation (see Annex 3). Testing for statistical criteria and liquidity in this context is relevant to check the efficient market

[66] The formula proposed is the one used by most NRAs as reported related to beta in op. cit., page 28.
[67] See SWD, page 85.

assumption of CAPM, which is useful for the final quotation of the peer group and asset beta range estimated.

5.4. Calculation steps – description of how the result is derived

For each comparable operator the information on the equity beta, gearing and asset beta has been derived.

The equity beta is calculated regressing the return of each the company with the return of the STOXX Europe TMI.

The STOXX Europe TMI covers approximately 95 percent of the free float European market capitalization (generally more than 1400 peers from different economic sectors) across 17 European countries: Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

The calculation is derived on a weekly sampling period, in line with the Notice.

The weekly estimation for the equity beta and the Equity component of the gearing is derived from the daily data selecting the information of the last price of the security and the corresponding price of the market index of one trading day for each week that is included in the time window.[68] For a time window of five years 260 points are collected from 1 April 2015 to 1 April 2020.

The gearing has been evaluated from five year average of the spot gearing taken at weekly frequency. Gearing is evaluated using book value of the net debt, for five years annual data. The net debt is equal to the Short-term Debt plus Long-term Debt minus Cash and Cash Equivalent.[69] The Commission states that "short term loans and liabilities are likely to be offset by short-term assets such as cash and cash equivalents"[70] and that it would seem appropriate to estimate the gearing using the book value of the firm's net debt, including the value of financial leases (capital lease). This is also the approach most frequently used by NRAs[71]. According to this approach for the book value of the debt component only long term debt[72] and capital lease[73] will be included as proxy of the net debt definition.

Specifically, this assumption on the definition of the net debt is partially fulfilled: in fact the ratio between "Cash" and "Cash Equivalent" with respect to the current liabilities "Notes Payable/Short Term Debt" and "Current Portion of Long Term Debt/Capital Leases" from the balance sheet of each peers is about 0.79 on average even excluding some outliers operators.

---

[68] The net return have been evaluated as r_t=P_t/P_(t-1)-1, with P_t the last price of the current trading day of one week and P_(t-1) the last price of the selected trading day of the week before for both the company and the market index (Friday and days before of the week have been considered as the last trading day of the week).
[69] Net Debt = STD+LTD−CCE.
[70] SWD, page 87.
[71] See Regulatory Accounting Report 2019 (BoR (19) 240), WACC chapter.
[72] Not including pension liabilities.
[73] A capital lease is a contract entitling a lease holder to the temporary use of an asset, and such a lease has the economic characteristics of asset ownership for accounting purposes. In comparison operating leases are recorded only as operating expenses. The capital lease requires a lease holder to book assets and liabilities associated.

At the same time, Bloomberg provides gearing data based on the book value of debt and the market value of equity. Debt also includes finance leases. Cash is not netted off.

Table 5 Ratio between Cash and Cash Equivalent in relation to current liabilities[74]

Peer Group	2019	2018	2017	2016	Average
BT GROUP PLC	0.79	0.23	0.20	0.27	0.37
DEUTSCHE TELEKOM AG-REG	0.41	0.43	0.48	0.72	0.51
ELISA OYJ	0.69	0.56	0.50	0.13	0.47
KONINKLIJKE KPN NV	0.71	0.81	47.56	1.60	12.67
NOS	0.09	0.01	0.01	0.01	0.03
ORANGE	0.68	0.47	0.53	0.75	0.61
PROXIMUS	2.86	2.74	0.58	0.73	1.73
TELE2 AB-B SHS	0.10	0.06	1.41	0.09	0.42
TELECOM ITALIA SPA	0.83	0.34	0.76	1.00	0.73
TELEFONICA SA	0.58	0.61	0.56	0.26	0.50
TELEKOM AUSTRIA AG	0.92	0.16	355.07	0.91	89.27
TELENET GROUP HOLDING NV	0.33	0.17	0.11	0.71	0.33
TELIA CO AB	0.58	1.37	3.81	1.61	1.84
VODAFONE GROUP PLC	2.68	0.45	0.73	0.64	1.13
Average excluding KPN,TA,NOS					0.79

Public data from Balance sheet of operators

The equity component of the gearing is evaluated weekly from the number of outstanding shares times the last price value of the share in the relevant trading day. The information is taken from Bloomberg.

5.5. Results

In the following the results for the **equity beta, asset beta and gearing** for each of the peers is shown in Table 6 below. The asset beta is evaluated following the formula provided in the Notice:

$$\beta_A = (1-g)\left(\beta_E + \frac{D}{E}\beta_D\right)$$

The results are given with β_D (beta debt) equal to "0.1".

[74] "Notes Payable/Short Term Debt" and "Current Portion of Long Term Debt/Capital Leases". Source: Operator's balance sheets.

Table 6 BEREC peer group 2020 – Equity beta, Gearing, Asset beta

Company	Equity Beta	Gearing	Asset beta
BT GROUP PLC	0.65	33.14%	0.47
DEUTSCHE TELEKOM AG	0.91	42.57%	0.57
ELISA OYJ	0.59	13.51%	0.52
KONINKLIJKE KPN NV	0.72	38.75%	0.48
NOS	0.77	25.80%	0.60
ORANGE	0.85	43.99%	0.52
PROXIMUS	0.74	19.48%	0.62
TELE2 AB-B SHS	0.80	16.64%	0.69
TELECOM ITALIA SPA	1.12	63.80%	0.47
TELEFONICA SA	1.07	50.39%	0.58
TELEKOM AUSTRIA AG	0.69	41.82%	0.45
TELENET GROUP HOLDING NV	0.63	47.55%	0.38
TELIA CO AB	0.75	34.10%	0.53
VODAFONE GROUP PLC	0.80	45.77%	0.49

6. ERP

6.1. Definition and data sources used

Like the RFR the ERP is a parameter reflecting general economic conditions. The ERP is the expected return on equities over and above the RFR, in other words, the expected additional reward (**premium**) for holding equities that entail a higher risk compared with the interest for holding risk-free assets. It compensates for the added risk of investing in equity rather than in a risk-free asset.[75]

The Commission follows a notional approach and considers it appropriate to calculate **a single EU-wide ERP using historical series** of market premiums in EU member states.[76] According to the Commission, estimating a single EU-wide ERP is consistent with empirical evidence suggesting that financial markets in the EU are increasingly integrated and therefore have convergent ERPs, which also is likely to ensure consistency with the CAPM assumption that investors hold an efficient portfolio and therefore should be rewarded only for non-diversifiable risks.[77]

In the following part the data used is described. Given that the calculation of the ERPs is based on the Morningstar data set and the data derived from Bloomberg using the implied pricing method the details of both the data used and the calculations based on it are described in this section (6.1). In section 6.3 the construction of the BEREC EU index with the BEREC weighting method based on the results of section 6.1 for each EU member state is explained. Finally, section 6.4 provides the detailed description of the "available years" weighting to "merge" data series of different lengths and its application. Section 6.5 displays and analysis the result.

For the calculation of a single EU-wide ERP BEREC retrieves data from the 2020 Morningstar data set (DMS in the following), which contains the so-called DMS Global Returns Data[78] from 1900 – 2019 for the following 13 EU member states: Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Netherlands, Portugal, Spain, Sweden, and the UK[79]. The DMS data consists of historical series of market premiums in the EU member states referred to above.[80] The DMS data is designed to measure the very long-run performance of equity (stocks) and bonds, and on this basis estimates the ERP an investor can expect to earn when

[75] Cf. Notice, para. 37, SWD, p. 46
[76] Cf. Notice, para. 38, SWD, p. 60 and section 5.2.3.2.
[77] Cf. Notice, para. 38, SWD, pp. 60 and below 6.2.
[78] Dimson/Marsh/Staunton (DMS) data, as published in the *Credit Suisse Global Investment Returns Yearbook 2020* by Credit Suisse/London Business School; a *Summary Edition of the Credit Suisse Global Investment Returns Yearbook 2020* is available here: https://www.credit-suisse.com/media/assets/corporate/docs/about-us/research/publications/credit-suisse-global-investment-returns-yearbook-2020-summary-edition.pdf;
see also the *Credit Suisse Global Investment Returns Sourcebook* (last edition 2016). The data source is Dimson/Marsh/Staunton, Global Investment Returns Database 2020 (distributed by Morningstar Inc.).
[79] The UK was an EU member state until 31st Jan. 2020.
[80] as well as data for other countries namely the USA, Australia, Canada, China, Japan, New Zealand, Norway, Russia, South Africa, and Switzerland. Together they represent 98% of world equity market capitalization at the start of 1900 and 91% of the investable universe in 2020.

investing in equity compared to holding risk-free assets. It is compiled by using best quality stock and bond indices and compiles long-run returns for each national market.[81]

The DMS database comprises annual returns for 21 countries in local currencies and the USD of the following main quantities: i) Nominal Equity Total Return; ii) Nominal Bond Total return; iii) Nominal Bill Total return; iv) Nominal Equity Premium Vs Bond; v) Nominal Equity Premium Vs Bill.[82]

For a better understanding of BEREC's calculation (see 6.3 and 6.4) based on the data series available it is relevant to explain three aspects of the DMS data:

i) General methodologies of the DMS data series;
ii) Equity Risk Premium evaluated for the "Europe Index" as provided in the Yearbook[83];
iii) Equity Risk Premium of the relevant 13 EU member states where time series are available.

i) The General methodologies of the DMS data series[84]

The DMS database includes annual returns and is based on the best-quality capital appreciation and income series available for each country, drawing on previous studies and other sources. To span the entire period from 1900, DMS linked multiple index series. The best index is chosen for each period, switching when feasible to better alternatives, as they become available. Other conditions being equal, DMS has chosen equity indexes that provide the broadest possible coverage of market of each country. Virtually all DMS equity indexes are capitalization weighted and are calculated from year-end stock prices, but in the early years, for a few countries, DMS was forced to use equally weighted indexes or indexes based on average- or mid-December prices. All the security returns include reinvested gross (pre-tax) income as well as capital gain.

[81] For more details on the data sources used and methods applied to construct the historical global investment returns series see Dimson/Marsh/Staunton, Triumph of the Optimists: 101 Years of Global Investment Returns (2002), Dimson/Marsh/Staunton, Equity Premia Around the World, LBS 2011, available here: https://ssrn.com/abstract=1940165. The indices are described in Dimson/Marsh/Staunton, Credit Suisse Global Investments Returns Yearbook 2020 (available from London Business School (LBS)).

[82] The time series list also for each country the Maturity premium, Inflation, Exchange rates with USD and Real evaluation are given.

[83] The Credit Suisse Yearbook 2020 (which contains the DMS results in hard copy, the underlying DMS data is included in the Morningstar data set 2020 as a soft copy). The data source is Dimson/Marsh/Staunton, Global Investment Returns Database 2020 (distributed by Morningstar Inc.).

[84] The following explanations are mainly based on publicly available descriptions of the compilation of the DMS data, see Elroy Dimson, Paul Marsh, and Mike Staunton, "The Worldwide Equity Premium: A Smaller Puzzle"; Chapter 11 in "Handbook of the equity risk premium", editor Rajnish Mehra 2008, and Dimson/Marsh/Staunton Global Returns Data (DMS Global) Documentation; see also Dimson/Marsh/Staunton, Triumph of the Optimists: 101 Years of Global Investment Returns (2002), Dimson/Marsh/Staunton, Equity Premia Around the World, LBS 2011, available here: https://ssrn.com/abstract=1940165.

The guiding principle of the index selection was to avoid survivorship[85], success, look-ahead[86], or any other form of ex post selection bias. The criterion was that each index should follow an investment policy that was specifiable in advance, so that an investor could have replicated the performance of the index (before trading costs) using information that would have been available at the time.[87] The conventional view of the historical equity premium is that, at the start of each period, investors make an unbiased, albeit inaccurate, appraisal of the end-of-period value of the stock market. Consequently, the ex-post premium, averaged over a sufficiently long interval, is expected to be a relatively accurate estimate of investors' expectations. At the same time historical premium may nevertheless be materially biased as a proxy for expectations because the past was in some sense unrepresentative.

The DMS bond indexes are based on government bonds that can be of different maturity, characteristic depending on the emitted product available along the time series for each country. They are usually equally weighted, and chosen to fall within the desired maturity range. Generally long term bonds are targeted, but where these are not available, either perpetual (usually for earlier periods) or shorter maturity bonds are used.

The Equity Risk Premium provided in the year book is estimated from the arithmetic difference between the logarithmic return on equities and the logarithmic return on the riskless asset. Equivalently, DMS defines 1 + Equity Premium to be equal to 1 + Equity Return divided by 1 + Riskless Return. Defined in this way, the Equity Premium is a ratio and therefore has no units of measurement. It is identical if computed from nominal or real returns, or if computed from dollar or euro returns.[88]

Each index starts from 1899 with a base index 1 and comprises data from 1900 – 2019, i.e. 120 years.

ii) The Global indexes: "World Index" and "Europe Index" from DMS time series.

In the DMS data base two Global indexes are included. One is the "World Index" that comprises 23 countries (including Russia and China), in common currency (USD). DMS assumes that at the beginning of each year the investor bought a portfolio of the 23 country weighting each country by its size. The "World equity index" is obtained through a weight based on the market capitalization of each of the 23 countries. The "World bond market index" is obtained through a weight based on country GDP of each of the 23 countries. The approach used to include a country is to avoid survivorship bias, in that sense the index includes this country also when they registered total loss (e.g. 1917 for Russia and 1949 for China), and re-enter the indexes when their market reopened in the early 1990ies.

[85] Survivorship bias is the logical error of concentrating only on the capital that is related to the present, making it past, and using some selection process and overlooking the capital that didn't have effects on the present. This can lead to false conclusions in several different ways.
[86] Look-ahead bias occurs by using information or data in a study or simulation that would not have been known or available during the period being analysed.
[87] Elroy Dimson, Paul Marsh, and Mike Staunton "The Worldwide Equity Premium: A Smaller Puzzle" Chapter 11 in "Handbook of the equity risk premium" editor Rajnish Mehra 2008.
[88] The time series are provided in each local currency, and in USD.

For the “Europe Index” the approach is the same; it includes 16 countries, the equity index and the bond index are evaluated in a common currency (USD), so local currency returns are converted to US dollars. In each period it is assumed that the investor bought a 16 positions portfolio composed of the following 16 countries: Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, The Netherlands, Norway, Portugal, Russia, Spain, Sweden, Switzerland, and the UK.

The equity risk premium is always evaluated as the ratio of the equity return and bond return, considering a logarithmic difference. In this way the equity risk premium is independent with respect to an evaluation done in nominal or real terms as the adjustment due to inflation to estimate real evaluation of each component, Equity and Bond is netted off. The equity risk premium is independent also with respect to the currency as, also in this case, the adjustment applied through exchange rates to convert the Equity and Bond index to the desired currency is netted off.

Switzerland, Russia, and Norway in the “Europe Index” are not relevant for the purpose of BEREC to calculate an EU-wide ERP.[89]

iii) The Equity Risk Premium of the relevant 13 EU member states from DMS time series.

The DMS Credit Swiss Global Investment Yearbook 2020 reports the following values in terms of arithmetic mean (AM) and geometric mean (GM): nominal annual Equity and Bond returns in local currency.[90]

Table 7 Geometric Mean and Arithmetic Mean 1900-2019 Equity/Bond annual return in nominal terms and Geometric and Arithmetic Average of Equity vs Bond premium[91]

	Mean returns % p.a.					
	Nominal				Premiums	
	Equities		Bonds		Equities vs Bonds	
	GM	AM	GM	AM	GM	AM
Austria	13.4	28.4	8.4	18.4	2.7	21.0
Belgium	7.7	10.1	5.5	5.9	2.1	4.1
Denmark	9.4	11.4	5.9	6.4	3.4	5.1
Finland	12.7	16.2	7.2	7.4	5.1	8.6
France	10.4	12.9	7.1	7.5	3.1	5.3
Germany	8.3	13.3	3.2	5.3	4.9	8.2
Ireland	8.5	10.9	5.8	6.5	2.6	4.6

[89] Switzerland can be a main outlier that can bias the estimation with respect to the BEREC need: specifically Switzerland had always historical relevance in terms of the Equity Market. The AM of the Equity return is 5.3 points lower with respect to the average of the other 13 countries with an AM of ERP of 3.6%.

[90] The data source of this table is Dimson/Marsh/Staunton, Global Investment Returns Database 2020 (distributed by Morningstar Inc.).

[91] ERPs as notified by the NRAs may differ from the ones provided in the table.

Italy	10.2	14.1	6.9	7.3	3.1	6.4
Netherlands	8.1	10.2	4.6	5.0	3.3	5.5
Portugal	11.1	16.2	5.7	6.7	5.0	9.1
Spain	9.2	11.4	7.5	8.1	1.6	3.5
Sweden	9.5	11.6	6.2	6.6	3.2	5.4
UK[92]	9.3	11.1	5.5	6.1	3.6	4.9

The values reported in the Yearbook refer to the time series from 1899 until 2019 for the index that is equal to 1 in 1899. The corresponding annual return for each year is evaluated from 1900 to 2019 as ((P_t/P_t-1)-1) with P_t the index value of the corresponding year "t" return.

The premium values Equity vs Bond are evaluated as averages (arithmetic/geometric) from the return evaluated as (1+Equity Annual return_t)/(1+Bond Return_t)-1.

The values reported in Table 7 are rounded from the first decimal place as in the Credit Suisse Yearbook and recalculated from the DMS data distributed by Morningstar Inc. acquired by BEREC Office for BEREC. For all the 13 EU member states the time series for Equity and Bond annual return are complete from 1900-2019, the only exceptions are Austria and Germany.

For Austria the Equity risk premium excludes from the averages (AM and GM) for the years 1921 and 1922, instead the values are maintained for the nominal Equity and Bond index.

For Germany the nominal return and the corresponding Equity risk premium are evaluated excluding hyperinflation years 1922 and 1923.

iv) The Equity Risk Premium of the 15 EU member states not included in the Morningstar data set calculated with the implied pricing method

For the missing 15 EU member states that are not contained in the Morningstar data set, i.e. Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Greece, Hungary, Latvia, Lithuania, Luxembourg, Malta, Poland, Romania, Slovakia, and Slovenia relevant data was retrieved from Bloomberg and calculated according to a method applied by the CFA Institute (Charted Financial Analysts, which is an association of investment professional)[93]. The calculation, which could be referred to as an **implied pricing method**, is based on the following three steps. First, the main equity index is identified for each market and with the annual P/E (ratio of the price of a stock and a company's earnings per share) for each index retrieved from Bloomberg it provides a valuation of each equity market. Secondly, the inverse of the P/E ratio (1/(P/E)) is calculated, which is the earnings yield. It is the percentage of how much a company earn per share, which in this case is how much all stocks in the index earns. This reflects the

[92] The UK was an EU member state until 31st Jan. 2020.

[93] Comparability and consistency with the Morningstar data has been assured (using the same definition to build the indices etc.). Source: Jason Voss, What the equity risk premium tells us today, Financial Times, FTfm, November 7, 2011.

return on investing in equity. The third step is to subtract the risk free rate, annual average on domestic long term government bonds, from the earnings yield, which gives the equity risk premium on an annual basis.

The historical returns series thus assembled cover only a shorter period (see Table 9 below) due to missing long-term (liquid) financial markets because financial markets did not exist in most of the countries prior to joining the EU.[94] This lack of data is a consequence of the planned economy and can therefore not be remedied – where there is no market and consequently no data it cannot be "invented". BEREC therefore had to find a robust, transparent and not overly complicated way to "merge" historical data series with different lengths without however making a methodological mistake resulting in a systematic over- or underestimation of one or the other values, i.e. misrepresenting longer and shorter historic returns series. The solution (the so-called "available years"-weighting) is described in more detail in section 6.4.

In the following part the information about the other EU member states is given separately. In this case the source of data for Equity comes from the implied pricing method time series, about the P/E ratio[95] evaluated in relation to Equity relevant market index of each country. For the bond component a specific index of government bond for each country has been considered as reported in Annex 4. These time series have on average been 13 years long. All the data has been derived from Bloomberg. The result is shown in Table 8.[96]

Table 8 Geometric Mean and Arithmetic Mean 2001-2019 Equity/Bond annual return in nominal terms and Geometric and Arithmetic Average of Equity vs Bond premium

	Mean returns % p.a.						Time series length
	Nominal				Premiums		
	Equities		Bonds		Equities vs Bonds		
	GM	AM	GM	AM	GM	AM	
Bulgaria	11.60%	11.70%	4.20%	4.70%	7.10%	7.70%	2006-2019
Croatia	9.30%	9.30%	1.30%	1.50%	7.90%	8.10%	2008-2019
Cyprus	28.20%	29.30%	2.30%	2.40%	25.30%	26.50%	2015-2019
Czech Rep.	7.90%	7.90%	3.20%	3.60%	4.60%	5.00%	2009-2019
Estonia							No data available

[94] This applies to the Central and Eastern European countries. For the two smallest EU member states Luxembourg and Malta no data is available for other reasons; only limited data is available also in the case of Cyprus and Greece due to specific situations.

[95] The price-to-earnings ratio or P/E is one of the most widely-used stock analysis tools used by investors and analysts for determining stock valuation. In essence, the price-to-earnings ratio indicates the amount of dollar an investor can expect to invest in a company in order to receive one dollar of that company's earnings. This is why the P/E is sometimes referred to as the price multiple because it shows how much investors are willing to pay per dollar of earnings.

[96] ERPs as notified by the NRAs may differ from the ones provided in the table. Among other things this is due to the fact that BEREC's estimation is based on a bottom-up approach which outcome is affected by the fact that only limited data is available, i.e. the time series are relatively short compared to the long time series with data for 120 years for the 13 EU member states (118 for Germany) included in the DMS data.

Greece	11.80%	12.80%	4.30%	4.40%	7.20%	8.50%	2002-2019
Hungary	7.80%	7.90%	7.00%	7.20%	0.70%	0.90%	2009-2019
Latvia	11.50%	11.50%	1.70%	1.90%	9.70%	10.10%	2005-2019
Lithuania	9.50%	9.60%	5.50%	5.80%	3.80%	4.20%	2005-2019
Luxemburg							No data available
Malta							No data available
Poland	8.00%	8.00%	4.80%	4.90%	3.10%	3.20%	2001-2019
Romania	11.10%	11.10%	3.70%	3.80%	7.10%	7.20%	2014-2019
Slovakia	7.40%	7.40%	5.70%	5.80%	1.60%	1.70%	2005-2019
Slovenia	8.50%	8.50%	4.90%	5.00%	3.50%	3.60%	2005-2019

6.2. Methodology with reference to Notice

BEREC follows the methodology outlined in section 4.2 of the Notice and described in more detail in section 5.2.3.2 of the SWD[97], i.e. it uses historical returns series of DMS data for 13 EU member states (listed above) and shorter historical returns series assembled by using the implied pricing method with data from Bloomberg for the 15 EU member states not included in the Morningstar data set (see above).

However, BEREC does not use an "off-the-shelf" European ERP as e.g. calculated by DMS as the countries included in the (Old World) "Europe" Index[98] deviate from the EU member states. To our best knowledge, alternative off-the-shelf European ERP estimations are not available. Consequently, BEREC has estimated its own EU-wide ERP by applying a second weighting to reflect the limitation of data availability, which is different for the two groups of EU member states as outlined above. That also explains the difference to the "Europe" ERP shown in Table 21 of the SWD[99] and the result (an EU-ERP) estimated by BEREC exhibited in Table 11 in section 6.5.

The Notice provides guidance on how the ERP should be estimated. In line with general portfolio theory which makes the assumption that investors were perfectly diversified over the world, it would make sense to measure a "worldwide" ERP. The Commission's approach of a single EU-wide ERP is based on the idea of a single EU capital market and assumes an investor with an EU perspective holding an efficient portfolio of assets in EU member states. Therefore the single EU-wide ERP is to be estimated based on appropriate data from all EU member states.

[97] SWD, pp. 65.
[98] Which comprises the following 16 countries: Austria, Belgium, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal, Spain, Denmark, Sweden, Norway, Switzerland, UK and Russia and is therefore not comparable with the EU-wide ERP calculated by BEREC.
[99] SWD, p. 66. Also Table 21 shows values for the period 1900 – 2010, i.e. is outdated. BEREC calculates the EU-wide ERP value using data until 2019.

6.3. Assumptions and choices made

In order to calculate a single EU-wide ERP a sound approach of using longer (for 13 EU member states) and shorter (for 15 EU member states) historical data series in one calculation without a systematic bias needed to be found. The solution is to apply a weighting reflecting the length of the available historical data series – the so-called **"available years"-weighting** as described below in section 6.4.

For 13 EU member states (listed above in Table 7) the estimation of the EU-wide ERP is based on the DMS historical returns series acquired by BEREC from Morningstar. These series do not cover the remaining 15 EU member states (listed above in Table 8). For these member states the estimation has been done considering for the equity return time series provided by the implied pricing method using Bloomberg, for the bond market compound index based on long term government bond has been used. In the index selection, inflation index linked bond has been omitted when possible and using local currency indexes composed by long term bonds. The time series of these countries have been included in the estimation from 2001 at the earliest when available.[100] The relative weighting of these time series addresses a selection bias that may happen if countries with shorter data series are included.[101]

Following the Notice BEREC provides an **EU-wide ERP** that is a weighted average of the ERP using DMS historical time series for 13 EU member states from 1900 and historical time series for 15 EU member states not included in the Morningstar data set calculated with the implied pricing method using Bloomberg starting from 2001 at the earliest and 2015 at the latest.[102] The **Equity component** of the new (BEREC) EU index will be derived considering **market capitalization** of each country (market size) in line with the global indexes constructed by DMS and **GDP** weight for the **bond component**.[103]

Using a weight for Equity that takes into account market capitalization is in line with the efficient market hypothesis[104] and with the general assumption that the weighted average market capitalization is the optimal method of asset allocation as it reflects the actual behaviour of markets. In this way, larger Equity markets tend to have a greater influence over the index, just as is the case of modern Index construction. This leads to a natural rebalancing mechanism where a growing Equity market is more influential in the index.

Market capitalization weighted indices reflect the available investment opportunity set in public equity markets. By design, they ignore any unlisted companies, whether privately held or state owned, since these are not accessible to the investing public.[105] However, all companies in a country contribute to the economy whether or not they are listed, available to local or foreign investors, private or public. Since the value of this larger universe of companies is not directly

[100] For more details see above section 6.1.
[101] E. Dimson, P. March, M. Staunton "Survivorship Bias Is Negligible", paragraph 5.4 Chapter 11 Handbook of Equity Risk premium.
[102] For more details see above section 6.1.
[103] The use of Market cap and GDP for the "World Index" and the "Europe Index" have been considered since 2012 by DMS.
[104] The efficient-market hypothesis (EMH) is a hypothesis in financial economics that states that asset prices reflect all available information. A direct implication is that it is impossible to "beat the market" consistently on a risk-adjusted basis since market prices should only react to new information.
[105] GDP Weighting in Asset Allocation 2010 MSCI Research bulletin.

observable, the value of the economy as measured by the GDP is often used as a reference against which a country's current market capitalization is contrasted. This is more effective to catch asset allocation probability in the Bond market portfolio.

BEREC's approach of applying a **5-year averaging window (2014-2018)** when calculating the weights for equity (with market capitalisation) and bonds (with GDP) instead of a "year-by-year" weighting (as done by DMS), leads to "fixed weightings along the years" instead of the rebalancing used by DMS.[106] BEREC's method in this way appears to have an upward bias compared to the estimation followed by DMS for the calculation of a "Europe Index". However, the sensitivity analysis run by BEREC showed that the difference is not material.[107]

The market capitalization data has been derived from public sources.[108] Where data is available only partially or not available other public sources have been considered.[109]

The GDP data has been derived from Eurostat in form of current prices in EUR[110].

Overall these assumptions allow BEREC to calculate a single EU-wide ERP in a robust, transparent and understandable way taking into account the limitations as regards data availability.

6.4. Calculation steps – description of how the result is derived

The first step of the analysis has been done considering the following.

As explained in section 6.3 above the weight for the market capitalization and GDP has been considered as an average with five year time windows (2014-2018), in line with the beta and RFR estimation. Using a five-year average window might slightly overestimate the result compared to using a year-by-year weighting which, for practical reasons (time and data constraints), was not possible.[111]

The evaluation of the ERP has been estimated using the following assumption:

For each year of the time series BEREC has obtained annual returns for Equity and Bond in nominal terms:

Equity_EU_t = (Equity return_t_x* Market Capitalization_x+ Equity return_t_y* Market Capitalization_y+…)/(Sum of market capitalization_t) ;

Bond EU_t = (Average Bond_t_x*GDP_x+ AverageBond_y*GDP y_t+.)/(sum fo GDP_t).

Along the time line the sum at the denominator takes into account the number of countries that are included in recent years. This happens via applying a second weighting to

[106] i.e. BEREC uses the same weighting *factors* (market capitalisation, GDP), however a different weighting *method* (due to data constraints).
[107] See below section 6.5.
[108] https://data.worldbank.org/indicator/CM.MKT.LCAP.GD.ZS.
[109] https://www.ceicdata.com/.
[110] https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_10_gdp&lang=en.
[111] See below section 6.5.

compensate for incomplete historic values. This is the **"available years"-weighting** according to the length of the time period of data availability. For the 13 EU member states listed in the Morningstar data set this would be 120 years[112] divided by the maximum time period available (120) and for the remaining 15 EU member states not included in the Morningstar data set the weight is the number of years for which data is available (2001 at the earliest – 2019) over the maximum time period available, i.e. 18/120). Thus BEREC is able to incorporate data of different time lengths of all EU member states without over- or understating available data series with different lengths. The formula is shown hereafter:

Equity_EU = (Average Equity_x*Market Capitalization_x*(1)+Average Equity_y*Market Capitalization_y*(y/120)+...)/(market capitalization_x*1+ market capitalization_y*(y/120)+..);

Bond EU = (Average Bond_x*GDP_x*(1) + AverageBond_y*GDPy*(y/120)+...)/(sum for GDP_x*(1)+GDP_y*(y/120)+...).

After obtaining the values of Equity and bond returns in nominal terms BEREC has estimated the equity risk premium in coherence with the approach used in the Yearbook, as the difference of logarithm like (1+ Equity_EU)/(1+ Bond_EU)-1 for each point in time. After that BEREC computed the Arithmetic average and Geometric average of the new time series established. The evaluated equity risk premium is independent from the nominal or real estimation as well as from the currency, due to the fact that BEREC used the ratio of the annual return instead of the difference of the annual return. In this way the adjustment due to nominal or real estimation as well as the currency are not relevant with respect to the final estimation.

Through this approach the time series of the 15 EU member states missing in the Morningstar data set are integrated in the final average only when data is available for both the Bond and Equity index.[113] The weights are adjusted year by year taking into account the relevant EU member states that are included. In the table below the information about the year in which the time series are included is also given. The date of inclusion depends on the availability of both equity and bond data. Only as of 2015, data for all countries (except Estonia, Luxembourg, and Malta) is available, and thus all EU member states (except three) are included.

Table 9 Year and duration of the time series of the 15 EU member states not included in the Morningstar data set

Country	First year of the time series	Time Weight
Bulgaria	2006	14/120
Croatia	2008	12/120

[112] Or less if individual years are taken out where the value is an outlier (this is the case for Germany for the two years 1922/1923 of hyperinflation, and the Austrian case for 1921/1922 is derived differently (see above). Apart from these two exceptions, BEREC did not make adjustments to the historic returns series of DMS/Morningstar.

[113] The data availability is also a measure of liquidity of the market and so also an indicator of the relevance on representing a likely share in the portfolio.

Cyprus	2015	5/120
Czech Rep.	2009	11/120
Estonia	No data available	
Greece	2002	18/120
Hungary	2009	11/120
Latvia	2005	15/120
Lithuania	2005	15/120
Luxemburg	No data available	
Malta	No data available	
Poland	2001	19/120
Romania	2014	6/120
Slovakia	2005	15/120
Slovenia	2005	15/120

The limitation of the proposed approach is related to the fact that weights are dependent on when data is available for each country. This gives a sort of "look-ahead" bias as the probability of investing along the years, as market capitalization/GDP has changed along the 100 years, but this is a trade-off with respect to the data availability, however, consistently in line with the general framework proposed by the Commission.

To estimate the single EU-wide ERP BEREC calculated the arithmetic mean (AM) and the geometric mean (GM). BEREC notes that the Notice and the SWD favour for transparency reasons the use of AM. With reference to the other regulatory objectives/principles the SWD is (at best) neutral and rightly points out – in line with financial theory – the drawbacks of an AM (upward bias), in particular with regard to predictability and efficiency.[114] To estimate the ERP on the basis of an arithmetic or geometric means has been subject to unresolved discussions in financial literature. Blume (1974) has shown that for estimating the end value of longer-term capital investments the arithmetic mean is generally an upward-biased estimator, whereas the geometric mean is a downward-biased estimator.[115] It follows that the AM usually provides the upper boundary of the value, whereas the GM is the lower boundary. Taking into account all four regulatory principles and the fact that the AM is supported only in one (transparency) of four, BEREC considers it justified to calculate both the GM and the AM.

In the following Figure 3 the time evolution (1900-2019) of the proposed annual returns of the new EU Equity risk premium is shown, including 13 EU member states with long time series and 15 EU member states with shorter time series as described before.

[114] SWD, section 5.1.2, pp. 36-38.
[115] See also SWD, p. 37/38. For this reason the Credit Suisse Yearbook publishes both the AM and the GM.

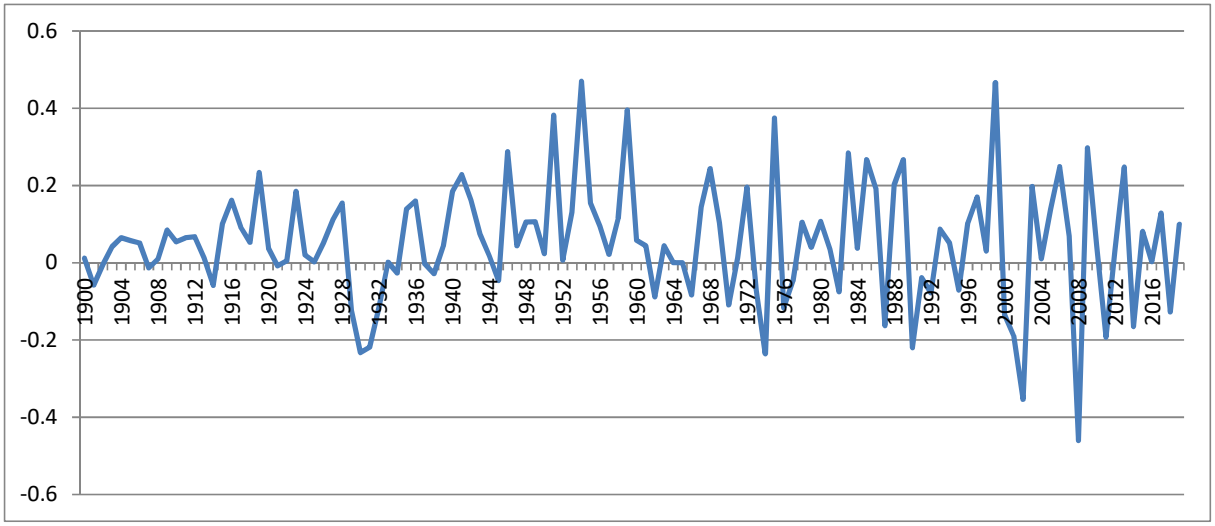


Figure 3 Equity Risk Premium 1900-2019 time series

The corresponding averages ERP are shown in Table 10.

Table 10 EU ERP (GM and AM)

Country	Geometric mean%	Arithmetic mean%
EU-ERP	**4.18%**	**5.31%**

While the effect of the 15 EU member states not included in the Morningstar data set is not large at this moment, it may increase in the future when the markets become more mature.

6.5. Result: EU-ERP

The result of the calculation is shown in Table 11. For each EU member state the GM and the AM is provided (unweighted).[116] The last line contains the lower boundary (GM) and the upper boundary (AM) of the single EU-wide ERP as estimated by BEREC with the method described above. BEREC considers that the result is robust based on the data available at this point in time. Only the EU-wide ERP is relevant for NRAs' own estimations.

[116] Taken from Table 7 and Table 8, ERPs as notified by the NRAs may differ from the ones provided in the table. For the 15 EU member states not included in the Morningstar data set, the available years-weight is taken from Table 9, the EU-ERP from Table 10.

Table 11 ERP

Country	Geometric mean%	Arithmetic mean%	Available years weight
Austria	2.7	21.0	100% (120/120)
Belgium	2.1	4.1	100% (120/120)
Bulgaria	7.1	7.7	11.67% (14/120)
Croatia	7.9	8.1	10% (12/120)
Cyprus	25.3	26.5	4.17% (5/120)
Czech Rep.	4.6	5.0	9.17% (11/120)
Denmark	3.4	5.1	100% (120/120)
Estonia			
Finland	3.4	5.1	100% (120/120)
France	3.1	5.3	100% (120/120)
Germany	4.9	8.2	98.3% (118/120)
Greece	7.2	8.5	15% (18/120)
Hungary	0.7	0.9	9.17% (11/120)
Ireland	2.6	4.6	100% (120/120)
Italy	3.1	6.4	100% (120/120)
Latvia	9.7	10.1	12.50% (15/120)
Lithuania	3.8	4.2	12.50% (15/120)
Luxembourg			
Malta			
Netherlands	3.3	5.5	100% (120/120)
Poland	3.1	3.2	15.83% (19/120)
Portugal	5.0	9.1	100% (120/120)
Romania	7.1	7.2	5.% (6/120)
Slovakia	1.6	1.7	12.50% (15/120)
Slovenia	3.5	3.6	12.50% (15/120)
Spain	1.6	3.5	100% (120/120)
Sweden	3.2	5.4	100% (120/120)
United Kingdom[117]	3.6	4.9	100% (120/120)
EU-ERP	**4.18**	**5.31**	

Analysis of results

The result of BEREC's calculation presented in this chapter is broadly in line with likely expected findings. It is plausible that the EU-ERP value is lower than the majority of the national ERP values computed by NRAs (and their average)[118] for two reasons. ERPs

[117] The UK was an EU member state until 31st Jan. 2020.

[118] See Regulatory Accounting Report 2019 (BoR (19) 240), WACC chapter, which shows that 17 out of 26 EU NRAs (excluding EE, LV), where data is available, estimate an ERP above 5.31%. The weighted average of the ERPs reported in the Regulatory Accounting Report 2019 by 24 EU NRAs (excluding EE, MT, LU which have not

estimated by NRAs may include a "home bias" towards the national market which the EU-wide ERP, calculated by BEREC looking at the single EU capital market, inherently does not have. Also, the larger single EU capital market is pushing down the ERP as more market participants compete with each other, i.e. the decrease is reflecting an efficiency gain.

Bearing in mind that the (inherent) upward bias[119] in the AM is further exacerbated by the BEREC weighting method[120], BEREC does not consider it justified to *solely* set the AM as (the) EU-wide ERP. Instead of making an arbitrary adjustment or using a combination of AM and GM, BEREC, taking all four regulatory principles into account, considers it more appropriate to set the AM as the upper boundary of the EU-wide ERP which is displaying the result of the AM calculation transparently[121]. Otherwise, the value would be challengeable on the allegation of the (concealed but certain) upward bias. As BEREC, on the other hand, sees the need to narrow as much as possible the margin within which the single EU-wide ERP oscillates, BEREC sets the GM as the lower boundary for the EU-wide ERP. The resulting margin reflects the fact that the single EU capital market has not yet been fully completed.

Thus BEREC considers that the appropriate value of the **single EU-wide ERP** is in the margin of 4.18% (GM) and 5.31% (AM). In BEREC's view this is in line with the purpose of the Notice/SWD as BEREC unifies the calculation of the ERP thereby eliminating any methodological differences of NRAs' estimations. This implies that the resulting margin only reflects the currently existing factual situation in the EU which NRAs need to take into account adequately in their decisions. Given that the margin is so narrow, it also implies that national ERPs will converge more when NRAs start applying the EU-wide ERP compared to the current situation[122] with the standard deviation expected to go down considerably.

Recognizing that the Notice favours the AM, NRAs not using the AM would need to provide an explanation justifying their result, although within the margin.

been included in the BEREC EU index and excluding also LV where no ERP is available in the 2019 RA Report) is 5.81% (GDP weighted) and 6.57% (market capitalisation weighted).

[119] See above section 6.3.

[120] In comparison to the estimation followed by DMS for the "Europe Index" BEREC's weighting method appears to have an upward bias caused by the use of a fixed five year averaging window (2014-2018), which is due to lack of data. The Credit Swiss Yearbook 2020 provides an estimation of 4.2% (AM) for its "Europe Index", which however also includes Switzerland, Norway, and Russia. In order to estimate the size of the upward bias BEREC made a sensitivity analysis including also Switzerland and Norway (Russian data was not available) in a calculation applying its weighting method to be able to compare the AM value published in the Credit Swiss Yearbook 2020 (4.2%) to the EU-ERP AM value estimated by BEREC (5.31%). The result of this estimation is 4.66%, i.e. a difference of +0.46%-points compared to 4.2%. So taking the 4.2% value as the "unbiased" value the difference of 0.46%-points can be considered as an indication of the upward bias. Including this in BEREC's method, this would provide a hypothetical (unbiased) EU-wide ERP of 4.85% (AM). This shows that albeit the bias exists it is relatively small.

[121] Without adjustments creating unnecessary complexity.

[122] As shown in the RA Report 2019 (BoR (19) 240), WACC chapter.

7. Summary of Results

7.1. Overview of Results

The following overview table (Table 12) summarizes all results related to company specific parameters for the BEREC peer group. It has been compiled using the results of Chapters 2 to 5.

Table 12 BEREC peer group 2020 – Overview of Results for company specific parameters

Peer group	SMP (Legacy infra-struct.)	Company Credit rating (S&P)	Country	Country Credit rating (S&P)	Debt premium (basis point)	RFR (domestic = national) of home country	Cost of Debt = Debt premium + RFR	Equity beta	Gearing	Asset beta	Major Telco Holdings in younger EU-MS (for info)
BT Group	Yes	BBB	UK	AA	167	1.25%	2.92%	0.65	33.14%	0.47	BT subsi. in BG, HR, CZ, CY, EL, HU, LV, LT, ME, MT
Deutsche Telekom	Yes	BBB+	DE	AAA	131	0.17%	1.48%	0.91	42.57%	0.57	OTE in EL, HR Telekom, SK Telecom, Magyar Telekom in HU, Telekom RO, T-Mobile PL + CZ, Cosmote Mobile in EL
Elisa	Yes	BBB+	FI	AA+	100	0.44%	1.44%	0.59	13.51%	0.52	Elisa Eesi + Elisa Teleteenused EE
KPN	Yes	BBB	NL	AAA	117	0.37%	1.54%	0.72	38.75%	0.48	-
NOS	No	BBB-	PT	BBB	42	2.16%	2.58%	0.77	25.80%	0.60	-
Orange	Yes	BBB+	FR	AA	87	0.57%	1.44%	0.85	43.99%	0.52	Orange in PL, RO, SK
Proximus	Yes	A	BE	AA	89	0.57%	1.46%	0.74	19.48%	0.62	-
Tele 2	No	BBB	SE	AAA	178	0.49%	2.27%	0.80	16.64%	0.69	-

Peer group	SMP (Legacy infra-struct.)	Company Credit rating (S&P)	Country	Country Credit rating (S&P)	Debt premium (basis point)	RFR (domestic = national) of home country	Cost of Debt = Debt premium + RFR	Equity beta	Gearing	Asset beta	Major Telco Holdings in younger EU-MS (for info)
Telecom Italia	Yes	BB+	IT	BBB	161	1.96%	3.57%	1.12	63.80%	0.47	-
Telefonica	Yes	BBB	ES	A	45	1.30%	1.75%	1.07	50.39%	0.58	-
Telekom Austria	Yes	BBB+	AT	AA+	81	0.46%	1.27%	0.69	41.82%	0.45	A1 in BG, HR, SI
Telenet	No	BB-	BE	AA	302	0.57%	3.59%	0.63	47.55%	0.38	
Telia	Yes	BBB+	SE	AAA	150	0.49%	1.99%	0.75	34.10%	0.53	Eesti Telekom in EE, Telia Lietuva in LT, LMT Mobile LV
Vodafone	No	BBB	UK	AA	170	1.25%	2.95%	0.80	45.77%	0.49	Vodafone Hellenic in EL

The result for the ERP is as follows. Based on the calculations described in Chapter 6 above BEREC considers that the appropriate value of the single EU-wide ERP is in the margin of 4.18% (GM) and 5.31% (AM).

7.2. Taxes and inflation

Section 6 of the Notice describes the taxes and inflation. Acc. to para. 60 it is appropriate to use the relevant domestic corporate tax rate.

Acc. to para 63 a Eurozone-wide inflation rate is appropriate for Eurozone Member States, for non-Eurozone Member States national inflation estimates may be justified. As a forecast the 5 year-ahead inflation forecast of the ECB is considered appropriate.

The latest available 5-year-ahead inflation forecast of the ECB is 1.7% (as of 31st March 2020)[123] , the next update will be on 30 June 2020.

7.3. Possible Covid-19 effects in the future

At this moment in time it is too early to say anything definitive on the possible Covid-19 effects on the WACC parameters in the near future. Therefore BEREC only makes the following few observations.

Generally it is assumed that the telecommunications sector is less affected by the crisis than most other sectors. The telecoms sector is considered to be relatively resilient and likely to perform ahead of general GDP trends.[124] Due to an accelerated digitalization of the economy the telecom sector might even benefit in the long term.

In the short term there are only limited effects to be seen so far. By the cut-off date of 1st April 2020 the financial market indicators did not show the impact yet. On the other side the long time series of historic data used for the estimation of the ERP cover also past crisis periods thereby factoring in to a certain extent possible long term effects.

BEREC does not deem appropriate to enter into the field of speculation in this time of uncertainty. To be on the safe side and in light of the limited information currently available BEREC therefore considers it most appropriate to be “neutral” in the sense that positive and negative effects “net off”.[125] Thus as a general principle no adjustments to the outcome of the calculations for possible crisis effects were deemed warranted. This may change in the future.

[123] https://www.ecb.europa.eu/stats/ecb_surveys/survey_of_professional_forecasters/html/table_hist_hicp.en.html
[124] Cf. e.g. Analysis Mason, COVID-19: the telecoms industry will suffer less than many others, and can thus help to support the economy, April 2020, https://www.analysysmason.com/About-Us/News/Newsletter/covid-19-telecoms-quarterly-apr2020/article-pdf/.
[125] This may be different on the national level.

Annex

List of tables

List of figures

Abbreviations

A

AM	Arithmetic mean

B

BEREC	Body of European Regulators for Electronic Communications
Bloomberg	Bloomberg financial system

C

CAPM	Capital Asset Pricing Model
CFA	Charted Financial Analysts Institute

Covid-19	Coronavirus disease 2019
Credit Suisse Yearbook	Credit Suisse Global Investment Returns Yearbook 2020

D

DMS	Dimson/Marsh/Staunton dataset (distributed by Morningstar)

E

ECB	European Central Bank
ERP	Equity Risk Premium
EUR	Euro
Eurostat	European Statistical Office

G

GM	Geometric mean

N

NGA	Next Generation Access network
Notice	Commission Notice on the calculation of t. cost of capital of 7th Nov. 19
NRA	National Regulatory Authority

O

OAO	Other Authorised Operator
OLS	Ordinary least square

P

P/E ratio	Price-to-earnings ratio

R

RA Report	BEREC Regulatory Accounting in Practice Report
RFR	Risk-free rate

S

S&P	Standard & Poor's
SEK	Swedish crowns
SMP	Significant Market Power
STOXX Europe TMI	STOXX Europe Total Market Index
SWD	European Commission Staff Working Document

W

WACC	Weighted Average Cost of Capital

Annex 1: RFR

EMU convergence criterion series - monthly data[126] (Source: Eurostat) *Derived by BEREC

	2015-04	2015-05	2015-06	2015-07	2015-08	2015-09	2015-10	2015-11	2015-12	2016-01	2016-02	2016-03	2016-04	2016-05	2016-06	2016-07	2016-08	2016-09	2016-10	2016-11	2016-12	2017-01	2017-02	2017-03	2017-04	2017-05	2017-06	2017-07	2017-08	2017-09	2017-10	2017-11	2017-12
Belgium	0.42	0.86	1.21	1.15	1.	1.01	0.85	0.84	0.89	0.86	0.72	0.62	0.55	0.55	0.43	0.2	0.15	0.18	0.27	0.57	0.61	0.7	0.87	0.87	0.78	0.77	0.62	0.83	0.73	0.7	0.69	0.58	0.53
Bulgaria	2.36	2.36	2.36	2.36	2.36	2.36	2.36	2.99	2.43	2.44	2.67	2.66	2.44	2.37	2.4	2.39	2.28	2.15	1.84	1.82	1.8	1.77	1.75	1.73	1.78	1.74	1.7	1.65	1.7	1.66	1.4	1.33	1.02
Czechia	0.26	0.6	1.01	0.97	0.74	0.68	0.56	0.49	0.49	0.62	0.46	0.35	0.43	0.46	0.45	0.37	0.29	0.25	0.37	0.55	0.53	0.47	0.63	0.87	0.96	0.74	0.77	0.9	0.83	0.97	1.45	1.68	1.5
Denmark	0.25	0.73	1.	0.94	0.84	0.93	0.83	0.81	0.83	0.79	0.55	0.51	0.4	0.41	0.23	0.07	0.04	0.01	0.13	0.32	0.39	0.37	0.33	0.19	0.55	0.64	0.53	0.67	0.55	0.51	0.53	0.44	0.41
Germany	0.12	0.56	0.79	0.71	0.61	0.65	0.52	0.52	0.55	0.43	0.17	0.17	0.13	0.13	-0.02	-0.15	-0.13	-0.09	0.	0.19	0.25	0.25	0.26	0.35	0.22	0.34	0.25	0.46	0.35	0.35	0.37	0.31	0.3
Estonia	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
Ireland	1	1.25	1.65	1	1.29	1.31	1	1.1	1.11	1	0.99	0.85	1	0.84	0.76	0	0.4	0.42	1	0.85	0.84	1	1.06	1.05	1	0.83	0.7	1	0.73	0.7	1	0.58	0.54
Greece	12.	10.95	11.43	:	10.26	8.54	7.81	7.41	8.21	9.08	10.41	9.12	9.03	7.64	7.92	7.99	8.19	8.34	8.33	7.33	6.94	7.04	7.52	7.17	6.7	5.86	5.76	5.33	5.55	5.56	5.59	5.22	4.44
Spain	1.31	1.78	2.22	2.1	1.96	2.03	1.73	1.72	1.69	1.72	1.72	1.54	1.53	1.57	1.48	1.17	1.01	1.04	1.07	1.43	1.44	1.46	1.7	1.72	1.61	1.57	1.45	1.6	1.48	1.54	1.61	1.49	1.44
France	0.44	0.89	1.2	1.11	1.01	1.	0.87	0.88	0.93	0.84	0.59	0.51	0.51	0.51	0.39	0.17	0.15	0.18	0.33	0.67	0.75	0.86	1.03	1.02	0.88	0.81	0.66	0.84	0.71	0.7	0.81	0.72	0.67
Croatia	3.17	2.98	3.07	4.23	3.9	3.91	3.93	3.86	3.92	3.84	3.68	3.66	3.62	3.52	3.81	3.75	3.58	3.34	3.07	3.01	2.95	2.8	2.71	2.74	2.98	3.01	2.83	2.78	2.87	2.71	2.66	2.65	2.47
Italy	1.36	1.81	2.2	2.04	1.84	1.92	1.7	1.57	1.58	1.53	1.56	1.38	1.44	1.53	1.45	1.23	1.18	1.27	1.45	1.94	1.89	1.99	2.35	2.4	2.26	2.19	2.05	2.23	2.11	2.11	2.07	1.79	1.8
Cyprus	6.	3.96	3.89	3.69	3.69	3.7	3.64	4.	3.87	3.82	4.	4.01	3.99	3.89	3.82	3.87	3.84	3.62	3.39	3.47	3.55	3.45	3.37	3.34	3.23	3.03	2.84	2.57	2.49	2.2	1.84	1.54	1.58
Latvia	0.42	0.84	1.28	1.25	0.96	1.03	1.07	1.19	1.08	1.05	0.88	0.71	0.61	0.51	0.48	0.3	0.12	0.1	0.19	0.56	0.9	0.89	0.99	0.94	0.92	0.88	0.85	0.98	0.85	0.72	0.71	0.69	0.59
Lithuania	0.58	0.99	1.41	1.64	1.64	1.64	1.64	1.57	1.49	1.47	1.42	1.42	1.31	0.86	0.86	0.86	0.86	0.79	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31
Luxembourg	0.06	0.42	0.65	0.56	0.45	0.43	0.31	0.25	0.27	0.72	0.43	0.42	0.34	0.33	0.17	0.	-0.05	-0.03	0.07	0.28	0.39	0.43	0.55	0.6	0.49	0.57	0.52	0.69	0.57	0.55	0.57	0.5	0.49
Hungary	3.28	3.59	3.86	3.72	3.61	3.5	3.28	3.34	3.47	3.36	3.36	3.13	3.02	3.35	3.31	2.88	2.83	2.88	2.93	3.36	3.31	3.4	3.52	3.48	3.28	3.1	2.99	3.1	3.05	2.76	2.57	2.23	2.07
Malta	1.15	1.5	1.79	1.78	1.57	1.61	1.37	1.29	1.29	1.25	1.16	1.03	1.	1.02	0.95	0.76	0.61	0.6	0.59	0.84	0.82	1.17	1.32	1.55	1.43	1.37	1.25	1.36	1.23	1.26	1.24	1.13	1.07
Netherlands	0.31	0.75	1.05	0.99	0.85	0.87	0.73	0.72	0.75	0.65	0.37	0.32	0.4	0.38	0.25	0.06	0.03	0.06	0.16	0.39	0.44	0.48	0.49	0.49	0.5	0.59	0.5	0.69	0.54	0.53	0.54	0.47	0.45
Austria	0.29	0.73	1.06	1.08	0.96	0.97	0.83	0.82	0.86	0.77	0.53	0.46	0.38	0.37	0.33	0.16	0.11	0.15	0.24	0.49	0.53	0.57	0.59	0.59	0.49	0.65	0.55	0.73	0.61	0.59	0.61	0.51	0.5
Poland	2.37	2.82	3.19	3.16	2.88	2.91	2.66	2.73	2.96	3.	3.03	2.89	2.95	3.04	3.11	2.89	2.71	2.85	3.01	3.41	3.54	3.68	3.81	3.66	3.42	3.35	3.19	3.3	3.33	3.26	3.38	3.39	3.27
Portugal	1.87	2.41	2.93	2.74	2.52	2.59	2.41	2.57	2.49	2.71	3.23	2.84	3.13	3.15	3.2	3.06	2.91	3.26	3.33	3.51	3.74	3.95	4.04	3.99	3.77	3.29	2.97	3.03	2.83	2.63	2.32	1.98	1.83
Romania	3.25	3.45	3.84	3.99	3.86	3.73	3.47	3.49	3.62	3.6	3.33	3.34	3.43	3.43	3.48	3.14	2.93	2.92	2.94	3.56	3.73	3.75	3.96	3.99	3.79	3.75	3.67	3.84	3.86	3.89	4.17	4.43	4.4
Slovenia	1.06	1.59	2.13	2.43	2.07	2.05	1.8	1.66	1.61	1.61	1.59	1.48	1.37	1.41	1.36	0.95	0.8	0.75	0.62	0.89	0.96	0.99	1.01	0.99	1.	0.98	0.86	1.15	1.09	0.98	0.97	0.81	0.69
Slovakia	0.96	1	1.15	1.25	1	0.89	0.75	1	0.72	0.71	1	0.43	0.38	0	0.77	0.49	0	0.32	0.42	1	1.01	1.03	1	1.09	1.06	1	0.86	0.93	1	0.82	0.83	1	0.67
Finland	0.27	0.72	1.01	0.95	0.82	0.9	0.81	0.81	0.86	0.78	0.53	0.53	0.46	0.45	0.33	0.12	0.06	0.08	0.17	0.41	0.46	0.5	0.52	0.51	0.38	0.49	0.56	0.76	0.65	0.58	0.6	0.52	0.51
Sweden	0.34	0.75	0.99	0.81	0.66	0.71	0.66	0.8	0.93	1.02	0.77	0.82	0.81	0.77	0.52	0.17	0.1	0.22	0.24	0.43	0.61	0.65	0.66	0.69	0.57	0.56	0.46	0.66	0.63	0.62	0.83	0.76	0.72
UK	1.65	1.94	2.06	2.03	1.86	1.85	1.81	1.94	1.87	1.73	1.44	1.46	1.48	1.43	1.18	0.79	0.6	0.77	1.04	1.34	1.39	1.38	1.24	1.13	1.	1.03	0.98	1.25	1.1	1.21	1.35	1.28	1.22

EMU convergence criterion series - monthly data (Continued)

[126] Maastricht criterion bond yields (mcby) are long-term interest rates, used as a convergence criterion for the European Monetary Union, based on the Maastricht Treaty.

	2018-01	2018-02	2018-03	2018-04	2018-05	2018-06	2018-07	2018-08	2018-09	2018-10	2018-11	2018-12	2019-01	2019-02	2019-03	2019-04	2019-05	2019-06	2019-07	2019-08	2019-09	2019-10	2019-11	2019-12	2020-01	2020-02	2020-03	5 Y Avg.
Belgium	0.7	0.97	0.87	0.81	0.83	0.79	0.68	0.71	0.77	0.85	0.81	0.75	0.77	0.69	0.54	0.47	0.41	0.15	0.	-0.28	-0.24	-0.16	-0.04	0.01	-0.03	-0.13	-0.02	0.57
Bulgaria	0.9	0.98	1.05	1.02	1.05	0.99	0.92	0.81	0.78	0.74	0.75	0.72	0.72	0.68	0.67	0.5	0.48	0.32	0.43	0.35	0.35	0.25	0.22	0.18	0.15	0.12	0.15	1.41
Czechia	1.77	1.82	1.81	1.74	1.89	2.14	2.11	2.14	2.14	2.14	2.07	2.01	1.85	1.76	1.82	1.82	1.86	1.58	1.36	0.99	1.24	1.32	1.47	1.51	1.62	1.47	1.28	1.16
Denmark	0.57	0.77	0.64	0.55	0.52	0.41	0.32	0.33	0.37	0.42	0.34	0.23	0.15	0.05	0.16	0.08	0.04	-0.22	-0.31	-0.58	-0.59	-0.43	-0.31	-0.26	-0.26	-0.41	-0.41	0.32
Germany	0.47	0.66	0.53	0.48	0.45	0.33	0.28	0.29	0.37	0.4	0.31	0.19	0.13	0.06	0.01	-0.04	-0.13	-0.31	-0.39	-0.65	-0.59	-0.47	-0.35	-0.3	-0.31	-0.47	-0.54	0.17
Estonia	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	0,94*
Ireland	1	1.13	1.01	1	0.98	0.92	1	0.86	0.93	1	0.98	0.91	1	0.86	0.67	1	0.5	0.27	0	-0.05	-0.01	0	0.07	0.04	0	-0.13	0.07	0.75
Greece	3.79	4.14	4.27	4.04	4.29	4.39	3.88	4.18	4.17	4.37	4.42	4.28	4.21	3.84	3.76	3.42	3.37	2.67	2.16	1.98	1.5	1.34	1.36	1.42	1.34	1.07	1.97	5.67
Spain	1.47	1.51	1.33	1.21	1.39	1.37	1.33	1.4	1.46	1.6	1.59	1.42	1.38	1.31	1.13	1.05	0.87	0.5	0.35	0.14	0.18	0.2	0.39	0.44	0.42	0.27	0.52	1.30
France	0.86	0.98	0.84	0.78	0.78	0.75	0.67	0.7	0.77	0.82	0.76	0.7	0.65	0.55	0.44	0.37	0.3	0.08	-0.07	-0.34	-0.28	-0.16	-0.02	0.04	-0.01	-0.18	-0.06	0.57
Croatia	2.35	2.27	2.19	2.12	2.16	2.2	2.26	2.18	2.14	2.09	2.07	2.04	2.23	2.31	2.07	1.82	1.69	1.36	1.06	0.83	0.49	0.47	0.53	0.59	0.61	0.57	0.96	2.53
Italy	1.98	2.08	1.97	1.77	2.18	2.74	2.64	3.16	2.96	3.47	3.39	2.98	2.77	2.81	2.69	2.62	2.64	2.28	1.65	1.4	0.9	1.	1.27	1.37	1.28	0.96	1.55	1.96
Cyprus	1.68	1.93	1.83	2.12	2.52	2.61	2.08	2.22	2.01	2.35	2.41	2.34	2.22	2.	1.74	1.49	1.34	0.82	0.66	0.44	0.48	0.51	0.58	0.57	0.61	0.56	1.26	2.58
Latvia	0.6	0.75	0.83	0.8	0.86	0.93	1.06	0.95	0.94	1.01	1.05	1.05	0.95	0.81	0.7	0.58	0.51	0.33	0.15	-0.07	-0.11	0.	0.1	0.16	0.11	-0.04	-0.06	0.67
Lithuania	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.59
Luxembourg	0.63	0.78	0.68	0.62	0.61	0.54	0.47	0.47	0.51	0.56	0.5	0.42	0.37	0.26	0.17	0.11	0.02	-0.16	-0.28	-0.54	-0.5	-0.4	-0.27	-0.23	-0.25	-0.43	-0.36	0.29
Hungary	2.06	2.55	2.6	2.47	2.92	3.37	3.39	3.41	3.57	3.74	3.47	3.15	2.85	2.68	3.03	3.14	3.19	2.74	2.33	1.83	2.02	1.94	1.95	1.88	2.08	2.15	2.43	2.96
Malta	1.29	1.38	1.23	1.24	1.32	1.37	1.34	1.46	1.52	1.56	1.54	1.39	1.25	1.17	1.03	1.	0.95	0.73	0.52	0.21	0.19	0.26	0.37	0.4	0.38	0.26	0.4	1.09
Netherlands	0.61	0.76	0.63	0.69	0.67	0.57	0.47	0.47	0.55	0.58	0.52	0.4	0.33	0.24	0.15	0.2	0.11	-0.09	-0.21	-0.5	-0.43	-0.31	-0.19	-0.14	-0.17	-0.34	-0.33	0.37
Austria	0.67	0.84	0.81	0.76	0.76	0.71	0.6	0.6	0.67	0.69	0.62	0.52	0.45	0.45	0.38	0.31	0.24	0.03	-0.1	-0.37	-0.3	-0.2	-0.09	-0.04	-0.09	-0.26	-0.09	0.46
Poland	3.32	3.39	3.27	3.06	3.23	3.21	3.17	3.14	3.24	3.22	3.19	2.94	2.78	2.69	2.75	2.76	2.72	2.35	2.13	1.93	2.02	1.96	2.05	2.03	2.23	2.07	1.8	2.93
Portugal	1.85	2.03	1.79	1.66	1.84	1.87	1.76	1.82	1.88	1.96	1.91	1.71	1.67	1.55	1.32	1.18	1.02	0.59	0.44	0.17	0.2	0.19	0.35	0.41	0.37	0.25	0.71	2.16
Romania	4.24	4.49	4.53	4.46	4.69	4.95	5.05	4.8	4.75	4.9	4.78	4.6	4.69	4.79	4.8	4.91	4.93	4.59	4.51	4.12	4.12	4.12	4.29	4.57	4.28	4.04	4.56	4.06
Slovenia	0.88	1.14	1.11	0.89	0.96	0.99	0.79	0.77	0.75	0.92	1.01	0.96	0.98	0.87	0.67	0.52	0.38	0.19	-0.01	-0.06	-0.16	-0.09	-0.01	0.02	0.09	0.04	0.02	0.94
Slovakia	0.69	1	0.8	0.75	1	1.01	0.94	1	0.98	1.07	1	0.94	0.88	1	0.68	0.57	0	0.25	0.02	0	-0.34	-0.2	0	0.13	0.13	0	0.04	0.66
Finland	0.68	0.84	0.72	0.69	0.7	0.63	0.53	0.56	0.66	0.73	0.66	0.55	0.49	0.38	0.35	0.34	0.25	0.05	-0.09	-0.35	-0.3	-0.21	-0.08	-0.04	-0.07	-0.25	-0.12	0.44
Sweden	0.85	0.91	0.77	0.71	0.66	0.55	0.51	0.52	0.6	0.67	0.6	0.47	0.43	0.36	0.29	0.23	0.07	-0.09	-0.12	-0.36	-0.23	-0.16	0	0.07	0.11	-0.05	-0.17	0.49
UK	1.33	1.57	1.45	1.44	1.42	1.32	1.27	1.31	1.52	1.56	1.44	1.27	1.28	1.2	1.14	1.15	1.06	0.84	0.73	0.49	0.58	0.61	0.73	0.78	0.67	0.57	0.41	1.25

Annex 2: Debt premium and cost of debt

Government bonds

- Austria: RAGB, Republic of Austria Government Bond
- Belgium: BGB, Kingdom of Belgium Government Bond
- Finland: RFGB, Finland Government Bond
- France: FRTR, French Republic Government Bond
- Germany: DBR, Bundesrepublik Deutschland Bundesanleihe (German Government bond)
- Italy: Italy, Republic of Italy Government International Bond
- The Netherlands: NETHER, Netherlands Government Bond
- Portugal: PGB, Portugal Government Bond
- Spain: SPGB, Spain Government Bond
- United Kingdom: UKT: United Kingdom Gilt (Government Bond)

Table bonds

BT GROUP PLC	**Issued**	**Currency**	**Government bond**	**Issued**	**Currency**	**Spread**
BRITEL 5.75 12/07/2028 REGS Corp	04/28/1999	GBP	UKT 6 12/07/2028 Govt	01/20/1998	GBP	1,50
BRITEL 5.75 12/07/2028 REGS Corp	04/28/1999	GBP	UKT 1.625 10/22/2028 Govt	03/15/2018	GBP	1,63
BRITEL 5.75 12/07/2028 REGS Corp	04/28/1999	GBP	UKT 0.875 10/22/2029 Govt	06/18/2019	GBP	1,57
BRITEL 3.125 11/21/2031 REGS Corp	11/14/2017	GBP	UKT 4.75 12/07/2030 Govt	09/25/2007	GBP	1,77
BRITEL 3.64 06/25/2033 REGS Corp	06/25/2018	GBP	UKT 4.5 09/07/2034 Govt	06/16/2009	GBP	1,90
Average						1,67
DEUTSCHE TELEKOM AG-	**Issued**	**Currency**	**Government bond**	**Issued**	**Currency**	**Spread**
DT 1.375 01/30/2027 REGS Corp	01/23/2017	EUR	DBR 0.25 02/15/2027 Govt	01/03/2017	EUR	1,00
DT 0.5 07/05/2027 REGS Corp	07/02/2019	EUR	DBR 0.5 08/15/2027 Govt	07/12/2017	EUR	0,98
DT 1.5 04/03/2028 REGS Corp	03/14/2016	EUR	DBR 0.25 08/15/2028 Govt	07/11/2018	EUR	1,11

DT 2 12/01/2029 REGS Corp	05/22/2018	EUR	DBR 0.25 02/15/2029 Govt	01/09/2019	EUR	1,26
DT 1.75 03/25/2031 REGS Corp	03/12/2019	EUR	DBR 0.25 02/15/2029 Govt	01/09/2019	EUR	1,39
DT 1.75 03/25/2031 REGS Corp	03/12/2019	EUR	DBR 5.5 01/04/2031 Govt	10/17/2000	EUR	1,34
DT 7.5 01/24/2033 Corp	01/16/2003	EUR	DBR 0.25 02/15/2029 Govt	01/09/2019	EUR	1,64
DT 7.5 01/24/2033 Corp	01/16/2003	EUR	DBR 4.75 07/04/2034 Govt	01/21/2003	EUR	1,34
DT 2.2 07/25/2033 REGS Corp	07/16/2018	EUR	DBR 4.75 07/04/2034 Govt	01/21/2003	EUR	1,73
Average						1,31
ELISA OYJ	**Issued**	**Currency**	**Government bond**	**Issued**	**Currency**	**Spread**
ELIAV 1.125 02/26/2026 REGS Corp	02/14/2019	EUR	RFGB 0.5 04/15/2026 Govt	03/01/2016	EUR	1,00
KONINKLIJKE KPN NV	**Issued**	**Currency**	**Government bond**	**Issued**	**Currency**	**Spread**
KPN 1.125 09/11/2028 REGS Corp	08/30/2016	EUR	NETHER 0.75 07/15/2028 Govt	03/13/2018	EUR	1,17
NOS	**Issued**	**Currency**	**Government bond**	**Issued**	**Currency**	**Spread**
NOSPL 0 07/18/2024 Corp	07/18/2019	EUR	PGB 5.65 02/15/2024 Govt	05/07/2013	EUR	0,29
NOSPL 0 07/18/2024 Corp	07/18/2019	EUR	PGB 4.95 10/25/2023 Govt	06/03/2008	EUR	0,34
NOSPL 1.125 05/02/2023 REGS Corp	04/23/2018	EUR	PGB 5.65 02/15/2024 Govt	05/07/2013	EUR	0,47
NOSPL 1.125 05/02/2023 REGS Corp	04/23/2018	EUR	PGB 4.95 10/25/2023 Govt	06/03/2008	EUR	0.58
Average						0.42
ORANGE	**Issued**	**Currency**	**Government bond**	**Issued**	**Currency**	**Spread**
ORAFP 4.125 11/30/2026 REGS Corp	11/30/2011	EUR	FRTR 0.25 11/25/2026 Govt	08/26/2016	EUR	0.85
ORAFP 0.875 02/03/2027 REGS Corp	10/26/2016	EUR	FRTR 1 05/25/2027 Govt	04/06/2017	EUR	0.56

ORAFP 1.5 09/09/2027 REGS Corp	03/02/2017	EUR	FRTR 2.75 10/25/2027 Govt	08/31/2012	EUR	0.59
ORAFP 3.22 04/11/2028 Corp	03/28/2013	EUR	FRTR 0.75 05/25/2028 Govt	10/05/2017	EUR	0.66
ORAFP 2 01/15/2029 REGS Corp	01/08/2019	EUR	FRTR 0.5 05/25/2029 Govt	03/07/2019	EUR	0.70
ORAFP 3.3 04/11/2029 Corp	04/03/2013	EUR	FRTR 0.5 05/25/2029 Govt	03/07/2019	EUR	1.00
ORAFP 1.375 01/16/2030 REGS Corp	01/09/2018	EUR	FRTR 2.5 05/25/2030 Govt	04/25/2014	EUR	0.76
ORAFP 2.6 09/17/2030 REGS Corp	09/03/2015	EUR	FRTR 2.5 05/25/2030 Govt	04/25/2014	EUR	0.98
ORAFP 1.342 05/29/2031 REGS Corp	05/20/2019	EUR	FRTR 1.5 05/25/2031 Govt	09/25/2015	EUR	0.84
ORAFP 0.5 09/04/2032 REGS Corp	03/31/2020	EUR	FRTR 5.75 10/25/2032 Govt	05/23/2001	EUR	0.84
ORAFP 8.125 01/28/2033 Corp	01/15/2003	EUR	FRTR 5.75 10/25/2032 Govt	05/23/2001	EUR	1.80
ORAFP 3.75 09/30/2033 Corp	09/19/2013	EUR	FRTR 1.25 05/25/2034 Govt	02/01/2018	EUR	0.86
Average						0.87
PROXIMUS	**Issued**	**Currency**	**Government bond**	**Issued**	**Currency**	**Spread**
PROXBB 3.19 03/20/2028 REGS Corp	03/06/2013	EUR	BGB 0.8 06/22/2028 Govt	01/16/2018	EUR	0,73
PROXBB 3.19 03/20/2028 REGS Corp	03/06/2013	EUR	BGB 5.5 03/28/2028 Govt	02/16/1998	EUR	0,75
PROXBB 1.75 09/08/2031 REGS Corp	02/27/2019	EUR	BGB 1 06/22/2031 Govt	02/09/2015	EUR	0,97
PROXBB 1.75 09/08/2031 REGS Corp	02/27/2019	EUR	BGB 0.1 06/22/2030 Govt	01/15/2020	EUR	1,11
Average						0,89
TELE2 AB-B SHS	**Issued**	**Currency**	**Government bond**	**Issued**	**Currency**	**Spread**
TELBSS 2.125 05/15/2028 REGS Corp	10/23/2018	EUR	DBR 0.5 02/15/2026 Govt	01/05/2016	EUR	1,78
TELECOM ITALIA SPA	**Issued**	**Currency**	**Government bond**	**Issued**	**Currency**	**Spread**

TITIM 3.625 05/25/2026 REGS Corp	05/18/2016	EUR	ITALY 1.448 04/17/2027 Govt	10/10/2016	EUR	1,74
TITIM 3.625 05/25/2026 REGS Corp	05/18/2016	EUR	ITALY 0 03/29/2026 Govt	03/30/2006	EUR	1,65
TITIM 7.75 01/24/2033 Corp	01/10/2003	EUR	ITALY 2 09/05/2032 Govt	03/02/2015	EUR	1,53
TITIM 7.75 01/24/2033 Corp	01/10/2003	EUR	ITALY 5.2 07/31/2034 Govt	06/25/2004	EUR	1,51
Average						1,61
TELEFONICA SA	**Issued**	**Currency**	**Government bond**	**Issued**	**Currency**	**Spread**
TELEFO 1.46 04/13/2026 REGS Corp	04/06/2016	EUR	SPGB 1.95 04/30/2026 Govt	01/12/2016	EUR	0,25
TELEFO 1.447 01/22/2027 REGS Corp	01/15/2018	EUR	SPGB 1.5 04/30/2027 Govt	01/24/2017	EUR	0,44
TELEFO 2.318 10/17/2028 REGS Corp	01/10/2017	EUR	SPGB 1.4 07/30/2028 Govt	06/26/2018	EUR	0,49
TELEFO 1.715 01/12/2028 REGS Corp	09/05/2017	EUR	SPGB 5.15 10/31/2028 Govt	07/082013	EUR	0,34
TELEFO 1.788 03/12/2029 REGS Corp	03/05/2019	EUR	SPGB 1.45 04/30/2029 Govt	01/22/2019	EUR	0,49
TELEFO 0.664 02/03/2030 REGS Corp	01/27/2020	EUR	SPGB 0.5 04/30/2030 Govt	01/14/2020	EUR	0,57
TELEFO 1.93 10/17/2031 REGS Corp	10/10/2016	EUR	SPGB 1.95 07/30/2030 Govt	02/24/205	EUR	0,50
TELEFO 5.875 02/14/2033 REGS Corp	02/06/2003	EUR	SPGB 5.75 07/30/2032 Govt	01/18/2001	EUR	0,55
TELEFO 5.875 02/14/2033 REGS Corp	02/06/2003	EUR	SPGB 2.35 07/30/2033 Govt	02/22/2017	EUR	0,39
Average						0,45
TELEKOM AUSTRIA AG	**Issued**	**Currency**	**Government bond**	**Issued**	**Currency**	**Spread**
TKAAV 1.5 12/07/2026 REGS Corp	11/30/2016	EUR	RAGB 0.75 10/20/2026 Govt	02/16/2016	EUR	0,81
TELENET GROUP HOLDING NV	**Issued**	**Currency**	**Government bond**	**Issued**	**Currency**	**Spread**
TNETBB 3.5 03/01/2028 REGS Corp	11/29/2017	EUR	BGB 1 06/22/2026 Govt	01/11/2016	EUR	3,18
TNETBB 3.5 03/01/2028 REGS Corp	11/29/2017	EUR	BGB 0.9 06/22/2029 Govt	01/08/2019	EUR	2,86

Average						3,02
TELIA CO AB	**Issued**	**Currency**	**Government bond**	**Issued**	**Currency**	**Spread**
TELIAS 4 01/18/2027 REGS Corp	01/09/2012	EUR	DBR 0.5 02/15/2026 Govt	01/05/2016	EUR	1,35
TELIAS 3 09/07/2027 REGS Corp	08/31/2012	EUR	DBR 0.5 08/15/2027 Govt	07/12/2017	EUR	1,10
TELIAS 5.135 04/01/2031 Corp	03/11/2011	EUR	DBR 0.25 02/15/2029 Govt	01/09/2019	EUR	1,74
TELIAS 5.03 07/01/2031 Corp	06/20/2011	EUR	DBR 0.25 02/15/2029 Govt	01/09/2019	EUR	1,78
TELIAS 3.5 09/05/2033 REGS Corp	08/29/2013	EUR	DBR 5.5 01/04/2031 Govt	10/17/2000	EUR	1,50
TELIAS 2.125 02/20/2034 REGS Corp	02/12/2019	EUR	DBR 4.75 07/04/2034 Govt	01/21/2003	EUR	1,54
Average						1,50
VODAFONE GROUP PLC	**Issued**	**Currency**	**Government bond**	**Issued**	**Currency**	**Spread**
VOD 5.9 11/26/32 Corp	11/20/2002	GBP	UKT 4.25 06/07/2032 Govt	05/16/2000	GBP	1,70
Average						1,70

Annex 3: Beta and Gearing

In this annex the process and the results of the estimation for the 14 peers analyzed will be reported.

The information for each peer about the estimation of the equity beta, the spot gearing and its components (Equity and Debt) are provided. For each comparable a statistic analysis is also reported to get information on the consistency, in term of bias and efficiency of the estimation.

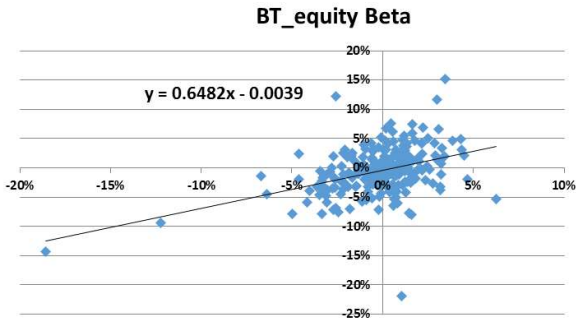
In the table below we report some information about the 14 peer-operators. Specifically, information about the revenues achieved from last financial reports public available, in the EU or European countries; if the company is an SMP operator or not; the home country where the shares are traded.

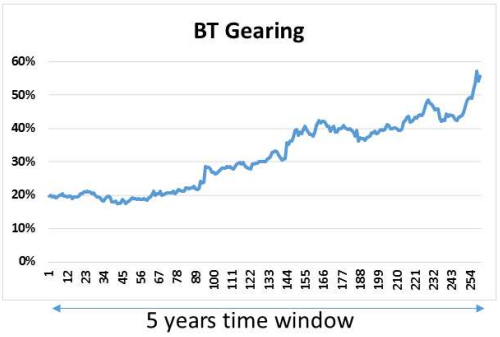
Name	Country	Main information	SMP	Revenues from EU
BT Group plc	UK	Provides a wide range of telecommunication services (mainly based in UK and fixed market)	YES	EU>90%
Deutsche Telekom	DE	Offers a broad range of telecommunication services	YES	EU>51%
Elisa Oyj	FI	Provides telecommunication solutions like mobile, fixed in Finland and Estonia	YES	EU About 100% (Finland and Estonia)
Koninklijke KPN	NL	Provides a broad range of telecommunications services throughout the Netherlands	YES	EU About 100%
NOS	PT	Provides television, cable and satellite broadcasting services as well as communication services	NO	EU About 100%
Orange S.A.	FR	Telecommunication network operator that provides a broad range of services	YES	EU>65%
Proximus S.A.	BE	Provide communication services nationally and internationally	YES	EU About 100% (including carrier activities)
Tele 2	SE	Provides a telecommunication services in Sweden and a number of other European countries using wholesale products	NO	EU About 100% (SE+Baltic+Germany)
Telecom Italia	IT	Offers fixed line and mobile telephone and data transmission services in Italy and abroad.	YES	EU>75%
Telefónica	ES	Provides telecom services in Central and Eastern Europé, a wide variety of services	YES	EU(ES)>51%
Telekom Austria	AT	Provides telecom services in Central and Eastern Europé, a wide variety of services	YES	EU>80% Austria, Croatia, Bulgaria, Slovenia
Telenet	BE	Provide telephone and internet services through a network of fibre optic and coax cable in Belgium	NO	EU About 100%
Telia Company AB	SE	Offers telecommunication services in the Nordic region, Baltic countries and international traffic	YES	EU>80%
Vodafone Group plc	UK	Provide a wide range of communication services throughout the world managing and investing in own Mobile and fixed network	NO	EU>65%

Table A1 Peer group companies

More detailed info for the selected parameters for each company are reported.

BT group

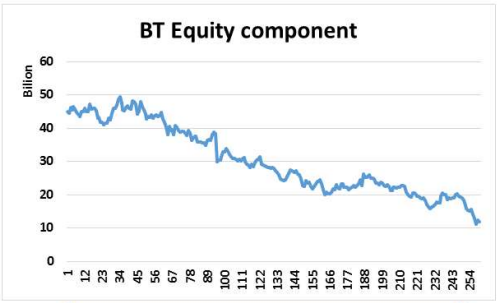




5 years time window

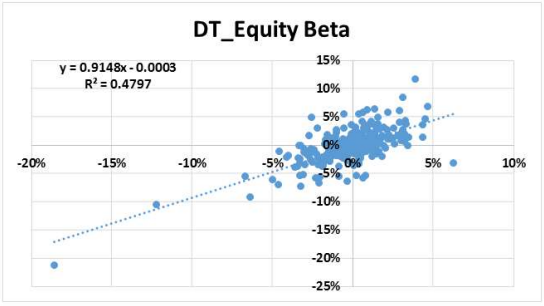
Debt BT Book value

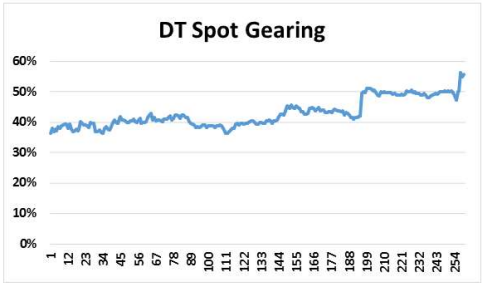
Milion of GDP	2019	2018	2017	2016	2015	2014
Long term debt (A)		14,586	11,789	9,867	10,800	7,643
Capital leases (B)		190	205	214	225	219
Minority Interest						
Deferred Tax Liability Non current		1,407	1,340	1,240	1,262	948
Other Non current Liabilities		10,335	9,412	11,791	8,916	9,861
Current portion of long term debt/capital lease		2,028	2,252	2,615	3,736	1,873
Net Debt relevant for gearing calculation (A+B)		14,776	11,994	10,081	11,025	7,862



5 years time window

Deutsche Telekom Group

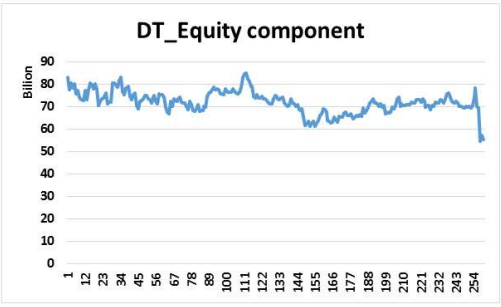




5 years time window

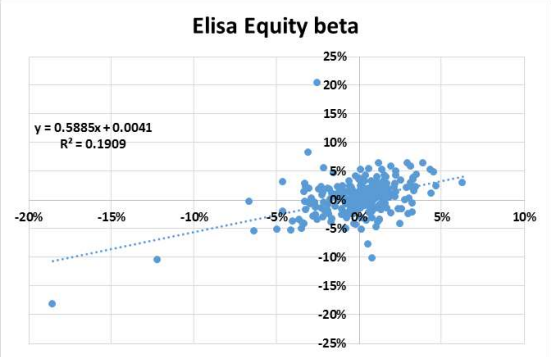
Debt DT Book value

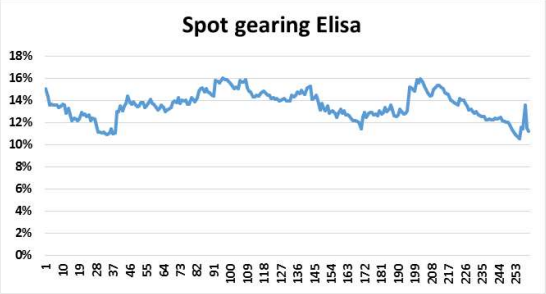
Milion of Euro	2019	2018	2017	2016	2015
Long term debt (A)	54,202	49,350	46,436	47,810	45,575
Capital leases (B)	15,848	1,622	1,884	1,962	1,616
Minority Interest					
Deferred Tax Liability Non current	8,954	8,240	6,967	10,007	9,205
Other Non current Liabilities	12,524	13,582	16,211	16,735	15,826
Current portion of long term debt/capital lease	13,013	8,617	6,952	10,771	9,447
Net Debt relevant for gearing calculation (A+B)	70,050	50,972	48,320	49,772	47,191



5 years time window

Elisa

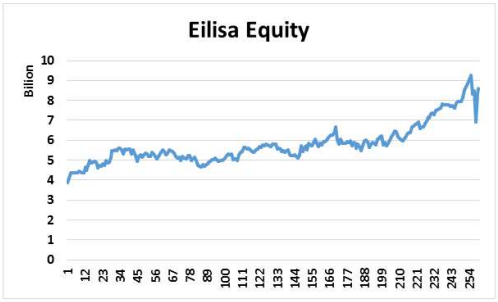




5 years time window

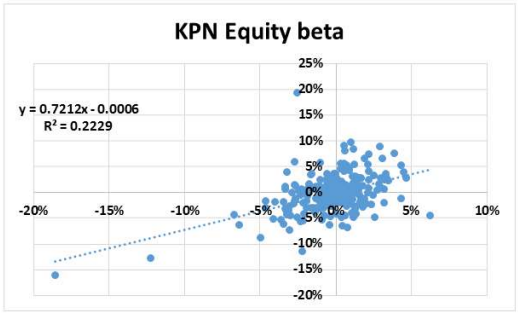
Debt book value Elisa

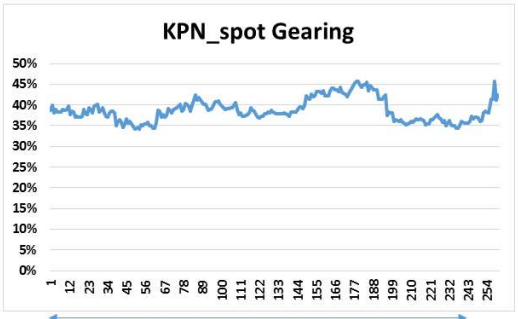
Milion of Euro	2019	2018	2017	2016	2015
Long term debt (A)	1,008	840	917	805	662
Capital leases (B)	78	22	22	23	24
Minority Interest					
Deferred Tax Liability Non current	26	26	24	29	23
Other Non current Liabilities	57	54	44	54	43
Current portion of long term debt/capital lease	18	180	4	3	4
Net Debt relevant for gearing calculation (A+B)	1,085	861	940	827	686



5 years time window

KPN

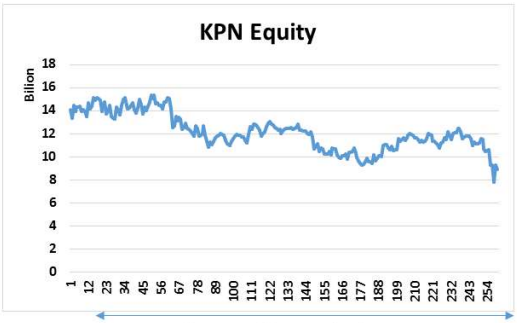




5 years time window

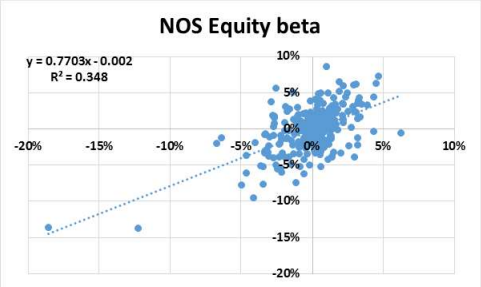
Debt KPN Book value

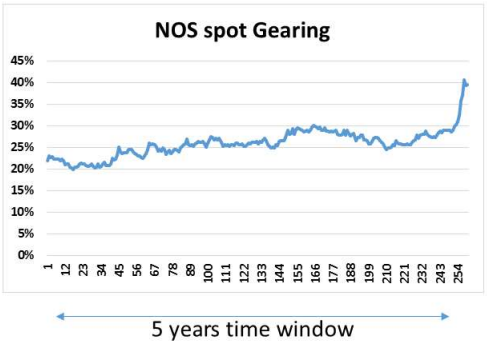
Milion of Euro	2019	2018	2017	2016	2015
Long term debt (A)	5,722	6,939	7,579	7,897	8,853
Capital leases (B)	785	827	0	0	0
Minority Interest					
Deferred Tax Liability Non current	0	0	1	0	47
Other Non current Liabilities	656	927	826	610	804
Current portion of long term debt/capital lease	1,082	729	18	735	847
Net Debt relevant for gearing calculation (A+B)	6,507	7,766	7,579	7,897	8,853



5 years time window

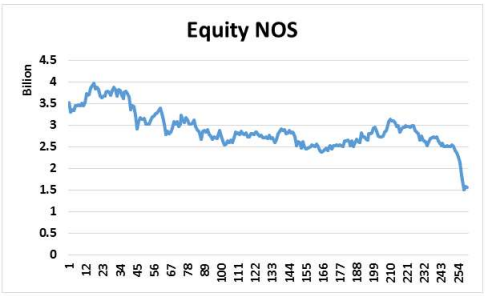
NOS



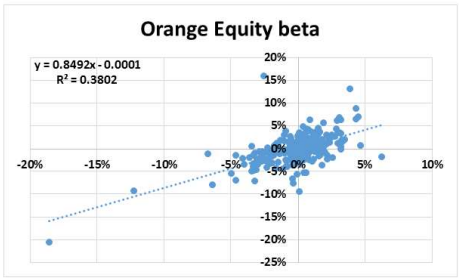


Debt book value NOS

Milion of Euro	2019	2018	2017	2016	2015	2014
Long term debt (A)		825	870	872	863	886
Capital leases (B)		189	84	100	117	72
Minority Interest						
Deferred Tax Liability Non current		5	26	10	14	16
Other Non current Liabilities		145	166	186	158	178
Current portion of long term debt/capital lease		263	168	209	139	111
Net Debt relevant for gearing calculation (A+B)		1,014	955	972	979	958

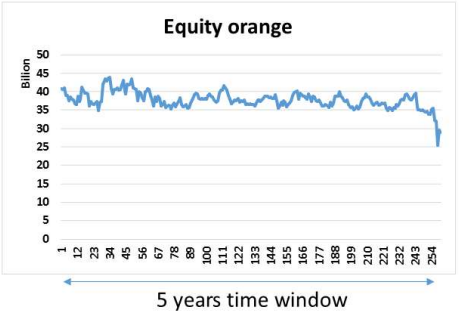


Orange

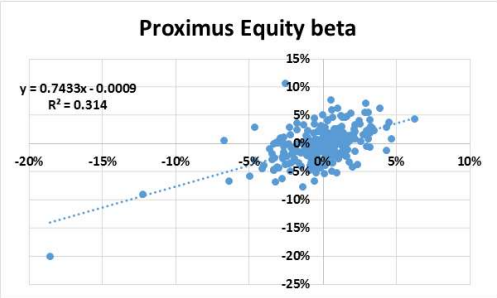


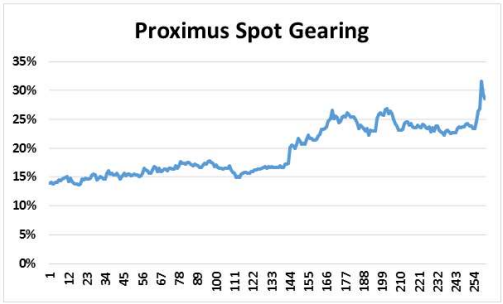
Debt Orange Book value

Milion of Euro	2019	2018	2017	2016	2015
Long term debt (A)	33,148	26,064	26,293	28,247	29,028
Capital leases (B)	5,225	426	0	506	500
Minority Interest					
Deferred Tax Liability Non current	703	631	655	658	879
Other Non current Liabilities	5,116	5,926	5,832	6,179	6,130
Current portion of long term debt/capital lease	9,110	10,570	9,420	7,668	3,602
Net Debt relevant for gearing calculation (A+B)	38,373	26,490	26,293	28,753	29,528



Proximus

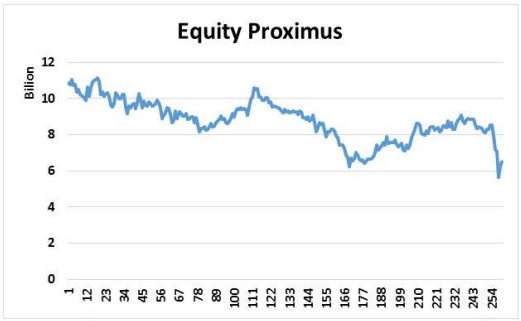




5 years time window

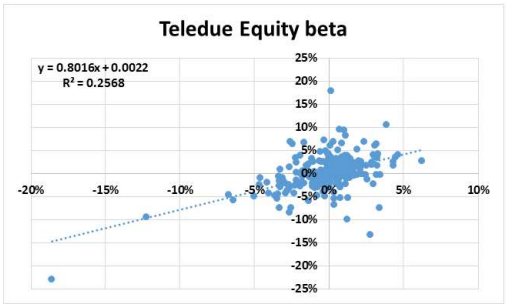
Debt Proximus Book value

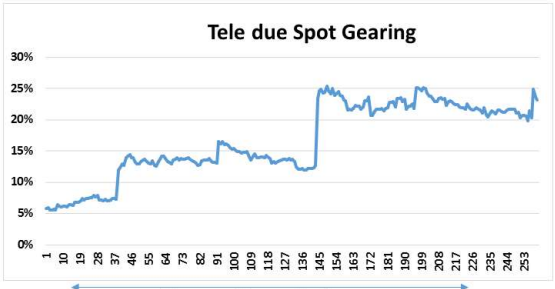
Milion of Euro	2019	2018	2017	2016	2015
Long term debt (A)	2,355	2,255	1,850	1,755	1,754
Capital leases (B)	243	4	6	2	3
Minority Interest					
Deferred Tax Liability Non current	110	91	72	84	96
Other Non current Liabilities	909	830	861	856	810
Current portion of long term debt/capital lease	65	76	407	407	673
Net Debt relevant for gearing calculation (A+B)	2,598	2,259	1,856	1,757	1,757



5 years time window

Tele 2

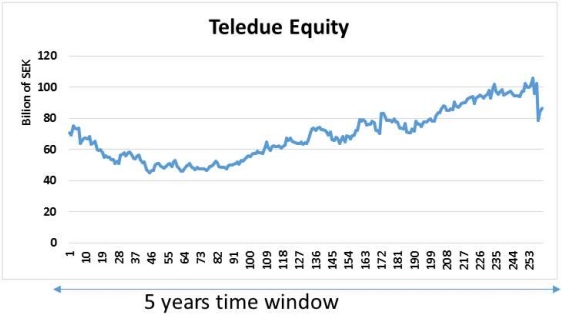




5 years time window

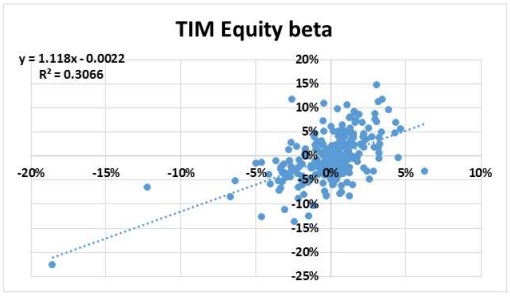
Debt Teledue Book value

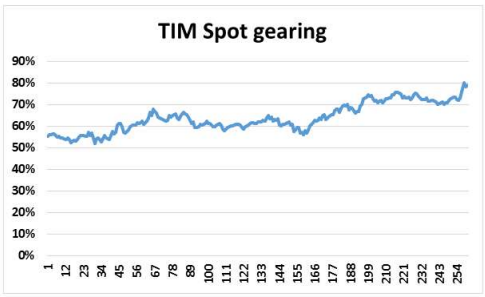
Milion of SEK	2019	2018	2017	2016	2015
Long term debt (A)	21,573	21,663	10,033	7,527	4,284
Capital leases (B)	4,501	14	15	32	45
Minority Interest					
Deferred Tax Liability Non current	4,360	4,203	998	1,066	697
Other Non current Liabilities	3,100	5,551	3,652	1,471	1,290
Current portion of long term debt/capital lease	3,368	1,580	45	2,962	4,964
Net Debt relevant for gearing calculation (A+B)	26,074	21,677	10,048	7,559	4,329



5 years time window

TIM

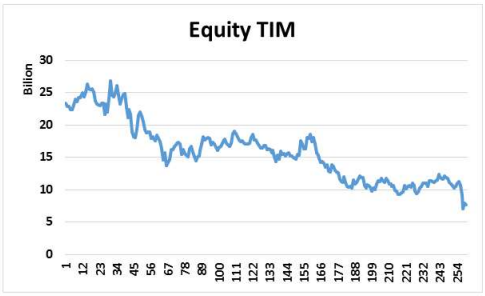




5 years time window

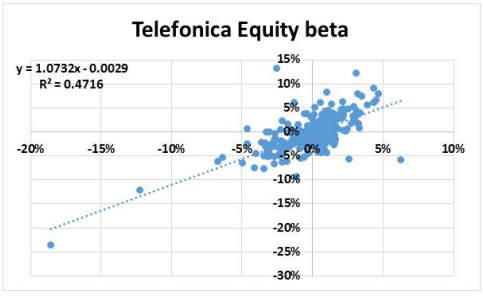
Debt TIM Book value

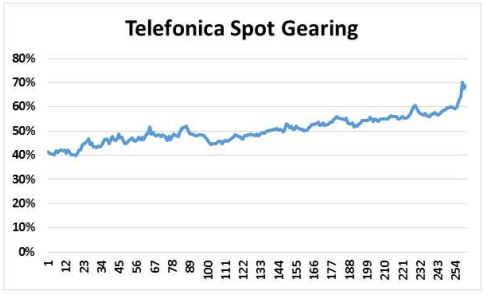
Milion of Euro	2019	2018	2017	2016	2015
Long term debt (A)	23,945	21,894	23,940	26,136	26,652
Capital leases (B)	4,576	1,740	2,249	2,444	2,271
Minority Interest					
Deferred Tax Liability Non current	309	192	310	359	372
Other Non current Liabilities	7,525	7,165	6,113	5,615	4,946
Current portion of long term debt/capital lease	3,759	5,575	4,681	3,976	5,549
Net Debt relevant for gearing calculation (A+B)	28,521	23,634	26,189	28,580	28,923



5 years time window

Telefonica

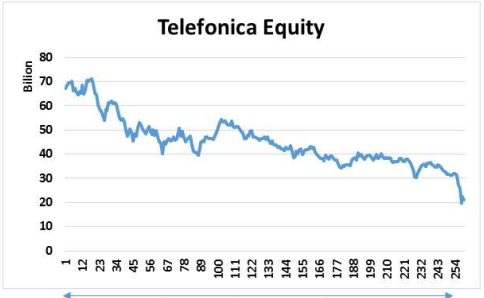




5 years time window

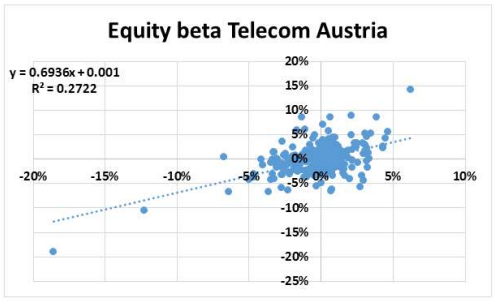
Debt Telefonica Book value

Milion of Euro	2019	2018	2017	2016	2015
Long term debt (A)	40,930	43,047	43,460	42,865	47,117
Capital leases (B)	5,626	0	0	0	0
Minority Interest					
Deferred Tax Liability Non current	2,908	2,674	2,145	2,395	2,550
Other Non current Liabilities	13,772	11,697	13,777	14,545	10,842
Current portion of long term debt/capital lease	8,517	7,159	7,027	10,916	12,970
Net Debt relevant for gearing calculation (A+B)	46,556	43,047	43,460	42,865	47,117



5 years time window

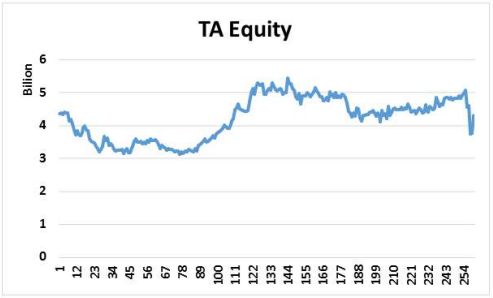
Telekom Austria



5 years time window

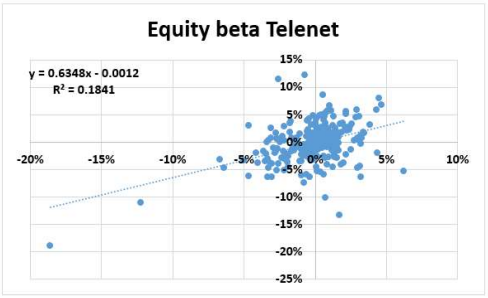
Debt Telekom Austria value

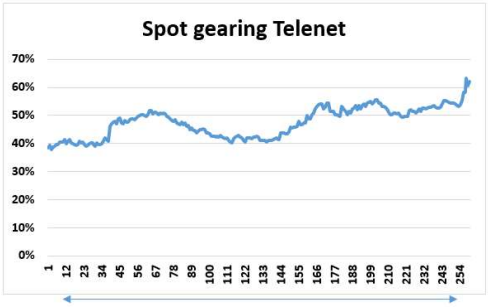
Milion of Euro	2019	2018	2017	2016	2015
Long term debt (A)	3,328	2,536	2,533	2,303	2,585
Capital leases (B)	788	859	0	0	0
Minority Interest					
Deferred Tax Liability Non current	7	15	42	63	71
Other Non current Liabilities	868	802	882	958	969
Current portion of long term debt/capital lease	276	389	1	500	1,505
Net Debt relevant for gearing calculation (A+B)	4,116	3,396	2,534	2,304	2,585



5 years time window

Telenet

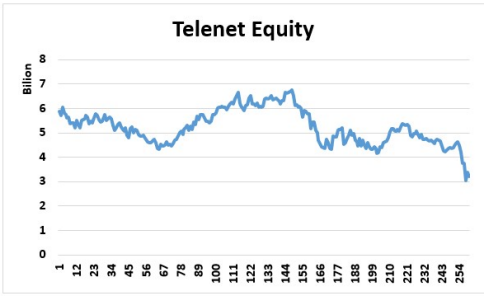




5 years time window

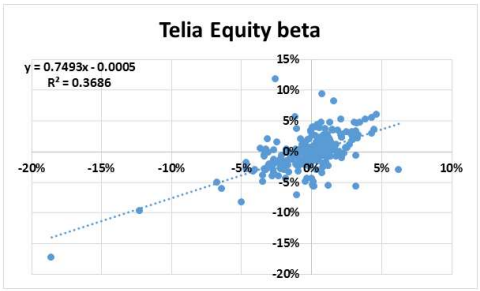
Debt book value Telenet

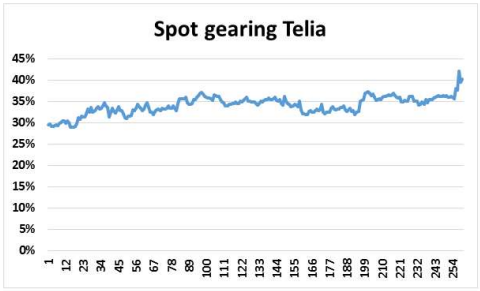
Milion of Euro	2019	2018	2017	2016	2015
Long term debt (A)	4,742	5,161	4,462	4,642	3,683
Capital leases (B)	505	0	0	0	0
Minority Interest					
Deferred Tax Liability Non current	172	163	151	166	125
Other Non current Liabilities	305	289	436	190	118
Current portion of long term debt/capital lease	527	504	362	139	111
Net Debt relevant for gearing calculation (A+B)	5,247	5,161	4,462	4,642	3,683



5 years time window

Telia Company

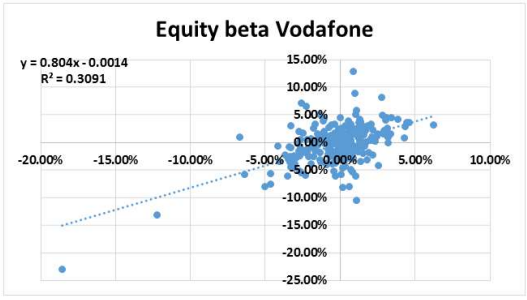


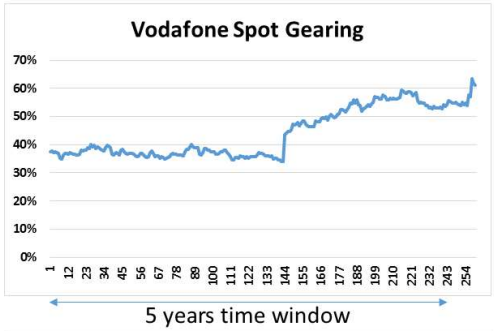


Debt book value Telia

Milion of SEK	2019	2018	2017	2016	2015
Long term debt (A)	84,929	83,673	85,376	80,255	89,279
Capital leases (B)	12,046	1,363	171	221	46
Minority Interest					
Deferred Tax Liability Non current	11,647	11,382	8,973	10,567	10,627
Other Non current Liabilities	12,708	9,832	12,426	10,692	9,222
Current portion of long term debt/capital lease	19,757	9,215	2,807	3,069	9,257
Net Debt relevant for gearing calculation (A+B)	96,975	85,036	85,547	80,476	89,325

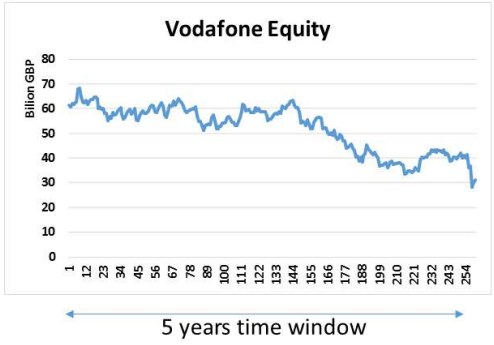
Vodafone





Debt book value Vodafone

Milion of GBP	2019	2018	2017	2016	2015	2014
Long term debt (A)		48,685	32,630	34,218	36,792	29,559
Capital leases (B)		0	0	0	0	0
Minority Interest						
Deferred Tax Liability Non current		478	644	535	564	593
Other Non current Liabilities		4,731	4,706	3,823	4,380	3,926
Current portion of long term debt/capital lease		3,397	7,639	8,403	5,422	7,925
Net Debt relevant for gearing calculation (A+B)		48,685	32,630	34,218	36,792	29,559



Statistical Analysis

The estimation of the asset betas is subject to the consistency of the OLS (Ordinary Least Square) in term of bias[127] (that affects the beta estimation) and efficiency[128] that affects the significance level of the estimation.

More specifically the following elements should be taken into account to address the consistency of the OLS estimation:

- The Error terms of the regression are normally distributed around a zero mean;
- The Error terms are homoscedastic that means that the error terms have constant variance across the sample.
- The Error terms are not autocorrelated, i.e. there is no systematic dependence across the error terms.

Specifically, the failure of normality can put some question on the validity on the single factor CAPM method. The presence of heteroscedasticity in the meaning of failing the general hypothesis of constant variance, generally does not bias the beta estimate, but affects the confidence interval and therefore statistical inferences around those estimates.[129] When error terms are "autocorrelated", this means that the validity of a time independent model can be questionable.[130]

In the following we present visual inspection and statistical test -when relevant- of the residual component of the regression model presented in the previous section, for each comparable, to test the three main issues previously addressed.

Normality

To test the normality only a visual approach[131] through the Box-plot, density plot, and Q-Q plot[132] have been used.

In the following picture, the Box-plot of the residual distribution is provided. The box-plot shows the median as a horizontal line inside the box and the interquartile range (range between the

[127] In statistics, an unbiased estimate refers to the property that the sample statistic converges to its true "population" value in repeated samples.

[128] In statistics, an efficient estimate is an estimate/sample statistic that has the minimum variance, i.e. lowest uncertainty surrounding that estimate/sample statistic.

[129] Armitage, S & Brzeszczynsky 2011 "Hetheroscedasticity and interval effects in estimating beta: UK evidence" Applied Financial Economics, Vol. 21, no. 20, pp. 1525-1538.

[130] The presence of autocorrelation in the residual for the beta estimation is generally attributable to significantly variation of the beta in the time windows considered due to the fact that the beta evolution is not a stationary process. The presence of autocorrelation can be more evident when daily observation are used on longer time windows. In this case the beta estimation using the OLS can be biased. When this happens dynamic models for beta estimation, generally, can be taken into account, such as ARCH model (AutoRegressive Conditional Heteroskedasticity) or GARCH (Generalized Autoregressive Conditional Heteroskedasticity). https://www.ofgem.gov.uk/ofgem-publications/145143

[131] Parametric test for larger samples (i.e. more than one hundred), as in the cases under consideration, are not suitable as the assumption of normality might be rejected too easily due to high sensitivity to outlier. So for large samples Q-Q plot, histogram are the best solution. https://www.sheffield.ac.uk/polopoly_fs/1.579191!/file/stcp-karadimitriou-normalR.pdf. Non parametric test are generally less powerful to test normality of the sample https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3693611/.

[132] In statistics, a Q–Q (quantile-quantile) plot is a probability plot, which is a graphical method for comparing two probability distribution by plotting their quantiles against each other. First, the set of intervals for the quantiles

25th to 75th percentiles) as the length of the box. The whiskers (line extending from the top and bottom of the box) represent the minimum and maximum values when they are within 1.5 times the interquartile range from either end of the box. Scores greater than 1.5 times the interquartile range are out of the boxplot and are considered as outliers, and those greater than 3 times the interquartile range are extreme outliers. A boxplot that is symmetric with the median line at approximately the center of the box and with symmetric whiskers that are slightly longer than the subsections of the center box suggests that the data may have come from a normal distribution.

The Kernel plot of the distribution of the residual is also included in comparison with the corresponding theoretical normal distribution with same mean and standard deviation is provided.

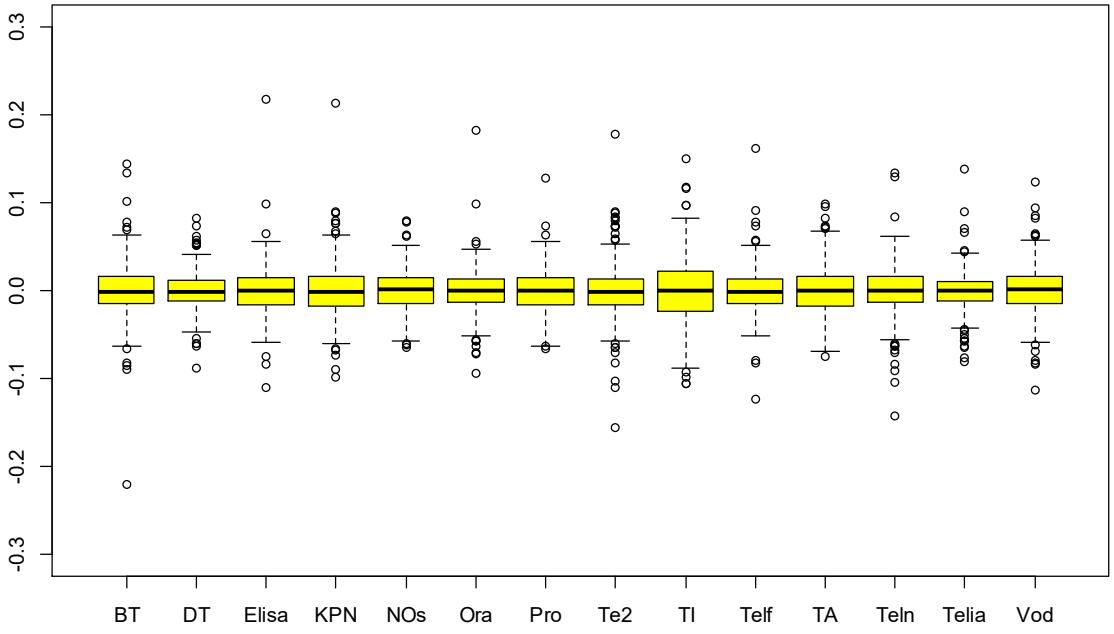


Figure A1 Box plot of residual distribution of the beta equity estimation

A more accurate picture of the distribution of the residual with respect to the theoretical normal distribution is provided in the Q-Q plot below. A Q-Q plot represents the quantiles (values that split a data set into equal portions) of the data on the y-axis with respect to the quantile of the theoretical normal distribution reported on the x-axis; the red line provide the theoretical line if

is chosen. A point (x, y) on the plot corresponds to one of the quantiles of the second distribution (y-coordinate) plotted against the same quantile of the first distribution (x-coordinate). Thus, the line is a parametric curve with the parameters which is the number of the interval for the quantile.

the residual data will come from a normal distribution with same average and standard deviation of the residual data under inspection.

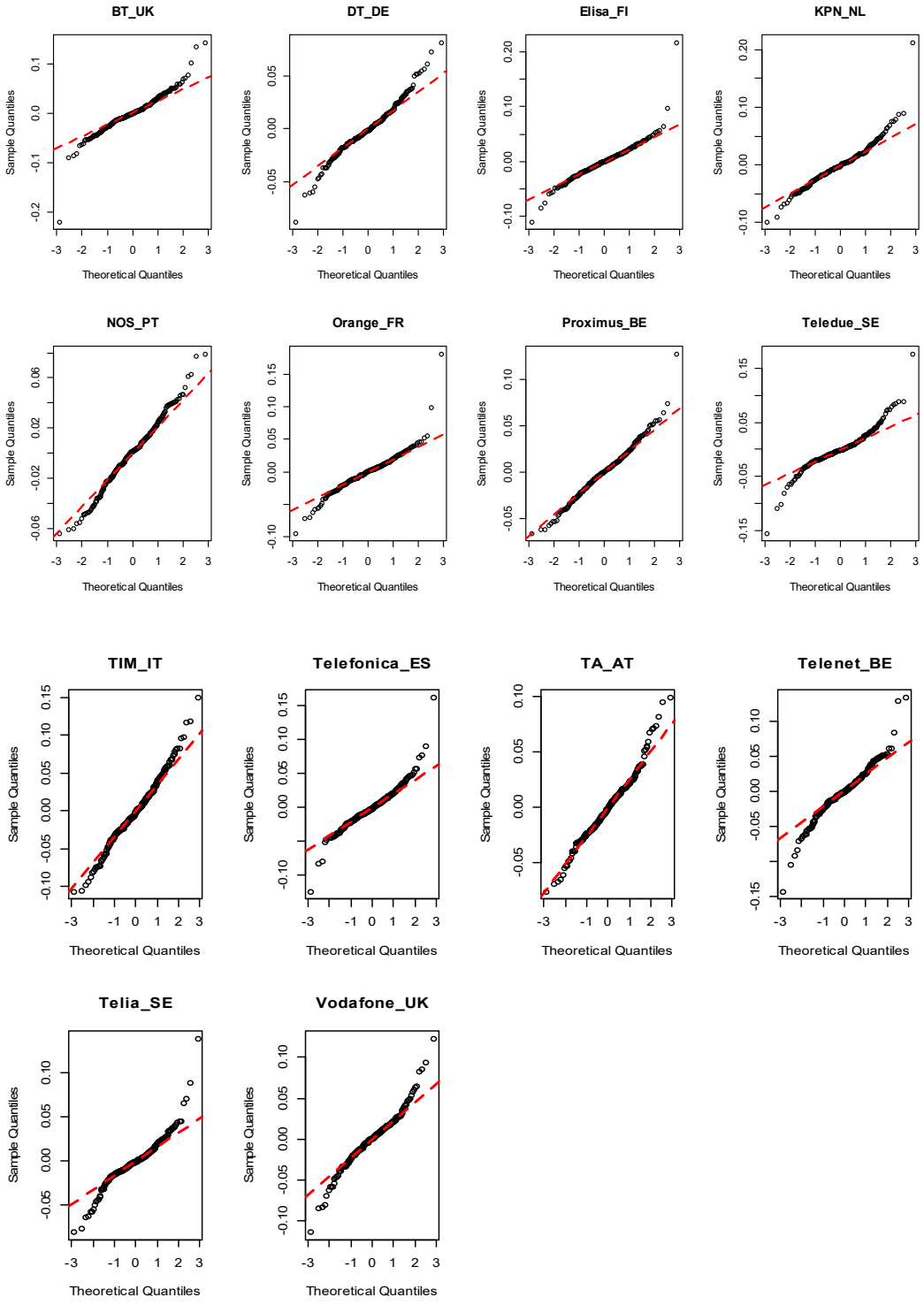


Figure A2 Q-Q plot of residual distribution of the beta equity estimation

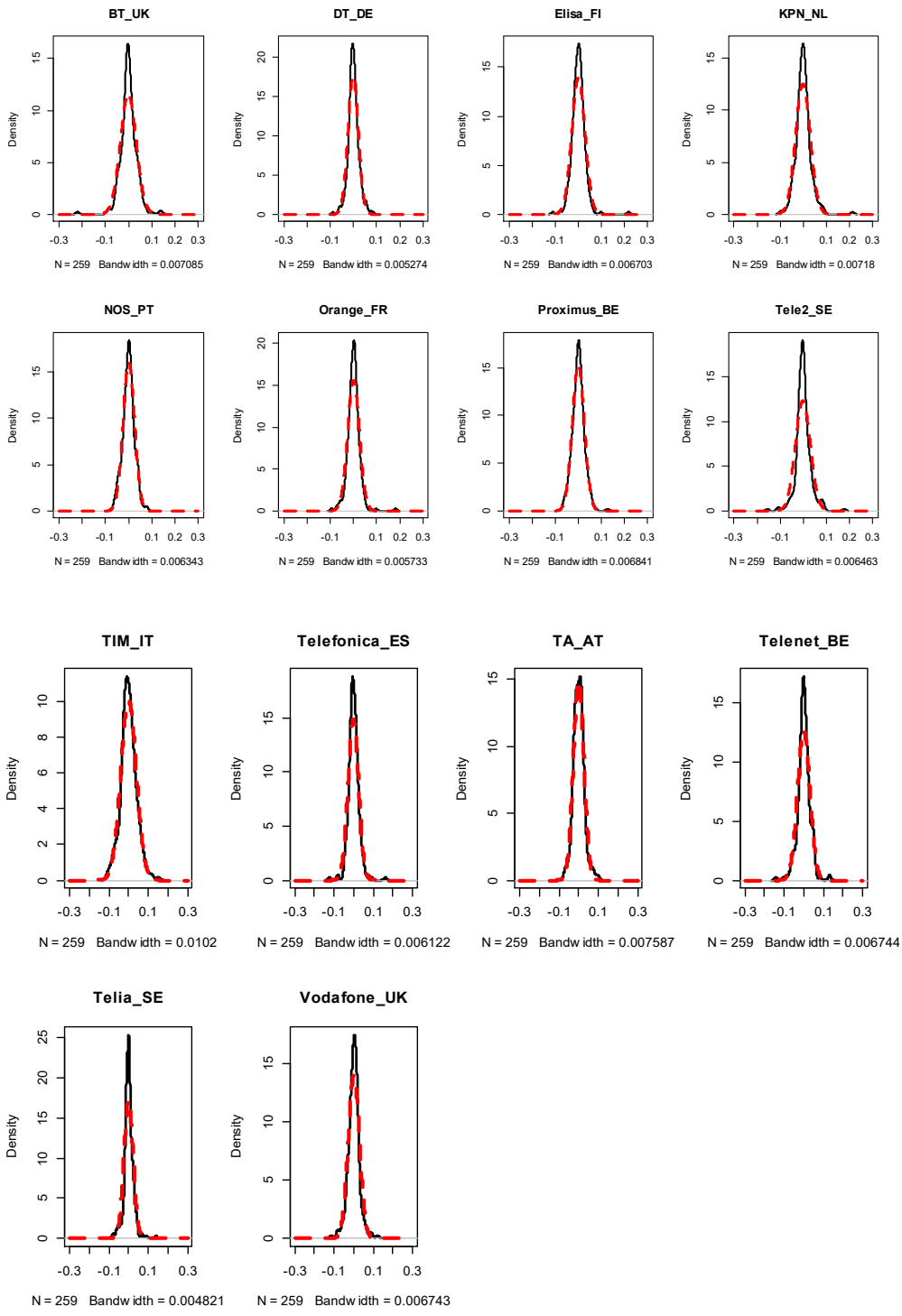


Figure A3 – Density plot of the residual of the distribution

From the graphical analysis of the box plot, density plot and Q-Q plot it is possible to observe that the normal distribution assumption is generally violated only due to presence of outliers'

values in the residual. In that sense a general approximation of normal distribution can be accepted.

In the following table for each comparable the number of relevant outliers[133] as well as the p-values of the Shapiro-Wilk normality test[134] are provided. This analysis shows that the normality assumption can be generally accepted, and the failure of the normality test is not due to systematic failure of the model assumption, but due the presence of some outliers that are between 3-6% of the whole number of observations.

	Number of outlier	p-value of the Shapiro Will normality test
BT_UK	10	3.029e-10
DT_DE	11	0.0001377
Elisa_FI	10	1.664e-12
KPN_NL	13	5.854e-10
NOS_PT	16	0.168
Orange_FR	9	1.041e-11
Proximus_BE	10	0.001152
Tele2_SE	12	4.889e-11
TIM_IT	13	0.02328
Telefonica_ES	11	7.555e-10
TA_AT	14	0.0003438
TeleNet_BE	13	3.062e-07
Telia_SE	11	6.311e-11
Vodafone_UK	15	2.716e-06

Table A2 –Relevant outlier and normality test

Homoscedasticity

In relation with the homoscedastic behavior (constant variance of the residual), a graphical analysis of the distribution of the residual with respect to the corresponding fitted value of the model is provided. If the residuals are distributed around the zero line, and no pattern is

[133] The number of outliers has been evaluated considering influential observations in the residual that have combination of high leverage and large error. The leverage coefficient is a measure of the effect of a particular observation on the regression predictions due to the position of that observation in the space of the inputs. A common measure of influence is Cook's Distance. The Cook's distance of each observation has been considered high if it is larger than 4/n with n the number of observations.

[134] The Shapiro-Wilk test is one of the most used normality test generally used for small sample (<50), as all the parametric normality tests. In this case the objective is to find a measure between comparables to detect outlier of the level of "non-normality". Only two operators can pass the normality test highlighted in blue. For the other with an alpha level is 0.05 the p-value is less than 0.05, then the null hypothesis that the data are normally distributed is rejected.

present it is possible to consider that the residuals are homoscedastic at least with respect to the constant variance attribute across the sample.

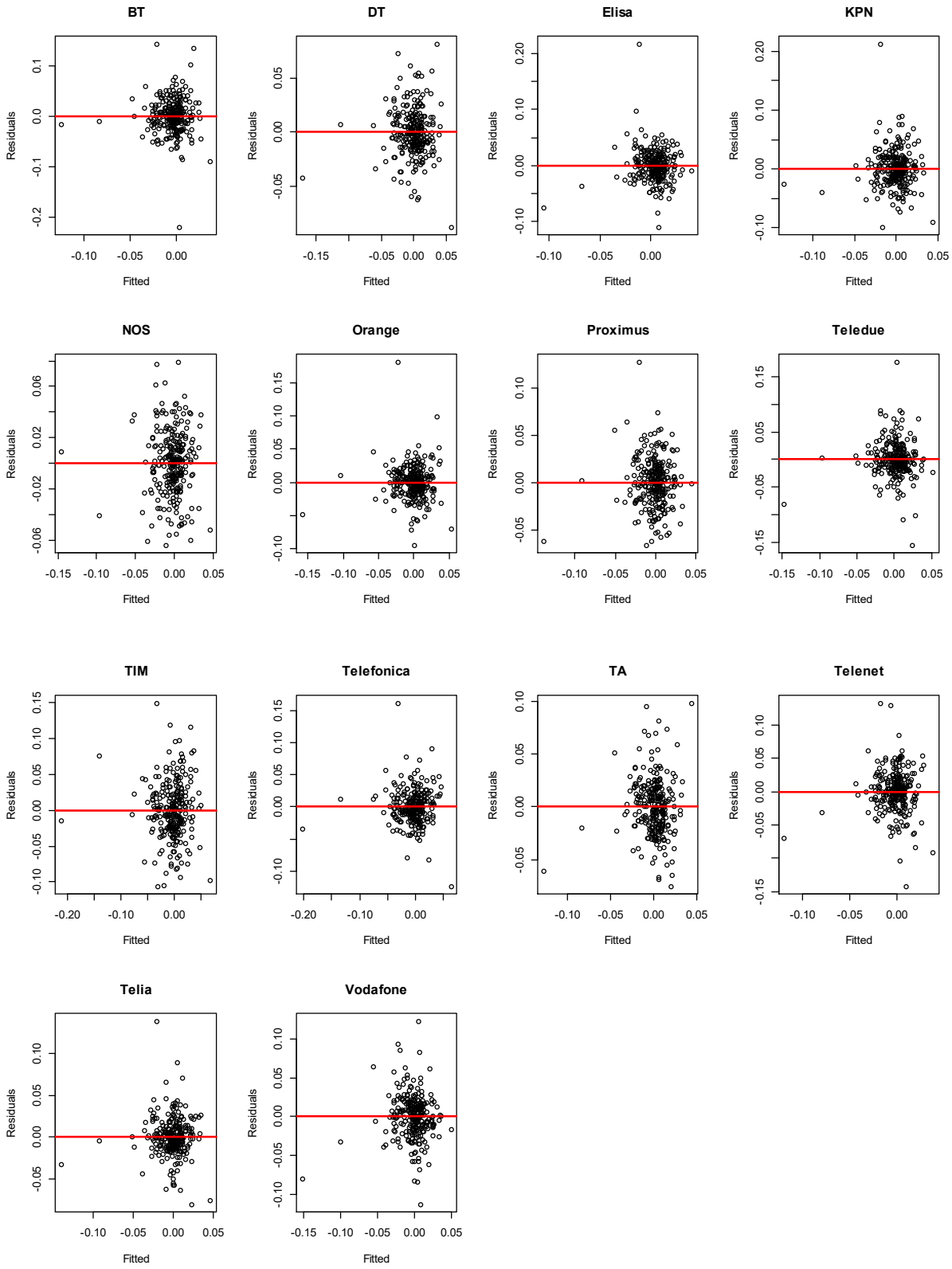


Figure A4 - Residual versus Fitted Values

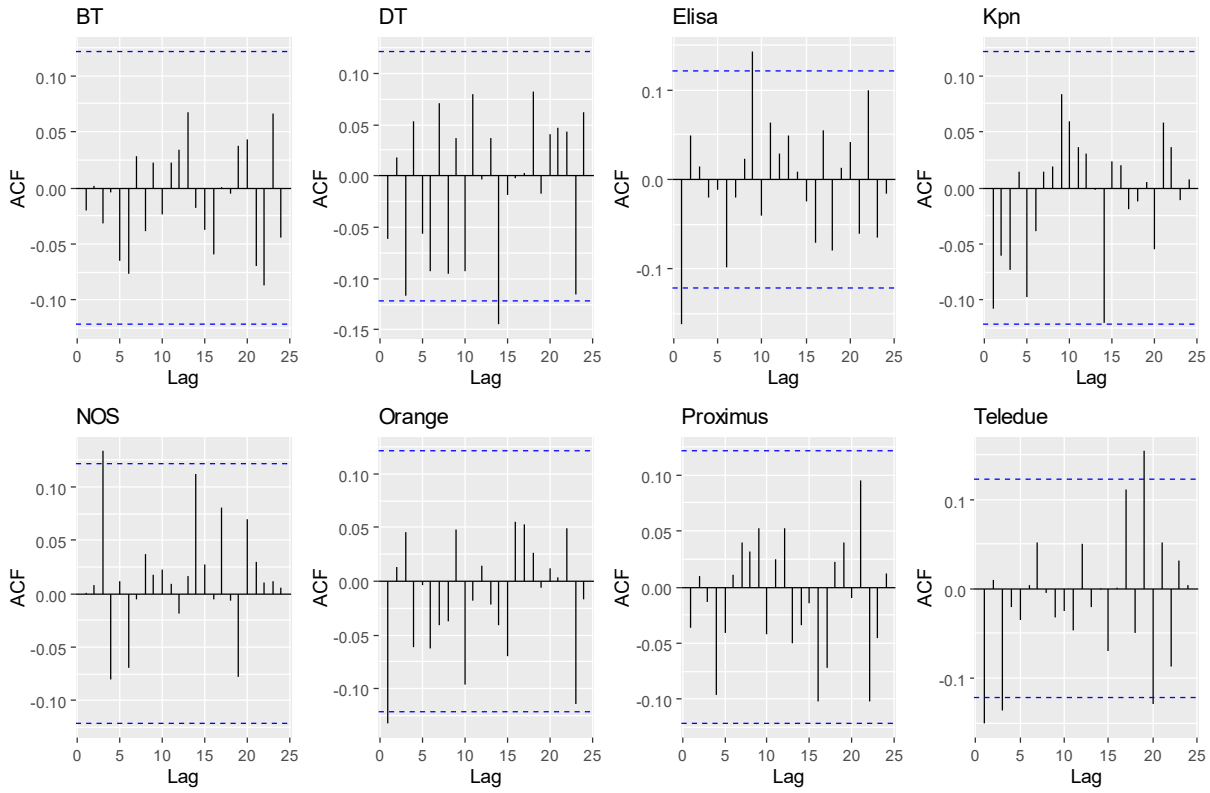
The general picture of the residuals shows a distribution in line with a homoscedastic property of the residuals. Deviation from a “random noise” of the residual around a zero line is only due to some outliers, and not on a systematic pattern of the residual.

Autocorrelation of the residuals

The graphical analysis reported in the previous section graphically indicates the fact that the presence of strong autocorrelation in the residuals is statistically unlikely. At the same time in this section a deepening on this issue will be given.

In the following the autocorrelation (ACF) of the residual from each comparable is reported.[135]

In the same graph the “test bound” (dashed lines) are also shown, these bounds are used to test the null hypothesis that an autocorrelation coefficient is 0. The null hypothesis is rejected if the sample autocorrelation is outside the bounds. From the picture below (Correlogram)[136] it is possible to observe that the level of autocorrelation of residual is low or absent for all the comparable considering until the 24 lags of the ACF taken into account.



[135] The Autocorrelation function are used to assess to what extent whether a time series is dependent on its past.
[136] The plot of the Autocorrelation sample for different lags known as also Autocorrelation plot.

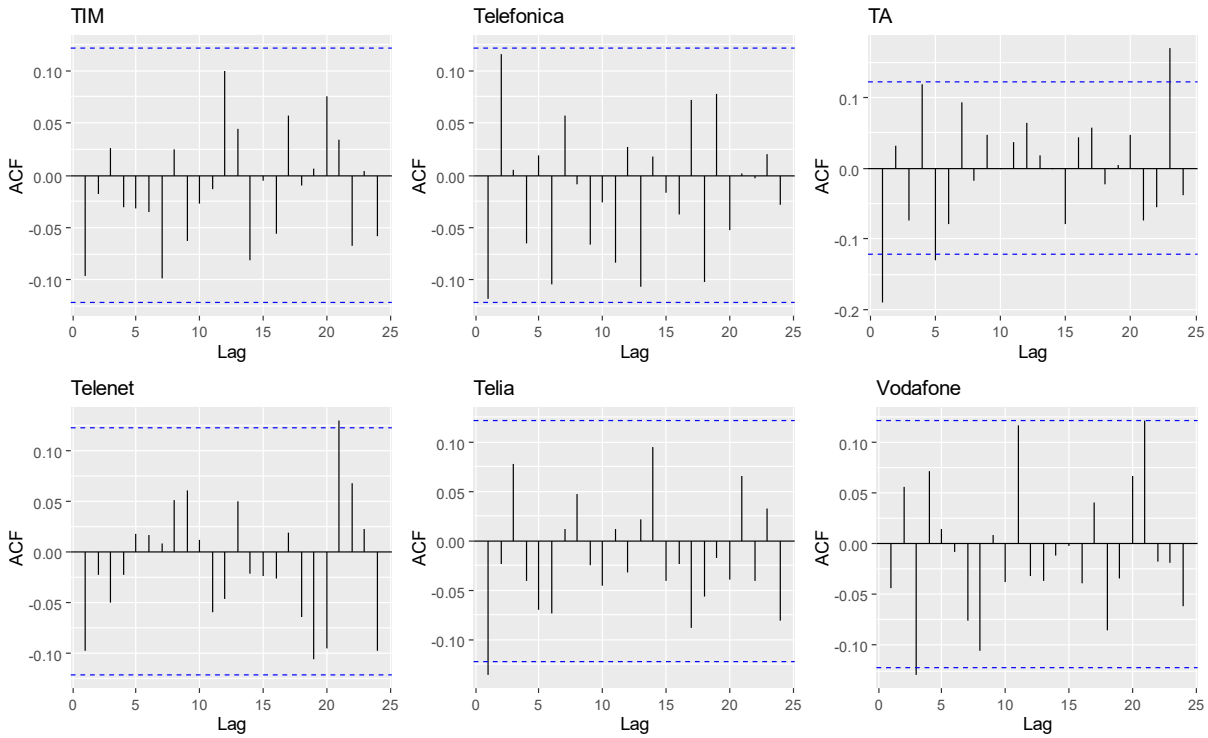


Figure 5 ACF residuals

To have a more quantitative picture and comparison between the 14 comparables of the Ljung-Box test and the Breusch-Godfrey test is also considered in the next table.[137]

[137] The Ljung-Box test and the Breusch-Godfrey test instead to proceed analyzing every single lag distinctly, as done by the ACF plot, it consists of a verification of absence of global correlation with respect to a certain number of lags.

Name	24 lags P-values of the test	24 lags P-values of the Breusch-Godfrey test
BT Group plc	0.9587	0.8959
Deutsche Telekom	0.1386	0.1262
Elisa Oyj	0.2397	0.1253
Koninklijke KPN	0.7736	0.4267
NOS	0.8273	0.6759
Orange S.A.	0.7145	0.4622
Proximus S.A.	0.7847	0.7935
Tele 2	0.08531	0.2343
Telecom Italia	0.7686	0.6326
Telefónica	0.3307	0.2625
Telekom Austria	**0.01724**	**0.009957**
Telenet	0.466	0.3404
Telia Company AB	0.5704	0.1398
Vodafone Group plc	0.328	0.3126

Table A3 Statistic test for the Ljung-Box test and the Breusch-Godfrey test for 24 lags

The p-values from the Ljung-Box and Breusch-Godfrey test applied on 24 lags[138] shows some small autocorrelation of the residual in Telekom Austria.

In the following picture the test is done considering different lags from 1 to 24, it is possible to observe that the statistical test fails at 95% for all lags only for Telekom Austria, considering a level of confidence at 99% also for TA the test is failed. From this analysis it is possible to say that in every case the level of autocorrelation in the residuals is still low so that we can still consider the beta estimation reliable and not biased also for TA.

[138] 24 lags are generally accepted as maximum inspection for the test.

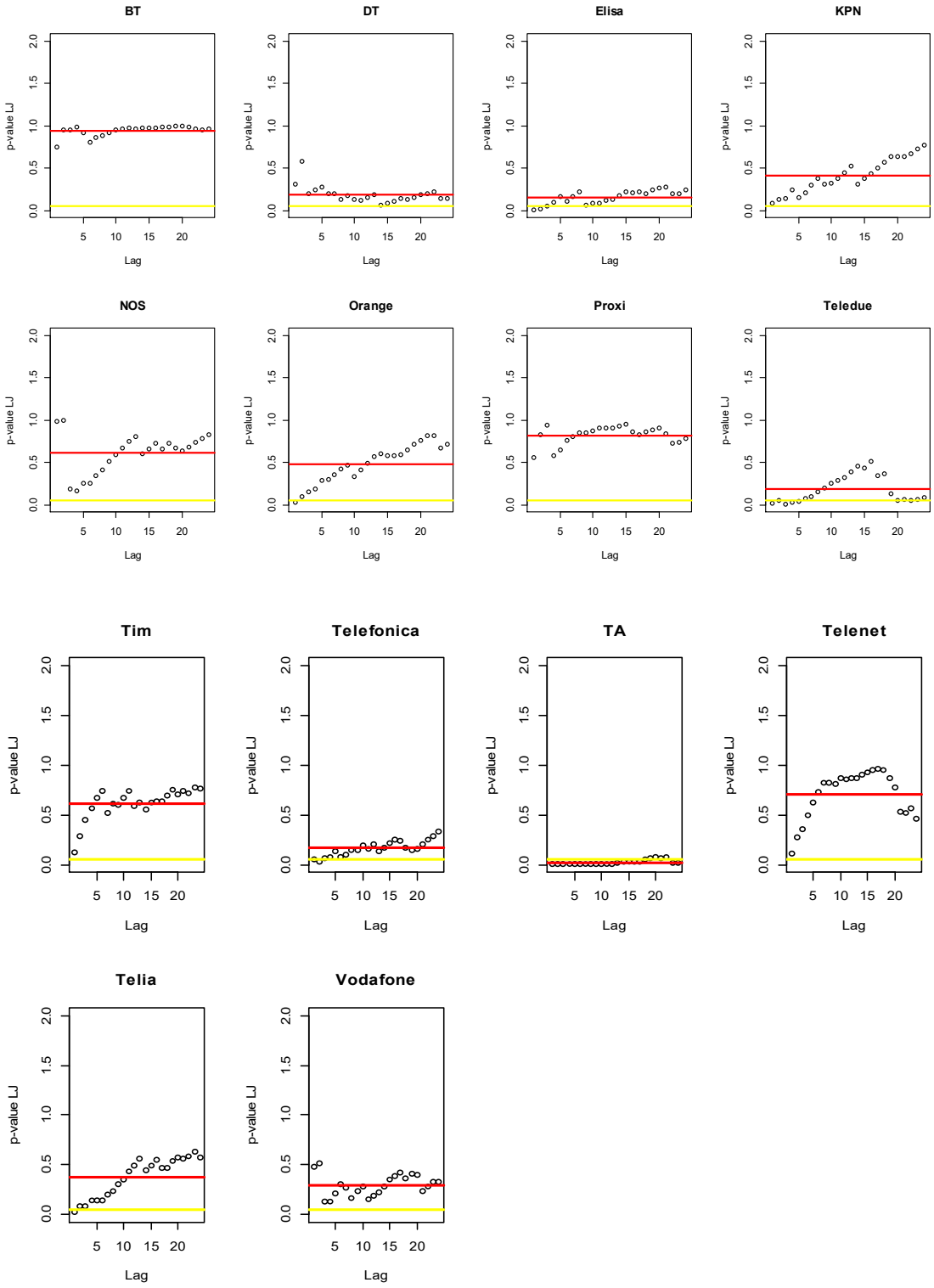


Figure A6: p-vales of Ljung-Box test for lag from 1 to 24 (yellow line: the 0.05 limit for null hypotesis evaluation; red line: average p-value over the 24 lags)

Another relevant test is to check if conditional heteroscedasticity in the residual is present. The presence of the Arch effect in the residual when there is no autocorrelation in the residual

is an indication that outliers are not independent. In presence of conditional heteroscedasticity, an uncorrelated time series can still be serially dependent due to a dynamic conditional variance process. A time series exhibiting conditional heteroscedasticity—or autocorrelation in the squared series—is said to have autoregressive conditional heteroscedastic (ARCH) effects.

For this reason, the ARCH Engle's test is carried on. The test is the Lagrange Multiplier test which is to fit a linear regression model for the squared residuals and examines whether the fitted model is significant. So the null hypothesis is that the squared residuals are a sequence of white noise, namely, the residuals are homoscedastic. This means that, under the ARCH framework, large shocks tend to be followed by another large shock. The Arch effect can be detected considering the following model

$$a_t^2 = \alpha_0 + \alpha_1 a_{t-1}^2 + \cdots + \alpha_m a_{t-m}^2 + e_t \qquad t = m+1, \ldots, T$$

Where e_t is the error term m is the lag order of the model and T the sample size with a_t the residual of the model considered. The test wants to verify the $\alpha_i = 0\ (i = 1, \ldots, m)$ in the previous linear regression.[139] By this analysis it is possible to observe that an Arch effect in the residual can be detected for the most part of the lags only in Telefonica, and Telecom Austria, but also in this case the level of arch effect is in every case can be considered low without the need to apply any adjustment to the equity beta estimated by the OLS.

To strengthen the assertion that the beta estimation in every case is not biased in a relevant way, we have estimated the Beta including in the error term of the regression the "Arch" effect and adjusted the regression estimation by a weighted least-squares, with weights equal to the reciprocals of the conditional variances of the Arch model estimated with respect to the time series of the standard residuals.

The fit of the residual with a suitable Arch model has followed the AIC[140] "Akaike Information Criteria", the best model has been selected choosing the one with the lower Akaike Information Criteria parameter considering different ARCH(p) models with p from 1 to N.

Recalculating the regressions lines through a weighted least square with weights equal to the reciprocal of the conditional variance of the Arch model estimated with relevant order, provides the following results for a beta adjusted for the two peers that main fails the statistical Engle's test.[141] The adjustment calculated with the same procedure for all the other peers provide always an adjustment in absolute term lower than 0.02.

	Equity Beta	Equity beta with adjustment	Variation
Telefonica	1.07	1.11	0.04

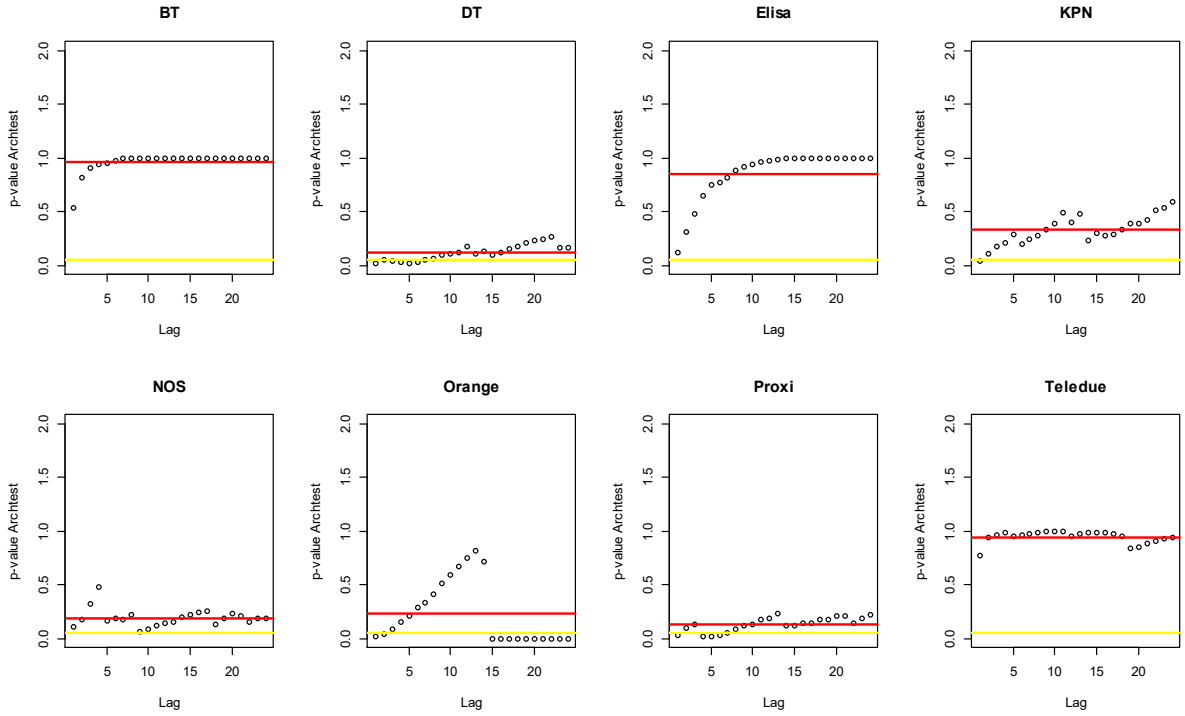
[139] The test evaluates the F statistic as ((SSR_0-SSR1)/m)/(SSR_1/(T-2m-1))) with SSR_0=∑(a_t-omega)^2 and SSR_1=∑e_t^2 with t from m+1 to T and omega is the sample mean a_t^2 which is asymptotically distributed as chi-squared distribution with m degrees of freedom under the null hypothesis. "Analysis of Financial Time Series" Wiley R.S. Tsay (2004)

[140] AIC rewards goodness of fit (as assessed by the likelihood function), but it also includes a penalty that is an increasing function of the number of estimated parameters. The penalty discourages overfitting, because increasing the number of parameters in the model almost always improves the goodness of the fit.

[141] D. Ruppert, "Statistics and Data analysis for financial engineering" Springer 2015.

TA[142]	0.693	0.686	-0.007

This is consistent with the literature that shows small adjustments in situation where there is conditional heteroscedasticity in the CAPM beta estimation.[143]



[142] For TA the statistical tests show also some small autocorrelation in the residual other than small cluster volatility
[143] Armitage, S & Brzeszczynski, J 2011, 'Heteroscedasticity and interval effects in estimating beta: UK evidence', *Applied Financial Economics*, vol. 21, no. 20, pp. 1525-1538.

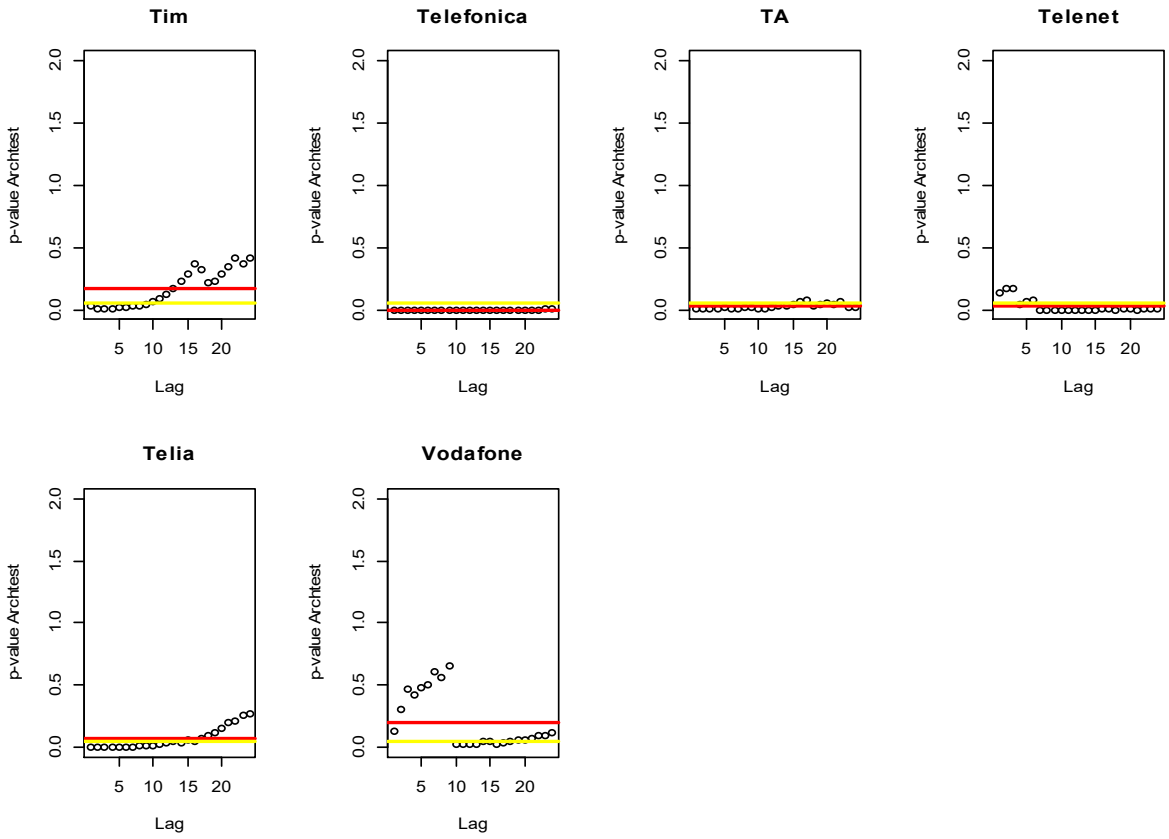


Figure A7 P-values of arch test for different order (lags) in the Egel's test model

To assess the uncertainty around the equity beta estimates presented in the previous sections, we calculate confidence intervals for each of our comparators. These figures show the 95 per cent confidence intervals of the equity beta estimation.[144]

[144] The confidence level is based on the estimation of the regression based on a generalized least squared error that provide a better estimate of the standard error in case of heterodiscracy and autocorrelation of the residual.

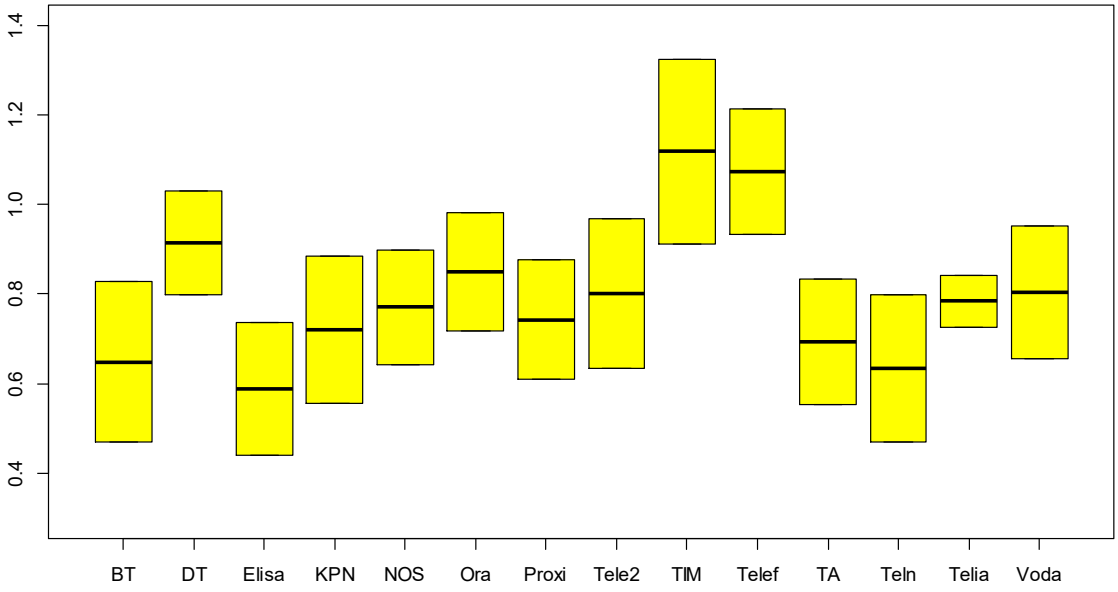


Figure A8 Confidence level of beta equity estimation

The estimated betas for companies with illiquid stocks tend to be unusually low and statistically less reliable. As a result, it is also necessary to assess the liquidity of stocks when selecting comparator companies. Failure in liquidity merit figures is also a reason for the failure of some statistical test previously carried on. As liquidity is a difficult concept to define and is subject to interpretation, it is useful to look at a wide range of measures. In particular, the following liquidity measures were considered.

Bid–ask spread as a percentage of closing price. It is the difference between the lowest price at which an asset is offered for sale in a market and the highest price that is offered for purchase of the asset. The lower the bid–ask spread, the more liquid the stock. A relatively narrow bid–ask spread could be a sign that there are a large number of buyers and sellers in the market.

Share turnover. It is a measure of stock liquidity calculated by dividing the total value of shares traded over a period of time by the average market capitalisation of the stock for the period. The higher the share turnover, the more liquid a stock is. For example, a high trading volume would indicate that a stock can be bought and sold easily.

In the picture below the five years average of Bid Ask Spread and Share Turnover are provided for the previous set of comparables. Telecom Austria have lower values with respect to the others considering the share turnover, that means low level of liquidity, this is already seen in the analysis of autocorrelation of residual.

	Bid ask spread	Share turnover
BT_UK	2.35%	0.24%
DT_DE	1.67%	0.27%
Elisa_FI	1.76%	0.29%
KPN_NL	1.95%	0.36%
NOS_PT	2.08%	0.14%
Orange_FR	1.76%	0.30%
Proximus_BE	1.92%	0.22%
Tele2_SE	1.81%	0.34%
TIM_IT	2.83%	0.52%
Telefonica_ES	1.84%	0.36%
TA_AT	2.19%	0.03%
TeleNet_BE	2.07%	0.16%
Telia_SE	1.53%	0.29%
Vodafone_UK	1.95%	0.24%

Table A4

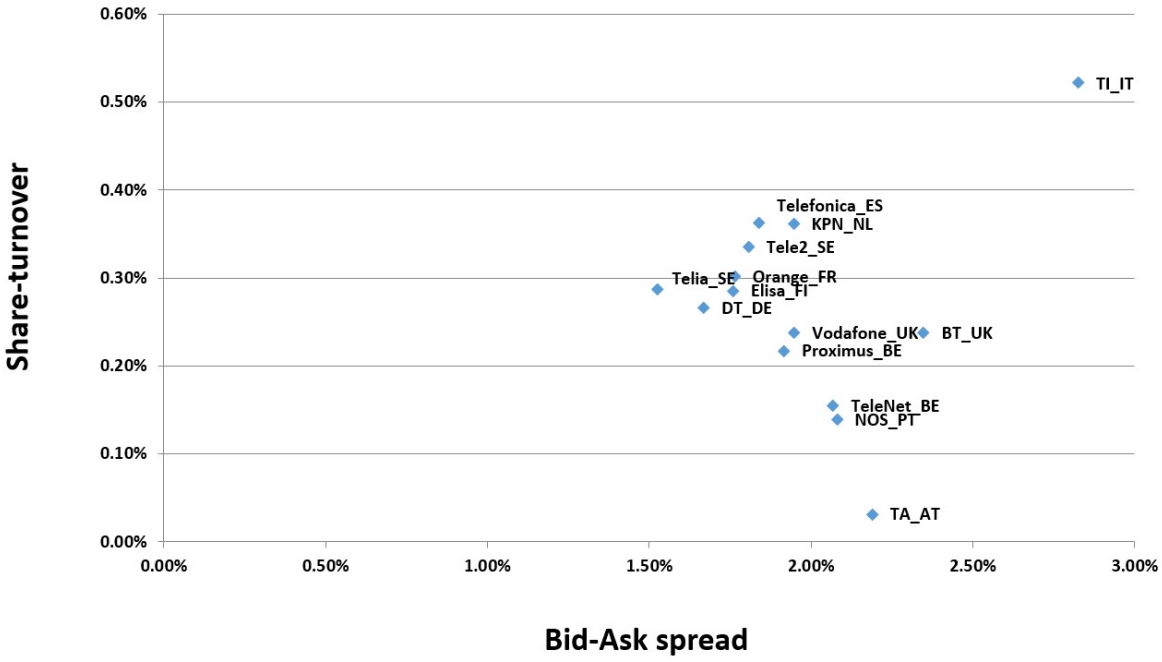


Figure A9 Bid-ask spread and Share turnover

Annex 4: Table of bond indices

Bulgaria	Bloomberg Barclays EM USD Sovereign: Bulgaria Total Index Unhedged USD	I01370US Index
Croatia	Bloomberg Barclays EM local currency: Croatia total return index unhedged	I20275HR Index
Cyprus	Bloomberg Barclays Global Agg, Cyprus Total Return Index Hedged EUR	H03355EU Index
Czechia	Bloomberg Barclays EM Local Currency Czech Republic	LCEZTRUU Index
Greece	Bloomberg Barclays EGILB All Markets EMI HICP Linked ex Greece total return Index	BHIC1T Index
Hungary	Bloomberg Barclays EM Local Currency, Hungary total return index unhedged	I20268HU Index
Latvia	Bloomberg Barclays Global Agg Index, Latvia total return Index Hedged EUR	H09101EU Index
Lithuania	Bloomberg Barclays EM Pan Euro Aggregate: Lithania Total Return Index Hedged EUR	H04307EU Index
Poland	Bloomberg Barclays Global AGG - Poland Total Return Index Unhedged EUR	I03368EU Index
Romania	Bloomberg Barclays EM Local Currency : Romania total return Index RON	H29114RO Index
Slovakia	Bloomberg Barclays global: Slovakia total return Index Unhedged EUR	I09992EU Index
Slovenia	Bloomberg Barclays Global: Slovenia total return index unhedged EUR	I09991EU Index