9/June/2022

BEREC Report on WACC parameter calculations according to the European Commission's WACC Notice of 6th November 2019

(WACC parameters Report 2022)

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Executive Summary

In this third 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 6th 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 national regulatory authorities (NRAs) thereby contributing to the development of the internal electronic communications market.

As the Commission's Notice has not changed, BEREC is following the same methodology (incl. 'technical choices') as in last year's Report providing utmost continuity.

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 Capital Asset Pricing Model (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

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

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 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 1 Summary of the structure of the BEREC WACC parameters Report 2022 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 2022 comprising 15 companies	Table 3
Chapter 4	Debt premium, Cost of debt	Debt premium, Cost of debt for each of the 15 companies of the BEREC Peer Group	Table 4
Chapter 5	Equity beta, Gearing, Asset beta	Equity beta, Gearing, Asset beta for each of the 15 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 **5.70% (AM).** As the same methodology as last year was used, the increase from 5.50% (AM 2021) to 5.70% (AM) in 2022 is attributable to factual developments, i.e. the increased value is attributable only to the

last year upgrade of the premium that is the seventh most relevant increase of the Equity premium over bond since 1900 and the second most relevant increase since sixties of the previous century.

Since 2021, BEREC estimates additionally a separate EU/EEA-ERP for exclusive use by Nkom (Norway), ECOI (Iceland) and AK (Liechtenstein)[2].

The BEREC peer group comprises now 15 peers as DIGI Communications N.V. was included for the first time.

BEREC publishes 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 2022 when the Commission applies it according to 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[3] and the Commission Staff Working Document (SWD)[4] 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.[5]

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[6] of the Notice.[7] 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.

[2] As no data is available for Liechtenstein, the separately estimated EU/EEA-ERP includes only data for Norway and Iceland.

[3] 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.

[4] SWD(2019) 397_final, https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=62834, the SWD.

[5] Legacy infrastructure means infrastructure of an SMP operator not subject to a Next Generation Access (NGA) premium.

[6] See section 1.1. below

[7] 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.

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 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[8] 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;

[8] As set out in section 2 of the WACC Notice.

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 third Report that 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[9] when setting the WACC in pricing decisions which are reported every year in a specific chapter of the BEREC Regulatory Accounting in practice Report.[10]

As the Commission's Notice has not changed, BEREC is following the same methodology (incl. 'technical choices') as in last year's Report. This implies that changes in the results are due to factual developments, i. e. reflect market and other developments.

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 an integrated EU capital market (cf. 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*[11] 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

[9] For the regulatory principles see below section 1.2.1.

[10] 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 (21) 161, publ. in Dec. 2021 https://berec.europa.eu/eng/document_register/subject_matter/berec/reports/10134-berec-report-regulatory-accounting-in-practice-2021.

[11] In a few exceptional cases, government bonds of a country with the same credit rating as the home country were used as a proxy (see Ch. 4).

rather than a global investor's perspective. The company-specific parameters will be estimated for each company of the peer group.

BEREC prepares 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 estimates the equity beta, gearing, debt premium and cost of debt for each company included in the list. Acc. to para. 67, BEREC also describes factors that may justify 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 2022 for this Report.

BEREC publishes 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 2022.

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[12].

With regard to the methodological approach the Notice follows the financial market theory known as the Capital Asset Pricing Model (CAPM)[13]. 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 and specific purpose of the calculation.[14] 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.[15]

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[16] necessary to estimate the single EU-wide ERP and data derived from the Bloomberg financial system[17] 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

[12] Cf. also BEREC Position Paper – Input to the Commission's WACC consultation 2018, BoR (18) 67, publ. in Oct. 2018.
[13] Cf. Chapter 5 below for a description.
[14] 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.
[15] Cf. BEREC Regulatory Accounting in practice Report, ch. 5, BoR (21) 161, publ. in Dec. 2021.
[16] 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 2022 version with data from 1900 through to 2021 was used, i.e. the data source is Dimson/Marsh/Staunton, Global Investment Returns Database 2021 (distributed by Morningstar Inc.). BEREC Office acquired the DMS data distributed by Morningstar Inc. for BEREC.
[17] BEREC Office acquired for BEREC access to the Bloomberg financial system, which is henceforth referred to as Bloomberg. This year, BEREC was able to make more extensive use of Bloomberg, therefore the data quality has further improved.

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 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 and also the separate EU/EEA ERP (for exclusive use by Nkom, ECOI and AK) which is a key parameter and certainly the most complex to calculate. Therefore, it is placed at the end of the Report.

Chapter 7 summarises 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 comparing the results of the 2022 and the 2021 WACC parameters Report.

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 might 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 in the past has been to calculate the risk free rate by using yields on 10-year domestic government bonds.[18]

BEREC's calculation of the risk free rate is based on data retrieved from Eurostat as the official publicly available source for EU data[19] 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). 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".[20]

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

[18] BEREC Report, Regulatory Accounting in Practice 2021202, Chapter 5.2.1 Risk Free Rate, Figure 9 Methodology used to estimate RFR (fixed market), BoR (21) 161, December 2021.
[19] Eurostat data set "Long term government bond yields", online data code: TEIMF050, Eurostat Data Source IRT_LT_MCBY_M.
[20] See further information on long-term interest rate statistics and convergence criteria for EU Member States: www.ecb.europa.eu

ensure that differences in risk free rates capture specific country-risks and reflect differences in financing conditions within the Member States.[21]

Eurostat provides the following description of how it derives this data: yields of long-term government bonds are provided on a monthly basis: only bonds with an outstanding amount of at least EUR 5 billion are included in the data.[22] The European Central Bank (ECB) provides the underlying data in line with their prescribed methodology.[23] 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.[24]

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.[25] 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.[26] The risk free rates have not been adjusted for any quantitative easing programs in line with the Notice[27].

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.[28]

2.3. Assumptions and choices made

The data used by BEREC has been retrieved from a reliable, publicly available official source (Eurostat). The Eurostat reference area for this data are EU member states. In the past, Estonia had not issued any 10-year government bonds that comply with the definition of long-

[21] Cf. Notice and SWD.
[22] See: Eurostat Data set "Long term government bond yields" (online data code TEIMF050) Explanatory text
[23] See ECB background information on the full monthly time series of long-term interest rate data on.www-ecb.europa.eu
[24] See: Eurostat Data set "Long term government bond yields" (online data code TEIMF050) Explanatory text, 3.4
[25] Details of the selection criteria for the series, including the yield formula used may be obtained from European Central Bank.
[26] See European Central Bank, Convergence Report, June 2020, section 6.5.
[27] Section 4, para. 36.
[28] Notice, para 27.

term interest rates for convergence purposes. Neither had 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 until June 2020, when such data became available for Estonia[29].

To remedy this lack of data for Estonia BEREC had applied the same Risk Free Rate to Estonia as was applied to another EU country with similar country characteristics and credit rating in order to derive monthly yields for long term government bonds until such time as they became available, i. e. until May 2020.[30]

Eurostat does not collect corresponding data for Iceland and Norway. Therefore, data for Iceland and Norway have been derived by BEREC using benchmark bonds with 10 years residual maturity. The choice of bonds to be included has been provided by Bloomberg. Over time Bloomberg modifies benchmark bonds to overcome the maturity drift over ten years, whenever better benchmarks become available. For Norway, the curve in five years was based on 5 benchmark bonds[31], for Iceland on 3 benchmark bonds.[32]

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[33] and calculating a five-year arithmetic average of this data from 1st April 2017 to 31st March 2022.[34]

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.

Moody's credit rating was used for this purpose.

[29] Due to the five year averaging period data for Estonia cannot be completely based on Eurostat data

[30] For details on BEREC's past approach see BoR (21) 86, Section 2.4. For Estonia the Yield time series for ten year bonds based on the emission of own government bonds start from June 2020 until March 2022. For the time series from April 2017 until May 2020, BEREC evaluates the Yield from comparable credit rating countries: Czechia (A1 Credit rating) from April 2017 until September 2019, and A2 and A3 countries with this credit rating at that time, between October 2019, until May 2020 (A2 Ireland, A2 Poland, A2 Slovakia, A3 Lithuania, A3 Latvia, A3 Malta), in line with BoR (21) 86.

[31] NGB 1 3/4 02/17/27, NGB 2 04/26/28, NGB 1 3/4 09/06/29, NGB 1 3/8 08/19/30, NGB 1 1/4 09/17/31

[32] ICEGB 8 06/12/25, ICEGB 5 11/15/28, ICEGB 6 01/24/31

[33] Source Eurostat Data set Long term government bond yields 2017M04 to 2022M03, last updated on 13.05.2022.

[34] Notice, paragraphs 27 and 29.

2.5. Results

A **Risk Free Rate** based on a five year arithmetic average (April 2017 to March 2022) has thus been determined for each EU member state.

Table 2 Country Economic Factors and Risk Free Rates

Country Code	Country	Country Credit Rating[35]	GDP per capita[36]	HICP (Harmonised Consumer Price Index)[37]	Risk Free Rate 5 year arithmetic average[38]
AT	Austria	AA1	109.03	118.11	0.20
BE	Belgium	AA3	114.14	120.28	0.30
BG	Bulgaria	BAA1	148.78	118.59	0.62
HR	Croatia	BA1	125.70	111.93	1.43
CY	Cyprus	BA1	110.45	106.13	1.33
CZ	Czechia	AA3	124.16	126.80	1.64
DK	Denmark	AAA	121.92	109.80	0.07
EE	Estonia	A1	160.28	127.31	0.50
FI	Finland	AA1	113.54	111.54	0.19
FR	France	AA2	111.36	112.26	0.30
DE	Germany	AAA	113.30	116.10	-0.09
EL	Greece	BA3	88.79	108.43	2.73
HU	Hungary	BAA2	149.90	126.90	2.84
IE	Ireland	A2	188.47	109.30	0.40
IT	Italy	BAA3	103.38	111.30	1.70
LV	Latvia	A3	161.77	122.24	0.40
LT	Lithuania	A2	169.72	129.93	0.26
LU	Luxembourg	AAA	106.90	117.22	0.03
MT	Malta	A2	137.59	108.46	0.85
NL	Netherlands	AAA	113.74	120.70	0.05
PL	Poland	A2	163.67	123.90	2.51
PT	Portugal	BAA2	109.50	109.49	1.12
RO	Romania	BAA3	173.91	124.05	4.23
SK	Slovakia	A2	129.33	120.43	0.37
SI	Slovenia	A3	127.27	111.30	0.45
ES	Spain	BAA1	107.51	115.51	0.84
SE	Sweden	AAA	118.62	116.12	0.31
IS	Iceland	A2	117.46	106.81	4.14[39]
NO	Norway	AAA	114.22	110.28	1.45[40]

[35] Source Moody's via Bloomberg (Moody's country credit ratings are comparable to S&P's country credit ratings.) (May 2022)

[36] Source: Eurostat Main GDP aggregates per capita (online data code NAMQ_10_PC) Q4, 2021, Index 2010 = 100, per capita. Further information on content and compilation see Explanatory Texts (Metadata).

[37] Source: Eurostat HICP All items (online data code TICP000), Q3 2022, Index 2015 = 100

[38] Source: BEREC calculated the five year average based on Eurostat Long term government bond yields 2017M04 to 2022M03. Data for Estonia, Iceland and Norway derived by BEREC from Bloomberg data. Also refer to the table in Annex 1.

Remarks on results

The results shown above differ from the current values of the 10 year government bonds yields since the methodology followed is based on data for the five-year time window from 1st April 2017 to 31st March 2022. It should be noted that if the increasing trend of the government bond yields observed in the last months caused by the international context is maintained in the following months, then it would be reflected in the upcoming annual reports. The following table shows the general reduction due the low interest rate period, but also that the reduction is slowing, i.e. the average is decreasing since last year (-0.29% from 2021-2020, -017% from 2022-2021)..

Table 2 (a) RFR evolution over time (2020 – 2022)

	RFR comparison			ΔYoY	
	2020 BoR (20) 116	2021 BoR (21) 86	2022 BoR (22) 70	Δ2021 (value 2021-value 2020)	Δ2022 (value 2022-value 2021)
Austria	0.46	0.26	0.20	-0.20	-0.06
Belgium	0.57	0.36	0.30	-0.21	-0.06
Bulgaria	1.41	0.97	0.62	-0.44	-0.34
Croatia	2.53	1.95	1.43	-0.58	-0.52
Cyprus	2.58	1.92	1.33	-0.66	-0.60
Czechia	1.16	1.27	1.64	0.11	0.37
Denmark	0.32	0.10	0.07	-0.22	-0.03
Estonia	1.09	0.97	0.50	-0.12	-0.47
Finland	0.44	0.24	0.19	-0.20	-0.05
France	0.57	0.37	0.30	-0.20	-0.07
Germany	0.17	-0.03	-0.09	-0.20	-0.07
Greece	5.67	4.04	2.73	-1.63	-1.31

[39] The relatively high RFR in relation to the country credit rating is influenced by the exchange rate risk of a country which is outside the EU and the Eurozone

[40] The relatively high RFR in relation to the country credit rating is influenced by the exchange rate risk of a country which is outside the EU and the Eurozone

Hungary	2.96	2.73	2.84	-0.23	0.11
Ireland	0.75	0.50	0.40	-0.25	-0.10
Italy	1.96	1.82	1.70	-0.14	-0.12
Latvia	0.67	0.45	0.40	-0.22	-0.06
Lithuania	0.59	0.35	0.26	-0.24	-0.09
Luxembourg	0.29	0.12	0.03	-0.17	-0.08
Malta	1.09	0.90	0.85	-0.19	-0.05
Netherlands	0.37	0.15	0.05	-0.22	-0.10
Poland	2.93	2.62	2.51	-0.31	-0.11
Portugal	2.16	1.71	1.12	-0.45	-0.59
Romania	4.06	4.05	4.23	-0.01	0.18
Slovakia	0.66	0.47	0.37	-0.19	-0.11
Slovenia	0.94	0.60	0.45	-0.34	-0.15
Spain	1.30	1.01	0.84	-0.29	-0.17
Sweden	0.49	0.34	0.31	-0.15	-0.03
Iceland	-	4.39	4.14		-0.25
Norway	-	1.38	1.45		0.07
Average trend (Arithmetic mean of ΔYoY)				**-0.29%**	**-0.17%**

3. Peer group

3.1. Definition and data source used

The peer group is defined by selecting the 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[41]:

[41] 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[42]

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

Prior to the publication of the 2021 WACC parameters Report (BoR (21) 86) BEREC, in line with clarifications from the EC, made two refinements to how it assesses the peer group:

1. Companies that are in the European Economic Area ("EEA") and that meet the criteria are eligible for inclusion in the peer group.

2. Companies are also assessed as to the level of their operations in the EU/EEA before inclusion in the peer group.

These refinements remain in place for the 2022 WACC parameters Report.

EU/EEA

The European Commission (EC) clarified that it is appropriate that companies (with headquarters) located in the EEA be considered for inclusion in the peer group if they meet the criteria listed in the Staff Working Document.

Criteria and level of activities in the EU/EEA

The EC also clarified that one of the aims in developing the peer group is that companies that are actively operating in the EU/EEA and meet the criteria are considered for inclusion in the peer group. Companies that possibly meet the criteria but have limited operations in the EU/EEA must be analysed further to see if it is appropriate to include them. A simple application of the criteria could result in companies being added to the peer group from outside the EU/EEA who have limited operations in the EU/EEA, which would not ensure ***consistency*** as set out in the SWD[43]. Therefore, and generally, it is important that the criteria are not applied mechanically but with a view to the objective of getting a fair representation of European operators with legacy infrastructure when considering whether or not to add companies to the peer group. This will ensure that companies who are outside of the EU/EEA but possibly meet various criteria are not automatically included within the peer group without further analysis.

[42] The illustrative list of the SWD has been used as the starting point but is subject to adjustments (as explained hereafter).
[43] See section 5.3.2.2 of the SWD.

Consistent with the 2021 WACC parameters Report, where possible, BEREC has followed the list of companies provided by the EC but uses Table 3 from the 2021 WACC parameters Report as the starting point for this year's peer group analysis. Consistent with the 2021 WACC parameters Report, BEREC has further assessed the criteria concerning national specificities and maintains its approach that two criteria require further refinement:

Companies have their main operations located in the EU/EEA

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 EU/EEA. 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 EU/EEA; and

(b) a substantial proportion of a company's revenue is generated within the EU/EEA

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. However, this will also have to be compared to an overall assessment of the criteria when compared to the level of operations in the EU/EEA.

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[44]. BEREC considers that where the asset beta is to be determined it is important to get a representative sample from across the EU/EEA. 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.

[44] Notice, para. 27.

Comparison of the BEREC 2022 peer group (Table) to the original proposal of the EC (Figure 1 above)[45]

The following paragraphs provide further explanation of the addition, removal or maintenance of certain companies in the 2022 WACC parameters Report compared to the original peer group as illustrated by the EC. By way of note, the BEREC 2022 peer group is almost identical to the 2021 peer group which – as explained above – generally followed the illustrative peer group of the Staff Working Document.[46] However, there is one change from the 2021 peer group through the addition of DIGI Communications N.V., which is discussed further below.

Updates in 2020 WACC parameters Report

The Notice proposed that ***TDC A/S*** (Denmark) be included in the peer group (based on status from 2017). TDC A/S delisted in 2018. As noted above, criterion 1 is mandatory for a company to be included in the peer group. As a result, TDC A/S was excluded from the peer group in the 2020 WACC parameters Report.

In the 2020 WACC parameters Report both ***Deutsche Telekom*** (Germany) and ***Telefónica*** (Spain) were added to the SWD's illustrative peer group due to national specificities. While these companies have significant operations outside of the EU/EEA, both have their headquarters and boards of directors within the EU/EEA. Therefore, all major strategic decisions are taken and significant proportions of their total revenues are generated within the Union. BEREC considered that this continues to qualify them for inclusion within the peer group.

In the 2020 WACC parameters Report BEREC considered that ***NOS*** (Portugal) should also be included in the peer group as it meets each of the five criteria. BEREC noted ongoing judicial proceedings against significant shareholders in NOS[47] but makes no further comment in this regard[48].

Updates in 2021 WACC parameters Report

In the 2020 WACC parameters Report ***BT Group plc*** (UK) was part of 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 were based and considered to have activities in countries who are members of the European Union. However, since the United Kingdom has left the EU, is not a member of the EEA and the majority of its revenues are earned outside of the EU/EEA, it was no longer considered appropriate to include BT Group plc in the peer group. Thus, it was excluded from the 2021 WACC parameters Report.

In the 2020 WACC parameters Report ***Vodafone Group plc*** (UK) was also included in the peer group. While it is currently headquartered in the United Kingdom it continues to have

[45] Electronic communications companies from relevant EU Member States with investment grade (2017)
[46] Companies not mentioned explicitly were taken over from the illustrative peer group in the BEREC 2021 peer group and continue to be in the BEREC 2022 peer group.
[47] https://www.bloomberg.com/news/articles/2020-04-05/lisbon-court-seizes-nos-stake-held-by-angola-s-dos-santos
[48] BEREC is aware that the conduct of judicial proceedings may affect the future tradability of NOS shares.

extensive activities in several EU member states and generates a significant proportion of its revenue from operations in the EU in comparison to its UK operations[49]. It is therefore considered appropriate to continue to include Vodafone Group plc in the peer group.

In the 2020 WACC parameters Report only companies in the Union were considered for inclusion in the peer group. As ***Telenor Group*** was within the EEA but outside of the Union it was not included in the peer group of the 2020 WACC parameters Report. As the EC has clarified that companies within the EEA could be considered, BEREC has assessed Telenor Group against the five criteria listed in the Staff Working Document (as modified). BEREC has found that Telenor Group meets the criteria listed and is eligible for inclusion in the peer group. Telenor Group was added in the 2021 WACC parameters Report.

Updates in 2022 WACC parameters Report

In the 2022 WACC parameters Report ***Digi Communications N.V.*** is included for the first time. In the 2021 WACC parameters Report it was noted that:

*"**DIGI Communications N.V**. has been publicly traded since May 2017. BEREC considers that its inclusion may be possible once they have a five-year stock exchange trading history, if they meet the criteria (as modified)."*

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 not included. While it noted that some companies in Central and Eastern Europe are publicly traded, they do not have a five-year trading history or have a credit rating and therefore are not included. In particular, the following should be noted:

- ***Telekom Slovenije*** is publicly traded and meets certain criteria[50], but the company does not have a credit rating and therefore is not to be included in the peer group.

In order to ensure that the peer group is representative of the entire EU/EEA, BEREC also examined whether or not the members of the peer group had significant investments in fixed line operators in Central and Eastern Europe. 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.[51]

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

[49] Vodafone Group Plc Annual Report 2022, https://vodafone.gemalpha.com/view/1e8040b1e4c444968b309e6aa160a9a0c24c33b1f5ba41cc9d3ca271000de367/Vodafone+2022+Annual+Report

[50] Listed on a stock exchange; owns/invests in electronic communications infrastructure; main operations in the EU/EEA; not involved in substantial mergers and acquisitions.

[51] Cf. below Chapter 7, Table 13.

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 may become 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.

Recent investment activity

During the review of data for the 2022 WACC parameters Report, BEREC observed there was varying levels of investment activity being undertaken by peer group members[52]. As a result of this it is providing further analysis on criterion 2 and criterion 5.

Criterion 2[53]

A review of the data would indicate that criterion 2 remains relevant to all members of the peer group. All peer group members continue to own and invest in legacy electronic communications infrastructure.

Criterion 5[54]

BEREC considered financial transactions of the members of the peer group. While there has been some, the majority of it relates to investment in fibre networks or the sale of towers infrastructure, international carriers, or even other businesses, rather than being directly related to legacy infrastructure. Fibre investment and tower infrastructure are not subject to the Notice.

BEREC is of the view, therefore, that no adjustment to the peer group is required due to mergers and acquisitions activity.

STOXX Europe Total Market Telecommunications index

When assessed against the STOXX Europe Total Market Telecommunications index[55], 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 55%[56] by market capitalisation of the STOXX Europe Total Market Telecommunications index.

3.4. Result: BEREC peer group 2022

Therefore, based on both the criteria and national specificities the **BEREC peer group 2022** is shown in Table 3.

[52] This includes mergers and acquisitions, investment and disinvestment
[53] […] own and invest in electronic communications infrastructure
[54] […] are not, or have not been recently, involved in any substantial mergers and acquisitions
[55] https://www.stoxx.com/index-details?symbol=BTEP.
[56] STOXX Europe Total Market Telecommunications index includes not only telecom operators, but also tower operators, ICT providers, satellite operators, etc.

Table 3 BEREC peer group 2022

Company	Country	S&P rating as of April 2022	Rating last reviewed by S&P	Stock Symbol
Deutsche Telekom AG	DE	BBB	27 April 2021	DTE GR
DIGI Communications N.V.	RO	BB-	23 March 2022	DIGI BVB
Elisa Oyj	FI	BBB+	25 March 2022	ELISA FH
Koninklijke KPN N.V.	NL	BBB	25 March 2022	KPN NA
NOS	PT	BBB-	25 March 2022	NOS PT
Orange S.A.	FR	BBB+	28 Sept. 2021	ORA FP
Proximus S.A.	BE	A	12 July 2021	PROX BB
Tele 2 AB	SE	BBB	23 Nov. 2021	TEL2B SS
Telecom Italia	IT	BB-	23 March 2022	TIT_MI
Telefónica	ES	BBB-	15 Dec. 2021	TEF SM
Telekom Austria AG	AT	BBB+	23 April 2021	TKA AV
Telenet Group Holding N.V.	BE	BB-	23 July 2021	TNET BB
Telenor	NO	A-	20 May 2021	TEQ
Telia Company AB	SE	BBB+	13 Jan. 2022	TELIA SS
Vodafone Group plc	UK	BBB	27 July 2021	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 that do not meet the criteria as set out above).

Where possible, NRAs should also maintain a peer group that is as wide as possible using the companies in Table 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[57];

(b) Competition conditions within the electronic communications sector, and in particular infrastructure-based competition, may vary between member states increasing risk for

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

both SMP and OAO operators (access seekers and wholesalers).[58] 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[59], 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 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

[58] See Digital agenda Scoreboard, https://ec.europa.eu/digital-single-market/en/desi, Connectivity report
[59]See 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" a study for the Commission (2016), p50: https://op.europa.eu/fr/publication-detail/-/publication/da1cbe44-4a4e-11e6-9c64-01aa75ed71a1/language-en.

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 source used for the calculation of the debt premium is Bloomberg. Bloomberg is extensively used in the financial and corporate sector.

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 2021[60].

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. Inflation-linked bonds have been excluded in order to keep consistency in the results.
- The five-year averaging window, where available, will cover the period from April 2017 to March 2022, however the maturity year of the bonds must be within the period from April 2028 - March 2036. BEREC has chosen this maturity period of the bond for the following reasons:
    - Striving to be as close as possible to a 10-year residual maturity.
    - Avoiding excluding too many corporate bonds.

[60] https://berec.europa.eu/eng/document_register/subject_matter/berec/reports/10134-berec-report-regulatory-accounting-in-practice-2021

- 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[61].

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.

Based on the above-mentioned criteria, BEREC has 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[62].

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, which maturity date is within April 2028 - March 2036, 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 maturity date is within April 2028 - March 2036, 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. Additionally, only sovereign bonds with an averaging time window equal or larger than the comparable corporate bond were considered.

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

    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,

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

[62] In the case of NOS, no bond is included, since it has not issued any bond which meets the criteria set in the section 4.3. Regarding Elisa, Telenet and Telekom Austria, their only bonds mature in Sept 2027, March 2028 and Dec 2026, respectively, so they do not fully meet the criteria either. However, we include them in the calculations since their deviation from the criteria are not that large as in the case of NOS.

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 1st April 2017 up to 31st March 2022 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 for each company the arithmetic average of the debt premiums of the identified bond pairs on a weekly basis. Then, the debt premium for each company is calculated as an arithmetic average of the previously described weekly average during the 5-years averaging window. All of this depends on the availability of corporate bonds that fulfill the above listed criteria.

   What is described in the previous paragraph has been a methodological upgrade which starts to be implemented in this year´s report. In the 2020 and 2021 reports BEREC calculated the arithmetic average of the difference between each bond pair for an averaging period up to five years. Then, the debt premium for each company was 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.

   This methodological improvement avoids that the most recent data is overweighted, since for some bonds data covers only one or two years (because they were issued in the last two years). Moreover, we ensure that for the different companies each point of the 5-years averaging window has the same weight by doing the 5-years arithmetic average.

On the whole, this calculation results in 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 taken from Table is added, which gives the cost of debt for each company.

BEREC now also shows for information purposes averages of the peer group, however there is no obligation for NRAs to use these averages.[63]

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
Deutsche Telekom AG	125	-0.09	116
DIGI Communications N.V.	260	4.23	683
Elisa Oyj	69	0.19	88
Koninklijke KPN N.V.	117	0.05	122
NOS	-	1.12	-
Orange S.A.	84	0.30	114
Proximus S.A.	96	0.30	126
Tele 2 AB	142	0.31	173
Telecom Italia	133	1.70	303
Telefónica S.A.	41	0.84	125
Telekom Austria AG	72	0.20	92
Telenet Group Holding N.V.	317	0.30	347
Telenor	100	1.45	245
Telia Company AB	139	0.31	170
Vodafone Group plc	141	0.91	232
Weighted Average (information only)[64]	113		
Arithmetic Average (information only)	131		

Remarks on results

The calculations of the debt premium are in line with the Notice and follow the same criteria as those of the 2021 WACC parameters Report, with the adjustment described in paragraph 4.4.5).

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

[63] For calculation details see Chapter 5 and Annex 3.
[64] The market cap has been calculated in Euro considering a five year average based on weekly prices of the shares (consistent with BEREC's approach to calculate five year averages). See Annex 3 for details.

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, for the Norwegian Telenor and for the Romanian DIGI Communications. The four companies have not issued corporate bonds in the domestic currency (SEK, NOK or RON). Since Norway and Sweden have the same Moody´s credit rating as Germany (AAA), those corporate bonds (Tele2, Telia and Telenor) have been compared to German government bonds. In the case of DIGI, their bonds have been compared to Italian government bonds since this is the only country where euro is the official currency and has the same Moody´s credit rating as Romania (Baa3).

In addition, some of the peer companies like DIGI Communications, Elisa, NOS, Proximus, Tele2, Telecom Italia, Telekom Austria, Telenet and Vodafone do not have or have only a very limited number of traded corporate bonds (one or two) meeting the criteria.

Altogether, these aspects should be borne 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[65] 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

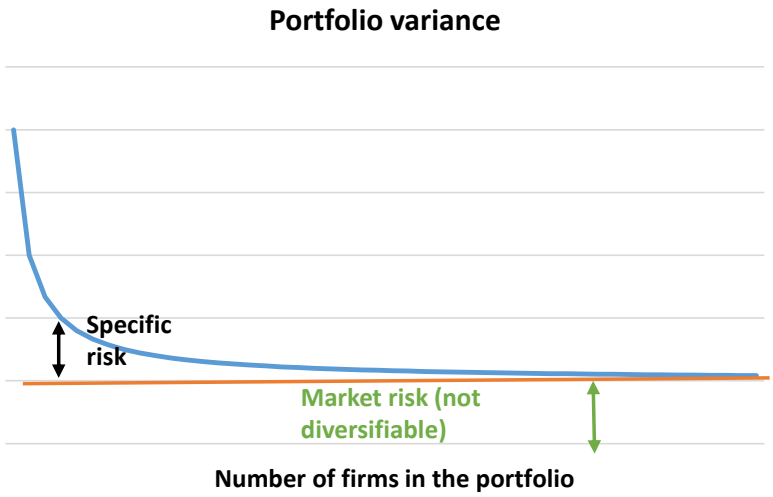
[65] Systematic Risks are non-diversifiable market risks in contrast to non-systematic risk relating to the risk associated with individual shares. CAPM serves to measure the systematic risk.

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.[66]

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:

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

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.

[66] Brealey, Myers, Allen, "Principles of corporate finance", 11th Edition (2014).

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:[67]

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

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.[68]

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.

[67] Theoretical relation in case of "unbiased" estimation of the OLS linear regression line between market index return and stock return
[68] See Notice, para. 45.

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.

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.[69]

[69] See SWD, page 86.

The Notice states that the equity beta calculation should use weekly data, a sampling period of, and a time window 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,[70] Dimson[71], Vasicek[72]. 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.[73]

The Commission, in line with portfolio theory, suggests using a wide index[74] which in this case is an EU index rather than a domestic market index and favours the STOXX Europe TMI (Europe Total Market Index) 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.[75]

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 the systematic risk of a company, which is included in the equity beta, with the others, it is common to estimate an asset beta from the company's equity beta. When estimating the equity beta in the WACC 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 using the formula known as "Miller Formula"[76]:

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

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 ratio of the covariance between bond yields and market returns and the variance of the market return can give incorrect results. For this reason, the Commission suggests to lever and re-lever the beta including a beta debt of 0.1.[77]

[70] 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.
[71] 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.
[72] 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.
[73] See SWD, page 80, and BEREC Regulatory accounting in practice 2021, WACC chapter, page 32.
[74] In the CAPM framework the market portfolio includes all risky assets, in proportions defined by their relative market values.
[75] 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 2021" (BoR (21) 161), page 32
[76] The formula proposed is the one used by most NRAs as reported related to beta in op. cit., page 28.
[77] See SWD, page 85.

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 estimation 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 15 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 analysis and the consistency of the estimation are reported in the Appendix).

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 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% of the free float of European market capitalization (generally more than 1800 peers from different economic sectors)[78] 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.[79] For a time window of five years 260 points are collected from 1st April 2017 to 1st April 2022.

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.[80] The Commission states that "short term loans and liabilities are likely to be offset by short-term assets such as cash and cash equivalents"[81] 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[82]. According to this approach for the book value of the debt component only long term debt[83] and capital lease[84] 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 peer is about 0.83 on average excluding some evident outlier observations. 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.

With respect to Table 5 of the 2021 WACC parameters Report (BoR (21) 86), the ratio values of cash and equivalent with respect to current liability increased from 83.38% to 86.47% closer to 1 considering only the 14 companies included in the Report in BoR (21) 86, and equal to 81.34% including also the new peer DIGI Communications.

[78] BKXP Sotxx Europe TMI, https://www.stoxx.com/index-details?symbol=BKXP.
[79] 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).
[80] Net Debt = STD+LTD−CCE.
[81] SWD, page 87.
[82] See Regulatory Accounting Report 2021 (BoR (21) 161), WACC chapter.
[83] Not including pension liabilities.
[84] 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.

Table 5 Ratio between Cash and Cash Equivalent in relation to current liabilities[85] 5. (a) and raw data from the balance sheets for the ratio calculation in 5. (b)[86]

5. (a)		Ratio between Cash and Cash Equivalent in relation to current liabilities					
No	**Company**	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**
1	Deutsche Telekom AG	38.41%	36.45%	37.62%	73.21%	44.19%	45.98%
2	DIGI Communications N.V.	19.59%	8.21%	5.63%	7.02%	7.02%	9.50%
3	Elisa Oyj	24.92%	28.15%	34.41%	104.21%	96.45%	57.63%
4	Koninklijke KPN N.V.	4755.56%	100.85%	70.79%	72.01%	97.42%	85.27%
5	NOS	1.43%	1.03%	14.50%	171.09%	12.51%	40.11%
6	Orange S.A.	92.06%	77.50%	124.83%	122.19%	179.98%	119.31%
7	Proximus S.A.	58.42%	145.30%	146.15%	134.20%	112.16%	119.25%
8	Telecom Austria AG	33733.33%	25.93%	50.91%	23.35%	31.17%	32.84%
9	Tele2 AB	141.45%	6.29%	9.26%	20.59%	21.91%	39.90%
10	Telefónica S.A.	56.84%	62.29%	59.52%	64.54%	98.80%	68.40%
11	Telenet Group Holding N.V.	10.81%	17.50%	19.25%	7.41%	8.92%	12.78%
12	Telenor	99.28%	117.48%	57.64%	123.99%	93.66%	98.41%
13	Telia Company AB	449.93%	203.67%	47.22%	265.52%	387.95%	270.86%
14	Telecom Italia	78.51%	34.39%	83.48%	113.78%	106.25%	83.28%
15	Vodafone Group plc	119.09%	63.61%	319.36%	112.33%	68.58%	136.59%
Average							81.34%

5. (b)		Cash and cash equivalent (Million of own currency)					Short Term Borrowings/Short Term Lease liabilities/Current Portion of Long Term Debt-Capital Leases (Million of own currency)				
No.	**Company**	**2017**	**2018**	**2019**	**2020**	**2021**	**2017**	**2018**	**2019**	**2020**	**2021**
1	Deutsche Telekom AG	3,312	3,679	5,393	12,939	7,617	8,623	10,093	14,334	17,675	17,236
2	DIGI Communications	75	64	53	52	52	383	785	936	733	733
3	Elisa Oyj	44	81	52	220	114	178	287	151	211	118
4	Koninklijke KPN N.V.	856	594	766	597	793	18	589	1,082	829	814
5	NOS	3	2	13	153	11	210	215	88	90	87
6	Orange S.A.	5,810	5,634	6,481	8,145	8,621	6,311	7,270	5,192	6,666	4,790

[85] "Notes Payable/Short Term Debt" and "Current Portion of Long Term Debt/Capital Leases". Source: Operator's balance sheets retrieved from Bloomberg. Red data is not included in the average calculation.

[86] The differences in the tables with respect to last year's report BoR (21) 86 are related to a restatement of the balance sheet for some operators: specifically for Orange this is due to the application of IFRS 16 on lease term; for NOS some values reported for 2020 in last year's report were related to a preliminary estimation no replaced, other differences are attributable to restatement issues. For Vodafone the classification of the Balance Sheet is the one of the release (31/03) of each year.

7	Proximus S.A.	333	340	323	310	249	570	234	221	231	222
8	Telecom Austria AG	202	64	140	211	534	1	245	276	903	1,714
9	Tele2 AB	802	404	448	970	880	567	6,426	4,836	4,712	4,016
10	Telefónica S.A.	5,192	5,692	6,042	5,604	8,580	9,134	9,138	10,152	8,683	8,684
11	Telenet Group Holding N.V.	39	88	101	37	45	362	504	527	500	499
12	Telenor	22,546	18,492	13,867	20,577	15,223	22,710	15,740	24,056	16,596	16,253
13	Telia Company AB	15,617	18,764	6,116	8,133	14,358	3,471	9,213	12,951	3,063	3,701
14	Telecom Italia	3,675	1,917	3,138	4,829	6,904	4,681	5,575	3,759	4,244	6,498
15	Vodafone Group plc	7,535	4,106	11,777	11,755	4,956	6,328	6,454	3,688	10,465	7,227

The equity component of the gearing is evaluated weekly from the number of outstanding shares[87] 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".

In line with the 2021 WACC parameters Report, the asset beta estimation is reported, considering also the "Pension liabilities"[88] for each operator in the debt component of the gearing, only for sensitivity purposes. In the literature, Pension Liabilities and Pension Assets should be treated in a way to include an adjustment to the asset beta provided in the Miller formula. A theoretical framework for taking into account pension assets and liabilities in the CAPM model has been developed by Jin, Merton and Bodie (JMB framework).[89] This framework sets out the need to estimate separate betas for pension asset (β_PA) and pension liabilities (β_PL) as well as the amount of pension asset (PA) and pension liability (PL), other than the equity beta (β_E), the beta debt (β_D), the Equity (E) and debt (D) components of a firm, as reported in the Miller formula, thus estimating the asset beta correctly.

[87] The numbers of outstanding shares are those available in the balance sheet for every year, as reported by Bloomberg in the Financial Analysis section of each operator (see Annex 3).

[88] Amount of pension obligations disclosed on companies' non-current liabilities section. The number may or may not net off with pension assets. It includes both pension and other post-retirement benefit obligations.

[89] L. Jin, R. Merton Z. Bodie: Do a firm's equity returns reflect the risk of its pension plan?. Journal of Financial Economics 2006, Vol 81, Issue 1.

In this framework the Miller formula for asset beta is only unbiased in case the pension liabilities and the pension assets offset each other and the β_PA and the β_PL are equal. The new asset beta can thus be rewritten in the following way:

$$\beta_A = \beta_E \frac{E}{D+E-S} + \beta_D \frac{D}{D+E-S} + \left(\beta_{PL} \frac{PL}{D+E-S} - \beta_{PA} \frac{PA}{D+E-S}\right)$$

This theoretical framework is hard to be applied in practice due to the fact that pension liabilities are not tradable as such. In general an upward adjustment to the asset beta is needed in case there is a negative balance between pension liabilities and pension assets (S=PA-PL<0) within the hypothesis that the β_PA and beta β_PL are equal.

In any case the pension deficit reported in the balance sheet is generally understood by investors as a source of debt. Therefore equity beta can be affected by a pension deficit as a leverage risk. At the same time the JMB framework states that the systematic "unlevered" risk increases in the presence of a pension deficit. Those two different views are sources of uncertainty about how to treat pension deficit: i) one view treated it to 100% as source of debt; ii) on the other to 100% as a source of systematic risk as in the JMB framework.[90]

Consequentially, the asset beta estimation has been carried out considering a case in which a pension deficit is treated as a full source of debt, in line with the "practitioners'" approach, with the outcome that the pension deficit, independent from the share of input to debt, does not have a material impact on the gearing calculation with an increase of the standard evaluation of about 1% and a decrease of the asset beta on average of about 0.01. The sensitivity analysis on impact of pension fund is reported in table A1 in Appendix 3 for each peer.

In the following table the weighted averages based on market cap[91] as well as the arithmetic average are provided for beta and gearing.

Table 6 BEREC peer group 2022 – Equity beta, Gearing, Asset beta

No.	Company	Equity beta	Asset Beta	Gearing	Market cap (Bilion Euro)
1	Deutsche Telekom AG	0.78	0.43	52.69%	72.87
2	DIGI Communications N.V.	0.46	0.22	66.60%	0.46

[90] https://www.ofcom.org.uk/__data/assets/pdf_file/0016/111535/Draft-statement-annex-30.pdf.

[91] The market cap has been calculated in Euro considering a five year average based on weekly prices of the shares (consistent with BEREC's approach to calculate five year averages). See Annex 3 for details.

3	Elisa Oyj	0.43	0.38	13.28%	7.08
4	Koninklijke KPN N.V.	0.65	0.44	38.55%	11.12
5	NOS	0.70	0.49	35.39%	2.26
6	Orange S.A.	0.70	0.40	50.58%	33.03
7	Proximus S.A.	0.53	0.41	26.66%	7.24
8	Tele2 AB	0.58	0.47	22.41%	7.59
9	Telecom Italia	1.02	0.38	70.52%	11.17
10	Telefónica S.A.	1.01	0.49	58.01%	32.91
11	Telecom Austria AG	0.68	0.48	34.35%	4.65
12	Telenet Group Holding N.V.	0.62	0.35	51.17%	4.89
13	Telenor	0.33	0.26	29.71%	22.77
14	Telia Company AB	0.62	0.43	36.27%	15.65
15	Vodafone Group plc	0.90	0.50	50.06%	47.76
	WA (information only)	0.75	0.43	47.07%	
	AM (information only)	0.67	0.41	42.42%	

Remarks on results

BEREC has performed a cross-check of the results above with a rolling regression method to verify that the decrease of betas that can be observed is correctly reflecting the trend. The estimation with the rolling regression method has confirmed the slow decrease of beta after the spike in the variation of the risk due to the pandemic in the first quarter 2020 for most operators.[92] After this spike the risk conditions reverted again for most operators, and the reduction trend has been generally accelerated without shock showing a reduction of the average perceived risk of telecom operators with respect to the market as a whole, i.e. the beta “normalizes” rapidly at a trend level comparable the one experienced before the shock for most operators. Thus it can be concluded that the hypothesis of a small variation over time of the beta still holds. This is also shown in the following table comparing the evolution of asset betas over time. A general reduction for most peers can be observed, i.e. a reduction of the

[92] If beta varies only slowly (relative to data sampling frequency) the forward looking beta may be well approximated by the current estimate on the most recent historical data,
cf. e.g. https://www.ofgem.gov.uk/sites/default/files/docs/2018/12/ofgem_dr_dec_2018.pdf,

risk perceived for the telecommunications sector compared to the general market. The trend reduction is constant on average for the last year (-0.06 2021-2020), -0.06 2022-2021).

Table 6 (a) Asset beta evolution over time (2020 – 2022)

	Asset beta comparison			ΔYoY	
	2020 Bor(20)116	2021 Bor(21)86	Berec 2022(22)70	Δ2021 (value 2021-value 2020)	Δ2022 (value 2022-value 2021)
BT	0.47	-	-		
Deutsche Telekom AG	0.57	0.48	0.43	-0.09	-0.05
Elisa Oyj	0.52	0.41	0.38	-0.11	-0.03
Koninklijke KPN N.V.	0.48	0.49	0.44	0.01	-0.05
NOS	0.60	0.57	0.49	-0.03	-0.08
Orange S.A.	0.52	0.44	0.40	-0.08	-0.04
Proximus S.A.	0.62	0.5	0.41	-0.12	-0.09
Tele2 AB	0.69	0.52	0.47	-0.17	-0.05
Telecom Italia	0.47	0.42	0.38	-0.05	-0.04
Telefónica S.A.	0.58	0.56	0.49	-0.02	-0.07
Telecom Austria AG	0.45	0.47	0.48	0.02	0.01
Telenet Group Holding N.V.	0.38	0.41	0.35	0.03	-0.06
Telia Company AB	0.53	0.48	0.43	-0.05	-0.05
Vodafone Group plc	0.49	0.52	0.50	0.03	-0.02
Telenor		0.33	0.26	0.33	-0.07
DIGI			0.22		

WA		**0.48**	**0.43**		**-0.05**
AM	**0.53**	**0.47**	**0.41**	**-0.06**	**-0.06**

6. ERP

6.1. Definition and data sources used

Like the RFR, the ERP is a parameter reflecting general macro-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.[93]

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.[94] 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.[95]

Furthermore, as in 2021 BEREC also estimated a separate EU/EEA ERP including data for Norway and Iceland (for exclusive use by Nkom and ECOI).

In the following part, the data used is described. Given that the calculation of the ERPs is based on the Morningstar data set, as updated for 2022[96], 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

[93] Cf. Notice, para. 37, SWD, p. 46
[94] Cf. Notice, para. 38, SWD, p. 60 and section 5.2.3.2.
[95] Cf. Notice, para. 38, SWD, p. 60 and below 6.2.
[96] The database in use by BEREC is the last available through Morningstar: February 2022. This version of DMS data updates the previous version dated February 2021. The estimations available in the 2022 Credit Suisse Yearbook are based on this new version of the raw data time series, since DMS continually updates and improves the series, including revising historical data series. Since the 2021 DMS data series have been updated to the new year when in 2020 the relevant Bond Total Return time series of the following countries: Belgium (since 1991), Denmark (since 1991), Finland (since 1996), France (since 1985), Germany (1995), Ireland (since 1999), Italy (since 1994), Netherlands (1985), Portugal (1999), Spain (1995) and Sweden (1991) have been adjusted. Main novelty with respect to 2021 data series distributed by Morningstar is the inclusion of **Greek data** with the Bond Total Return index started from 1992 and the Equity Total Return index from 1953.).

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 and an EU/EEA ERP, BEREC retrieves data from the 2022 Morningstar data set, which contains the so-called DMS Global Returns Data (DMS in the following).[97] This dataset contains historical time series from 1900 – 2021 for the following 13 EU member states: Austria, Belgium, Denmark, Finland, France, Greece, Germany, Ireland, Italy, Netherlands, Portugal, Spain and Sweden and additionally for the EEA country Norway. For Iceland and other countries not included in the DMS data, the Implied pricing method has been applied with data retrieved from Bloomberg.

The DMS data consists of historical series of market premiums in the EU member states and Norway referred to above.[98] 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 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.[99]

The DMS database comprises annual returns for 35 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.[100]

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[101];
iii) Equity Risk Premium of the relevant 13 EU member states plus Norway where time series are available.

[97] Dimson/Marsh/Staunton (DMS) data, as published in the *Credit Suisse Global Investment Returns Yearbook 2022* by Credit Suisse/London Business School; a *Summary Edition of the Credit Suisse Global Investment Returns Yearbook 2022* is available here: https://www.credit-suisse.com/about-us-news/en/articles/media-releases/credit-suisse-global-investment-returns-yearbook-2022-202202.html. The data source is Dimson/Marsh/Staunton, Global Investment Returns Database 2022 (distributed by Morningstar Inc.).

[98] as well as data for other countries namely UK, USA, Argentina, Australia, Brazil, Canada, Chile, China, Hong Kong, India, Japan, Malesia, Mexico, New Zealand, Russia, Singapore, South Africa, South Korea, Taiwan, Thailand, and Switzerland. Together they represent 98% of world equity market capitalization at the beginning of 1900. Together, these 35 countries cover 98.7% of the investable universe at the beginning of 2022.

[99] 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 2022 (available from London Business School (LBS)).

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

[101] The Credit Suisse Yearbook 2022 (which contains the DMS results in hard copy, the underlying DMS data is included in the Morningstar data set 2022 as a soft copy). The data source is Dimson/Marsh/Staunton, Global Investment Returns Database 2022 (distributed by Morningstar Inc.).

i) The General methodologies of the DMS data series[102]

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.

The guiding principle of the index selection was to avoid survivorship[103], success, look-ahead[104], 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.[105] 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

[102] 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.

[103] 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.

[104] 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.

[105] 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.

units of measurement. It is identical if computed from nominal or real returns, or if computed from dollar or euro returns.[106]

Each index starts from 1899 with a base index 1 and comprises data from 1900 – 2021, i.e. 122 years.

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

In the DMS data base four Global indexes are included: the "World Index",[107] the "Europe Index", the "Developed Market Index" and the "Emerging Markets Index".

The **"World Index"** comprises 23 countries (including Russia and China) plus 9 countries that were added in the 2021 Yearbook and 3 new countries listed in the 2022 Yearbook[108]. It is evaluated in common currency (USD) for both equity and bond. This year, DMS assumes that at the beginning of each year the investor bought a portfolio of the 23+9+3+55[109] countries weighting each country by its size. The "World equity index" is obtained through a weight based on the market capitalization[110] of each of the 23+9+3+55 countries. The "World bond market index" is obtained through a weight based on country GDP of each of the 23+9+3[111] countries. The approach used in order to include a country is to avoid survivorship bias, in the sense that the index also includes this country when it registered a total loss (e.g. 1917 for Russia and 1949 for China), and re-enters the indexes when their market reopened in the early 1990ies.

For the **"Europe Index"** the approach is the same; it includes the 16 original 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[112] 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.[113]

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

[106] The time series are provided in each local currency, and in USD.
[107] There is also a derived composite index World excluding US.
[108] **Greece**, Chile and Argentina have been included in the Yearbook of 2022.
[109] The equity index includes new countries when the data become available. The 2022 World Equity index includes as well 55 other countries where data is available.
[110] The market capitalization is included considering a free float adjustment from 2001.
[111] The bond index includes also 9+3 new countries of 2021 and 2022, but doesn't include the 55 other countries since in this case the data is not available.
[112] Greek data starts only in 1953.
[113] The European index starts from 1899 with 16 countries and increases to 35 countries over the years when data becomes available by 2021.

applied through exchange rates to convert the Equity and Bond index to the desired currency is netted off.

Switzerland, Russia and the UK, in the "Europe Index" are not relevant for BEREC's calculation of an EU-wide ERP; moreover, Norway is now included in the calculation of an EU/EEA-ERP for EEA notification purposes only. It has to be noted that the updated "Europe Index" is published in the Credit Swiss Global Investment Returns Yearbook 2022, but no longer appears in the free Summary edition.[114]

For the "Developed Market Index" and the "Emerging Market Index" DMS identify whether a market was developing or emerging at each year in the past based on GDP per capita. The "Developed Market Index" at the end of 2020 thus contains the following countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, UK, US, Hong Kong, Singapore, Luxemburg and Israel while the "Emerging Market Index" contains China, South Korea, Taiwan, India, Brazil, South Africa, Russia, Saudi Arabia, Thailand, Mexico, Malaysia, Indonesia as well as 14 smaller markets.

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

The DMS Credit Swiss Global Investment Yearbook 2022 reports the following values in terms of arithmetic mean (AM) and geometric mean (GM): nominal annual Equity and Bond returns in local currency.[115]

Table 7 Geometric Mean and Arithmetic Mean 1900-2021 Equity/Bond annual return in nominal terms and Geometric and Arithmetic Average of Equity vs Bond premium[116]

		Mean returns % p.a.					
		Nominal				Premiums	
		Equities		Bonds		Equities vs Bonds	
No.	Country	GM	AM	GM	AM	GM	AM
1	Austria	13.4%	28.2%	8.3%	18.1%	3.2%	21.3%
2	Belgium	7.8%	10.3%	5.4%	5.9%	2.2%	4.3%
3	Denmark	9.7%	11.6%	6.0%	6.5%	3.5%	5.2%
4	Finland	12.8%	16.4%	7.0%	7.2%	5.4%	9.0%
5	France	10.4%	12.9%	7.0%	7.4%	3.2%	5.4%
6	Germany	8.2%	13.2%	3.2%	5.3%	4.8%	8.2%
7	Greece	12.2%	21.4%	12.7%	16.1%	-10.7%	-4.8%
8	Ireland	8.5%	10.9%	5.7%	6.4%	2.7%	4.7%

[114] See below for a comparison of the Credit Suisse "Europe Index" with the BEREC EU27-ERP.
[115] The data source of this table is Dimson/Marsh/Staunton, Global Investment Returns Database 2022 (distributed by Morningstar Inc.).
[116] ERPs as notified by the NRAs may differ from the ones provided in the table.

9	Italy	10.2%	14.1%	7.0%	7.5%	3.0%	6.3%
10	Netherlands	8.2%	10.3%	4.6%	4.9%	3.4%	5.7%
11	Portugal	11.1%	16.1%	5.6%	6.6%	5.1%	9.2%
12	Spain	9.2%	11.3%	7.5%	8.0%	1.6%	3.5%
13	Sweden	9.8%	11.9%	6.1%	6.5%	3.5%	5.7%
14	Norway	8.2%	11.0%	5.4%	5.7%	2.7%	5.5%

The values reported in the Yearbook refer to the time series from 1899 until 2021 for the index that is equal to 1 in 1899. The corresponding annual return for each year is evaluated from 1900 to 2021 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 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 the 12 EU member states + Norway the time series for Equity and Bond annual return are complete from 1900-2021, the only exceptions are Austria, Germany and the newly included Greece[117].

For Austria the Equity Risk Premium excludes the averages (AM and GM) for the hyperinflationary years 1921 and 1922, instead the values for the corresponding nominal Equity and Bond index are maintained.

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 14 EU member states plus Iceland not included in the DMS data calculated with the implied pricing method

For Iceland and the 14 EU member states that are not contained in the Morningstar data set, i.e. Bulgaria, Croatia, Cyprus, Czechia, Estonia, 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)[118]. 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

[117] For Greece the index starts from 1954 for the Equities and from 1993 for Bonds and the corresponding Premium.
[118] 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, FT, November 7, 2011.

provides a valuation of each equity market.[119] 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 return on investing in equity. The third step is to subtract a total bond return index 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 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.[120] 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[121] 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 15 years long. All the data has been derived from Bloomberg. The result is shown in Table .[122]

Table 8 Geometric Mean and Arithmetic Mean 2001-2021 Equity/Bond annual return in nominal terms and Geometric and Arithmetic Average of Equity vs Bond premium.[123]

		Mean returns % p.a.						
		Nominal				Premiums		Time series length
		Equities		Bonds		Equities vs Bonds		
No.	Country	GM	AM	GM	AM	GM	AM	
1	Bulgaria	12.88%	13.11%	3.89%	4.36%	8.65%	9.30%	2006-2021
2	Croatia	8.49%	8.53%	3.92%	4.48%	4.40%	5.08%	2006-2021

[119] For the purpose of the Equity index the adjusted positive Price/Earnings ratio has been considered, calculated as the ratio of the last price divided by the positive Earnings per Share.
[120] This applies to Central and Eastern European countries. For the smallest EU member state, Malta, data is still not available for other reasons.
[121] 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.
[122] 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 where the 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 122years for the 12 EU member states (120 for Germany) originally included in the DMS data.
[123] Values last checked via Bloomberg in May 2022.

3	Cyprus	29.62%	31.40%	2.21%	2.42%	26.82%	28.35%	2015-2021
4	Czechia	7.52%	7.52%	3.77%	4.24%	3.61%	4.09%	2006-2021
5	Estonia	7.50%	7.50%	-8.00%	-8.00%	16.85%	16.85%	2021-2021
6	Hungary	9.07%	9.11%	4.29%	5.24%	4.58%	5.62%	2001-2021
7	Latvia	10.53%	10.62%	1.32%	1.80%	9.10%	9.87%	2005-2021
8	Lithuania	9.37%	9.39%	4.42%	5.09%	4.74%	5.46%	2005-2021
9	Luxemburg	6.20%	6.21%	1.65%	1.94%	4.48%	4.78%	2016-2021
	Malta							No data available
10	Poland	8.09%	8.11%	5.57%	6.20%	2.38%	3.16%	2001-2021
11	Romania	12.74%	13.22%	1.15%	1.85%	11.46%	14.00%	2006-2021
12	Slovakia	7.65%	7.67%	4.18%	4.59%	3.33%	3.69%	2005-2021
13	Slovenia	9.02%	9.07%	3.79%	4.22%	5.04%	5.58%	2005-2021
14	Iceland	6.98%	7.01%	6.40%	7.24%	0.55%	1.27%	2009-2021

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[124], i.e. it uses historical returns series of DMS data for 13 EU member states (listed above, including Greece) + Norway and shorter historical returns series assembled by using the implied pricing method with data from Bloomberg for 13[125] EU member states + Iceland not included in the Morningstar data set (see above).

Therefore, BEREC cannot simply use an "off-the-shelf" European ERP as e.g. calculated by DMS, as the countries included in their (Old World) "Europe" Index[126] deviate from the EU member states that are relevant for BEREC's calculation of an EU-wide ERP. To our best

[124] SWD, pp. 65.
[125] Since 2021 Greece has been included in the Morningstar DMS data and new data is available for Estonia, and no data is available for Malta.
[126] Which comprises the following 16 countries: Austria, Belgium, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal, Spain, Denmark, Sweden, Norway, Switzerland, UK and Russia. It is therefore not comparable with the EU-wide ERP calculated by BEREC.

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[127] and the result (an EU-wide ERP) estimated by BEREC exhibited in Table 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 (and from EU/EEA countries for the separate EU/EEA-wide ERP).

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, now including Greece) + Norway and shorter (for 13 EU member states + Iceland)[128] 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 + Norway (listed above in Table) the estimation of the EU-wide ERP (and EU/EEA-ERP resp.) is based on the DMS historical returns series acquired by BEREC from Morningstar2022. These series do not cover the remaining 14 EU member states + Iceland (listed above in Table). For these member states the estimation has been carried out 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.[129] The relative weighting of these time series addresses a selection bias that may happen if countries with shorter data series are included.[130]

Following the Notice, BEREC provides an **EU-wide ERP** that is a weighted average of the ERP using DMS historical time series for 12 EU member states + Norway from 1900 and using DMS historical time series for Greece which time series of the Equity return start from 1954 and for the Bond return from 1993. In line with the approach used by DMS, all relevant

[127] SWD, p. 66. Table 21 shows values for the period 1900 – 2010, i.e. is outdated. BEREC calculates the EU-wide ERP value using data until 2021.
[128] As of this year Estonia will also be included.
[129] For more details see section 6.1. above
[130] E. Dimson, P. March, M. Staunton "Survivorship Bias Is Negligible", paragraph 5.4 Chapter 11 Handbook of Equity Risk premium.

countries are fully included in the composite indexes once data becomes available (Greece is included from 1954 with respect to Equity and from 1993 for the Bond) and for 13 EU member states + Iceland, where data is available, not included in the Morningstar data set calculated with the implied pricing method using Bloomberg starting from 2001 at the earliest and 2021 at the latest.[131] 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**.[132]

Using a weight for Equity that takes into account market capitalization is in line with the efficient market hypothesis[133] 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.[134] 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 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 (2017-2021)** 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.[135] 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" calculated until 2021. However, the sensitivity analysis run by BEREC shows that the difference is not material.[136]

The annual market capitalisation data has been derived from Bloomberg using all outstanding shares that are only actively traded, the figure does not contain ETF (Exchange trade found) and ADR (America Deposit Receipt) as they do not represent companies directly. It includes only actively traded, primary securities on the countries' exchanges to avoid double counting. It is evaluated in Euro in line with the GDP weight used for the Bond index.[137] The same

[131] For more details see above section 6.1.
[132] The use of Market cap and GDP for the "World Index" and the "Europe Index" have been considered since 2012 by DMS.
[133] 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.
[134] GDP Weighting in Asset Allocation 2010 MSCI Research bulletin.
[135] i.e. BEREC uses the same weighting *factors* (market capitalisation, GDP), however a different weighting *method* (due to data constraints).
[136] See below section 6.5.
[137] Data is consistent with publicly available: https://data.worldbank.org/indicator/CM.MKT.LCAP.GD.ZS.

approach is applied in the DMS Yearbook where the World equity index is weighted using market capitalisation free float adjusted from 2001.

The GDP data has been derived from Eurostat in form of current prices in Euro[138].

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

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

The first step of the analysis has been carried out considering the following.

As explained in section 6.3 above the weight for the market capitalisation and GDP has been considered as an average with five year time window (2017-2021), 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.[139]

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 Bonds 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 of the denominator takes into account the number of countries that are included in recent years. This is effected via applying a second weighting to compensate for incomplete historic values. This is the **"available years"-weighting** according to the length of the time period of data availability. For the 12 EU member states + Norway listed in the Morningstar data set this would be 122 years[140] divided by the maximum time period available (122), while for Greece the Equity time series started from 1954 with a maximum time period available of 68 years, and the Bond time series started from 1993 with a maximum time period of 29 years; for the remaining 13 EU member states + Iceland not included in the Morningstar data set the weight is the number of years for which data is available (2001 at the earliest – 2021) over the maximum time period available, i.e. 21/122). 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:

[138] https://ec.europa.eu/eurostat/databrowser/view/nama_10_gdp/default/table?lang=en
[139] See below section 6.5.
[140] 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.

Equity_EU = (Average Equity_x*Market Capitalization_x*(1)+Average Equity_y*Market Capitalization_y*(y/121)+...)/(market capitalization_x*1+ market capitalization_y*(y/121)+..);

Bond EU = (Average Bond_x*GDP_x*(1) + AverageBond_y*GDPy*(y/121)+...)/(sum for GDP_x*(1)+GDP_y*(y/121)+...).

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 13 EU member states + Iceland (not contained in the Morningstar data set) are integrated in the final average only where data is available for both the Bond and Equity index.[141] The weights are adjusted year by year taking into account the relevant EU/EEA member states that are included. In the table below 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. Data is available for all countries (except Malta), and thus all EU member states (except one) are included.

Table 9 Year and duration of the time series of the 13 EU member states + Iceland not included in the Morningstar data set

No.	Country	First year of the time series	Time Weight
1	Bulgaria	2006	16/122
2	Croatia	2006	16/122
3	Cyprus	2015	7/122
4	Czechia	2006	16/122
5	Estonia	2021	1/122
6	Hungary	2001	21/122
7	Latvia	2005	17/122
8	Lithuania	2005	17/122
9	Luxemburg	2016	6/122
	Malta	No data available	
10	Poland	2001	21/122
11	Romania	2006	16/122

[141] 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.

12	Slovakia	2005	17/122
13	Slovenia	2005	17/122
14	Iceland	2009	13/122

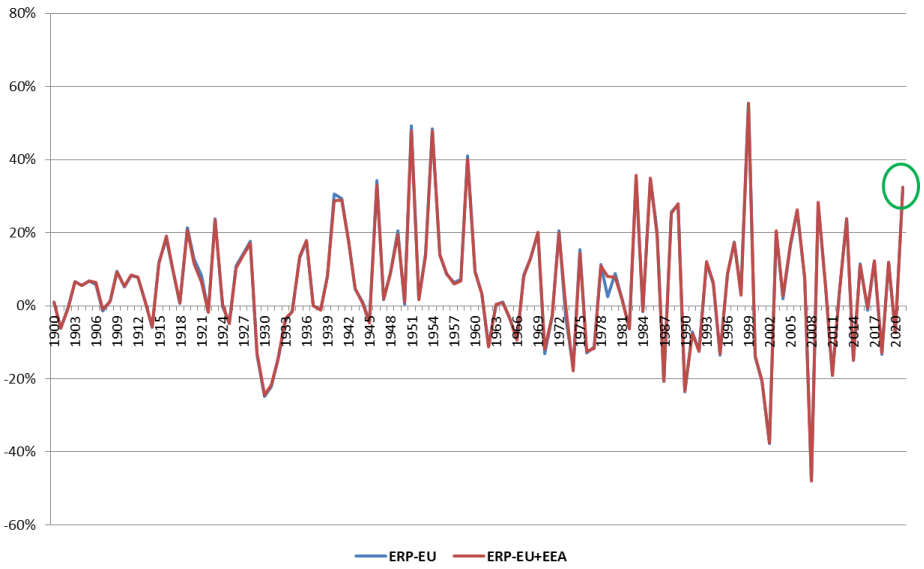
The limitation of the proposed approach is related to the fact that weights are dependent on when data is available for each country. This gives a sort of "look-ahead" bias as the probability of investing along the years, as market capitalization/GDP has changed along the 100 years, but this is a trade-off 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.[142] 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.[143] It follows that the AM usually provides the upper boundary of the value, whereas the GM is the lower boundary. For transparency reasons BEREC provides both the GM and the AM.

In the following Figure 3 the time evolution (1900-2021) of the proposed annual returns of the new EU Equity risk premium is shown, including 13 EU member states with long time series and 13 EU member states with shorter time series as described before. In the figure the evolution over time including Norway and Iceland (EEA) is also given. The increase of the average with respect to last year EU-ERP is mainly due to the strong increase of the premium experienced for the most part of the countries in 2021.

[142] SWD, section 5.1.2, pp. 36-38.
[143] 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 1900-2021 time series



The corresponding ERP averages are shown in Table 10.

Table 10 EU ERP (GM and AM) / EU/EEA-ERP (GM and AM)

	Geometric Mean (GM)	Arithmetic Mean (AM)
EU-ERP	**4.37%**	**5.70%**
EU/EEA-ERP	**4.37%**	**5.69%**

While the effect of the 13 EU member states + Iceland not included in the Morningstar data set is currently not substantial, the significance may increase in the future as markets become more mature.

6.5. Results EU-ERP and EU/EEA-ERP

The result of the calculation is shown in Table . For each EU member state the GM and the AM is provided (unweighted).[144] The line below the last EU member state contains the lower boundary (GM) and the upper boundary (AM) of the single EU-wide ERP as estimated by

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

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 with a value of **5.70%** (AM) is relevant for NRAs' own estimations.

In addition, a separate EU/EEA-wide ERP average (GM and AM) is calculated. The EU/EEA-wide ERP with a value of **5.69%** (AM) is a relevant reference only for the two EEA countries Norway and Iceland for EEA notification purposes.

Table 11 ERP

Country	Geometric Mean in %	Arithmetic Mean in %	Available years weight
Austria	3.2%	21.3%	100% (122/122)
Belgium	2.2%	4.3%	100% (122/122)
Bulgaria	8.65%	9.30%	13.11% (16/122)
Croatia	4.40%	5.08%	13.11% (16/122)
Cyprus	26.82%	28.35%	5.74% (7/122)
Czechia	3.61%	4.09%	13.11% (16/122)
Denmark	3.5%	5.2%	100% (122/122)
Estonia	16.85%	16.85%	0.82% (1/122)
Finland	5.4%	9.0%	100% (122/122)
France	3.2%	5.4%	100% (122/122)
Germany	4.8%	8.2%	98.36% (120/122)
Greece[145]	-10.7%	-4.8%	55.73% (68/122)
Hungary	4.58%	5.62%	17.21% (21/122)
Ireland	2.7%	4.7%	100% (122/122)
Italy	3.0%	6.3%	100% (122/122)
Latvia	9.10%	9.87%	13.93% (17/122)
Lithuania	4.74%	5.46%	13.93% (17/122)
Luxembourg	4.48%	4.78%	4.92% (6/122)
Malta	No data available		
Netherlands	3.4%	5.7%	100% (122/122)
Poland	2.4%	3.2%	17.21% (21/122)
Portugal	5.1%	9.2%	100% (122/122)
Romania	11.46%	14.00%	13.11% (16/122)
Slovakia	3.33%	3.69%	13.93% (17/122)
Slovenia	5.04%	5.58%	13.93% (17/122)
Spain	1.6%	3.5%	100% (122/122)
Sweden	3.5%	5.7%	100% (122/122)
EU-ERP	**4.37%**	**5.70%**	
Norway	2.7%	5.5%	100% (122/122)
Iceland	0.55%	1.27%	10.65% (13/122)
EU/EEA-ERP	**4.37%**	**5.69%**	

[145] A negative premium is derived for the time series since 1993 on average. The presence of a negative premium is related to the fact that for the time series (since 1993) the Greek Bond market provided higher yields than the corresponding Equity market, due to the financial crisis of the government bond.

Analysis of results

The result of BEREC's calculation presented in this chapter is broadly in line with likely expected findings.

Specifically, with respect to last year, the level of ERP increases by 0.2 points, in line with the "European ERP" evaluated by DMS from 4.0% (2021 Yearbook) to 4.2% (2022 Yearbook). As for the past year, it is plausible that the EU-ERP value – although in line with the median value of ERP adopted by the most part of the EU NRAs – is lower than the majority of the national ERP values computed by NRAs (and their average)[146]. ERPs 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 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. It should be noted that the increased value is attributable only to the last year upgrade of the premium that is the seventh most relevant increase of the Equity premium over bond since 1900 and the second most relevant increase since sixties of the previous century. The impact of including data from Greece is not material (about 0.01 point in reduction).[147]

Bearing in mind that the (inherent) upward bias[148] in the AM is further exacerbated by the BEREC weighting method[149], BEREC does not consider it justified to *solely* show the AM of the EU-wide ERP. Instead of making an arbitrary adjustment or using a combination of AM and GM, BEREC, provides both the AM (the upper boundary) of the EU-wide ERP which is displaying the result of the AM calculation transparently[150] and the GM (the lower boundary). Otherwise, the AM value would be challengeable on the allegation of the (concealed but certain) upward bias.

BEREC considers that the appropriate value of the **single EU-wide ERP** has a value of **5.70%** which is the upper boundary of the margin given by the 4.37% (GM as the lower boundary) and 5.70% (AM). With this BEREC unifies the calculation of the ERP in line with the Notice/SWD, thereby eliminating any methodological differences of NRAs' estimations while

[146] See Regulatory Accounting Report 2021 (BoR (21) 161), WACC chapter, which shows that 14 out of 25 EU NRAs on fixed market, where data is available, estimate an ERP above 5.53%.
[147] This is due to the fact that generally the Equity Risk Premium over Bonds for Greece was negative for most part of the time series.
[148] See above section 6.3.
[149] 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 (2017-2021), which is due to lack of data. The Credit Swiss Yearbook 2022 provides an estimation of 4.2% (AM) for its "Europe Index", which however also includes Switzerland, Norway, Russia and the UK. In order to estimate the size of the upward bias BEREC conducted a sensitivity analysis also including Switzerland, Norway, Russia and the UK in a calculation applying its weighting method to be able to compare the AM value published in the Credit Swiss Yearbook 2022 (4.2% up from 4.0% in 2021) to the EU-ERP AM value estimated by BEREC (5.70%). The result of this estimation is 4.92%, i.e. a difference of +0.71% points compared to 4.2%. So, taking the 4.2% value as the "unbiased" value, the difference of 0.71% points can be considered as an indication of the upward bias. Including this in BEREC's method would provide a hypothetical (unbiased) EU-wide ERP of 4.98% (AM). This shows that albeit the bias exists, it is relatively small and substantially in line with the upward bias estimated in the 2021 BEREC report (0.69% points).
[150] Without adjustments, in order to avoid unnecessary complexity.

NRAs need to take into account the existing factual situation in their respective member states adequately in their decisions by setting the (other) parameters based on the BEREC parameter values. In a first step this implies that national ERPs will converge more when NRAs start applying the EU-wide ERP compared to the current situation[151] with the standard deviation expected to go down considerably. In a second step, WACC values would also converge.

Overall, the WACC methodology as provided for in the Notice and used in the BEREC WACC parameters Report carefully balance consistency, transparency and continuity, i.e. aiming to reflect market realities of 27 EU Member States as well as the convergence towards an EU-wide capital market not yet fully completed. The application of the historical data series for both Bond and Equity index for the ERP estimation provides the best estimate in the long run perspective based on empirical evidence on the Equity premium over bond compared to other methodologies available.

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

7. Summary of Results

7.1. Overview of Results

The following overview table (Table) summarizes all results related to company specific parameters for the BEREC peer group. It has been compiled using the results of Chapters 2 to 6.

[151] As shown in the RA Report 2021 (BoR (21) 161), WACC chapter. Since last year's WACC parameters Report only a limited number of NRAs had fully applied the WACC Notice/BEREC's parameters values, many NRAs were using the one-year transition period.

Table 12 BEREC peer group 2022 – Overview of results for company specific parameters

Peer Group Company	SMP (legacy infrastructure)	Company Credit Rating (S&P)	Country	Country Credit Rating (Moody's)	Debt Premium	RFR (domestic = national) of home country	Cost of Debt (=Debt Premium + RFR)	Equity beta	Gearing	Asset beta
Deutsche Telekom AG	Yes	BBB	DE	AAA	125	-0.09	1.16	0.78	52.69%	0.43
DIGI Communications N.V.	No	BB-	RO	BAA3	260	4.23	683	0.46	66.60%	0.22
Elisa Oyj	Yes	BBB+	FI	AA1	69	0.19	88	0.43	13.28%	0.38
Koninklijke KPN N.V.	Yes	BBB	NL	AAA	117	0.05	122	0.65	38.55%	0.44
NOS	No	BBB-	PT	BAA3	-	1.12	-	0.70	35.39%	0.49
Orange S.A.	Yes	BBB+	FR	AA2	84	0.30	114	0.70	50.58%	0.40
Proximus S.A.	Yes	A	BE	AA3	96	0.30	126	0.53	26.66%	0.41
Tele 2 AB	No	BBB	SE	AAA	142	0.31	173	0.58	22.41%	0.47
Telecom Italia	Yes	BB-	IT	BAA3	133	1.70	303	1.02	70.52%	0.38
Telefónica S.A.	Yes	BBB-	ES	BAA1	41	0.84	125	1.01	58.01%	0.49
Telekom Austria AG	Yes	BBB+	AT	AA1	72	0.20	92	0.68	34.35%	0.48
Telenet Group Holding N.V.	No	BB-	BE	AA3	317	0.30	347	0.62	51.17%	0.35
Telenor	Yes	A-	NO	AAA	100	1.45	245	0.33	29.71%	0.26
Telia Company AB	Yes	BBB+	SE	AAA	139	0.31	170	0.62	36.27%	0.43
Vodafone Group plc	No	BBB	UK	(Aa3)	141	0.91	232	0.90	50.06%	0.50

Table 13 Major EU/Peer Group Operators' Ownership[152]

Country	SMP/Other Operator	Included in Peer Group (directly or indirectly)	Publicly Traded (directly or indirectly)	Major owners
AT	Telekom Austria	Yes	Yes	America Movil 51%, Oesterreichische Beteiligungs AG 28.42%
BE	Proximus	Yes	Yes	Kingdom of Belgium 53.51%, Black Rock Inc 4.80%, Proximus SADP 4.54%
BG	Vivacom prev Bulgarian Telecommunications Company (BTC)	No	No	No longer SMP operator. Owned by American International Group
HR	T-Hrvatski (T-HT)	Yes	Yes	Deutsche Telekom 52.14%, Raiffeisen OMF Kat B 9.23%, WAR Veteran Fund 6.84%
CY	CYTA	No	No	Semi-government organisation
CZ	CETIN	No	No	PPF Group
DK	TDC	No	No	Pension funds: ATP, PFA and PKA, infrastructure fund MIRA.
EE	Telia Eesti	Yes	Yes	Telia Company
FI	DNA Elisa	Yes	Yes	DNA is owned by Telenor. Elisa is owned by institutional owners, of which OP Rahastoyhtio Oy owns 12.76%. The Finnish state owns 10%.

[152] Source: Bloomberg and BEREC survey.

	Telia Finland			Telia Finland is owned by Telia Company.
FR	Orange	Yes	Yes	French Republic 13.39%, BPI France SA 9.56%, Credit Agricole Group 7.76%.
DE	Deutsche Telekom	Yes	Yes	Kreditanstalt fuer Wiederaufbau 16.63%, Federal Republic of Germany 13.83%, SoftBank Group Corp 4.51%
EL	Hellenic Telecommunications Organization (OTE)	Yes	Yes	Deutsche Telekom 48.20%, Hellenic Republic 5.36%, Massachusetts Financial Services Co 5.12%
HU	Magyar Telekom	Yes	Yes	Deutsche Telekom 59,21%
IE	Eircom	No	No	Private consortium controlled by Iliad SA and NJJ Telecom Europe fund
IT	Telecom Italia	Yes	Yes	Vivendi 23.75%, Cassa Depositi e Prestiti SpA 9.81%, Black Rock Inc 4.74%.
LV	Lattelecom	Yes	YES	Latvian Government 51% and Telia Company 49%
LT	Telia Lietuva AB	Yes	Yes	Telia Company 88.15%
LU	Entreprise des Postes et Télécommunications (Post Luxembourg)	No	No	Luxembourg state
MT	Go	No	Yes	Institutional owners
NL	Koninklijke KPN	Yes	Yes	America Movil 20.38%, Capital Group Cos 12.00%, BlackRock Inc 4.24%.
NO	Telenor	Yes	Yes	Norway Ministry of Trade Industry & Fisheries 53.97%, Folketrygdfondet 4.55%, JP Morgan Chase & Co 3.51%

PL	Orange Polska/Telekomunikacja Polska/Polish Telekom (TPSA)	Yes	Yes	Orange SA 50.67%, Aviva PLC 4.86%, Nationale-Nederlanden OFE 4.30%
PT	MEO NOS	Yes	Yes	MEO is SMP. It is not listed owned by Altice which is privately owned. NOS is not SMP, owned by Zopt SGPS SA 52.15%, Sonae SGPS SA 7.38%, Emirate of Abu Dhabi United Arab Emirates 5.00%
RO	Orange Romania Communications SA RCS & RDS	Yes	Yes	Orange 54%, Romanian State 46% Digi Communications N.V., and institutional owners
SK	Slovak Telekom	Yes	Yes	Deutsche Telekom 100%
SI	Telekom Slovenije	No	Yes	Republic of Slovenia 62.54%, Kapitalska Družba Pokojninskega in Invalidskega 5.59%, Slovenian Sovereign Holding 4.29%, Norges Bank 2.69%
ES	Telefonica	Yes	Yes	Institutional owners, Black Rock 5.15%, Bank Bilbao Vizcaya Argentaria SA 5.11%
SE	Telia	Yes	Yes	Kingdom of Sweden 39.50%, Black Rock Inc 3.00%, Swedbank AB 2.55%.

The result for the ERP is as follows. Based on the calculations described in Chapter 6 (and shown in Table 10) above BEREC considers that the appropriate value of the single EU-wide ERP is **5.70%** (AM) and the single EU/EEA-wide ERP relevant only for the EEA countries Norway and Iceland is 5.69% (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 (SPF) is 2.1 % (as of Q2/2022).[153]

Market participants are currently concerned about rising inflation, which has been strongly influenced by the after-effects of the Covid crisis with a strong uptake of economic activity and the still ongoing war in the Ukraine. While the ECB has revised their short and medium-term inflation expectations upwards, their longer-term forecast shows a relatively moderate increase:

> *„SPF respondents revised up their inflation expectations for 2022 and 2023. These stand at 6.0 % and 2.4 % respectively, higher by 3.0 and 0.6 percentage points compared with the previous survey. Regarding the near-term outlook, respondents cited the war in Ukraine and the sharp increases in energy and food commodity prices as the main factors behind their upward revision to the 2022 and 2023 inflation forecasts. For the shorter and medium-term horizons, quantitative indicators of uncertainty surrounding the inflation outlook remained elevated and those for the balance of risks were on the upside. Longer-term inflation expectations (for 2026) averaged 2.1 %, a further upward revision from 2.0 % in the previous round".* [154]

7.3. Comparison to last year's Report

The 2022 WACC parameters Report is the third BEREC Report, therefore high level comparisons can be made between the 2022 and the 2021 Reports. The WACC methodology as provided for in the Notice and the BEREC WACC parameters Report carefully balance consistency, transparency and continuity, i.e. aiming to reflect market realities of 27 EU Member States as well as the convergence towards an EU-wide capital market. The latter is accounted for by estimating an **EU-ERP** using the CAPM. The CAPM assumes a rational investor acting in an efficient capital market which is the state of the art approach to estimate the cost of equity (as a fair reward for taking the risk to invest) and thus provides *objective* results of expected returns based on the comprehensive historic data series.

[153] www.ecb.europa.eu / HICP inflation forecasts
[154] www.ecb.europa.eu / Statistics / ECB Surveys / Survey of professional forecasters

First, this year's Report uses the same methodology[155] as last year's Report, so the difference in parameter values is attributable to factual developments. The results based on the application of the methodology of the WACC Notice reflect the fundamental factors driving the cost of capital. As shown above, the increase from 5.50% (AM last year) to 5.70% this year can be explained with the generally observed considerable uptake of the premium (seventh most relevant increase of the Equity premium over bond since 1900) that is attributable to the "shift from conditions that have proved so supportive for financial assets in the world since the Global Financial Crisis to a potentially less benign backdrop"[156].

Second, as the BEREC peer group the EU/EEA area is considered as a whole, no distinction needed to be made when the eligibility criteria are fulfilled, thus Telenor was included in 2021. In 2022 DIGI Communications was added as it fulfills the eligibility criteria for the first time.

Another important point to highlight is the continued effort undertaken by BEREC to incorporate the longer time series available for non-DMS countries for the calculation of the EU-wide ERP and the fact that with Bloomberg a single data source could be used, which improves the robustness of the results. Generally, relying on long(er) time series of historical returns (such as the DMS data now including also Greek data) is evidence based and contributes to the reliability of the results as short term volatilities are reduced. The application of the historical data series for both Bond and Equity index for the ERP estimation provides the best estimate in the long run perspective based on empirical evidence on the Equity premium over bond compared to other methodologies available.

This approach is in line with the objectives of the WACC Commission Notice: i) to improve consistency in the methodology; ii) to enhance regulatory predictability by limiting unexpected variations in the methodology and the value over time; iii) to promote efficient investment and innovation by setting rates reflecting the appropriate level of risk; iv) to provide more transparency to all stakeholders on the way the calculations are done.

Comparison with values reported in previous reports BoR (20) 116 and BoR (21) 86 are given.

[155]With the technical adjustment described in section 4.4.

[156] Credit Suisee 2022 Yearbook Summary, p. 4, https://www.credit-suisse.com/ch/en/about-us/research/research-institute.html

Annex

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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
Credit Suisse Yearbook	Credit Suisse Global Investment Returns Yearbook 2022

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
NOK	Norwegian crowns
Notice	Commission Notice on the calculation of t. cost of capital of 6th 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
RON	Romanian lei

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[157]

	2017-04	2017-05	2017-06	2017-07	2017-08	2017-09	2017-10	2017-11	2017-12	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	2020-04	2020-05	2020-06	2020-07	2020-08	2020-09	2020-10	2020-11	2020-12	2021-01	2021-02	2021-03	2021-04	2021-05	2021-06	2021-07	2021-08	2021-09	2021-10	2021-11	2021-12	2022-01	2022-02	2022-03	5 Y Avg.
Austria	0,49	0,65	0,55	0,73	0,61	0,59	0,61	0,51	0,5	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	0,05	-0,1	-0,13	-0,25	-0,28	-0,32	-0,4	-0,41	-0,42	-0,49	-0,2	-0,09	-0,04	0,08	0,02	-0,13	-0,23	-0,08	0,08	-0,01	-0,05	0,18	0,54	0,72	0,20
Belgium	0,78	0,77	0,62	0,83	0,73	0,7	0,69	0,58	0,53	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	0,14	0,04	-0,04	-0,17	-0,21	-0,25	-0,34	-0,38	-0,39	-0,36	-0,21	-0,04	0,04	0,18	0,12	-0,03	-0,14	0,01	0,16	0,07	0,03	0,26	0,59	0,79	0,30
Bulgaria	1,78	1,74	1,7	1,65	1,7	1,66	1,4	1,33	1,02	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	0,2	0,2	0,68	0,5	0,26	0,2	0,2	0,2	0,19	0,19	0,15	0,14	0,14	0,14	0,14	0,14	0,14	0,15	0,25	0,25	0,44	0,57	0,61	1,09	0,62
Croatia	2,98	3,01	2,83	2,78	2,87	2,71	2,66	2,65	2,47	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	1,24	0,91	0,96	0,97	0,85	0,79	0,78	0,73	0,63	0,59	0,52	0,51	0,5	0,5	0,49	0,45	0,43	0,37	0,32	0,32	0,38	0,7	1,23	2,08	1,43
Cyprus	3,23	3,03	2,84	2,57	2,49	2,2	1,84	1,54	1,58	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	1,87	1,69	1,05	0,95	0,89	0,72	0,44	0,29	0,19	0,21	0,3	0,39	0,41	0,54	0,36	0,25	0,15	0,23	0,39	0,55	0,64	0,86	1,59	1,92	1,33
Czechia	0,96	0,74	0,77	0,9	0,83	0,97	1,45	1,68	1,5	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	1,28	0,92	0,86	0,86	0,95	0,98	0,94	1,12	1,26	1,28	1,49	1,87	1,86	1,74	1,67	1,72	1,74	1,9	2,34	2,62	2,62	3,12	3,03	3,53	1,64
Denmark	0,55	0,64	0,53	0,67	0,55	0,51	0,53	0,44	0,41	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	-0,21	-0,29	-0,26	-0,34	-0,36	-0,39	-0,46	-0,46	-0,47	-0,44	-0,28	-0,03	0,	0,11	0,11	-0,05	-0,16	-0,01	0,1	0,01	-0,08	0,11	0,46	0,57	0,07
Estonia	0,48	0,37	0,39	0,45	0,42	0,49	0,73	0,84	0,75	0,89	0,91	0,91	0,87	0,95	1,07	1,06	1,07	1,07	1,07	1,04	1,01	0,93	0,88	0,91	0,91	0,93	0,79	0,68	0,50	0,62	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,14	0,05	0,00	0,01	-0,08	-0,14	-0,18	-0,19	-0,11	0,05	0,09	0,16	0,13	0,09	0,02	0,03	0,18	0,20	0,11	0,31	0,79	1,20	0,45
Finland	0,38	0,49	0,56	0,76	0,65	0,58	0,6	0,52	0,51	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	0,03	-0,12	-0,18	-0,21	-0,25	-0,3	-0,38	-0,4	-0,41	-0,38	-0,22	-0,13	-0,08	0,05	-0,02	-0,1	-0,21	-0,07	0,08	0,	-0,06	0,18	0,51	0,72	0,19
France	0,88	0,81	0,66	0,84	0,71	0,7	0,81	0,72	0,67	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	0,06	-0,03	-0,04	-0,15	-0,17	-0,21	-0,3	-0,33	-0,34	-0,31	-0,15	-0,07	-0,01	0,21	0,15	-0,01	-0,11	0,04	0,2	0,09	0,05	0,31	0,68	0,78	0,30
Germany	0,22	0,34	0,25	0,46	0,35	0,35	0,37	0,31	0,3	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	-0,45	-0,52	-0,43	-0,52	-0,52	-0,52	-0,61	-0,61	-0,62	-0,58	-0,45	-0,36	-0,33	-0,22	-0,29	-0,45	-0,54	-0,36	-0,21	-0,31	-0,38	-0,12	0,15	0,28	-0,09
Greece	6,7	5,86	5,76	5,33	5,55	5,56	5,59	5,22	4,44	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	2,05	1,93	1,32	1,14	1,08	1,08	0,9	0,75	0,63	0,65	0,81	0,91	0,88	0,99	0,81	0,7	0,59	0,8	0,96	1,22	1,29	1,62	2,46	2,61	2,73
Hungary	3,28	3,1	2,99	3,1	3,05	2,76	2,57	2,23	2,07	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	2,49	1,99	2,18	2,23	2,18	2,39	2,27	2,15	2,15	2,22	2,43	2,68	2,69	2,94	2,85	2,83	2,84	3,09	3,69	4,07	4,4	4,71	4,86	5,92	2,84
Ireland	0,91	0,83	0,7	0,87	0,73	0,7	0,66	0,58	0,54	0,91	1,13	1,01	0,94	0,98	0,92	0,83	0,86	0,93	1,01	0,98	0,91	0,94	0,86	0,67	0,56	0,5	0,27	0,13	-0,05	-0,01	0,02	0,07	0,04	0,	-0,13	0,07	0,2	0,11	0,08	-0,05	-0,12	-0,13	-0,22	-0,25	-0,29	-0,24	-0,06	0,03	0,08	0,24	0,18	0,03	-0,08	0,07	0,22	0,19	0,1	0,38	0,78	0,93	0,40
Italy	2,26	2,19	2,05	2,23	2,11	2,11	2,07	1,79	1,8	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	1,8	1,76	1,46	1,2	1,03	0,98	0,77	0,66	0,58	0,62	0,59	0,7	0,8	0,98	0,88	0,75	0,63	0,78	0,96	1,01	1,05	1,35	1,79	1,85	1,70
Latvia	0,92	0,88	0,85	0,98	0,85	0,72	0,71	0,69	0,59	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	0,3	0,26	0,01	-0,17	-0,19	-0,2	-0,23	-0,25	-0,29	-0,29	-0,25	-0,2	-0,21	-0,06	0,14	0,09	0,	0,02	0,17	0,26	0,3	0,38	0,79	1,2	0,40
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	0,31	0,31	0,31	0,31	0,31	0,31	0,31	0,31	0,31	0,31	0,31	0,17	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,16	0,26
Luxembourg	0,49	0,57	0,52	0,69	0,57	0,55	0,57	0,5	0,49	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	-0,25	-0,32	-0,34	-0,43	-0,45	-0,5	-0,54	-0,54	-0,55	-0,54	-0,45	-0,4	-0,38	-0,31	-0,33	-0,4	-0,47	-0,37	-0,2	-0,21	-0,22	-0,04	0,4	0,55	0,03
Malta	1,43	1,37	1,25	1,36	1,23	1,26	1,24	1,13	1,07	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	0,57	0,7	0,76	0,64	0,54	0,51	0,38	0,37	0,27	0,32	0,41	0,4	0,44	0,53	0,5	0,49	0,44	0,57	0,67	0,64	0,59	0,8	1,21	1,26	0,85
Netherlands	0,5	0,59	0,5	0,69	0,54	0,53	0,54	0,47	0,45	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	-0,22	-0,31	-0,29	-0,39	-0,41	-0,44	-0,53	-0,54	-0,55	-0,53	-0,39	-0,33	-0,3	-0,19	-0,24	-0,38	-0,48	-0,34	-0,18	-0,27	-0,32	-0,1	0,24	0,34	0,05
Poland	3,42	3,35	3,19	3,3	3,33	3,26	3,38	3,39	3,27	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	1,46	1,35	1,31	1,33	1,32	1,35	1,26	1,2	1,29	1,19	1,31	1,53	1,55	1,82	1,78	1,61	1,6	1,87	2,63	3,12	3,35	4,	3,95	4,83	2,51
Portugal	3,77	3,29	2,97	3,03	2,83	2,63	2,32	1,98	1,83	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	0,97	0,81	0,53	0,4	0,36	0,32	0,18	0,07	0,03	0,03	0,16	0,23	0,35	0,53	0,43	0,27	0,14	0,26	0,39	0,39	0,36	0,58	1,06	1,16	1,12
Romania	3,79	3,75	3,67	3,84	3,86	3,89	4,17	4,43	4,4	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	4,83	4,54	3,89	3,94	3,88	3,49	3,29	3,04	2,94	2,72	2,65	2,96	2,84	3,03	3,11	3,24	3,72	4,	4,75	5,11	5,37	5,37	5,6	6,2	4,23
Slovakia	1,06	1	0,86	0,93	1	0,82	0,83	1	0,67	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	1	0,56	0,04	-0,16	-0,22	0	-0,35	-0,39	-0,52	-0,43	-0,18	-0,05	-0,06	0,07	0,03	-0,14	-0,25	-0,08	0,13	0,02	-0,02	0,25	0,71	0,99	0,37
Slovenia	1,	0,98	0,86	1,15	1,09	0,98	0,97	0,81	0,69	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	0,27	0,74	0,42	0,09	-0,1	-0,08	-0,13	-0,18	-0,23	-0,17	0,02	0,03	0,02	0,21	0,15	0,14	-0,09	0,05	0,17	0,15	0,17	0,4	0,7	1,04	0,45
Spain	1,61	1,57	1,45	1,6	1,48	1,54	1,61	1,49	1,44	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	0,82	0,74	0,51	0,37	0,29	0,27	0,17	0,09	0,04	0,08	0,23	0,31	0,37	0,52	0,45	0,33	0,21	0,33	0,47	0,47	0,41	0,66	1,11	1,22	0,84
Sweden	0,57	0,56	0,46	0,66	0,63	0,62	0,83	0,76	0,72	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	-0,07	-0,06	0,01	-0,07	-0,04	-0,08	-0,03	0,	0,01	0,07	0,25	0,4	0,37	0,42	0,36	0,18	0,11	0,27	0,38	0,27	0,14	0,36	0,61	0,82	0,31
UK	1,	1,03	0,98	1,25	1,1	1,21	1,35	1,28	1,22	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	0,31	0,22	0,23	0,15	0,21	0,21	0,24	0,31	0,26	0,28	0,56	0,78	0,78	0,82	0,76	0,62	0,57	0,81	1,1	0,93	0,83	1,17	1,45	1,51	0,91
Iceland	4,85	4,67	4,59	4,75	4,9	5,14	4,85	4,75	4,85	5,17	5,11	5,24	5,18	5,22	5,24	4,92	4,92	5,88	6,11	5,93	5,44	5,18	5,29	4,65	4,15	4,22	3,9	3,84	3,61	3,48	3,36	3,69	3,5	3,18	2,88	2,6	2,35	2,25	2,53	2,53	2,61	2,69	3,01	3,12	3,18	3,4	3,61	3,49	3,76	3,74	3,51	3,45	3,58	3,9	4,03	3,95	4,07	4,47	4,54	5,13	4,14
Norway	1,61	1,49	1,63	1,65	1,52	1,58	1,60	1,49	1,58	1,80	1,93	1,84	1,85	1,66	1,76	1,87	1,74	1,92	1,93	1,80	1,75	1,70	1,72	1,53	1,68	1,56	1,46	1,36	1,13	1,23	1,36	1,38	1,55	1,31	1,11	0,87	0,62	0,58	0,61	0,55	0,79	0,61	0,68	0,83	0,94	1,03	0,00	1,52	1,49	1,52	1,36	1,18	1,27	1,58	1,68	1,48	1,70	1,96	2,05	2,55	1,43

[157] 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. Data Source: Eurostat. Data for Estonia, Iceland and Norway are derived by BEREC. Data for Estonia has only become available via Eurostat from June 2006, the previous years to be included for determining the 5 year average have been derived by BEREC. For Norway, the curve in five years is derived from 5 benchmark bonds (NGB 1 3/4 02/17/27, NGB 2 04/26/28, NGB 1 3/4 09/06/29, NGB 1 3/8 08/19/30, NGB 1 1/4 09/17/31); for Iceland from three benchmark bonds (ICEGB 8 06/12/25, ICEGB 5 11/15/28, ICEGB 6 01/24/31). The choice of bonds to be included has been provided by Bloomberg. Over time, Bloomberg modifies benchmark bonds to overcome the maturity drift over ten years, whenever better benchmarks become available. UK is only included for the purpose of determining the RFR for Vodafone in the cost of debt calculation.

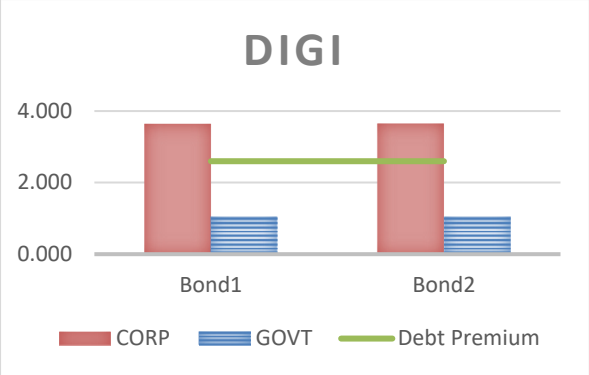
Annex 2: Debt premium and cost of debt

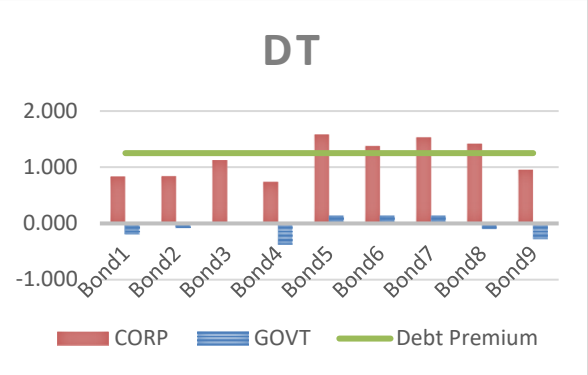
Deutsche Telekom	Issued	Currency	Government bond	Issued	Currency
DT 1 1/2 04/03/28	23/03/2016	EUR	DBR 5 5/8 01/04/28	23/01/1998	EUR
DT 2 12/01/29	01/06/2018	EUR	DBR 6 1/4 01/04/30	21/01/2000	EUR
DT 4 1/2 10/28/30	28/10/2010	EUR	DBR 5 1/2 01/04/31	27/10/2000	EUR
DT 1 3/4 03/25/31	25/03/2019	EUR	DBR 5 1/2 01/04/31	27/10/2000	EUR
DT 3.55 01/17/33	14/01/2013	EUR	DBR 4 3/4 07/04/34	31/01/2003	EUR
DT 7 1/2 01/24/33	24/01/2003	EUR	DBR 4 3/4 07/04/34	31/01/2003	EUR
DT 3.55 02/11/33	11/02/2013	EUR	DBR 4 3/4 07/04/34	31/01/2003	EUR
DT 2.2 07/25/33	25/07/2018	EUR	DBR 4 3/4 07/04/34	31/01/2003	EUR
DT 1 3/8 07/05/34	05/07/2019	EUR	DBR 4 3/4 07/04/34	31/01/2003	EUR
DIGI	**Issued**	**Currency**	**Government bond**	**Issued**	**Currency**
RCSRDS 3 1/4 02/05/28 Corp (ZP7074161 Corp)	27/01/2020	EUR	ITALY 1.862 02/02/28	26/01/2015	EUR
RCSRDS 3 1/4 02/05/28 Corp (ZP7074153 Corp)	27/01/2020	EUR	ITALY 1.862 02/02/28	26/01/2015	EUR
Elisa	**Issued**	**Currency**	**Government bond**	**Issued**	**Currency**
ELIAV 0 1/4 09/15/27	15/09/2020	EUR	RFGB 0 1/2 09/15/27	06/09/2017	EUR
KPN	**Issued**	**Currency**	**Government bond**	**Issued**	**Currency**
KPN 1 1/8 09/11/28	09/09/2016	EUR	NETHER 5 1/2 01/15/28	15/01/1998	EUR
KPN 0 7/8 12/14/32	14/09/2020	EUR	NETHER 2 1/2 01/15/33	09/03/2012	EUR
KPN 0 7/8 11/15/33	04/11/2021	EUR	NETHER 2 1/2 01/15/33	09/03/2012	EUR
Orange	**Issued**	**Currency**	**Government bond**	**Issued**	**Currency**
ORAFP 3.22 04/11/28	11/04/2013	EUR	FRTR 2 3/4 10/25/27	11/09/2012	EUR
ORAFP 2 01/15/29	15/01/2019	EUR	FRTR 0 3/4 11/25/28	11/06/2018	EUR
ORAFP 3.3 04/11/29	11/04/2013	EUR	FRTR 5 1/2 04/25/29	12/03/1998	EUR

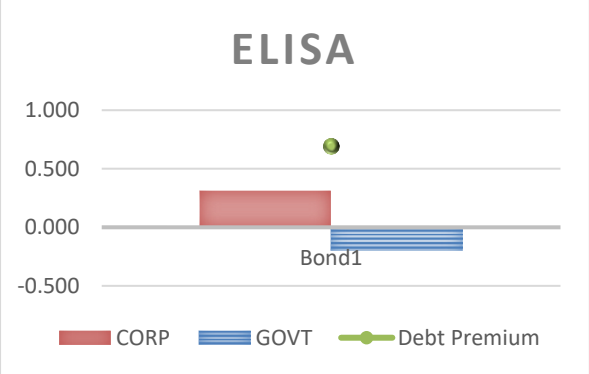
ORAFP 0 1/8 09/16/29	16/09/2020	EUR	FRTR 0 11/25/29	07/10/2019	EUR
ORAFP 1 3/8 01/16/30	16/01/2018	EUR	FRTR 2 1/2 05/25/30	06/05/2014	EUR
ORAFP 1 7/8 09/12/30	12/09/2018	EUR	FRTR 2 1/2 05/25/30	06/05/2014	EUR
ORAFP 2.6 09/17/30	17/09/2015	EUR	FRTR 2 1/2 05/25/30	06/05/2014	EUR
ORAFP 1.342 05/29/31	29/05/2019	EUR	FRTR 1 1/2 05/25/31	05/10/2015	EUR
ORAFP 1 5/8 04/07/32	07/04/2020	EUR	FRTR 5 3/4 10/25/32	12/06/2001	EUR
ORAFP 0 1/2 09/04/32	04/09/2019	EUR	FRTR 5 3/4 10/25/32	12/06/2001	EUR
ORAFP 8 1/8 01/28/33	28/01/2003	EUR	FRTR 5 3/4 10/25/32	12/06/2001	EUR
ORAFP 3 3/4 09/30/33	30/09/2013	EUR	FRTR 5 3/4 10/25/32	12/06/2001	EUR
ORAFP 0 5/8 12/16/33	07/12/2021	EUR	FRTR 1 1/4 05/25/34	05/02/2018	EUR
ORAFP 0 3/4 06/29/34	23/06/2021	EUR	FRTR 1 1/4 05/25/34	05/02/2018	EUR
ORAFP 1.2 07/11/34	11/07/2019	EUR	FRTR 1 1/4 05/25/34	05/02/2018	EUR
Proximus	**Issued**	**Currency**	**Government bond**	**Issued**	**Currency**
PROXBB 1 3/4 09/08/31	08/03/2019	EUR	BGB 1 06/22/31	17/02/2015	EUR
PROXBB 0 3/4 11/17/36	08/11/2021	EUR	BGB 1.45 06/22/37	23/05/2017	EUR
Tele2	**Issued**	**Currency**	**Government bond**	**Issued**	**Currency**
TELBSS 2 1/8 05/15/28	15/11/2018	EUR	DBR 4 3/4 07/04/28	09/10/1998	EUR
TELBSS 0 3/4 03/23/31	16/03/2021	EUR	DBR 0 02/15/31	06/01/2021	EUR
Telecom Italia	**Issued**	**Currency**	**Government bond**	**Issued**	**Currency**
TITIM 1 5/8 01/18/29	18/01/2021	EUR	ITALY 1.771 03/05/29	05/03/2015	EUR
TITIM 7 3/4 01/24/33	24/01/2003	EUR	ITALY 2 09/05/32	05/03/2015	EUR
Telefonica	**Issued**	**Currency**	**Government bond**	**Issued**	**Currency**
TELEFO 2.318 10/17/28	17/01/2017	EUR	SPGB 5.15 10/31/28	16/07/2013	EUR
TELEFO 1.788 03/12/29	12/03/2019	EUR	SPGB 6 01/31/29	15/01/1998	EUR
TELEFO 2.932 10/17/29	17/10/2014	EUR	SPGB 1.95 07/30/30	04/03/2015	EUR
TELEFO 0.664 02/03/30	03/02/2020	EUR	SPGB 0 1/2 04/30/30	21/01/2020	EUR
TELEFO 1.93 10/17/31	17/10/2016	EUR	SPGB 5 3/4 07/30/32	23/01/2001	EUR

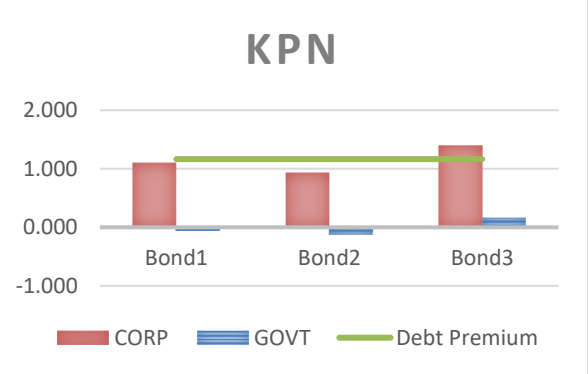
TELEFO 1.807 05/21/32	21/05/2020	EUR	SPGB 5 3/4 07/30/32	23/01/2001	EUR
TELEFO 5 7/8 02/14/33	14/02/2003	EUR	SPGB 5 3/4 07/30/32	23/01/2001	EUR
Telekom Austria	**Issued**	**Currency**	**Government bond**	**Issued**	**Currency**
TKAAV 1 1/2 12/07/26	07/12/2016	EUR	RAGB 0 3/4 10/20/26	23/02/2016	EUR
Telenet	**Issued**	**Currency**	**Government bond**	**Issued**	**Currency**
TNETBB 3 1/2 03/01/28 (AQ232269 Corp)	13/12/2017	EUR	BGB 5 1/2 03/28/28	26/02/1998	EUR
TNETBB 3 1/2 03/01/28 (AQ232276 Corp)	13/12/2017	EUR	BGB 5 1/2 03/28/28	26/02/1998	EUR
Telenor	**Issued**	**Currency**	**Government bond**	**Issued**	**Currency**
TELNO 1 1/8 05/31/29	31/05/2019	EUR	DBR 0 08/15/29	12/07/2019	EUR
TELNO 0 5/8 09/25/31	25/09/2019	EUR	DBR 5 1/2 01/04/31	27/10/2000	EUR
TELNO 1 3/4 05/31/34	31/05/2019	EUR	DBR 4 3/4 07/04/34	31/01/2003	EUR
TELNO 0 7/8 02/14/35	14/02/2020	EUR	DBR 0 05/15/35	13/05/2020	EUR
Telia	**Issued**	**Currency**	**Government bond**	**Issued**	**Currency**
TELIAS 0 1/8 11/27/30	27/11/2020	EUR	DBR 5 1/2 01/04/31	27/10/2000	EUR
TELIAS 5.135 04/01/31	01/04/2011	EUR	DBR 5 1/2 01/04/31	27/10/2000	EUR
TELIAS 5.03 07/01/31	01/07/2011	EUR	DBR 5 1/2 01/04/31	27/10/2000	EUR
TELIAS 3 1/2 09/05/33	05/09/2013	EUR	DBR 4 3/4 07/04/34	31/01/2003	EUR
TELIAS 2 1/8 02/20/34	20/02/2019	EUR	DBR 4 3/4 07/04/34	31/01/2003	EUR
TELIAS 1 5/8 02/23/35	23/02/2015	EUR	DBR 4 3/4 07/04/34	31/01/2003	EUR
Vodafone	**Issued**	**Currency**	**Government bond**	**Issued**	**Currency**
VOD 5.9 11/26/32	26/11/2002	GBP	UKT 4 1/4 06/07/32	25/05/2000	GBP

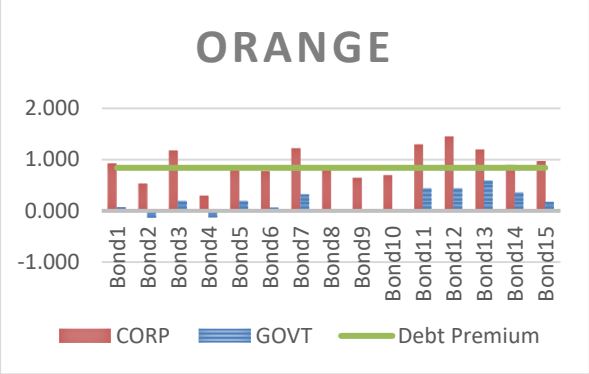
The following figures show for each operator the yields of the pairs of corporate and government bonds that have been used and the resulting premium debt.

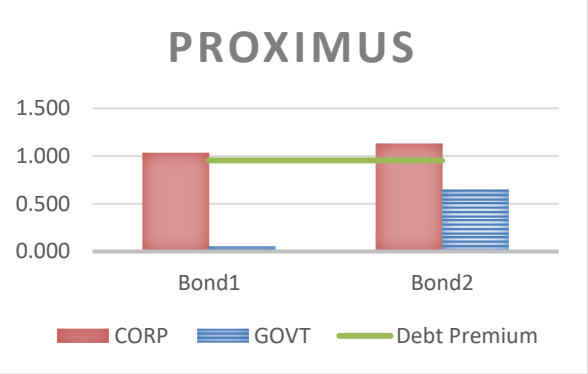

DIGI
4.000
2.000
0.000
Bond1
Bond2
CORP
GOVT
Debt Premium

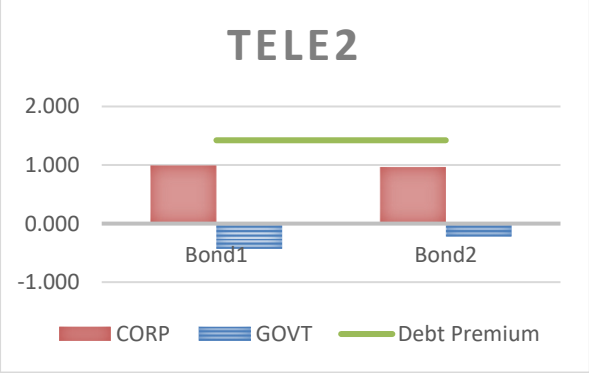

DT
2.000
1.000
0.000
-1.000
Bond1
Bond2
Bond3
Bond4
Bond5
Bond6
Bond7
Bond8
Bond9
CORP
GOVT
Debt Premium

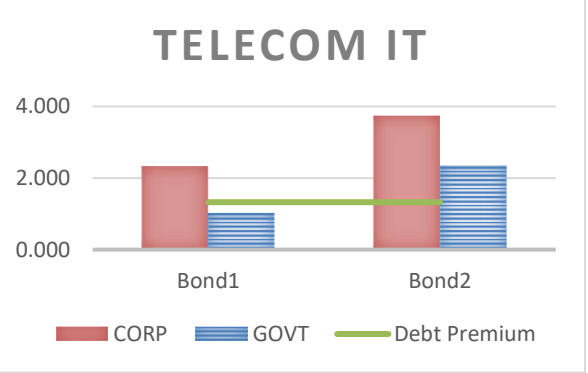

ELISA
1.000
0.500
0.000
-0.500
Bond1
CORP
GOVT
Debt Premium

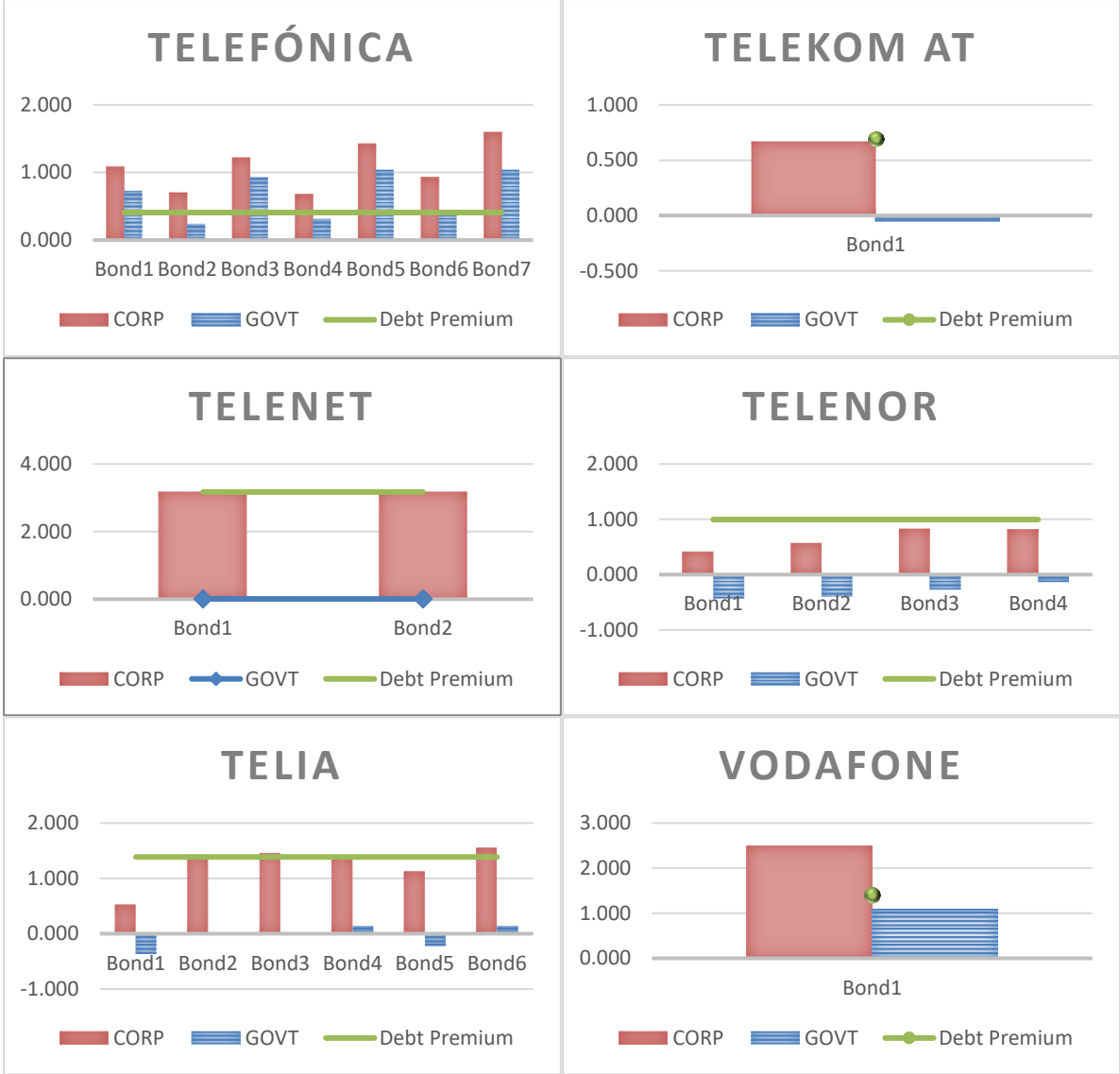

KPN
2.000
1.000
0.000
-1.000
Bond1
Bond2
Bond3
CORP
GOVT
Debt Premium


ORANGE
2.000
1.000
0.000
-1.000
Bond1
Bond2
Bond3
Bond4
Bond5
Bond6
Bond7
Bond8
Bond9
Bond10
Bond11
Bond12
Bond13
Bond14
Bond15
CORP
GOVT
Debt Premium

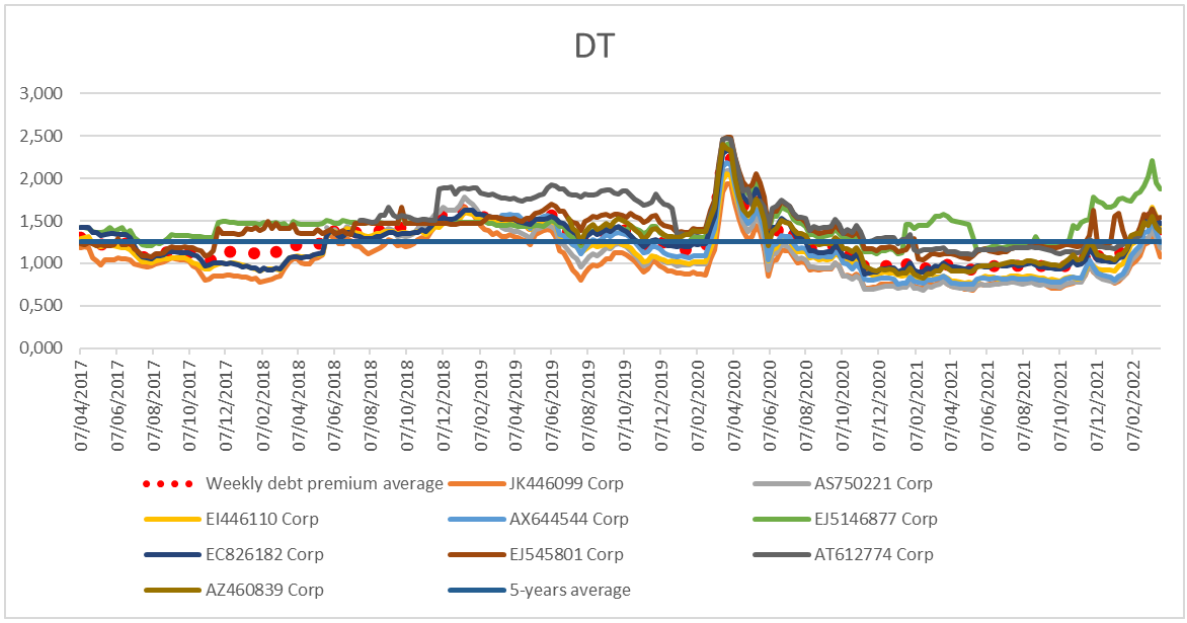

PROXIMUS
1.500
1.000
0.500
0.000
Bond1
Bond2
CORP
GOVT
Debt Premium

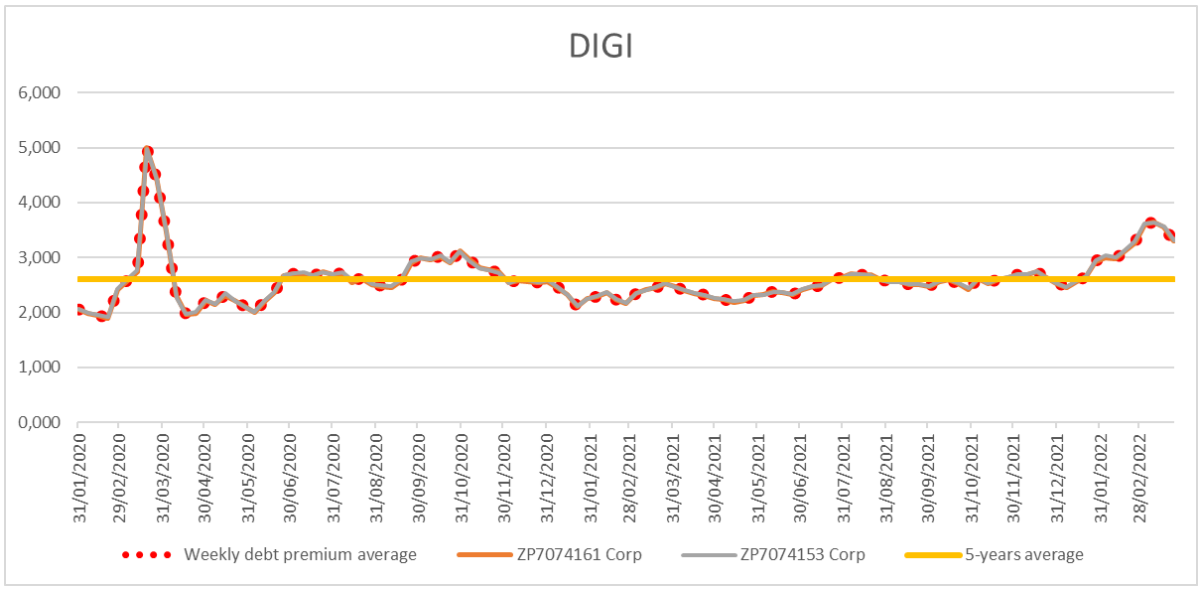

TELE2
2.000
1.000
0.000
-1.000
Bond1
Bond2
CORP
GOVT
Debt Premium

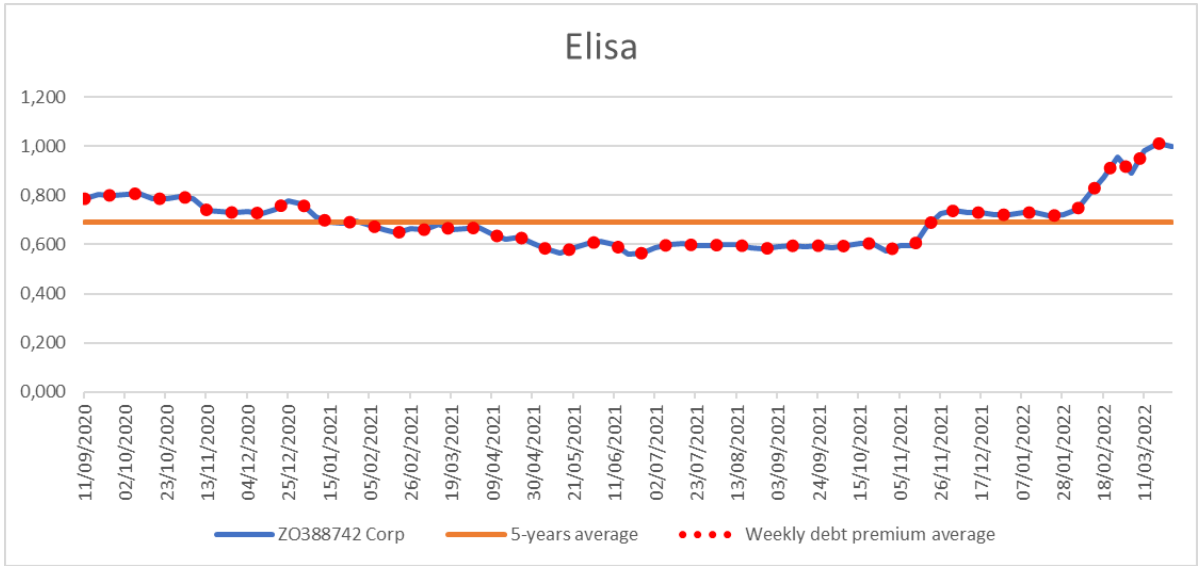

TELECOM IT
4.000
2.000
0.000
Bond1
Bond2
CORP
GOVT
Debt Premium

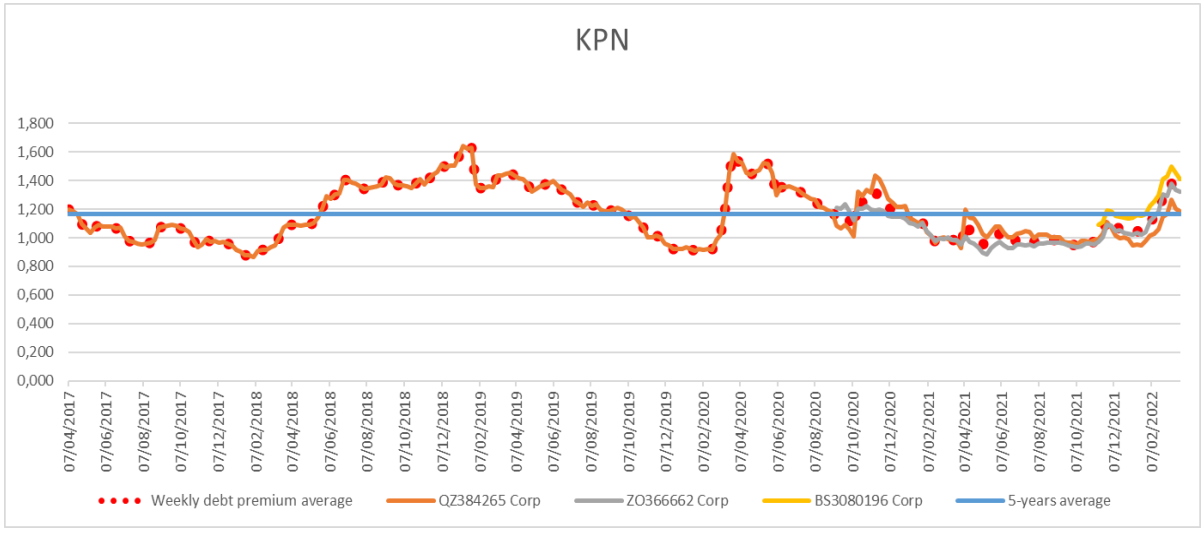


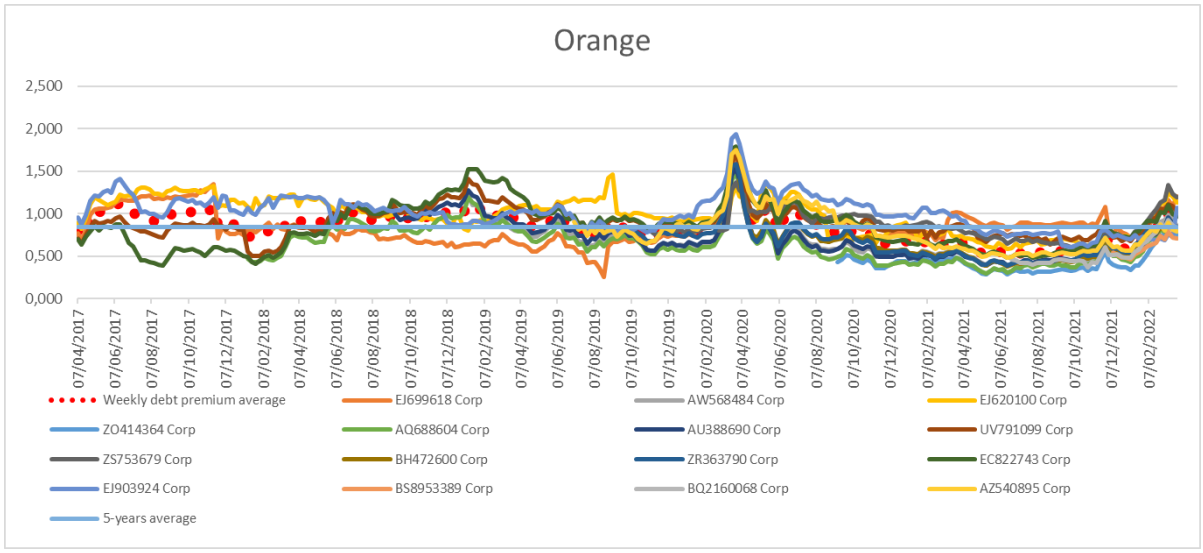
In addition, a graph for each company with the evolution during the 5-years averaging window of the debt premium of their different pairs of bonds are attached:

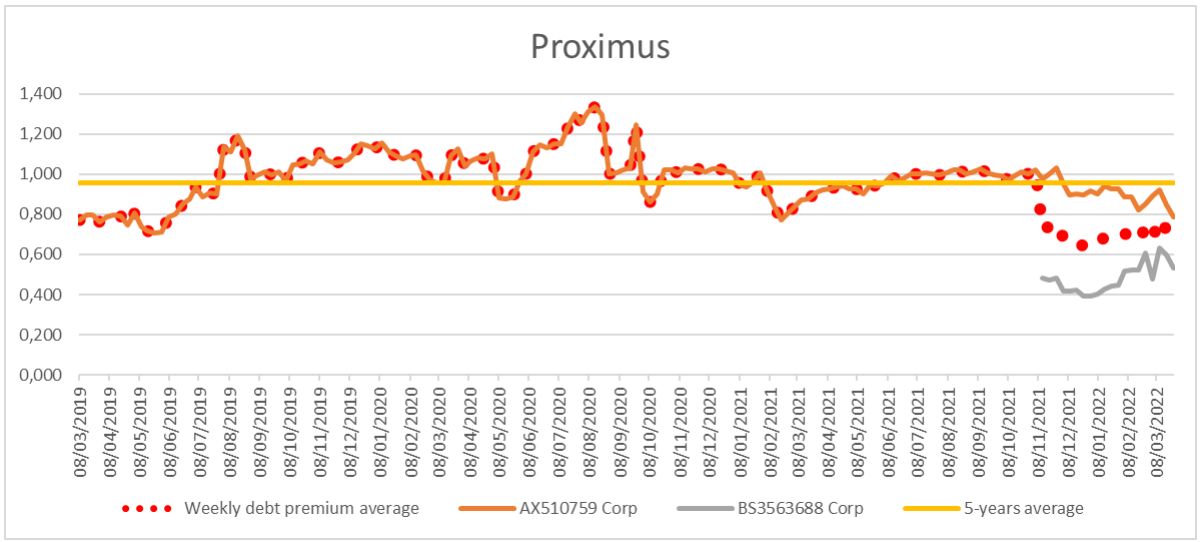

DT
3,000
2,500
2,000
1,500
1,000
0,500
0,000
07/04/2017
07/06/2017
07/08/2017
07/10/2017
07/12/2017
07/02/2018
07/04/2018
07/06/2018
07/08/2018
07/10/2018
07/12/2018
07/02/2019
07/04/2019
07/06/2019
07/08/2019
07/10/2019
07/12/2019
07/02/2020
07/04/2020
07/06/2020
07/08/2020
07/10/2020
07/12/2020
07/02/2021
07/04/2021
07/06/2021
07/08/2021
07/10/2021
07/12/2021
07/02/2022
Weekly debt premium average
JK446099 Corp
AS750221 Corp
EI446110 Corp
AX644544 Corp
EJ5146877 Corp
EC826182 Corp
EJ545801 Corp
AT612774 Corp
AZ460839 Corp
5-years average

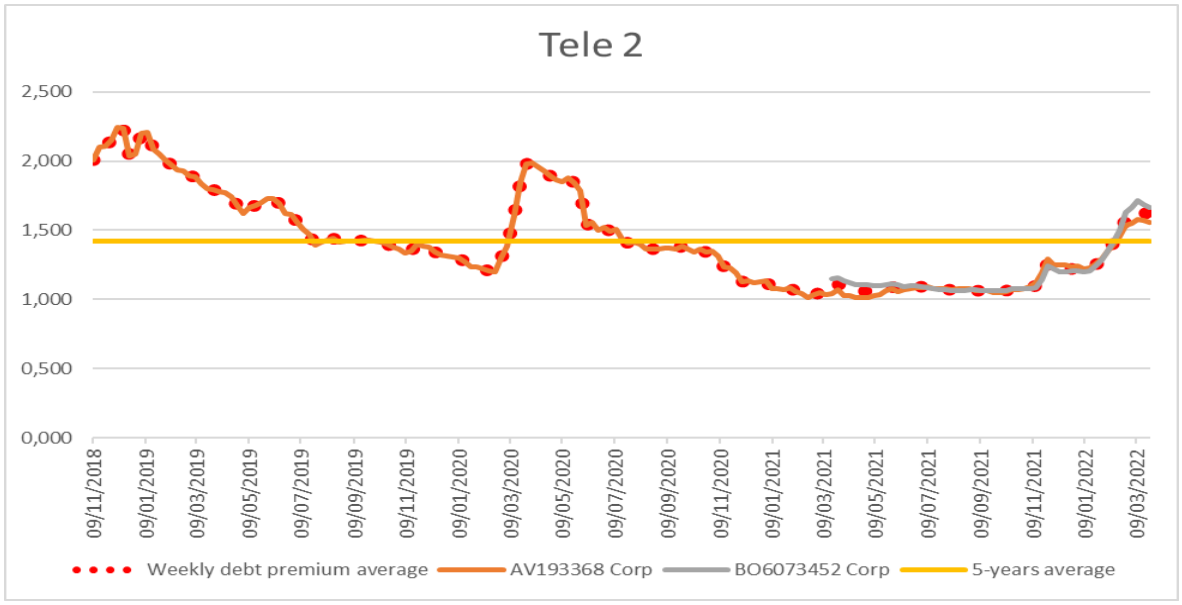

DIGI
6,000
5,000
4,000
3,000
2,000
1,000
0,000
31/01/2020
29/02/2020
31/03/2020
30/04/2020
31/05/2020
30/06/2020
31/07/2020
31/08/2020
30/09/2020
31/10/2020
30/11/2020
31/12/2020
31/01/2021
28/02/2021
31/03/2021
30/04/2021
31/05/2021
30/06/2021
31/07/2021
31/08/2021
30/09/2021
31/10/2021
30/11/2021
31/12/2021
31/01/2022
28/02/2022
Weekly debt premium average
ZP7074161 Corp
ZP7074153 Corp
5-years average


Elisa
1,200
1,000
0,800
0,600
0,400
0,200
0,000
11/09/2020
02/10/2020
23/10/2020
13/11/2020
04/12/2020
25/12/2020
15/01/2021
05/02/2021
26/02/2021
19/03/2021
09/04/2021
30/04/2021
21/05/2021
11/06/2021
02/07/2021
23/07/2021
13/08/2021
03/09/2021
24/09/2021
15/10/2021
05/11/2021
26/11/2021
17/12/2021
07/01/2022
28/01/2022
18/02/2022
11/03/2022
ZO388742 Corp
5-years average
Weekly debt premium average


KPN
1,800
1,600
1,400
1,200
1,000
0,800
0,600
0,400
0,200
0,000
07/04/2017
07/06/2017
07/08/2017
07/10/2017
07/12/2017
07/02/2018
07/04/2018
07/06/2018
07/08/2018
07/10/2018
07/12/2018
07/02/2019
07/04/2019
07/06/2019
07/08/2019
07/10/2019
07/12/2019
07/02/2020
07/04/2020
07/06/2020
07/08/2020
07/10/2020
07/12/2020
07/02/2021
07/04/2021
07/06/2021
07/08/2021
07/10/2021
07/12/2021
07/02/2022
Weekly debt premium average
QZ384265 Corp
ZO366662 Corp
BS3080196 Corp
5-years average


Orange
2,500
2,000
1,500
1,000
0,500
0,000
07/04/2017
07/06/2017
07/08/2017
07/10/2017
07/12/2017
07/02/2018
07/04/2018
07/06/2018
07/08/2018
07/10/2018
07/12/2018
07/02/2019
07/04/2019
07/06/2019
07/08/2019
07/10/2019
07/12/2019
07/02/2020
07/04/2020
07/06/2020
07/08/2020
07/10/2020
07/12/2020
07/02/2021
07/04/2021
07/06/2021
07/08/2021
07/10/2021
07/12/2021
07/02/2022
Weekly debt premium average
EJ699618 Corp
AW568484 Corp
EJ620100 Corp
ZO414364 Corp
AQ688604 Corp
AU388690 Corp
UV791099 Corp
ZS753679 Corp
BH472600 Corp
ZR363790 Corp
EC822743 Corp
EJ903924 Corp
BS8953389 Corp
BQ2160068 Corp
AZ540895 Corp
5-years average


Proximus
1,400
1,200
1,000
0,800
0,600
0,400
0,200
0,000
08/03/2019
08/04/2019
08/05/2019
08/06/2019
08/07/2019
08/08/2019
08/09/2019
08/10/2019
08/11/2019
08/12/2019
08/01/2020
08/02/2020
08/03/2020
08/04/2020
08/05/2020
08/06/2020
08/07/2020
08/08/2020
08/09/2020
08/10/2020
08/11/2020
08/12/2020
08/01/2021
08/02/2021
08/03/2021
08/04/2021
08/05/2021
08/06/2021
08/07/2021
08/08/2021
08/09/2021
08/10/2021
08/11/2021
08/12/2021
08/01/2022
08/02/2022
08/03/2022
Weekly debt premium average
AX510759 Corp
BS3563688 Corp
5-years average


Tele 2
2,500
2,000
1,500
1,000
0,500
0,000
09/11/2018
09/01/2019
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09/05/2021
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Weekly debt premium average
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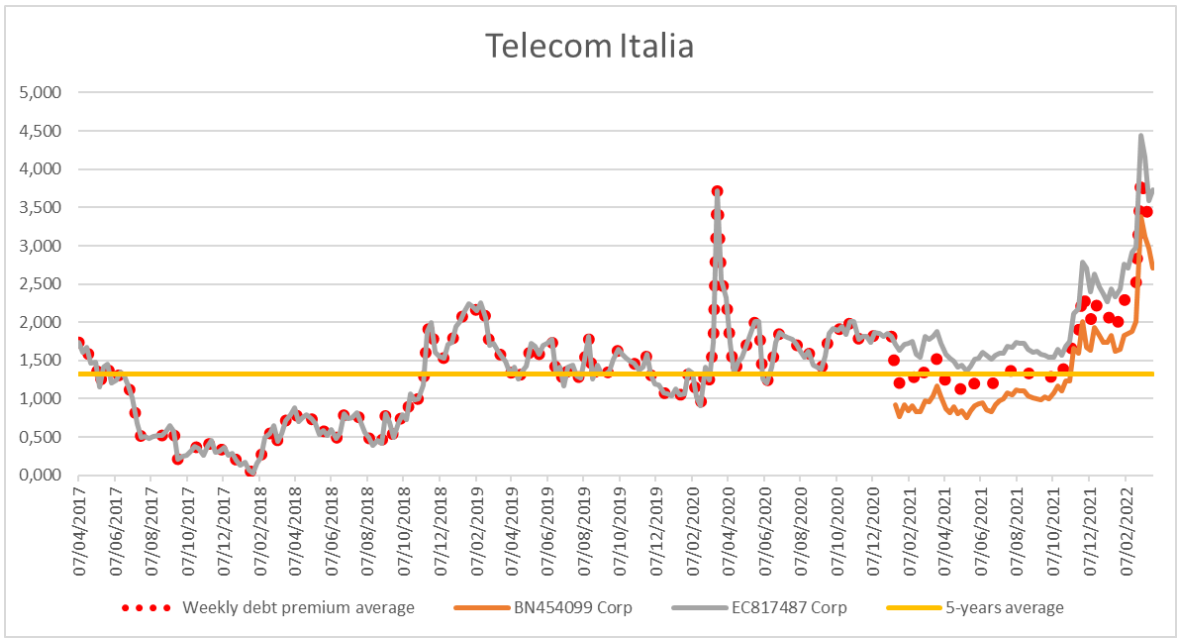
5-years average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3,000
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2,000
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07/06/2017
07/08/2017
07/10/2017
07/12/2017
07/02/2018
07/04/2018
07/06/2018
07/08/2018
07/10/2018
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07/02/2019
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07/12/2020
07/02/2021
07/04/2021
07/06/2021
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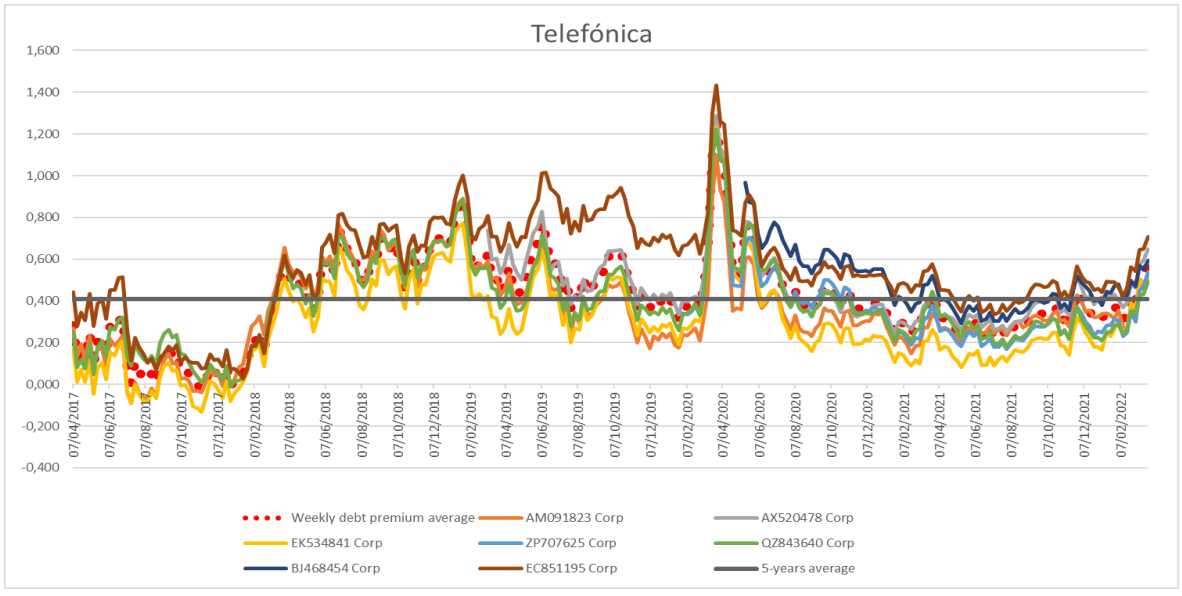
07/02/2022
Weekly debt premium average
BN454099 Corp
EC817487 Corp
5-years average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1,200
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07/04/2018
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07/08/2018
07/10/2018
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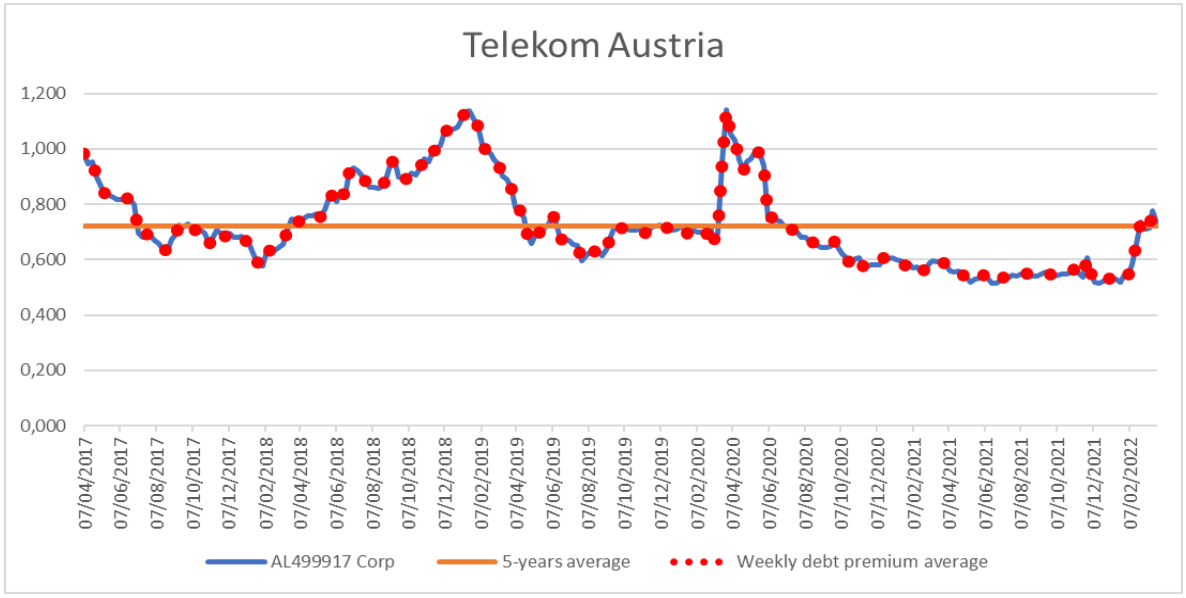
07/10/2020
07/12/2020
07/02/2021
07/04/2021
07/06/2021
07/08/2021
07/10/2021
07/12/2021
07/02/2022
Weekly debt premium average
AM091823 Corp
AX520478 Corp
EK534841 Corp
ZP707625 Corp
QZ843640 Corp
BJ468454 Corp
EC851195 Corp
5-years average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07/02/2021
07/04/2021
07/06/2021
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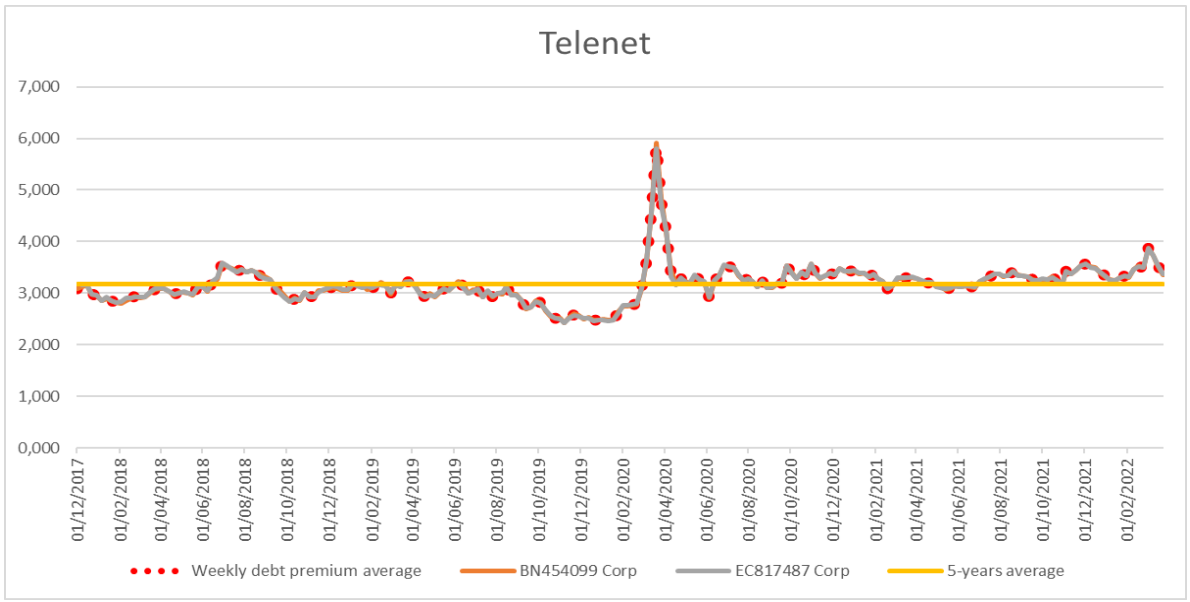
07/10/2021
07/12/2021
07/02/2022
AL499917 Corp
5-years average
Weekly debt premium average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01/02/2021
01/04/2021
01/06/2021
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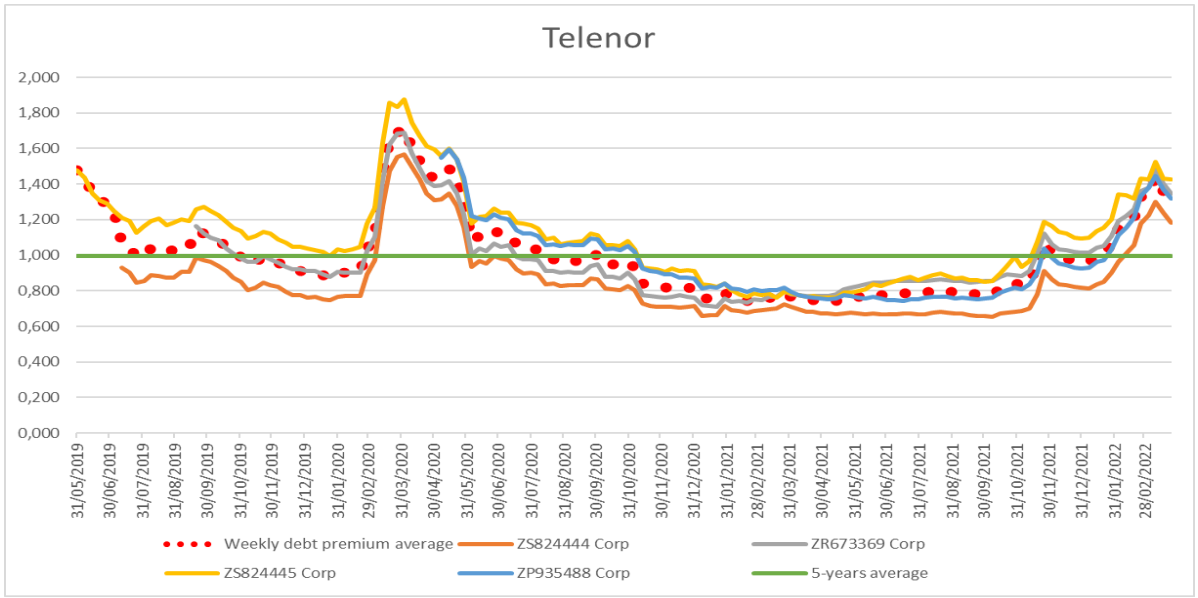
01/02/2022
Weekly debt premium average
BN454099 Corp
EC817487 Corp
5-years average


Telenor
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1,400
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1,000
0,800
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0,400
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0,000
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31/07/2021
31/08/2021
30/09/2021
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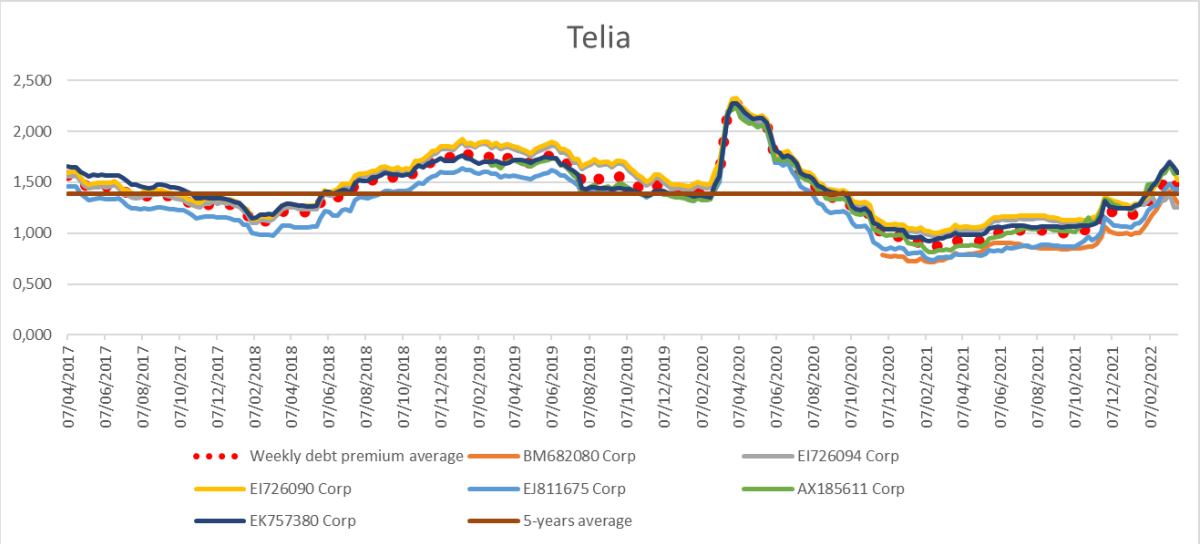
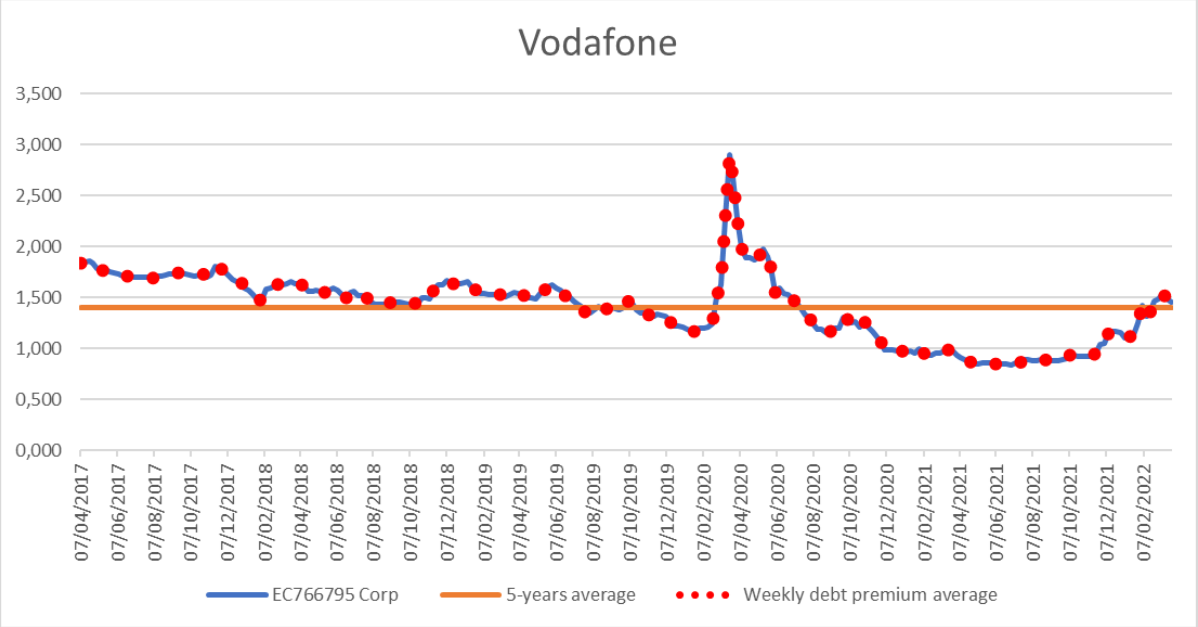
Weekly debt premium average
ZS824444 Corp
ZR673369 Corp
ZS824445 Corp
ZP935488 Corp
5-years average





Annex 3: Beta and Gearing

In this annex the process and the results of the estimation for the 15 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 15 peer-operators. Specifically, information about where i) the shares have been traded; ii) the revenues have been achieved

since last financial, reports public available, in the EU countries; iii) the free float percentage of the traded share (spot value);[158] iv) the sensitivity analysis as reported in chapter 5 considering an estimation of the gearing including pension liabilities in the debt component and the corresponding asset beta evaluated with this new gearing.

Table A1 Peer group companies

	Peer Group operator	country	Fitch	Moody's	S&P	Free Float	Market Cap (5Years time window weekly sampling period in EURO)	Weight (market cap)	Equity beta	Gearing	Asset beta	Gearing including pension found	Asset beta with gearing including pension found
1	Deutsche Telekom AG	Germany	BBB+	Baa1	BBB	65.03%	72.87	25.89%	0.78	52.69%	0.43	54.85%	0.41
2	DIGI	Romania		Ba3	BB-	49.23%	0.46	0.16%	0.46	66.60%	0.22	66.60%	0.22
3	Elisa Oyj	Finland		Baa2	BBB+	87.86%	7.08	2.52%	0.43	13.28%	0.38	13.44%	0.38
4	Koninklijke KPN N.V.	Netherlands	BBB	Baa3	BBB	77.65%	11.12	3.95%	0.65	38.55%	0.44	39.10%	0.43
5	NOS	Portugal	BBB		BBB-	39.67%	2.26	0.80%	0.70	35.39%	0.49	35.39%	0.49
6	Orange S.A.	France	BBB+	Baa1	BBB+	75.27%	33.03	11.74%	0.70	50.58%	0.40	52.46%	0.39
7	Proximus S.A.	Belgium		A1	A	41.95%	7.24	2.57%	0.53	26.66%	0.41	30.50%	0.40
8	Tele2 AB	Sweeden			BBB	73.81%	7.59	2.70%	0.58	22.41%	0.47	22.41%	0.47
9	Telecom Italia	Italy	BB	Ba3	BB-	65.40%	11.17	3.97%	1.02	70.52%	0.38	71.42%	0.37
10	Telefónica S.A.	Spain	BBB	Baa3	BBB-	88.03%	32.91	11.69%	1.01	58.01%	0.49	60.02%	0.47
11	Telecom Austria AG	Austria		Baa1	BBB+	20.50%	4.65	1.65%	0.68	34.35%	0.48	36.31%	0.47
12	Telenet Group Holding N.V.	Belgium	BB-	Ba3	BB-	38.61%	4.89	1.74%	0.62	51.17%	0.35	51.31%	0.35
13	Telenor	Norway	NR	A3	A-	45.79%	22.77	8.09%	0.33	29.71%	0.26	30.28%	0.26
14	Telia Company AB	Sweeden	WD	Baa1	BBB+	58.96%	15.65	5.56%	0.62	36.27%	0.43	37.18%	0.42
15	Vodafone Group plc	UK	BBB	Baa2	BBB	99.93%	47.76	16.97%	0.90	50.06%	0.50	50.33%	0.50
Weighted average based on market cap (information only)									0.75	47.07%	0.43	48.42%	0.42
Arithmetic average (information only)									0.67	42.42%	0.41	43.44%	0.40

[158] March 2022

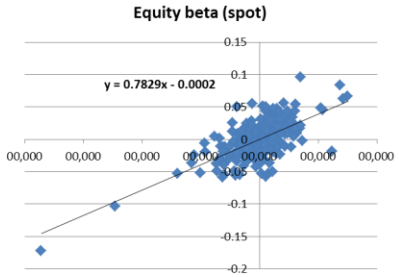
More detailed information for the selected parameters for each company are reported in the following. Specifically, the balance sheet data which are needed for the debt component of the gearing are reported including ten year data (2012-2021) due to the fact that a rolling beta estimation over a time windows of five years is reported for information only to show a clearly the trend present along the years. The values that are reported in the pictures on the rolling Equity beta refer: i) to the equity beta estimated through the standard OLS estimator along the time windows (5 years) and on a weekly basis; ii) the equity beta +/- one Standard error[159] (population corrected and homoscedasticity assumption of the error); iii) the simple average of the three values on a five year time windows and using a weekly sampling period. The corresponding rolling asset beta is provided as well based on the corresponding equity beta which is reported and gearing used for estimating the corresponding asset beta in the same graph.

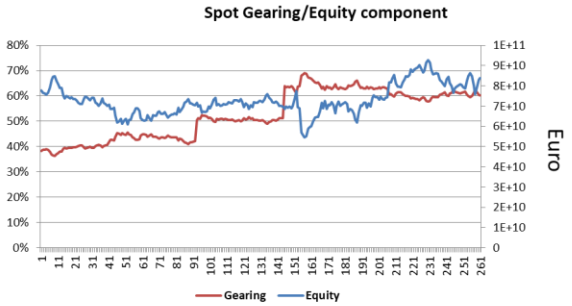
<u>Deutsche Telekom Group</u>

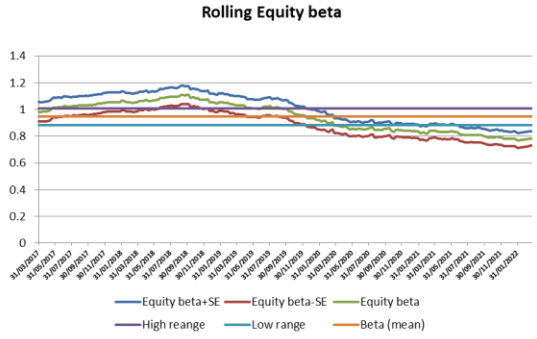
DT

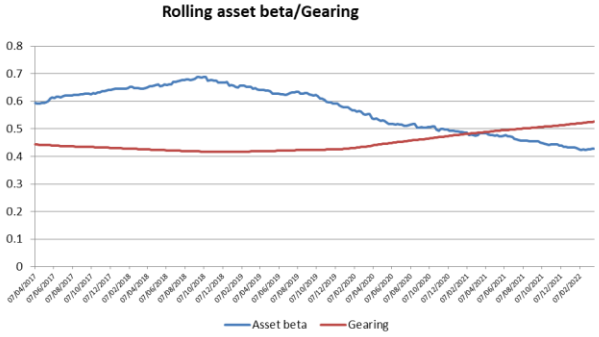
Balance sheet

	1	2	3	4	5	6	7	8	9	10
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Long term debt	34,226	42,424	43,388	45,575	47,810	46,436	49,485	57,327	93,678	98,566
Capital leases	1,128	1,284	1,281	1,616	1,962	1,884	1,622	15,848	27,607	28,094
Cash and Cash Equivalent	4,026	7,970	7,523	6,897	7,747	3,312	3,679	5,393	12,939	7,617
Pension liability	7,280	7,006	8,465	8,028	9,734	9,211	6,307	5,831	7,684	6,134
Short debt/Current portion of long term debt-capital lease	9,141	7,757	10,152	14,255	13,144	8,623	10,093	14,334	17,675	17,236
Outstanding shares (milion)	4,319	4,446	4,516	4,607	4,657	4,743	4,743	4,743	4,715	4,950







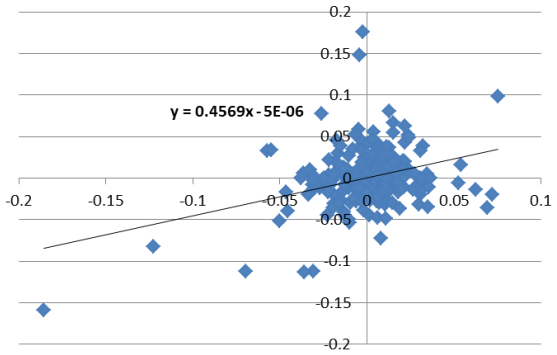


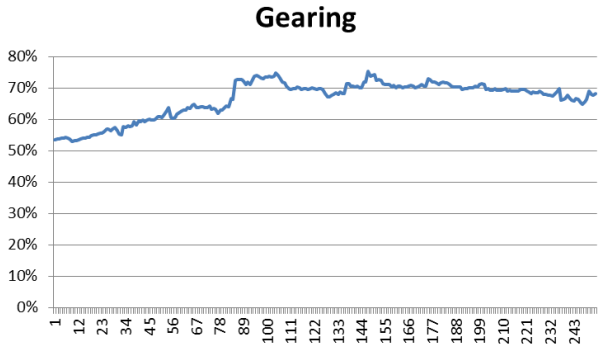
[159] The standard error of the estimate represents the average distance that the observed values fall from the regression line.

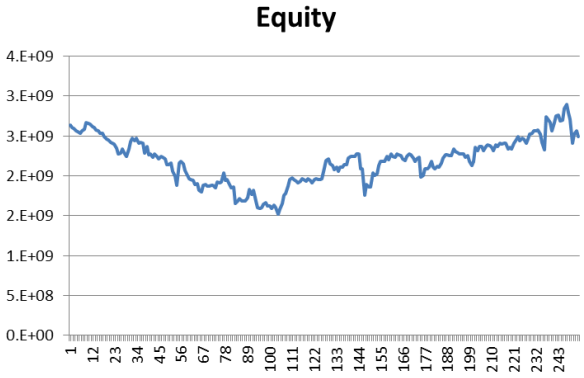
DIGI Communications

DIGI

	2017	2018	2019	2020	2021
Long term debt	3014	3316.6	3884.7	4583	4583
Capital leases	11.2	16.7	639.4	794.9	794.9
Cash and Cash Equivalent	75	64.4	52.7	51.5	51.5
Pension liability	0	0	0	0	0
Short debt/Current portion of long term debt-capital lease	382.8	784.8	935.5	733.4	733.4
Outstanding shares (milion)	65	65	65	65	65





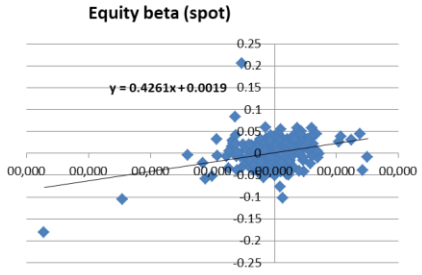


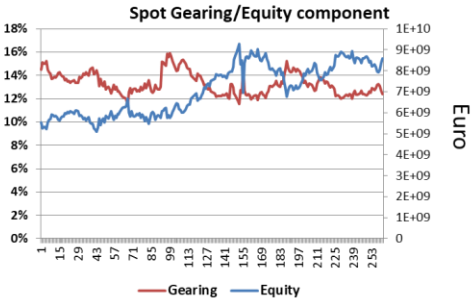
Elisa

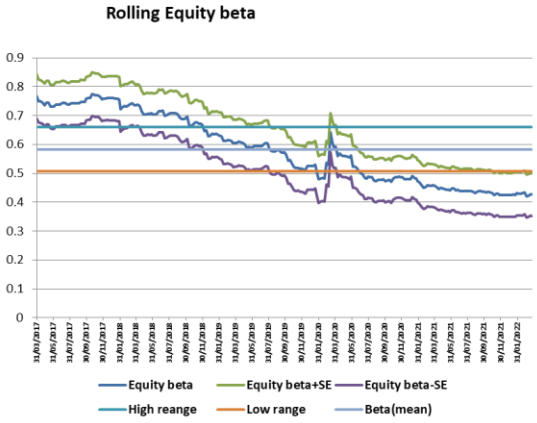
Elisa

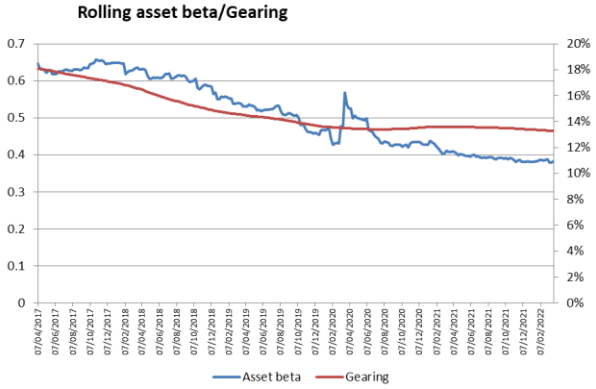
Balance sheet

	1	2	3	4	5	6	7	8	9	10
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Long term debt	670	800	791	662	805	917	840	1,008	1,137	1,141
Capital leases	33	30	27	24	23	22	22	78	79	73
Cash and Cash Equivalent	40	138	41	29	45	44	81	52	220	114
Pension liability	1	14	18	16	17	16	15	17	11	14
Short debt/Current portion of long term debt-capital lease	176	279	225	305	341	178	287	151	211	118
Outstanding shares (milion)	157	159	159	160	160	167	160	160	160	160





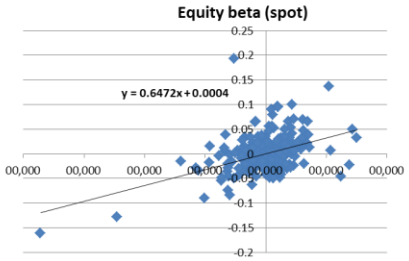


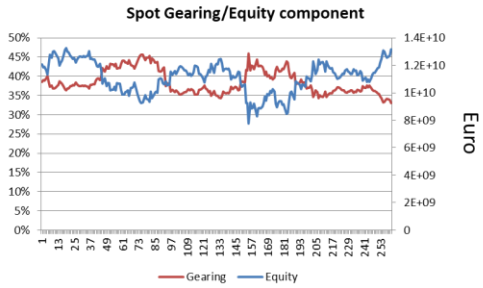


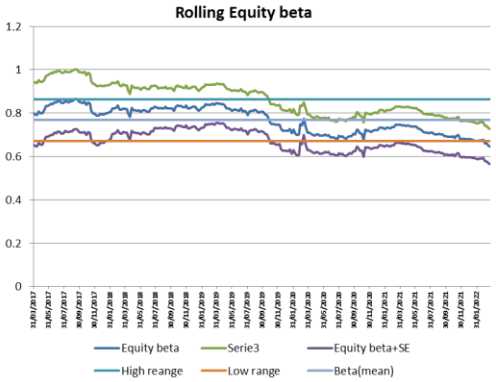
KPN

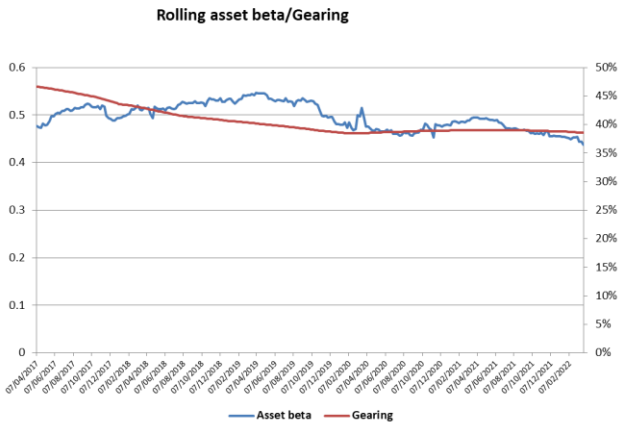
KPN **Balance sheet**

	1	2	3	4	5	6	7	8	9	10
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Long term debt	12,369	11,656	9,397	8,853	7,897	7,579	6,939	5,722	5,821	5,722
Capital leases	0	0	0	0	0	0	827	785	787	785
Cash and Cash Equivalent	1,286	3,946	1,976	1,446	1,179	856	594	766	597	793
Pension liability	314	1,019	316	259	262	218	206	188	152	92
Short debt/Current portion of long term debt-capital lease	1,527	2,008	1,044	847	735	18	589	1,082	829	814
Outstanding shares (milion)	2,361	4,270	4,270	4,270	4,270	4,270	4,203	4,203	4,203	4,203





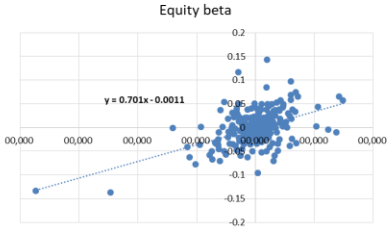


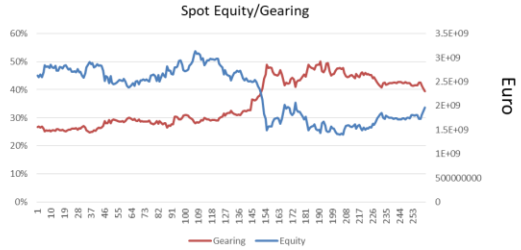


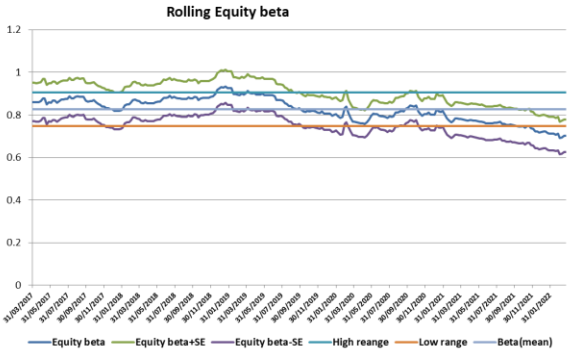
NOS

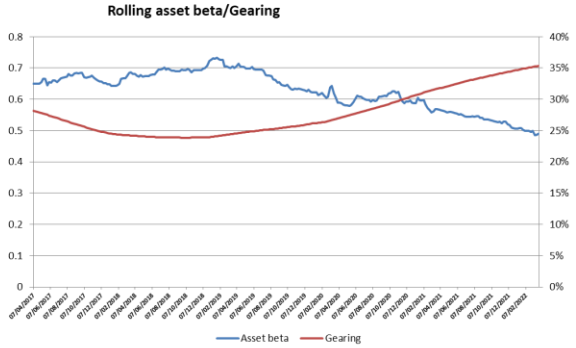
NOS **Balance sheet**

	1	2	3	4	5	6	7	8	9	10
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Long term debt	608	798	485	863	872	870	825	1,022	855	807
Capital leases	114	117	122	117	100	84	189	195	575	469
Cash and Cash Equivalent	308	74	21	10	2	3	2	13	153	11
Pension liability	0	0	0	0	0	0	0	0	0	0
Short debt/Current portion of long term debt-capital lease	363	2,013	504	178	225	210	215	88	90	87
Outstanding shares (million)	308	515	513	514	512	513	513	513	512	512







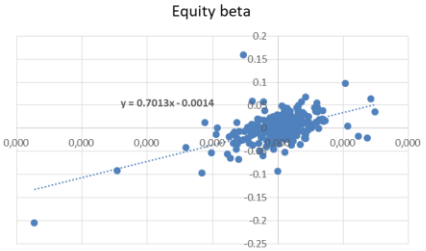


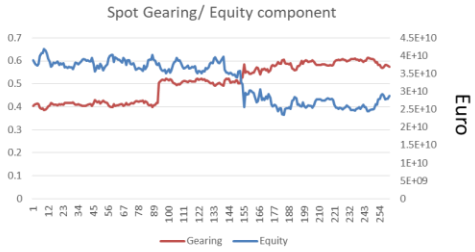
Orange

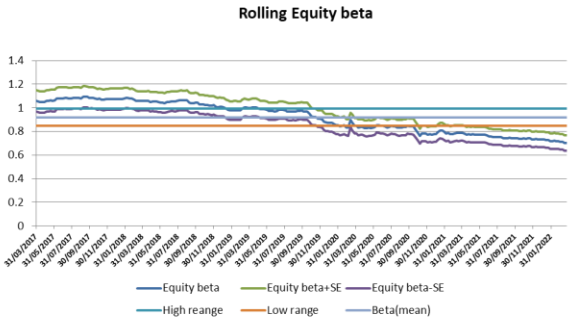
Orange

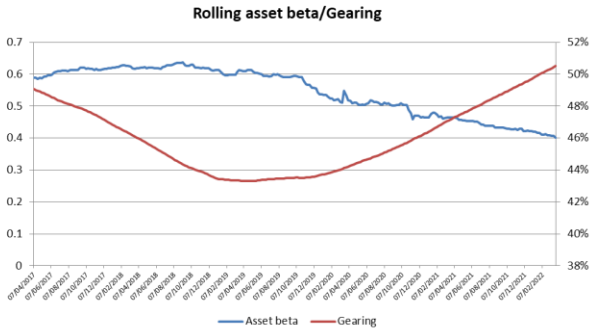
Balance sheet

	1	2	3	4	5	6	7	8	9	10
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Long term debt	32,365	30,664	29,482	29,528	28,404	25,839	26,323	33,148	30,089	31,922
Capital leases	0	0	0	0	505	454	426	5,225	5,875	6,696
Cash and Cash Equivalent	8,321	5,916	6,758	4,469	6,355	5,810	5,634	6,481	8,145	8,621
Pension liability	2,989	2,924	3,239	3,142	3,029	2,674	2,823	2,554	2,202	2,798
Short debt/Current portion of long term debt-capital lease	7,442	7,265	4,891	4,536	4,759	6,311	7,270	5,192	6,666	4,790
Outstanding shares (million)	2,627	2,627	2,649	2,649	2,660	2,660	2,653	2,650	2,659	2,658





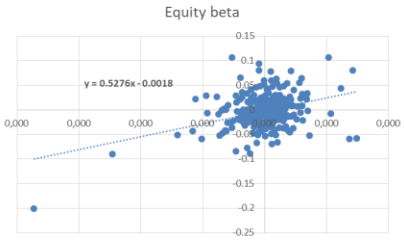


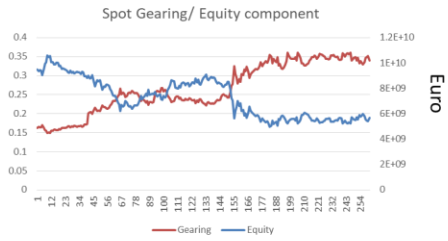


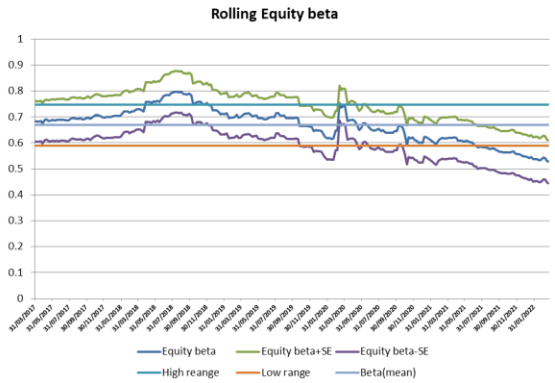
Proximus

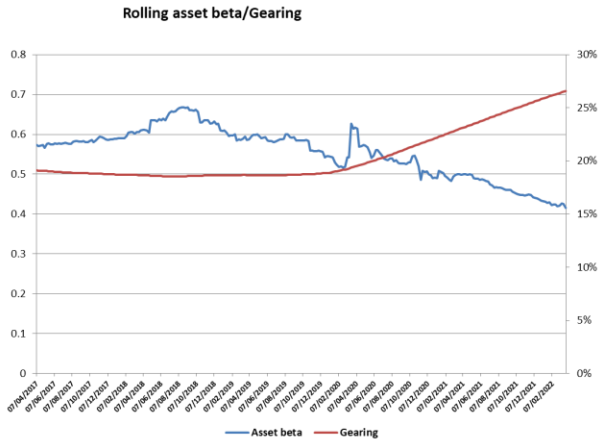
Proximus **Balance sheet**

	1	2	3	4	5	6	7	8	9	10
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Long term debt	1,672	1,919	2,363	1,753	1,755	1,850	2,255	2,355	2,506	2,738
Capital leases	2	2	3	3	2	6	4	243	216	205
Cash and Cash Equivalent	152	255	702	502	297	333	340	323	310	249
Pension liability	402	473	504	464	544	515	553	639	559	447
Short debt/Current portion of long term debt-capital lease	216	316	153	673	407	570	234	221	231	222
Outstanding shares (milion)	318	319	321	322	323	323	323	323	323	323





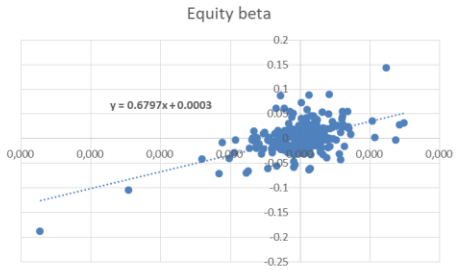


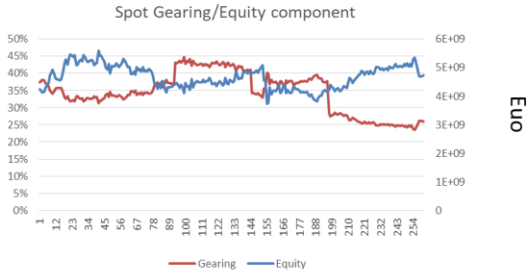


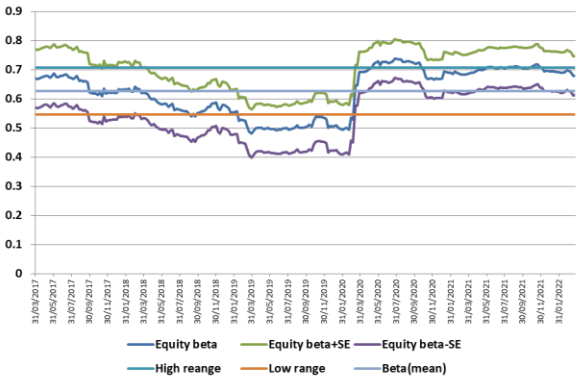
Telekom Austria

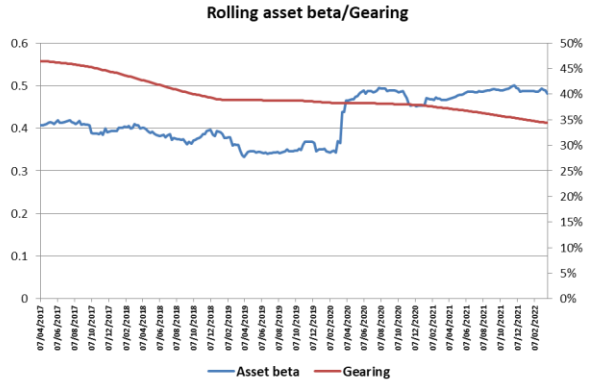
TA **Balance sheet**

	1	2	3	4	5	6	7	8	9	10
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Long term debt	2,832	3,738	3,385	2,584	2,303	2,533	2,536	2,540	1,794	1,046
Capital leases	0	0	0	0	0	0	0	788	701	606
Cash and Cash Equivalent	601	201	1,018	909	458	202	64	140	211	534
Pension liability	139	164	201	197	206	197	204	220	232	222
Short debt/Current portion of long term debt-capital lease	1,049	230	341	904	500	1	245	276	903	1,714
Outstanding shares (milion)	481	481	664	664	664	664	664	664	664	664







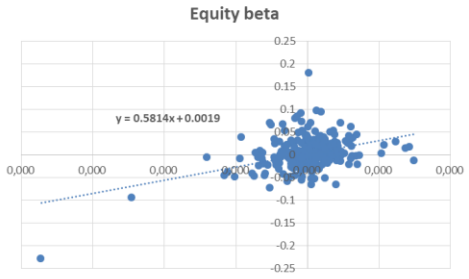


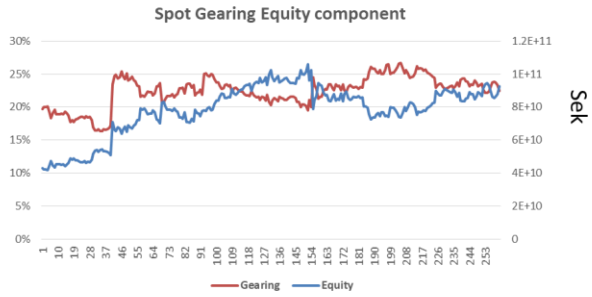
Tele 2

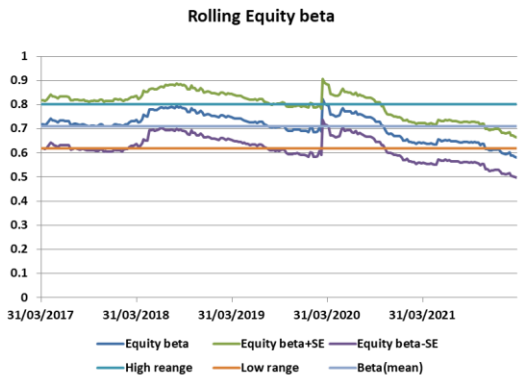
Tele2

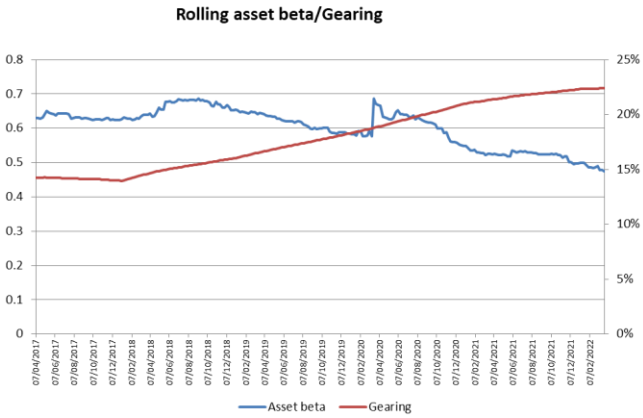
Balance sheet

	1	2	3	4	5	6	7	8	9	10
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Long term debt	12,622	5,649	4,555	4,284	7,746	10,567	21,753	21,572	21,406	22,512
Capital leases	192	49	38	45	32	15	14	4,501	4,209	4,289
Cash and Cash Equivalent	1,673	1,348	151	107	257	802	404	448	970	880
Pension liability	0	0	0	0	0	0	0	0	0	0
Short debt/Current portion of long term debt-capital lease	2,716	1,557	2,609	4,964	3,037	567	6,426	4,836	4,712	4,016
Outstanding shares (milion)	461	462	463	463	502	503	687	690	689	690







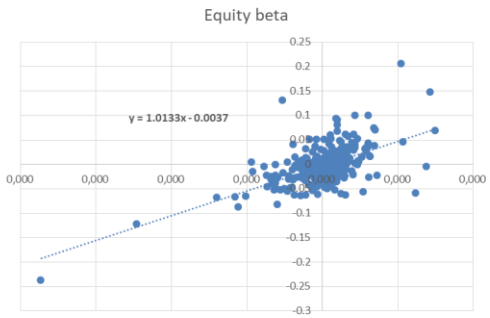


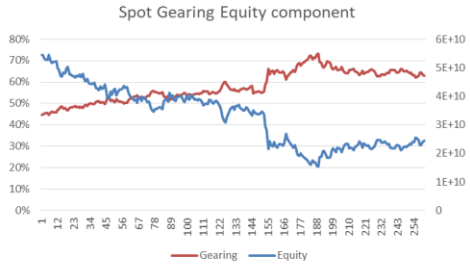
Telefonica

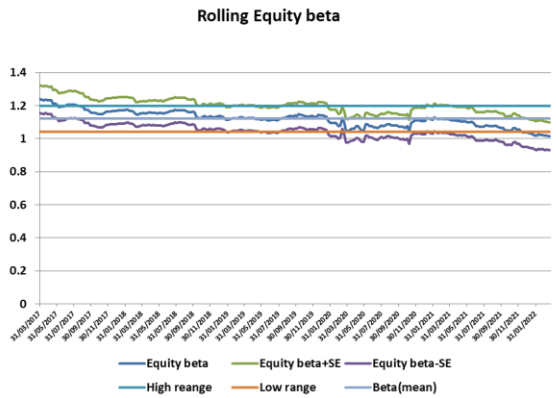
Telefonica

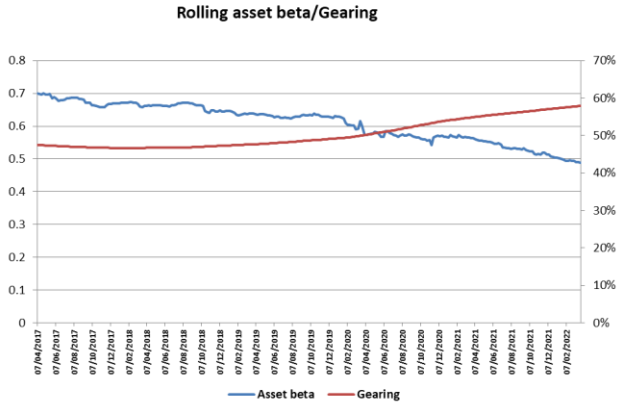
Balance sheet

	1	2	3	4	5	6	7	8	9	10
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Long term debt	53,410	48,366	47,457	44,110	43,562	44,120	43,805	40,930	38,129	35,290
Capital leases	0	0	0	0	0	0	0	5,626	4,039	6,391
Cash and Cash Equivalent	9,847	9,977	6,529	2,599	3,736	5,192	5,692	6,042	5,604	8,580
Pension liability	4,410	3,722	3,426	5,366	6,147	5,666	4,499	5,789	4,960	0
Short debt/Current portion of long term debt-capital lease	10,054	9,387	8,693	12,625	13,977	9,134	9,138	10,152	8,683	8,684
Outstanding shares (million)	4,603	4,603	4,711	4,975	5,038	5,192	5,192	5,192	5,526	5,779





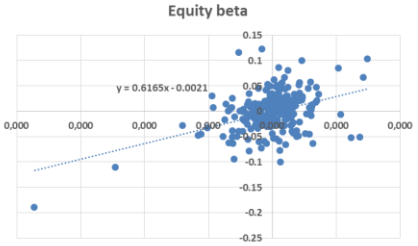


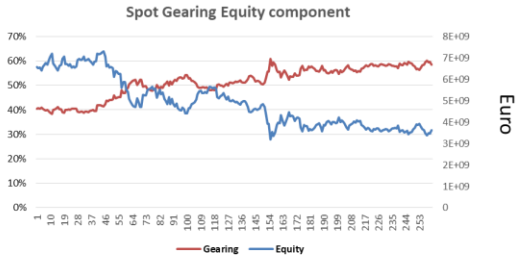


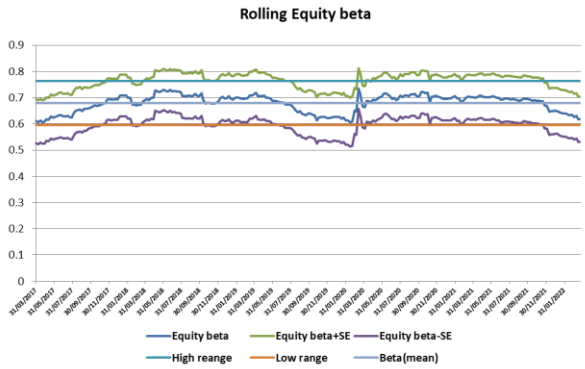
Telenet

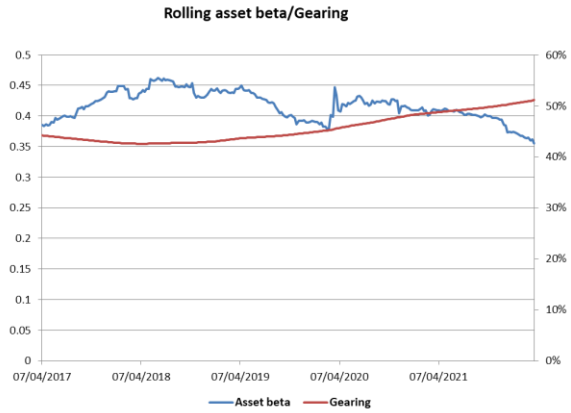
Telnet **Balance Sheet**

	1	2	3	4	5	6	7	8	9	10
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Long term debt	3,466	3,473	3,325	3,379	4,329	4,128	4,798	4,742	4,452	4,652
Capital leases	304	318	329	304	314	334	363	464	467	428
Cash and Cash Equivalent	906	214	189	277	99	39	88	101	37	45
Pension liability	14	22	25	25	33	31	26	30	32	27
Short debt/Current portion of long term debt-capital lease	73	78	79	111	139	362	504	527	500	499
Outstanding shares (milion)	113	116	117	117	117	118	118	115	114	114







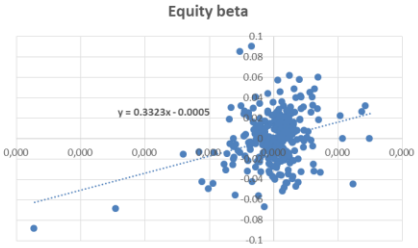


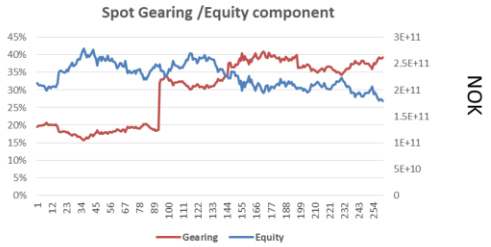
Telenor

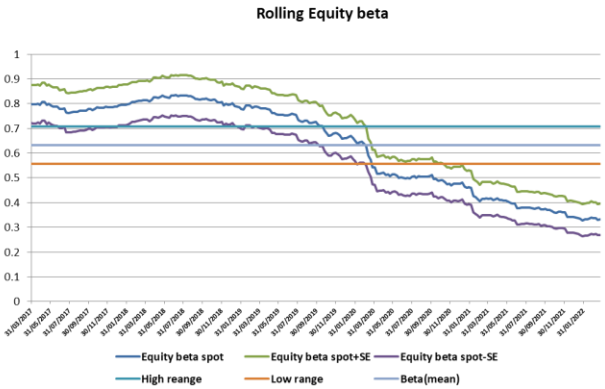
Telnor

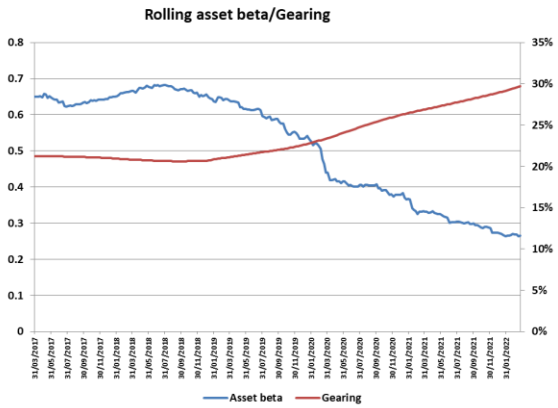
Balance sheet

	1	2	3	4	5	6	7	8	9	10
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Long term debt	39,046	50,166	59,982	62,784	59,467	50,745	55,120	83,987	98,627	87,810
Capital leases	780	835	832	1,018	924	842	805	32,002	35,584	28,101
Cash and Cash Equivalent	8,805	11,978	13,956	13,956	23,085	22,546	18,492	13,867	20,577	15,223
Pension liability	2,169	2,736	3,568	2,424	2,585	2,565	2,819	2,386	2,747	2,429
Short debt/Current portion of long term debt-capital lease	10,274	7,291	7,388	12,626	25,968	22,710	15,740	24,056	16,596	16,253
Outstanding shares (milion)	1,544	1,517	1,502	1,502	1,502	1,493	1,458	1,423	1,400	1,400





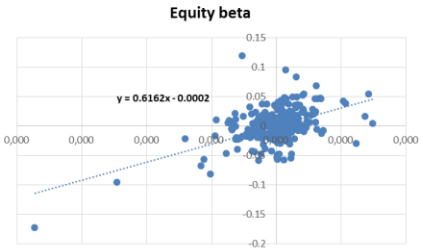


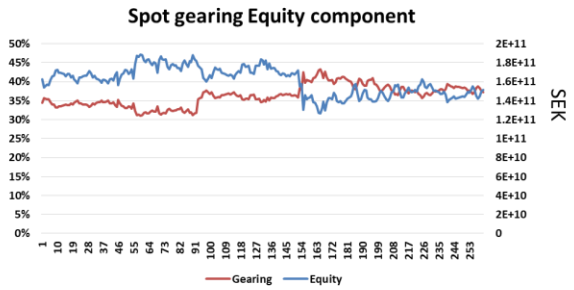


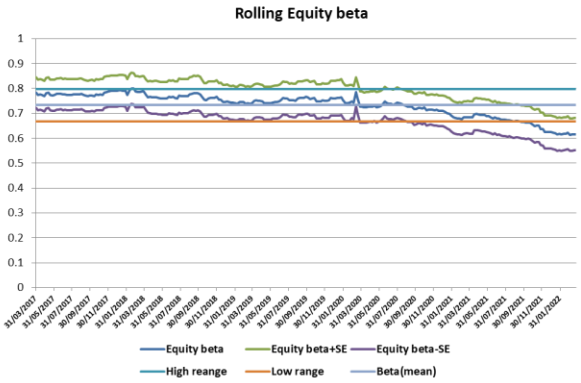
Telia Company

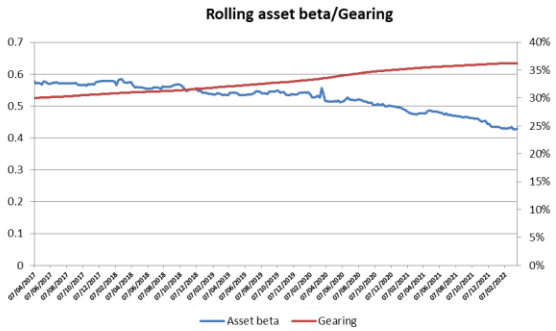
Telia **Balance sheet**

	1	2	3	4	5	6	7	8	9	10
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Long term debt	79,826	78,149	88,247	89,279	80,256	85,375	83,673	84,929	84,014	77,206
Capital leases	62	56	62	46	221	171	1,363	12,046	12,183	12,859
Cash and Cash Equivalent	29,805	31,721	28,735	14,647	14,510	15,617	18,764	6,116	8,133	14,358
Pension liability	1,209	1,468	3,505	1,824	2,109	2,377	2,519	3,334	7,428	2,682
Short debt/Current portion of long term debt-capital lease	8,989	10,586	10,991	9,266	11,113	3,471	9,213	12,951	3,063	3,701
Outstanding shares (milion)	4,330	4,330	4,330	4,330	4,330	4,330	4,330	4,113	4,090	4,090







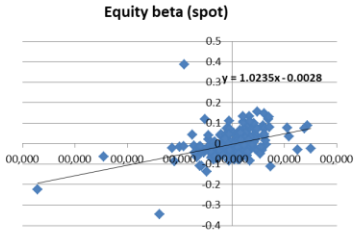


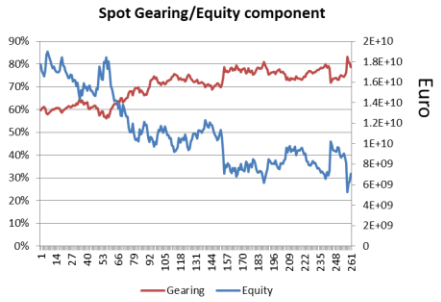
Telecom Italia

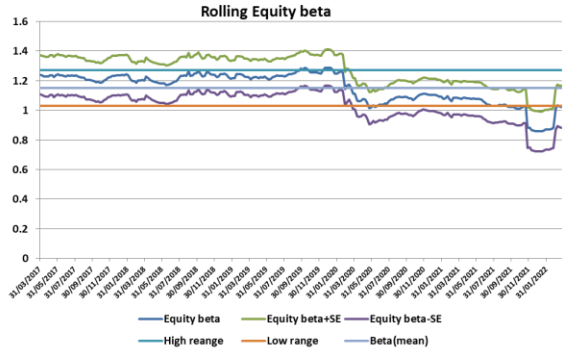
TIM

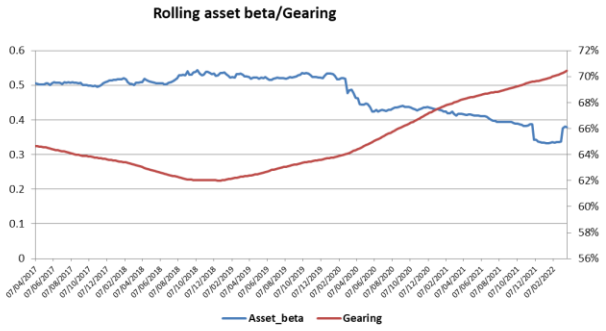
Balance sheet

	1	2	3	4	5	6	7	8	9	10
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Long term debt	30,361	27,958	29,172	26,652	26,136	23,940	21,894	23,945	21,813	22,083
Capital leases	1,159	1,100	984	2,271	2,444	2,249	1,740	4,576	4,199	4,064
Cash and Cash Equivalent	7,436	5,744	4,812	3,559	4,064	3,675	1,917	3,138	4,829	6,904
Pension liability	872	889	1,056	1,420	1,355	1,736	1,567	1,182	724	699
Short debt/Current portion of long term debt-capital lease	5,783	5,896	4,441	5,549	3,976	4,681	5,575	3,759	4,244	6,498
Outstanding shares (milion)	19,443	19,281	19,335	19,363	19,363	21,067	21,067	21,067	21,196	21,241







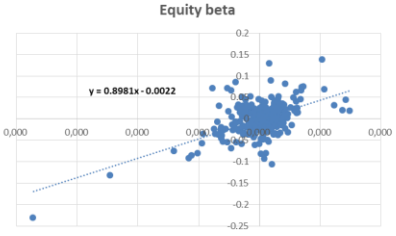


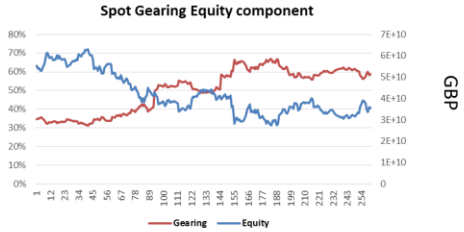
Vodafone

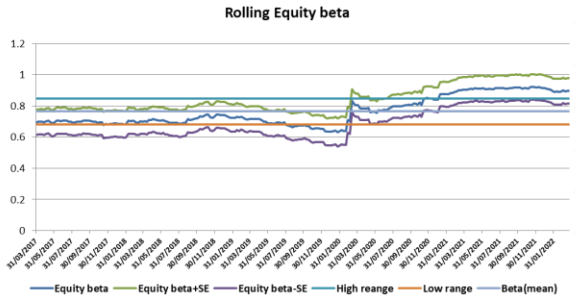
Vodafone

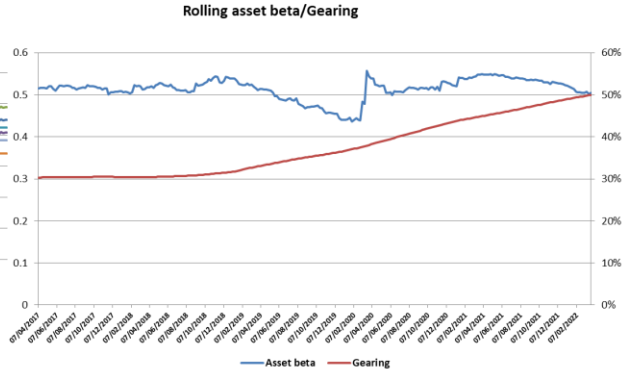
Balance sheet

	1	2	3	4	5	6	7	8	9	10
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Long term debt	28,294	29,013	21,351	22,310	28,931	28,981	28,428	41,824	52,424	47,329
Capital leases	68	95	103	125	159	203	234	221	3,229	3,138
Cash and Cash Equivalent	7,138	7,623	10,134	6,882	10,217	7,535	4,106	11,777	11,755	4,956
Pension liability	337	629	584	567	447	555	457	476	388	437
Short debt/Current portion of long term debt-capital lease	6,258	12,289	7,747	12,623	16,020	6,328	6,454	3,688	10,465	7,227
Outstanding shares (million)	27,080	26,683	26,440	26,512	26,559	26,622	26,676	27,230	26,772	28,224









Statistical Analysis

The estimation of the asset betas is subject to the consistency of the OLS (Ordinary Least Square) in term of bias[160] (that affects the beta estimation) and efficiency[161] 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.

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

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

- The Error terms are not autocorrelated, i.e. there is no systematic dependence across the error terms.

Specifically, the failure of normality can put a 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 it affects the confidence interval and therefore statistical inferences around those estimates.[162] When error terms are "autocorrelated", this means that the validity of a time independent model can be questionable.[163]

In the following we present visual inspections and statistical tests -where relevant- of the residual component of the regression model presented in the previous section, for each comparable, to test the three main issues (normality, heteroscedasticity, autocorrelation) previously addressed. The subsequent analysis focalizes on last five year time series spot beta as 1 of April 2022 and, when relevant, all the rolling beta data estimations are also taken into account for the analysis.

Normality

To test the normality only a visual approach[164] through the Box-plot, density plot, and Q-Q plot[165] 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 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.

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

[163] 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

[164] 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 is 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/.

[165] 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 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 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.

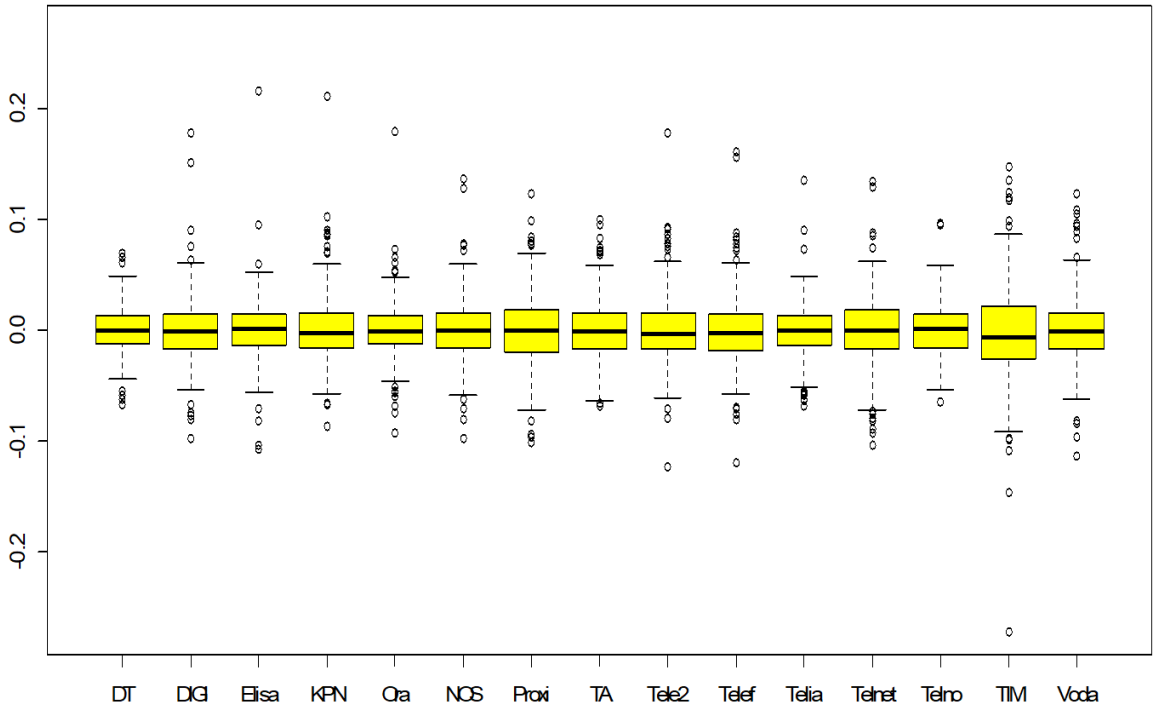
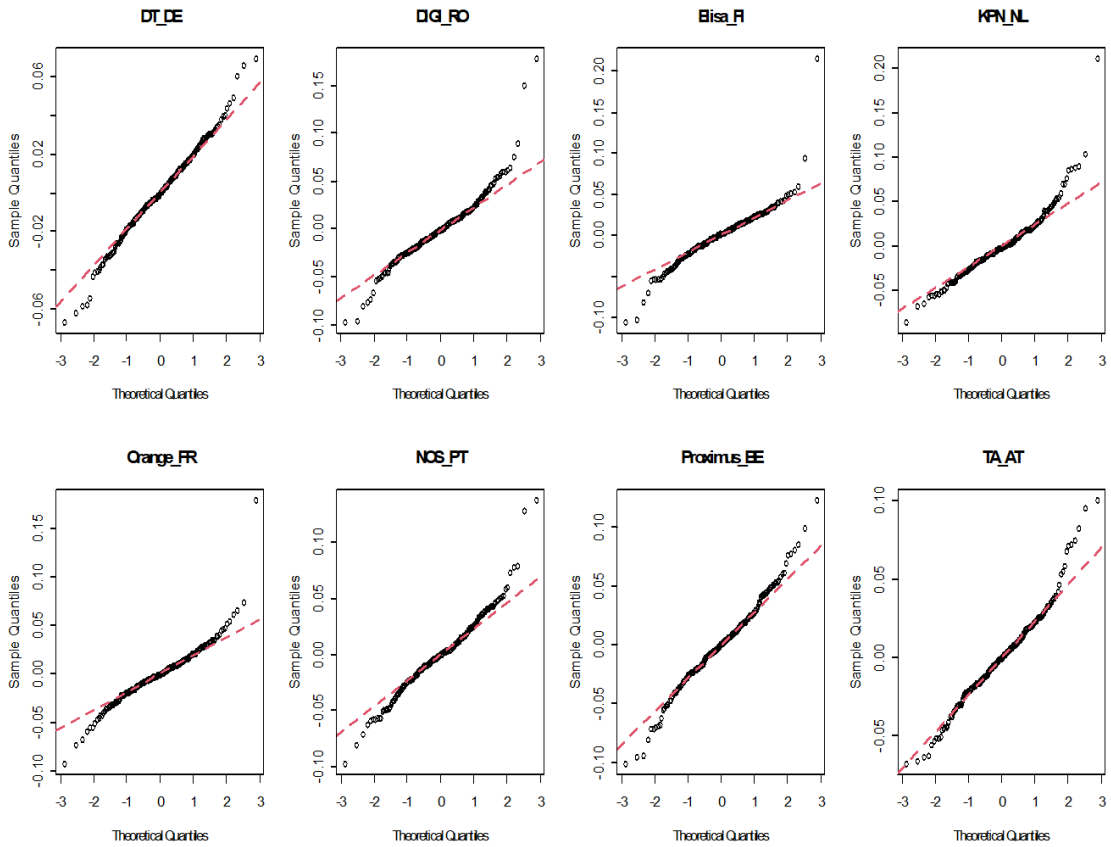


Figure A1 Box plot of residual distribution of the beta equity estimation

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 provides the theoretical line if the residual data comes from a normal distribution with same average and standard deviation of the residual data under inspection.


DT_DE
DIGI_RO
Elisa_FI
KPN_NL
Orange_FR
NOS_PT
Proximus_BE
TA_AT
Sample Quantiles
Theoretical Quantiles

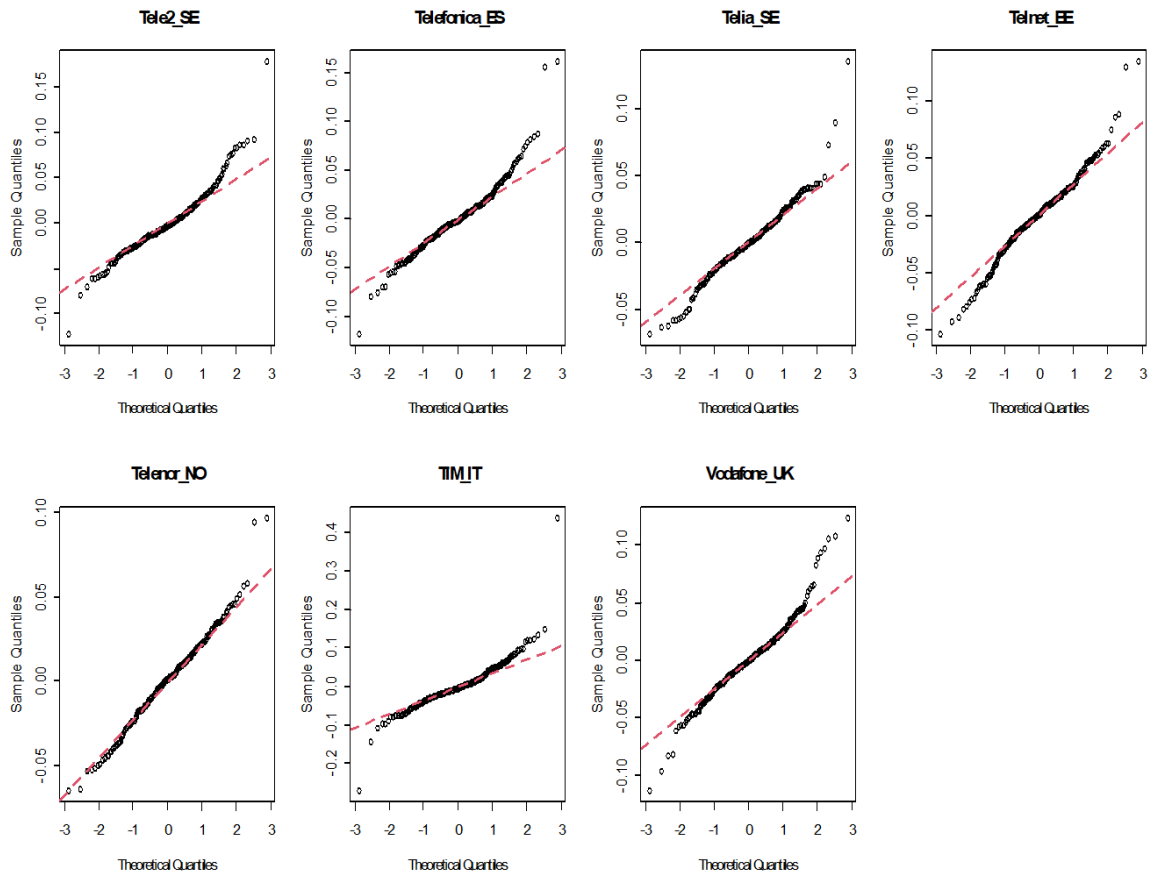
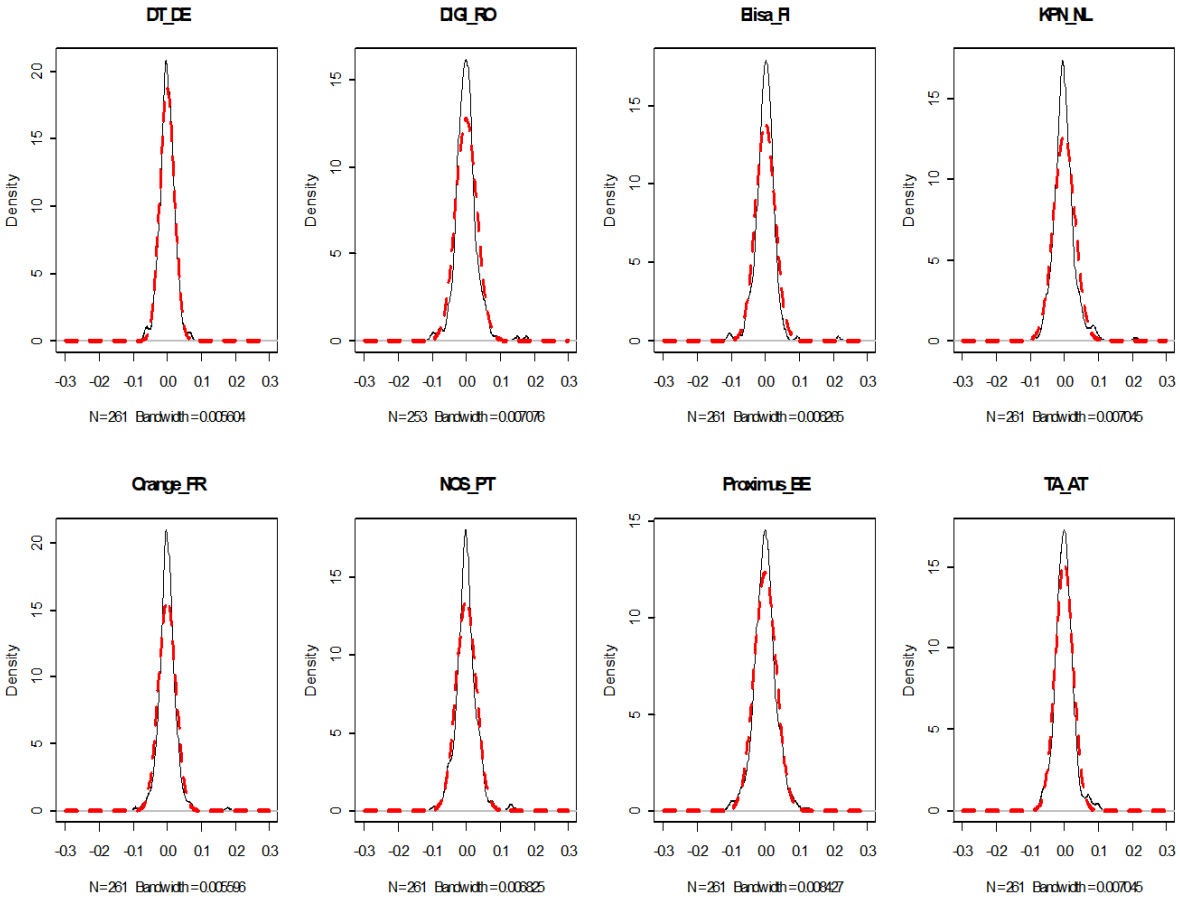


Figure A2 Q-Q plot of residual distribution of the beta equity estimation


DT_DE
Density
N=261 Bandwidth=0.005604
DIGI_RO
Density
N=253 Bandwidth=0.007076
Elisa_FI
Density
N=261 Bandwidth=0.008265
KPN_NL
Density
N=261 Bandwidth=0.007045
Orange_FR
Density
N=261 Bandwidth=0.005596
NOS_PT
Density
N=261 Bandwidth=0.008825
Proximus_BE
Density
N=261 Bandwidth=0.008427
TA_AT
Density
N=261 Bandwidth=0.007045

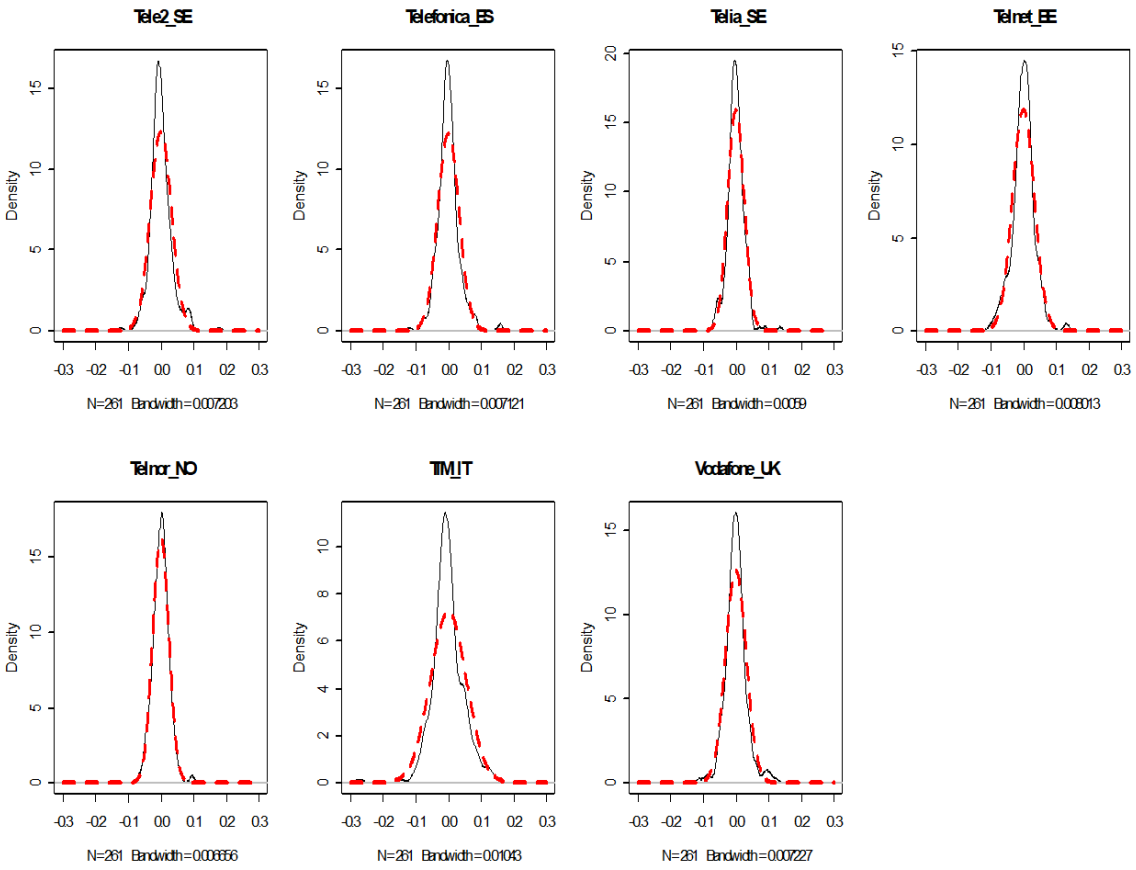


Figure A3 – Density plot of the residual of the distribution

From the graphical analysis of the box plot, density plot and Q-Q plot it can be observed that the normal distribution assumption is generally violated only due to the presence of outliers' values in the residual. In that sense, a general approximation of normal distribution can be accepted.

Table A2 focuses on each comparable and on: i) the beta spot at 1 of April 2022, ii) the rolling beta estimated over a five year time window. It provides the number of relevant outliers[166] as well as the p-values of the Shapiro Wilk normality test[167]. For the rolling beta the averages on the number of outliers as well as the p-values for each comparable over a five year time window and a weekly sampling period are reported. In figure A4 and A5 the corresponding values of the number of outliers, and the p-values of the Statistical tests are shown for visual inspection and transparency reasons over the five year time window from which the

[166] The number of outliers has been evaluated considering influential observations in the residual that have a 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.

[167] 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 outliers of the level of "non-normality". Only two operators pass the normality test highlighted in blue. For the others where the alpha level is 0.05 and the p-value is less than 0.05, the null hypothesis that the data are normally distributed is rejected.

corresponding averages for the rolling beta have been derived (blue lines of figures A4 and A5)

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.

	Spot beta (last value)		Rolling beta (averages values)	
	Number of outliers	P-value shapiro test	Number of outliers	P-value shapiro test
DT	12	0.080761	16	0.156291
Digi	14	4.87E-10	-	-
Elisa	11	5.25E-13	15	0.000638
KPN	15	4.47E-11	13	0.00019
NOS	17	3.69E-06	16	0.291301
Orange	14	4.13E-11	13	0.003295
Prox	14	0.004155	15	0.068044
Tele2	13	1.18E-08	13	2.68E-09
TIM	13	6.14E-15	15	0.186118
Telef	11	1.30E-08	15	0.004802
TA	16	5.25E-05	17	0.008656
Telnet	14	0.000113	14	0.000182
Telenor	16	0.012145	17	0.007917
Telia	12	1.09E-06	13	1.16E-07
Vodafone	14	1.81E-06	14	4.43E-05

Table A2 –Relevant outlier and normality test of spot beta and rolling beta for each peer

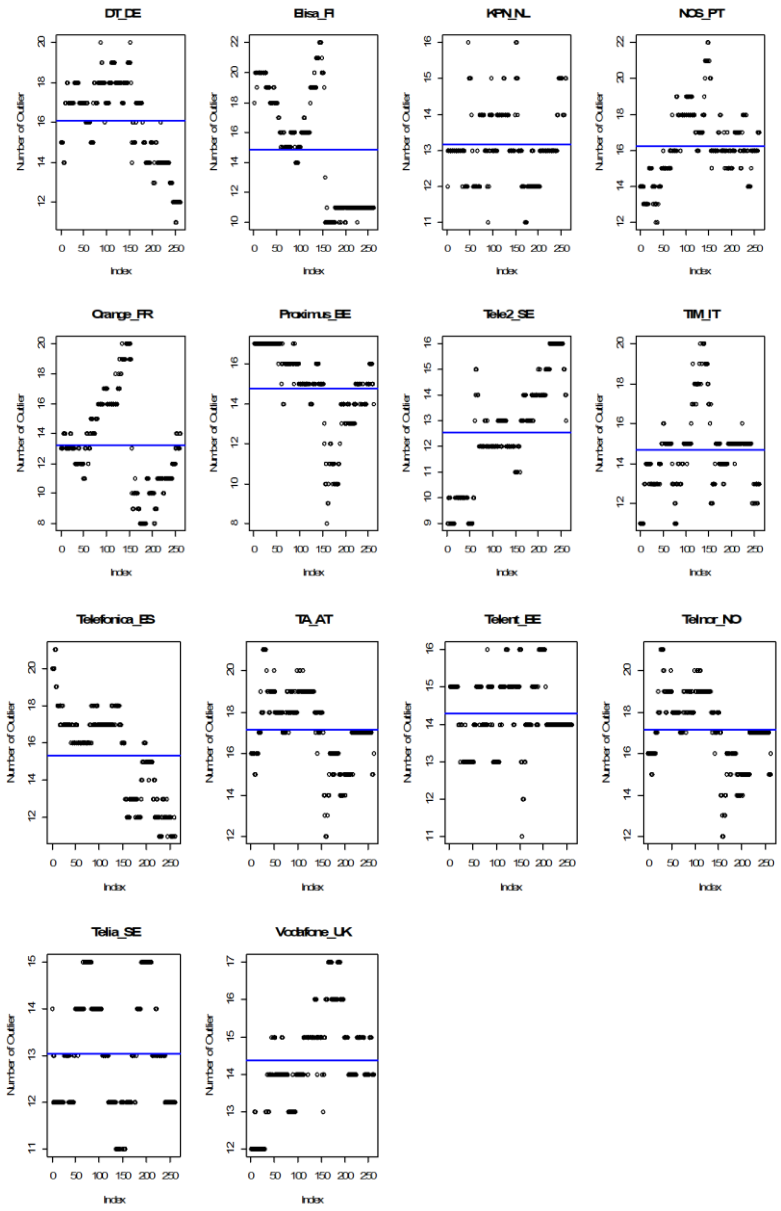


Figure A4 –Number of outlier along the rolling beta time window (the blue line is the average value reported in table A2)

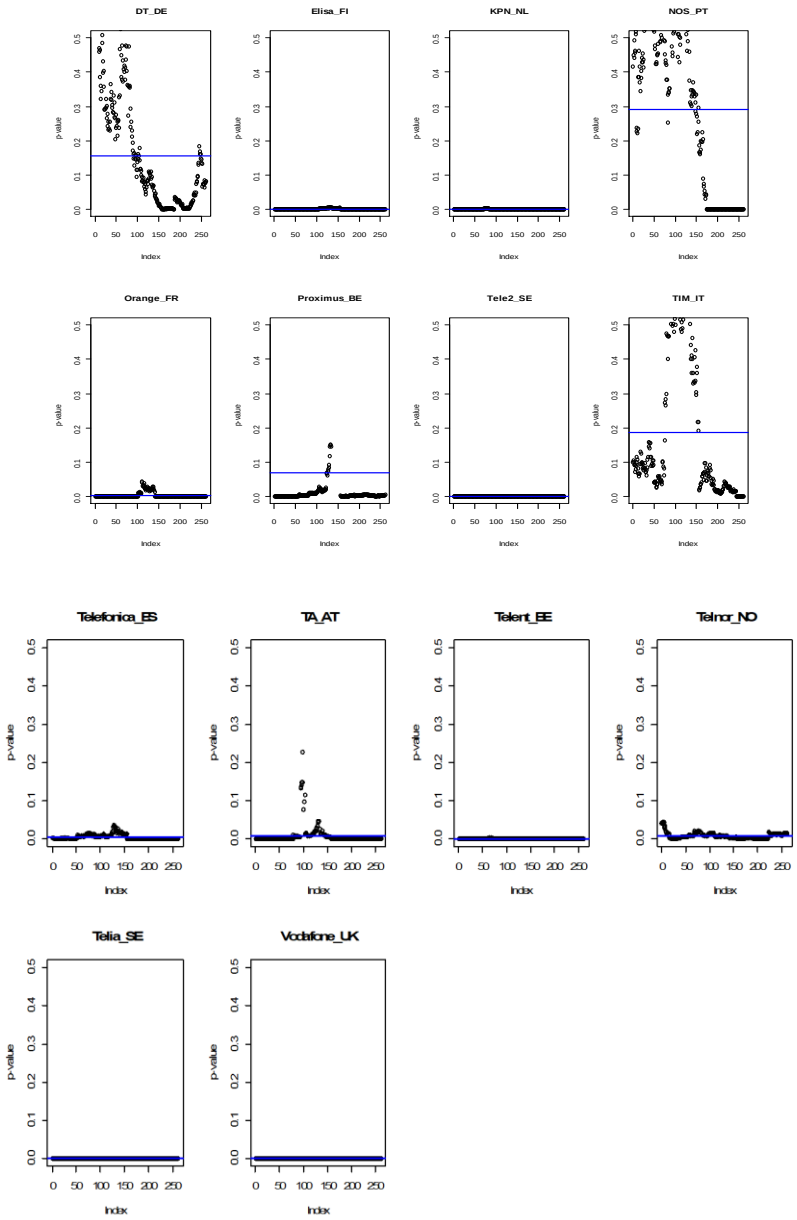
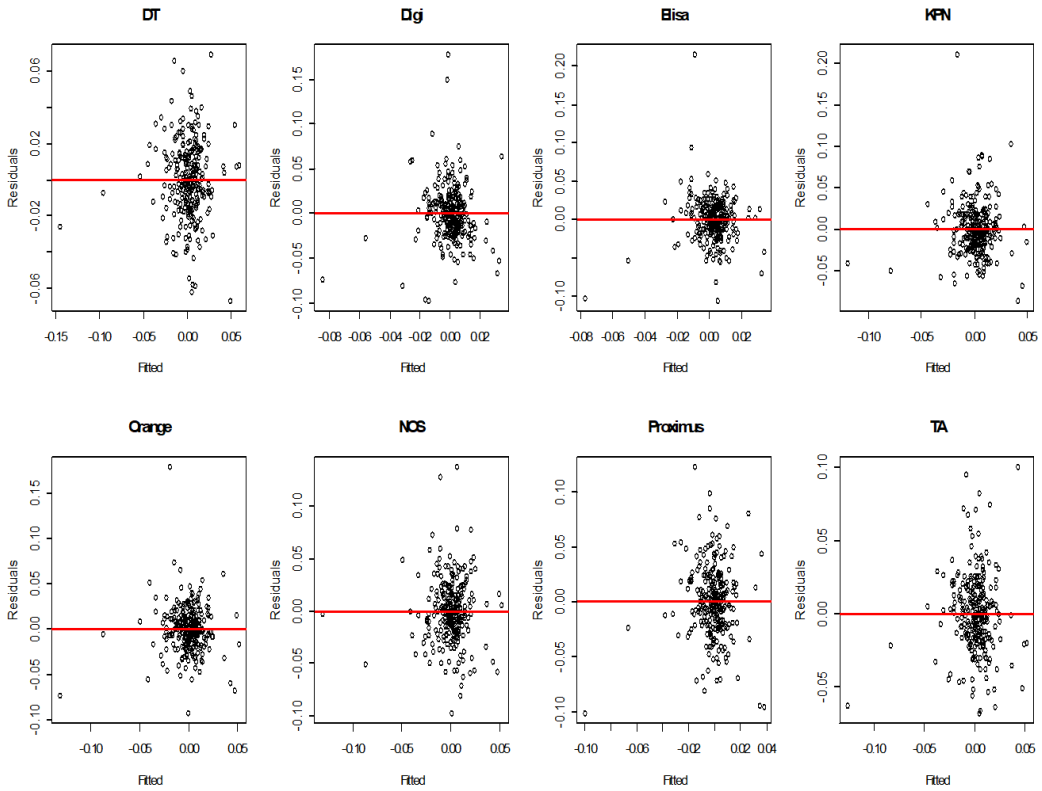


Figure A5 –P-value of Shapiro-Will Normality test along the rolling beta time window (the blue line is the average value reported in table A2)

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 observable, then the residuals are homoscedastic at least with respect to the constant variance attribute across the sample. In figure A6 the corresponding situation of the residual estimation is given for the spot beta at 1 of April 2022.


DT
Digi
Elisa
KPN
Orange
NOS
Proximus
TA
Residuals
Fitted

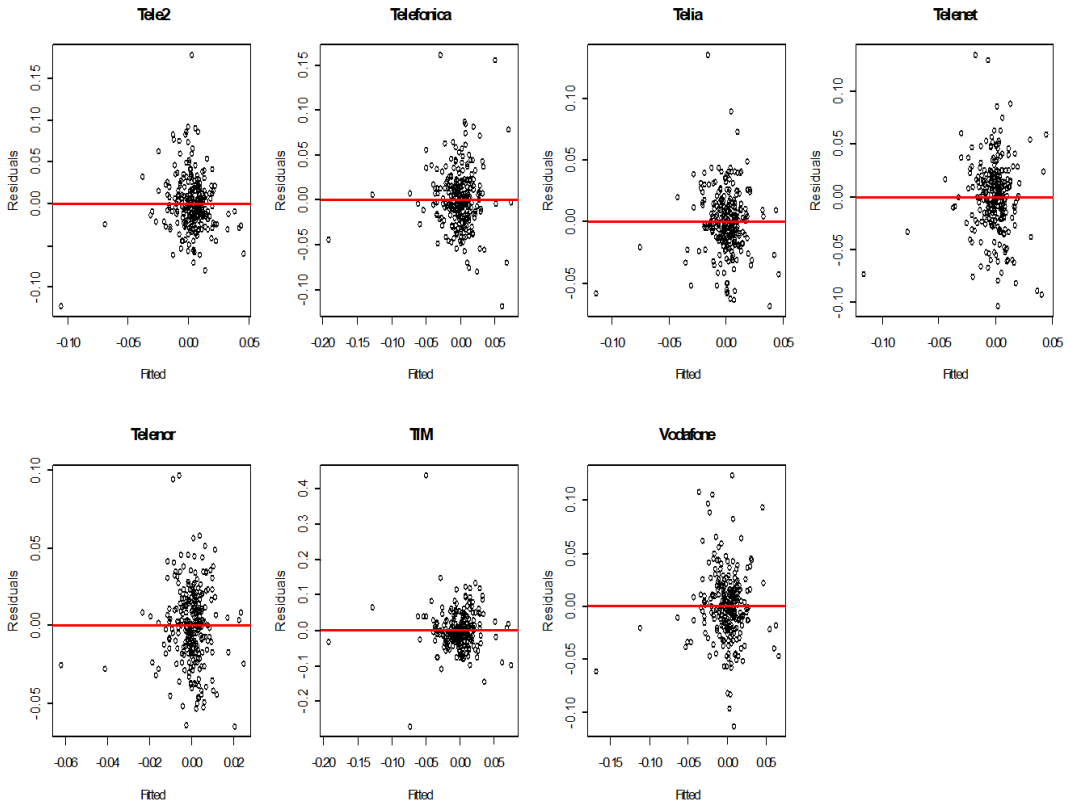


Figure A6 - Residual versus Fitted Values (spot beta at 1 of April 2022)

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 thus not based on a systematic pattern of the residual.

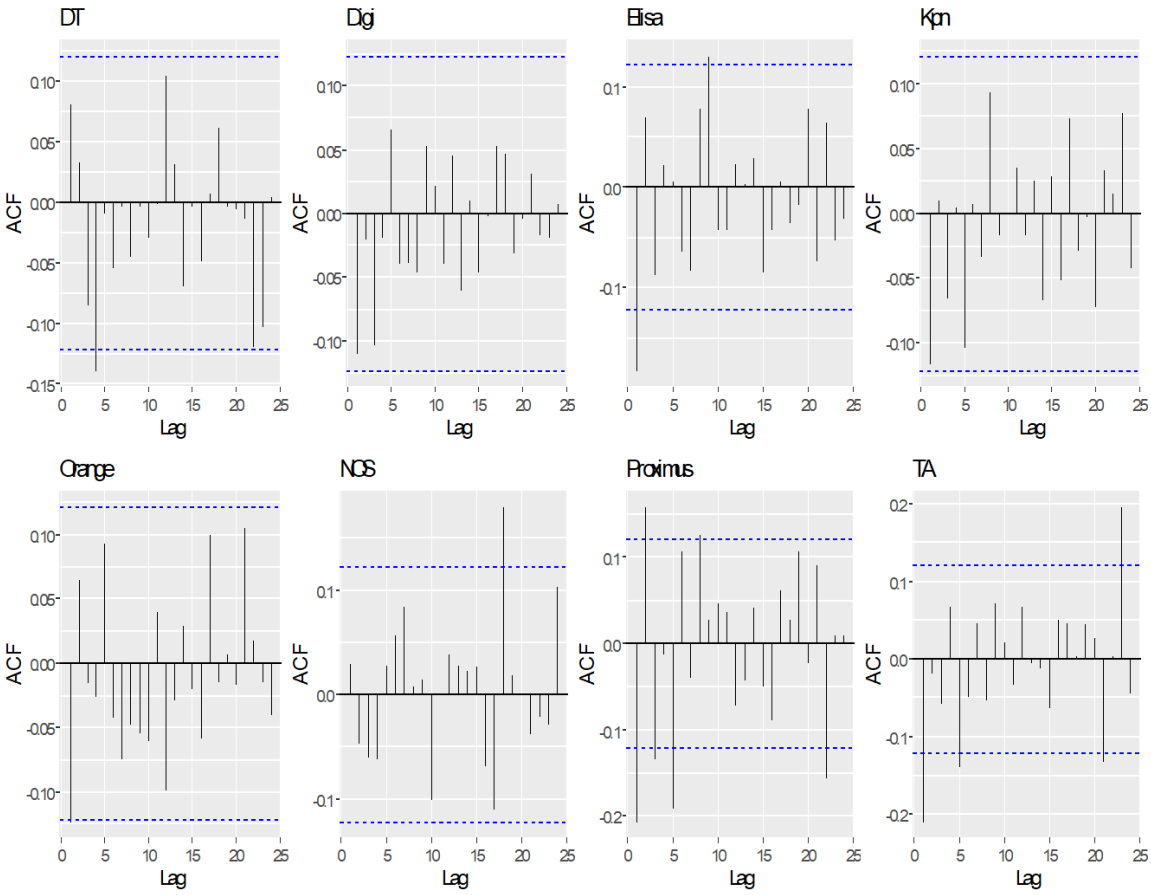
Autocorrelation of the residuals

The graphical analysis reported in the previous section indicates 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 for the residual of the spot beta at 1 of April 2022.[168]

In the same graph the “test bound” (dashed lines) is 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. The picture below (Correlogram)[169] shows that the level of autocorrelation of the residual is low or absent for all the comparables considered until the 24 lags of the ACF are taken into account.

[168] The Autocorrelation function is used to assess to what extent a time series is dependent on its past.
[169] The plot of the Autocorrelation sample for different lags is known as an Autocorrelation plot.


DT
Digi
Elisa
Kpn
Orange
NOS
Proximus
TA
ACF
Lag

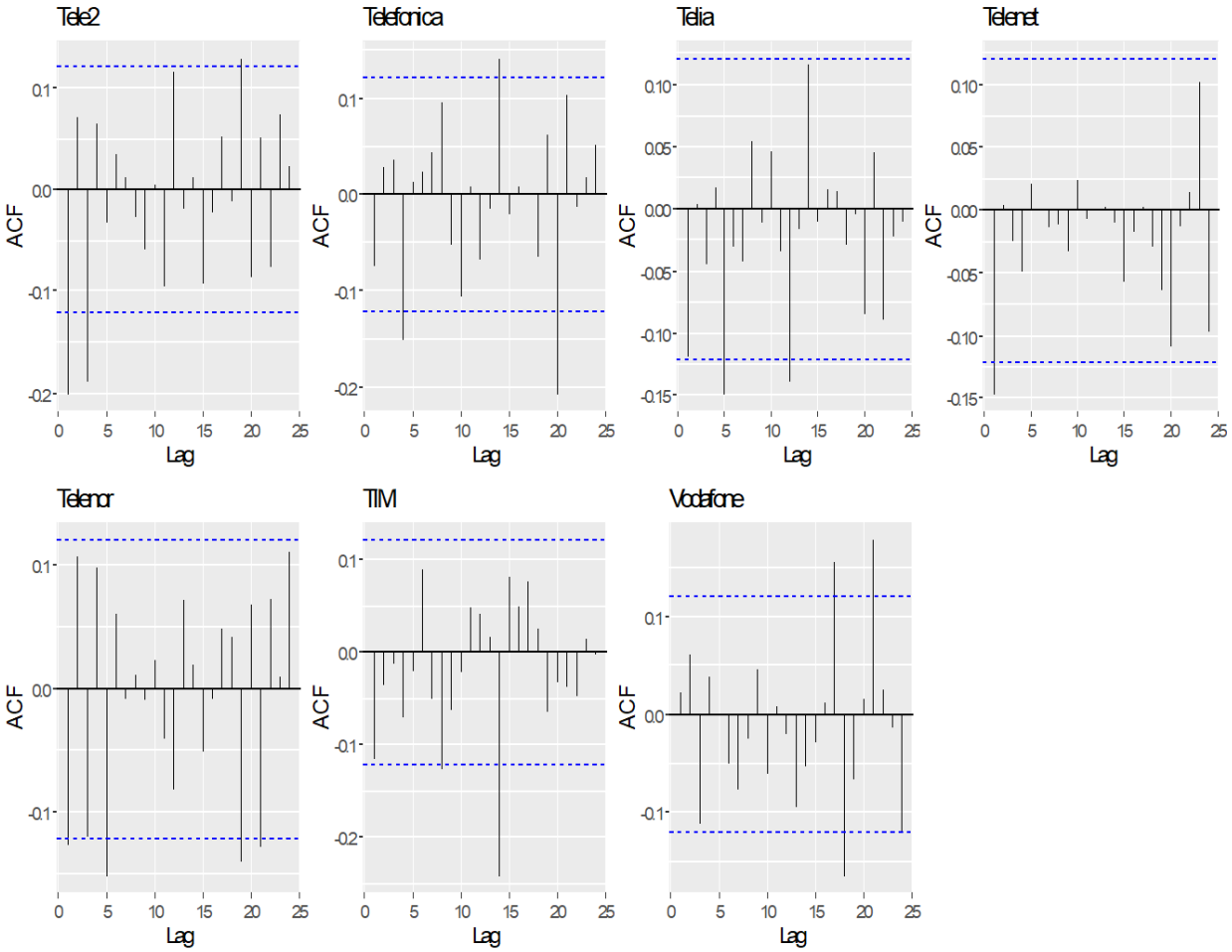


Figure A7 ACF residuals (spot beta at 1 of April 2022)

To obtain a more quantitative picture and comparison between the 15 comparable, the Ljung-Box test and the Breusch-Godfrey test[170] are also considered in the next table A3. In the table for each comparable and for both: i) the beta spot at 1 of April 2022, ii) the rolling beta estimated over a five year time window; the p-values of the two test are reported. For the rolling beta estimation the average values over five year time windows is given. In figures A8 and A9 the corresponding values along the time series used for estimating the average on rolling beta are given.

Instead of analysing every single lag distinctly, as done by the ACF plot,

[170] the Ljung-Box test and the Breusch-Godfrey test consist of the verification of absence of global correlation with respect to a certain number of lags.

	Spot beta (last value)		Rolling beta (averages values)	
	P-value (spot value)	P-value (spot value)	P-value (mean value over five years)	P-value (mean value over five years)
DT	0.444735	0.507584	0.492088	0.462227
Digi	0.945552	0.934453	-	-
Elisa	0.149559	0.183571	0.466174	0.497511
KPN	0.745771	0.890818	0.508942	0.553583
NOS	0.300374	0.491128	0.591773	0.605532
Orange	0.493263	0.334422	0.604911	0.538612
Prox	4.55E-05	0.002164	0.277961 (164/260)	0.287466
Tele2	0.005747	0.132156	0.141734(117/260)	0.235502
TIM	0.033398	0.005322	0.393679	0.325305
Telef	0.019513	0.095426	0.252715	0.222013
TA	0.007906	0.002911	0.133097(120/260)	0.160411
Telnet	0.765404	0.605829	0.547903	0.458477
Telenor	0.008158	0.169522	0.431575	0.522497
Telia	0.285311	0.111997	0.638855	0.535264
Vodafone	0.013332	0.025188	0.374989	0.350503

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

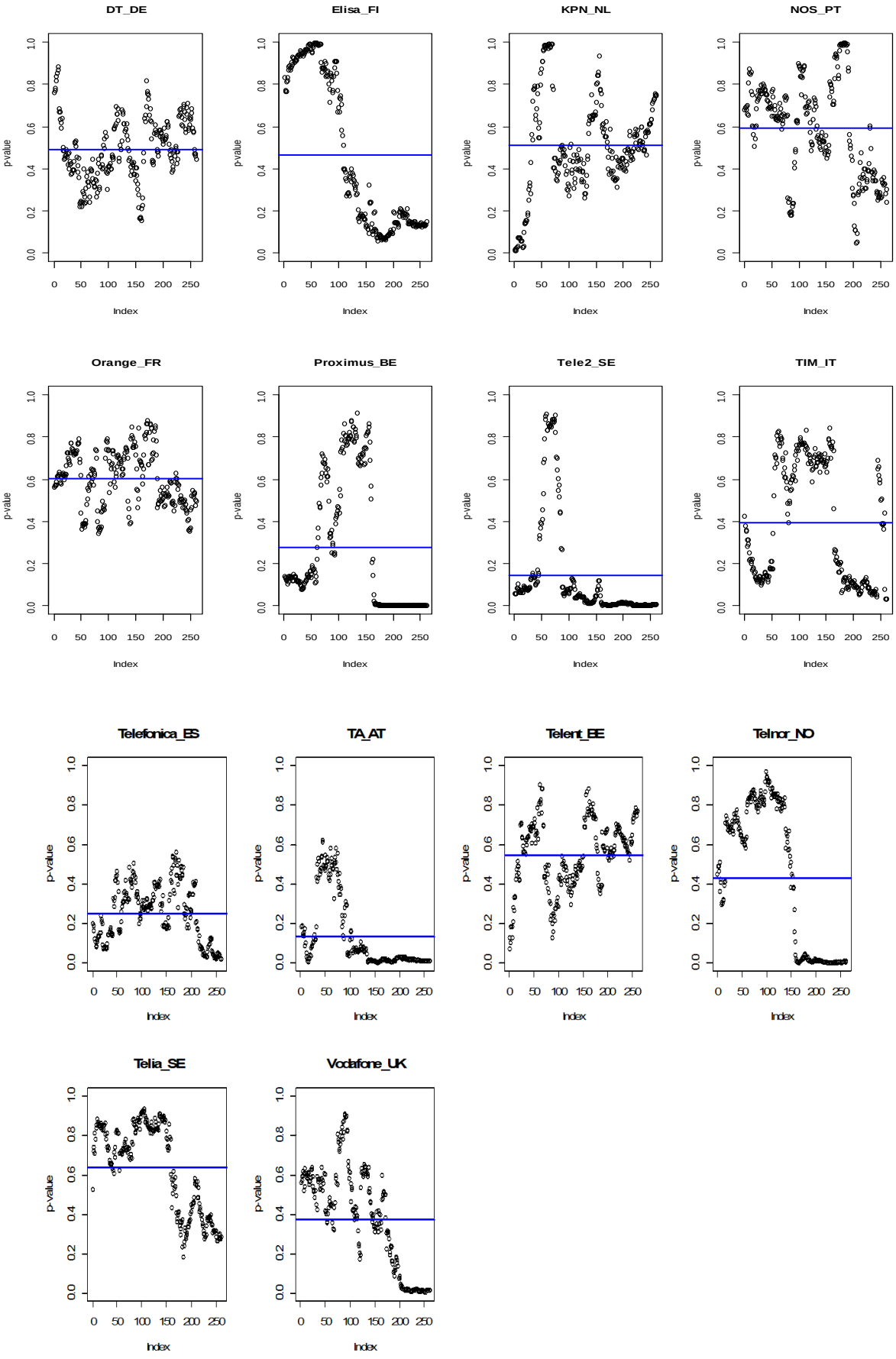

DT_DE
Elisa_FI
KPN_NL
NOS_PT
Orange_FR
Proximus_BE
Tele2_SE
TIM_IT
Telefonica_ES
TA_AT
Telent_BE
Telnor_NO
Telia_SE
Vodafone_UK
p-value
Index

Figure A8 –P-value of Ljung-Box Test along the rolling beta (the blue line is the average value reported in table A3)

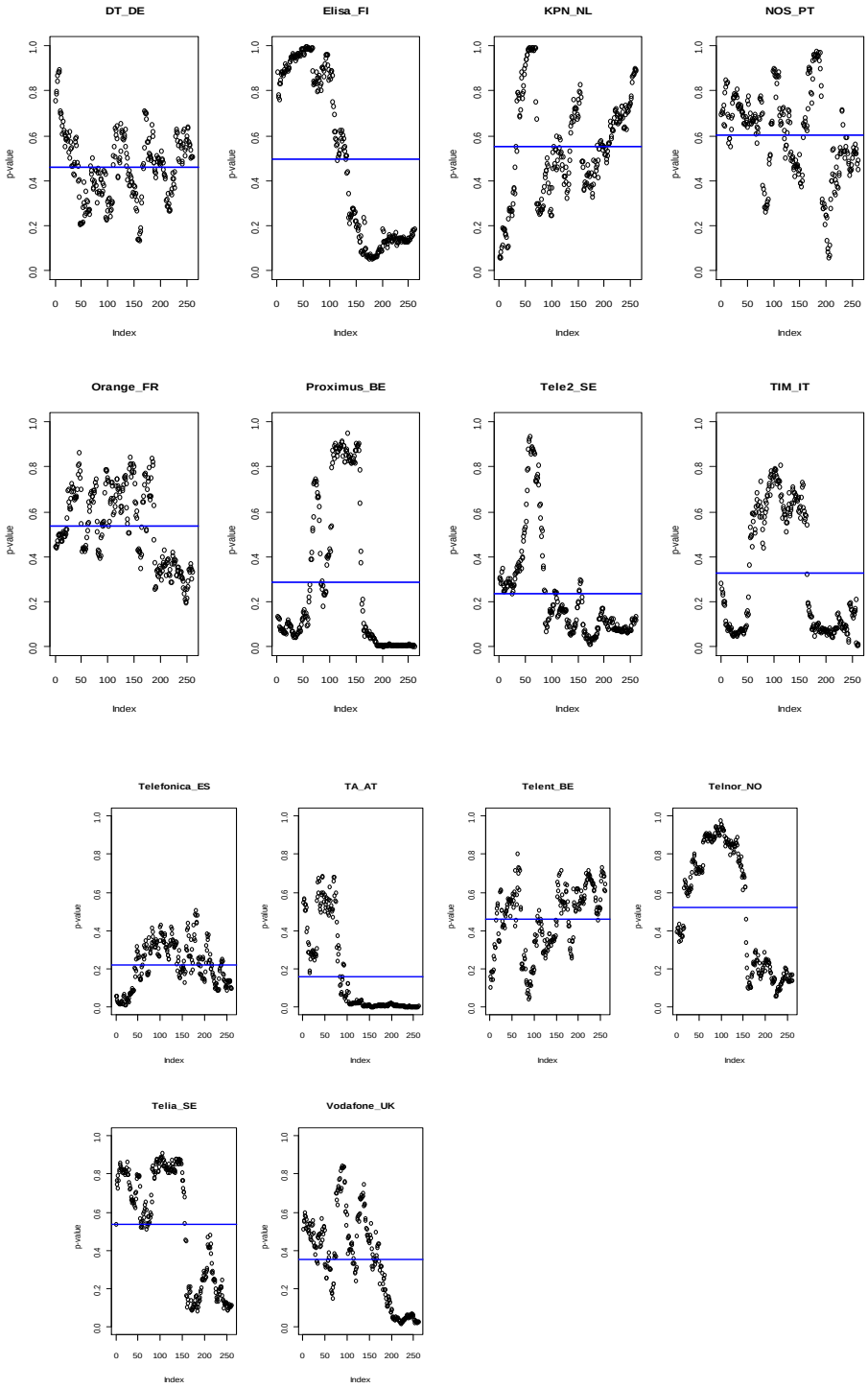
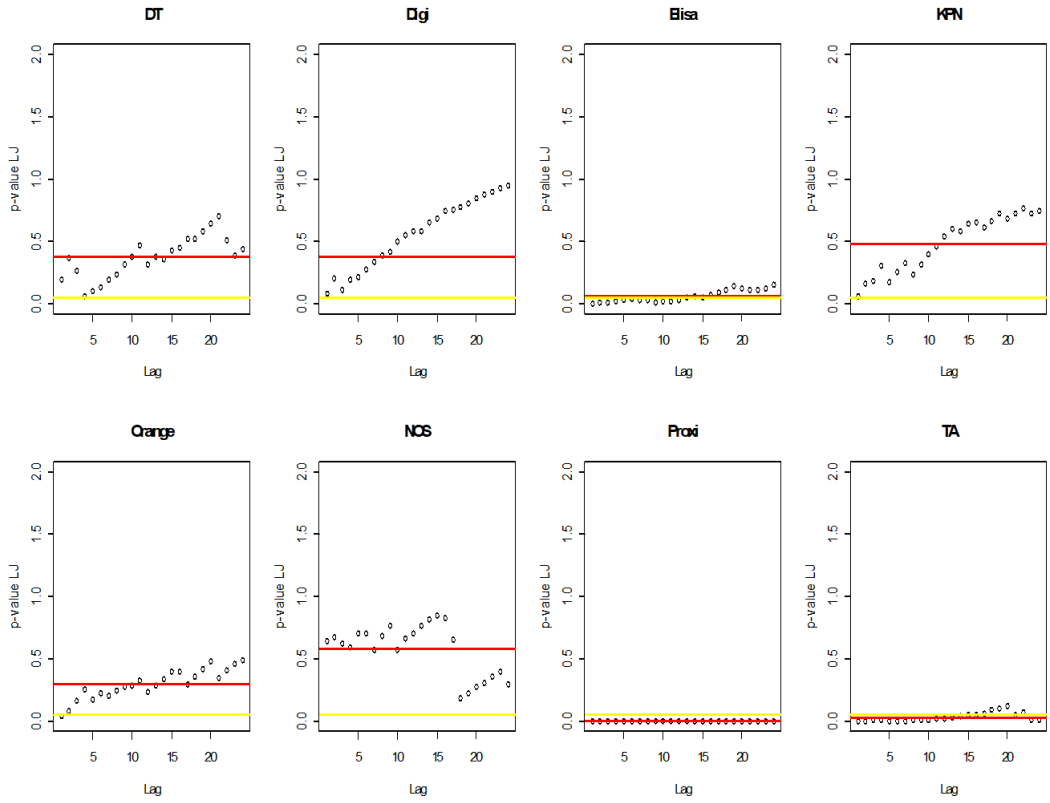


Figure A9 –P-value of Godfrey test Test along the rolling beta (the blue line is the average value reported in table A3)

The p-values from the Ljung-Box and Breusch-Godfrey test applied on 24 lags[171] show on average on the time windows considered that no systematic autocorrelation is present in the residual. Tim, Telenor and Tele2, Proximus, Telekom Austria show a small level of autocorrelation due to their increased volatility during the last year when last year report only Proximus and Telekom Austria show this situation. It is possible to observe that in the long run the quality of the statistical data is on average better than the spot value for all the peers, as the number of failures of the test is marginal along the time series for the most part of the operators and on average all operators in principle pass the test.

In the following picture the test is done considering different lags from 1 to 24 for the spot beta at 1 of April 2022. The statistical test fails at 95 % on average (same as last year) only for Telekom Austria, Proximus, Tele2 and Telenor, considering a level of confidence at 99 % also for those operators the test fails for the most part of the lag. This analysis shows that in every case the level of autocorrelation in the residuals is low so that we can still consider the beta estimation to be reliable and unbiased.



[171] 24 lags are generally accepted as maximum inspection for the test.

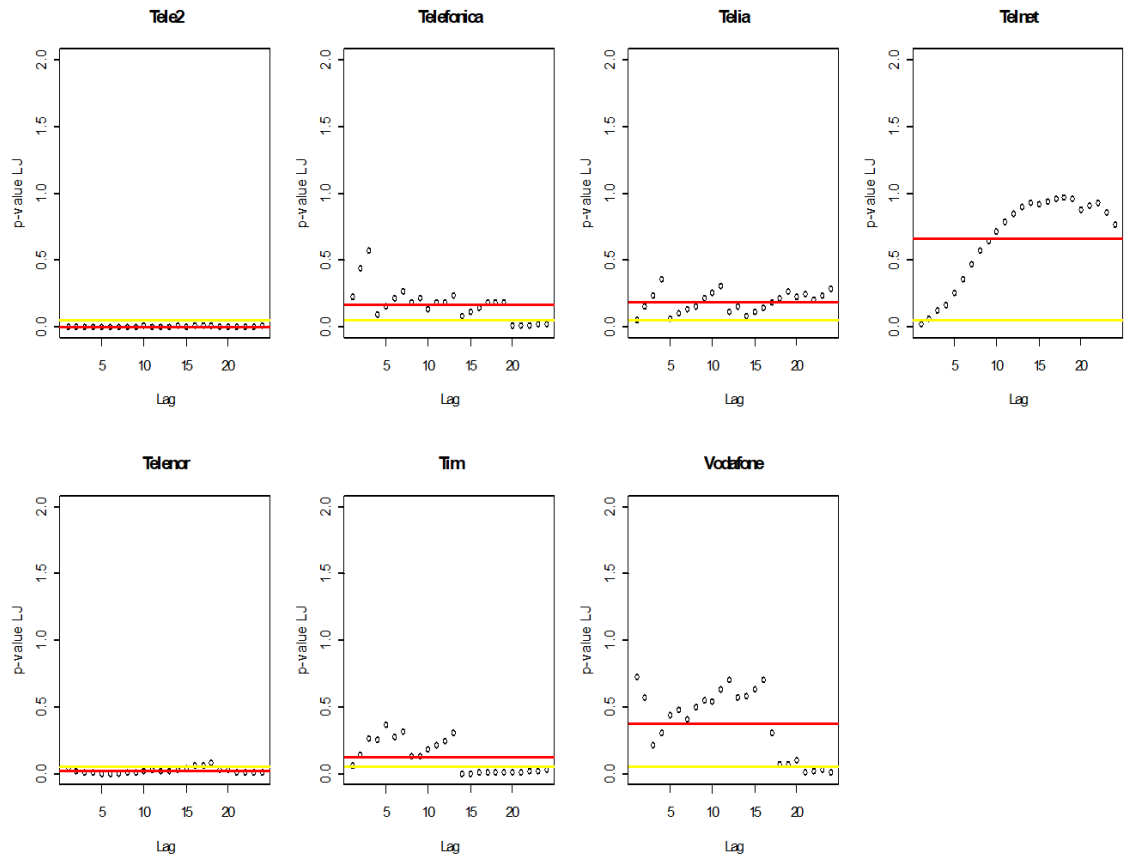


Figure A9: p-values of Ljung-Box test for lag from 1 to 24 (yellow line: the 0.05 limit for null hypothesis evaluation; red line: average p-value over the 24 lags)

The increased volatility that has caused a reduction in the quality of the OLS estimator in comparison to last year, can be understood looking at the squared residuals in the picture below, specifically after the first pandemic induced lockdown in March 2020, which was applied in many European countries, the picture refers to the data for the spot beta at 1 April 2022.

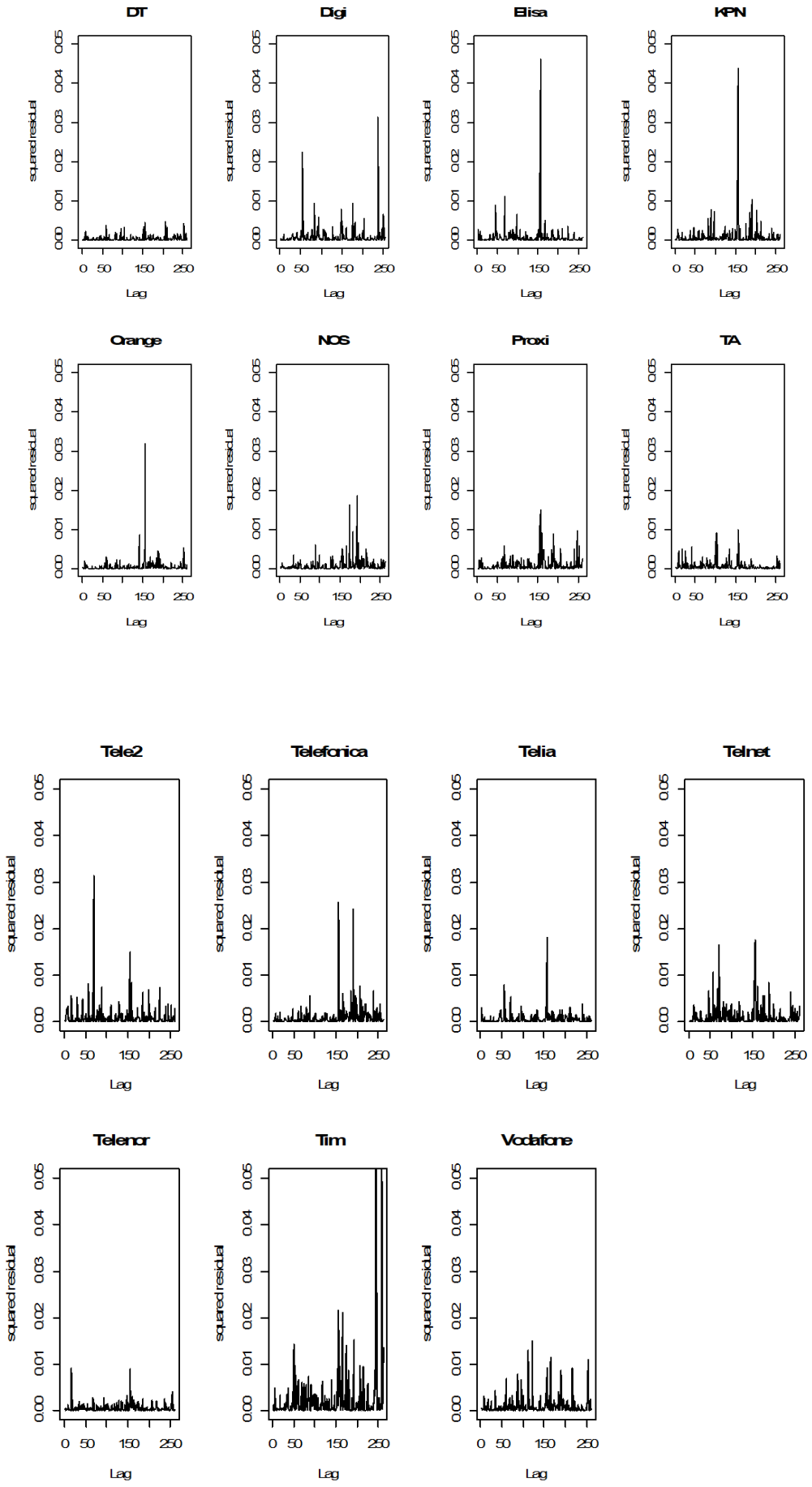

DT
Digi
Elisa
KPN
Orange
NOS
Proxi
TA
Tele2
Telefonica
Telia
Telnet
Telenor
Tim
Vodafone
squared residual
Lag
0.00
0.01
0.02
0.03
0.04
0.05
0
50
150
250

Figure A10: Squared residual representation of spot beta at 1 April 2022

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 aims 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

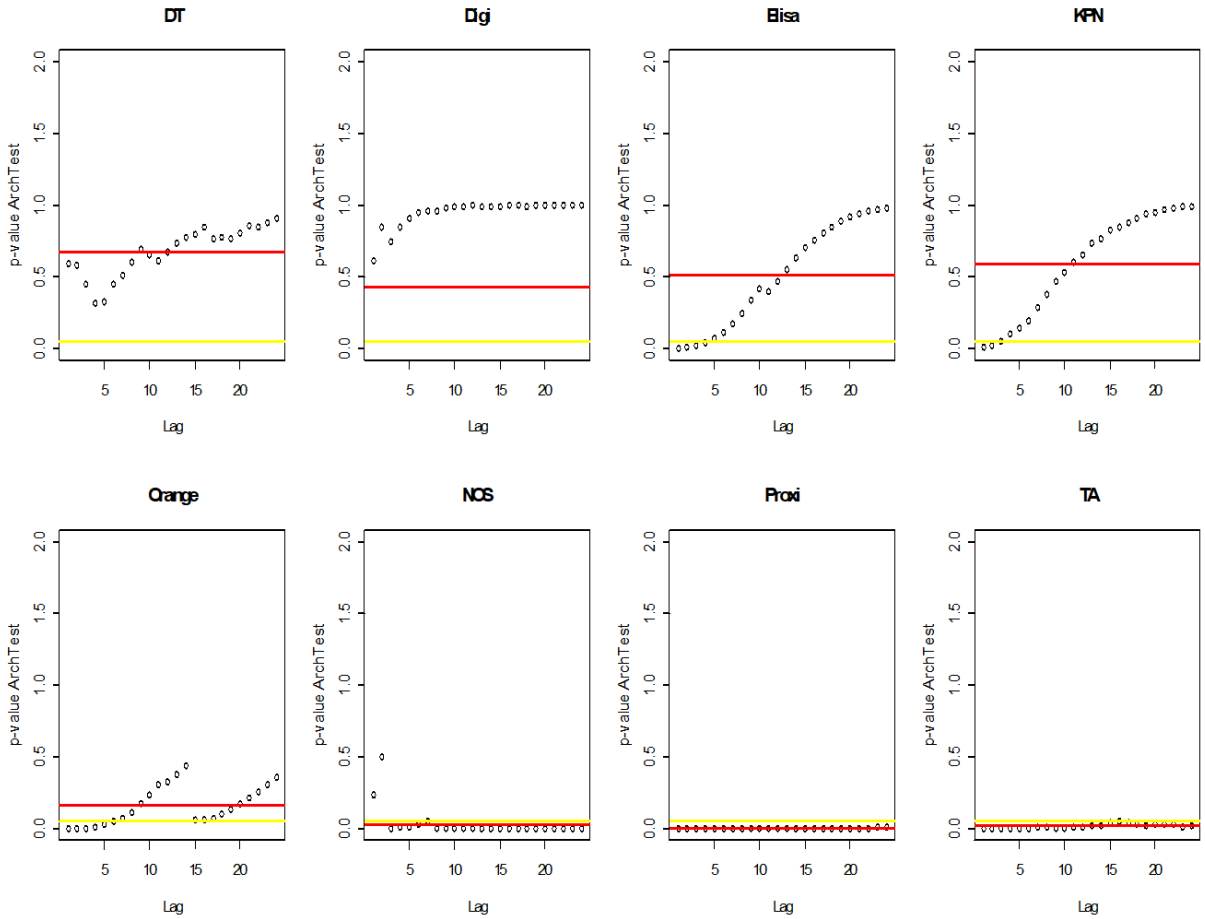
$$a_t^2 = \alpha_0 + \alpha_1 a_{t-1}^2 + \cdots + \alpha_m a_{t-m}^2 + e_t \qquad t = m+1, \ldots, T$$

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.[172] In line with past year the test is applied before on the spot beta and then this year for the rolling beta as well.

With this analysis an Arch effect in the residual can be detected for the most part of the lags in Proximus, Telecom Austria, NOS, Telefonica, and Telia in line with last year report BoR(21)86 that "fail" the test of absence of conditional heteroscedasticity in comparison to last year.[173] In every case the level of "arch effect" can be considered low without the need to apply any adjustment to the equity beta estimated by the OLS as it can be seen in the following.

[172] 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)

[173] The considered operators are those with an Egel test with an average failure of 24 lags.


DT
Digi
Elisa
KFN
Orange
NOS
Proxi
TA
p-value ArchTest
Lag
0.0
0.5
1.0
1.5
2.0
5
10
15
20

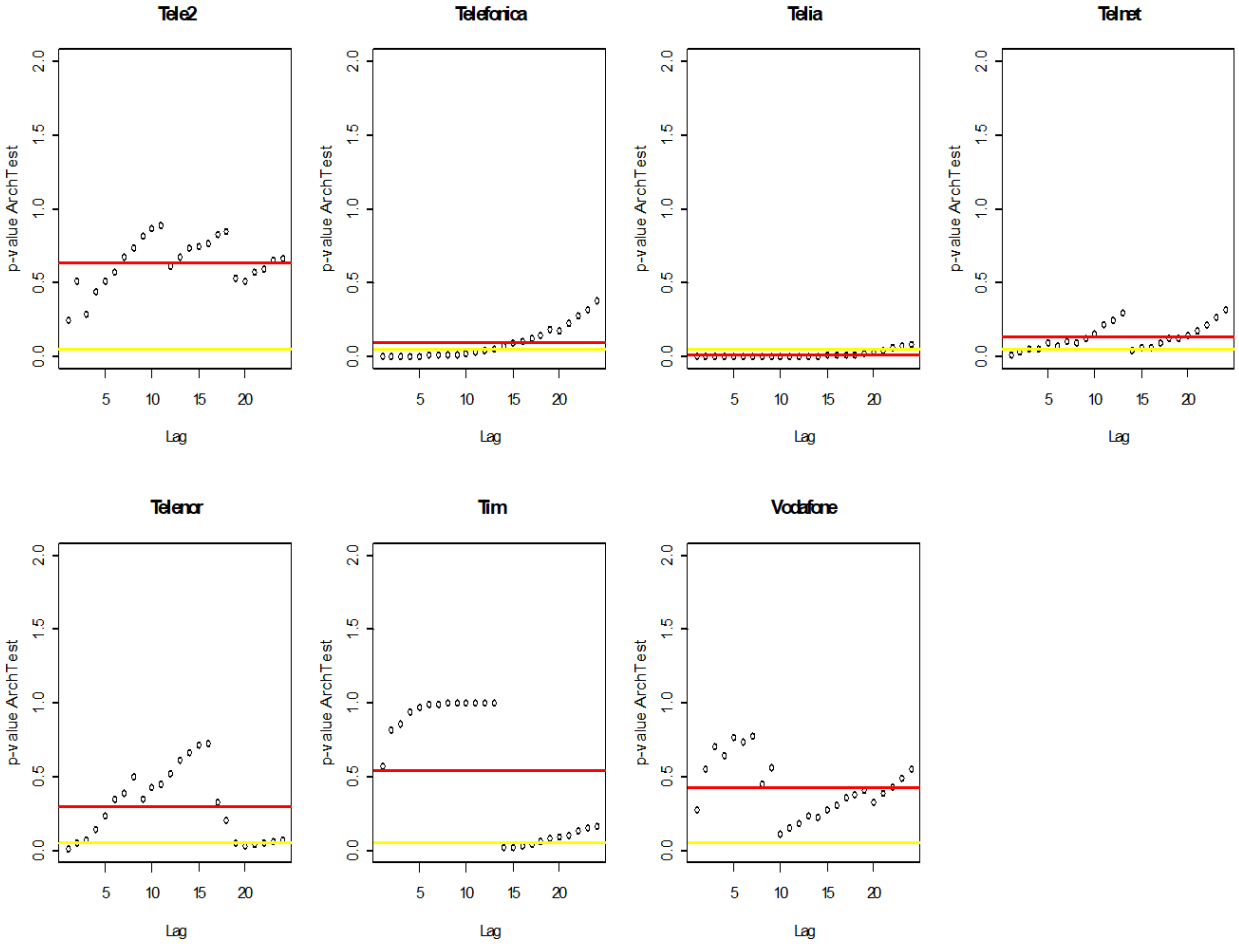


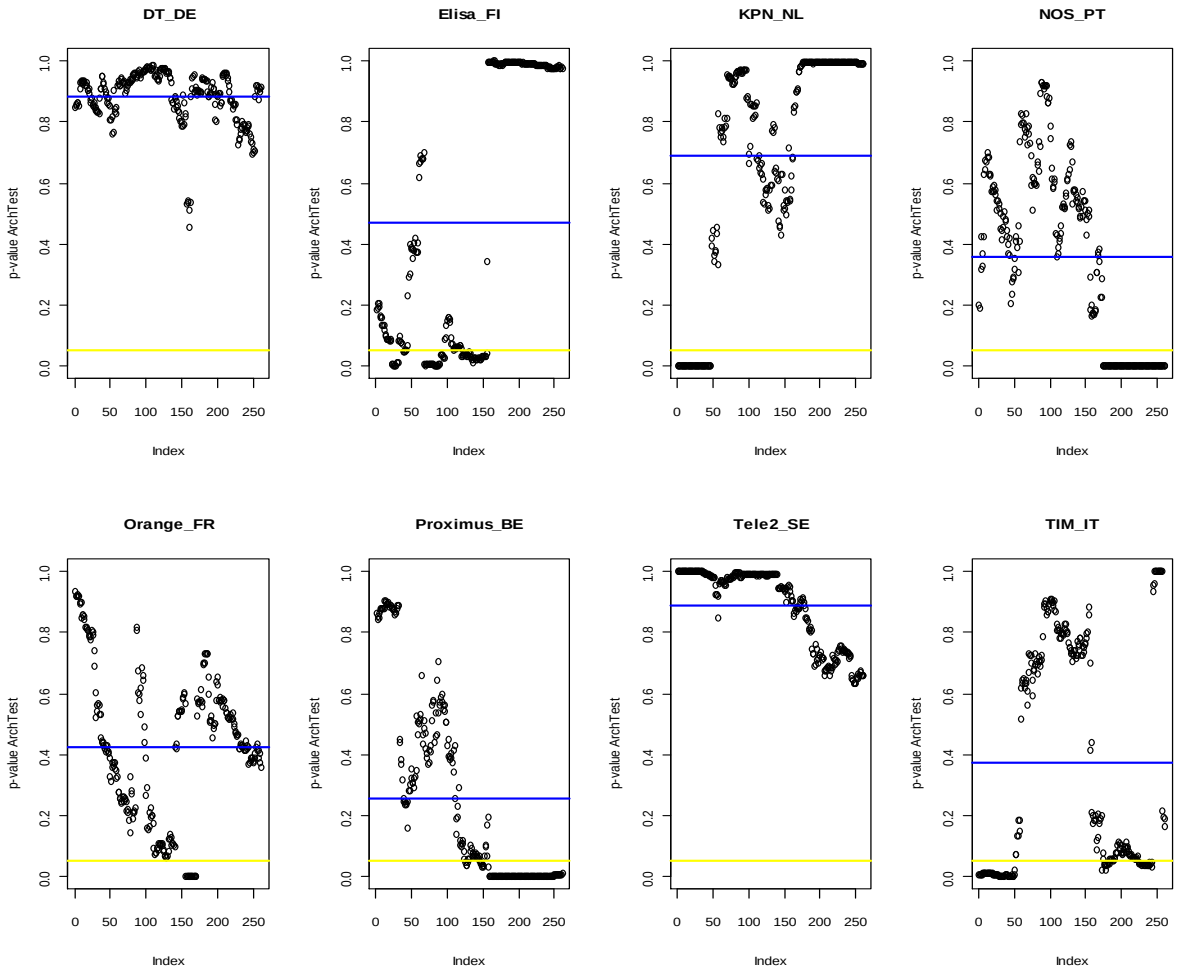
Figure A11 P-values of arch test for different order (lags) in the Egel's test model

In table A5 the p-value of the corresponding outcome of the Arch test evaluated at 24 lags is reported separately for the spot beta at 1 April 2022 and on average over the time window of the rolling beta. As for the other test before the p-value reported for the rolling beta refers to the average p-value detected over the time windows of five year and weekly sampling period. In figure A11 the corresponding evolution over the time windows of five years of the p-value is reported from which the average for the rolling beta is derived. Also for this test it is possible to observe that on average over the five year time window it is passed for all operators with respect to the spot value where three operators fail the test.

	Beta (spot value)	Rolling beta (average)
	Arch test p-value 24 lags (spot)	Arch test p-value 24 lags (average)
DT	0.914107	0.883637
Digi	0.999762	
Elisa	0.978270	0.467960
KPN	0.990128	0.687998

NOS	1.68E-05	0.359511
Orange	0.357883	0.42561
Proximus	0.009273	0.253523
Tele2	0.661305	0.890149
TIM	0.164898	0.375095
Telefonica	0.376688	0.099307
Telekom Austria	0.022083	0.160959
Telenet	0.321661	0.225854
Telenor	0.073722	0.767055
Telia	0.085263	0.463542
Vodafone	0.549759	0.477779

Table A5 Statistic test for the Arch test for 24 lags for rolling beta and spot beta



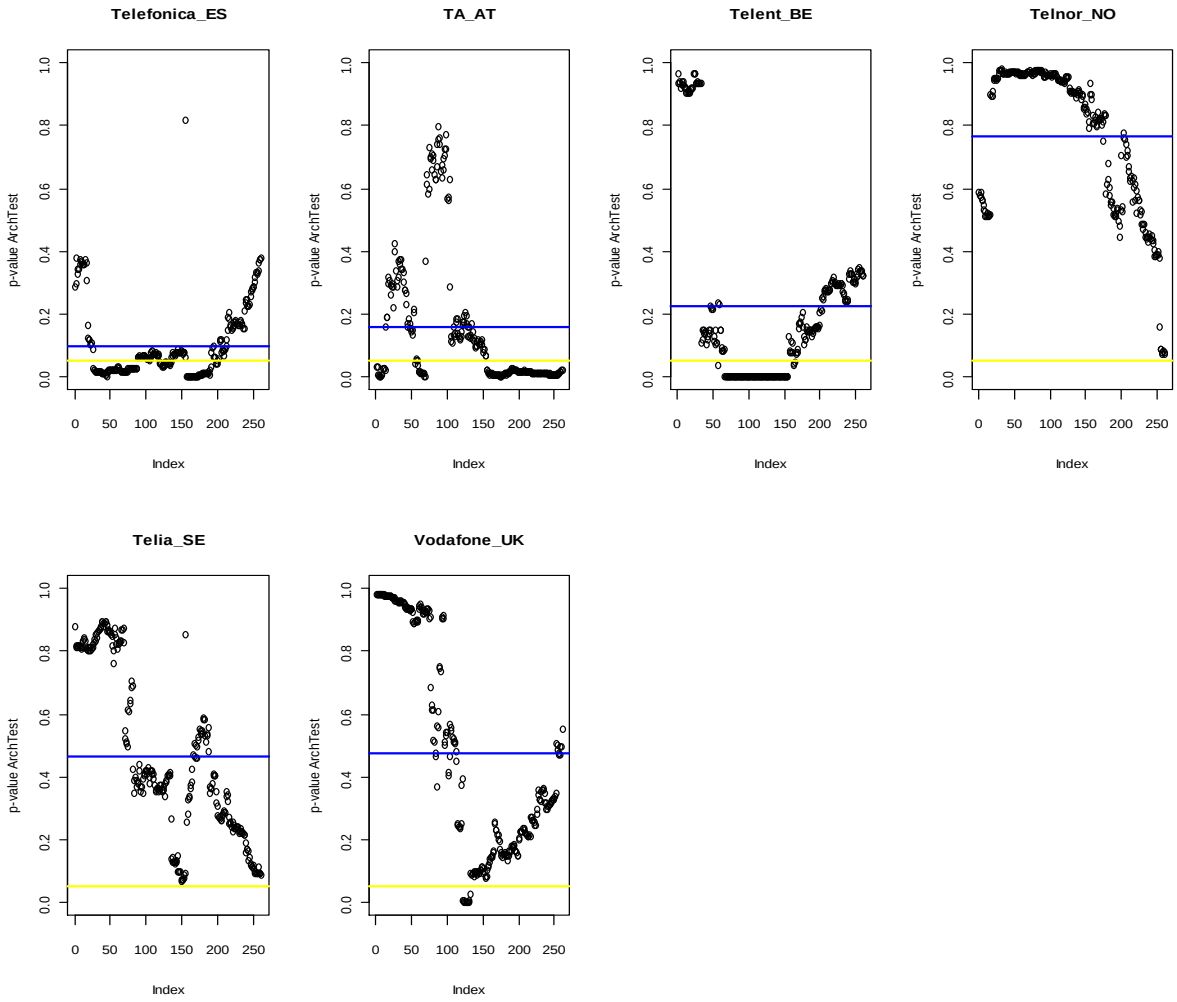


Figure A11 P-values of arch test for different order (lags) in the Egel's test model the blue line report the average value also reported in Table A5. The Yellow line provides the threshold of the test failure

To strengthen the assertion that the beta estimation in every case is not biased in a significant way, as in previous years 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/Garch model estimated with respect to the time series of the standard residuals.

The fit of the residuals with a suitable Arch model has followed the AIC[174] "Akaike Information Criteria", the best model has been selected choosing the one with the lower Akaike Information Criteria parameter considering different GARCH(p,q) models with p,q from 1 to N.

[174] 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.

The regressions lines have been recalculated through a weighted least square with weights equal to the reciprocal of the conditional variance of the Arch/Garch[175] model estimated with relevant order. It provides the following results for a beta adjusted for the three peers that fails the statistical Engle's test for the spot beta at 1 of April 2022.[176] The adjustment calculated with the same procedure for all the other peers provides always an adjustment in absolute term lower than 0.02 as reported in the following.

	EQUITY BETA	EQUITY BETA ADJUSTED	VARIATION	Adjustment in the error term
NOS	0.70	0.69	0.01	Garch(1,1)
PROXIMUS	0.527	0.544	0.02	Garch(1,1)
TA	0.679	0.677	0.002	Arch(1)

Table A6 Adjustment of spot beta on Arch/Garch effect for the three peers that fail the test (Table A5)

This is consistent with the literature that shows small adjustments in situations where there is conditional heteroscedasticity in the CAPM beta estimation.[177]

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 tests 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 other than considering the free float reported in table A1 for each comparable.

Bid–ask spread as a percentage of closing price. This 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. The merit figure has been evaluated considering the data, reported by Bloomberg with respect to the maximum and minimum price of the days.

Share turnover. This is a measure of stock liquidity calculated by dividing the total value of shares traded over a period of time by the average market capitalization 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.

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[175] The Garch model is a generalization of the Arch model when the estimation of the variance of the error term includes both autoregressive term the squared error and of the variance itself. With Garch (p,q), p is the order of the Autoregressive variance and q is the maximum order of Autoregressive term of the square error.

$$\sigma_t^2 = \omega + \alpha_1 \epsilon_{t-1}^2 + \cdots + \alpha_q \epsilon_{t-q}^2 + \beta_1 \sigma_{t-1}^2 + \cdots + \beta_p \sigma_{t-p}^2 = \omega + \sum_{i=1}^{q} \alpha_i \epsilon_{t-i}^2 + \sum_{i=1}^{p} \beta_i \sigma_{t-i}^2$$

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

[177] Armitage, S & Brzeszczynski, J 2011, 'Heteroscedasticity and interval effects in estimating beta: UK evidence', *Applied Financial Economics*, vol. 21, no. 20, pp. 1525-1538.

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, which means a low level of liquidity - this is already seen in the analysis of autocorrelation of residual and free float. The value reports also comparable data considering the values for 2021 of last year report on comparable merit figure.[178]

	Bid-Ask spread	Share Turn Over
DT_DE_21	4.14%	1.15%
DT_DE_22	4.14%	1.15%
ELI_FI_21	4.16%	1.27%
ELI_FI_22	4.04%	1.20%
KPN_NL_21	4.74%	1.72%
KPN_NL_22	4.48%	1.76%
NOS_PT_21	5.00%	0.70%
NOS_PT_22	4.84%	0.74%
ORA_FR_21	4.13%	1.30%
ORA_FR_22	3.93%	1.35%
PRO_BE_21	4.85%	1.03%
PRO_BE_22	4.99%	1.09%
T2_SE_21	4.63%	1.87%
T2_SE_22	4.59%	1.71%
TI_IT_21	7.11%	2.42%
TI_IT_22	7.20%	2.60%
TEL_ES_21	5.49%	2.25%
TEL_ES_22	5.38%	2.13%
TA_AT_21	4.60%	0.11%
TA_AT_22	4.58%	0.10%
TEN_BE_21	5.49%	0.74%
TEN_BE_22	5.46%	0.75%
TEN_NO_21	4.07%	0.58%
TEN_NO_22	3.80%	0.56%
TIA_SE_21	3.76%	1.33%
TIA_SE_22	3.68%	1.33%
VO_UK_21	5.02%	1.14%
VO_UK_22	5.11%	1.14%
Digi_22	4.24%	0.16%
Average_21	4.80%	1.26%
Average_22	4.73%	1.26%

Table A8

[178] This year report the Bid-ask spread is evaluated considering the high and lower price in the same trading day. In the last year report we referred to last 20 days.

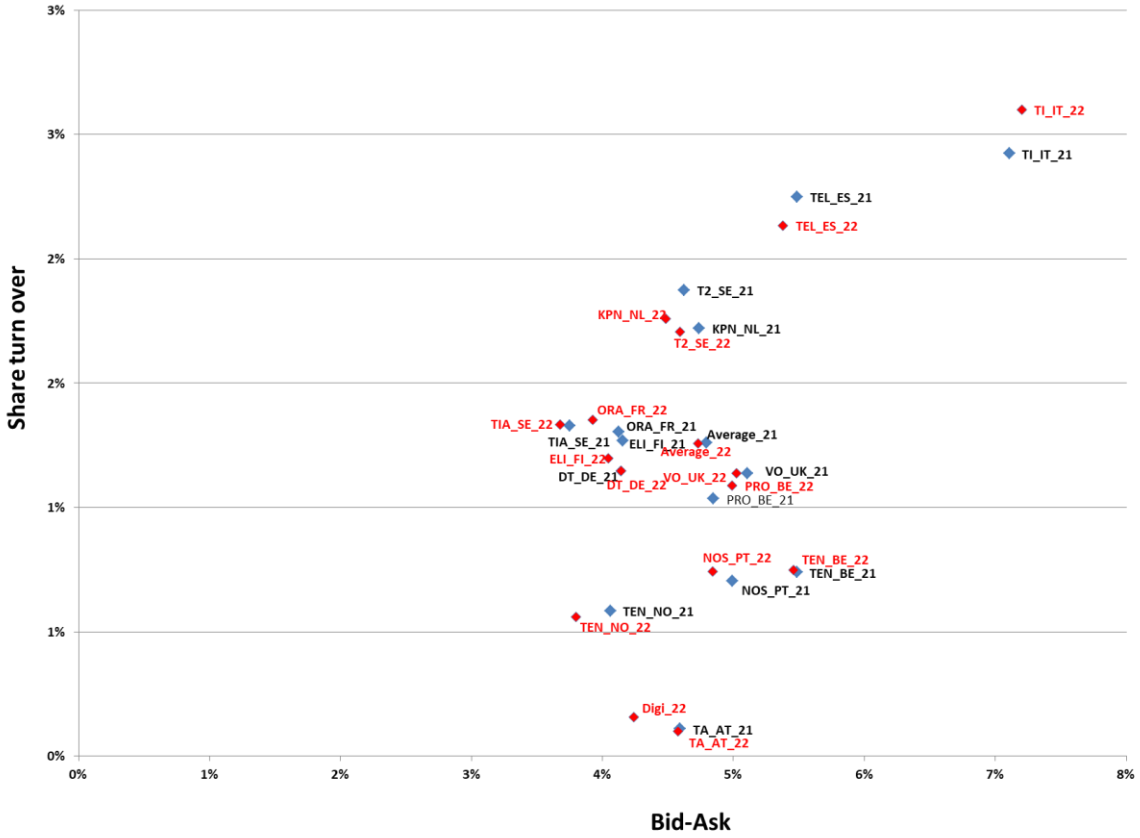

Figure A13 Bid-ask spread and Share turnover

Annex 4: Table of bond indices

Country	Thicker Bloomberg Barclays Index Global index	
Bulgaria	I11095US	Bulgaria Global Aggregate Index
Croatia	I03354US	Croatia Global Aggregate Total return Index Unhedged
Cyprus	I03355US	Cyprus Global Aggregate Total return Index Unhedged
Czech Rep.	I03356US	CzechRep Global Aggregate Return Total return Index
Estonia	I13197US	Estonia Global Aggregate Return Total return Index
Greece	I03361US	Greece Global Aggregate Total return index Unhedged
Hungary	I03362US	Hungary Global Aggregate Total return index Unhedged
Latvia	I09101US	Latvia Global Aggregate Total return index Unhedged
Lithuania	I06240US	Lithuania Global Aggregate Total return index Unhedged
Luxemburg	I03365US	Luxemburg Global Aggregate Total return index Unhedged
Malta		
Poland	I03368US	Poland Global Aggregate Total return index Unhedged
Romania	I13198US	Romania Global Aggregate
Slovakia	I06239US	Slovakia Global Aggregate Total return index
Slovenia	I03370US	Slovenia Global Aggregate Total return index
Iceland	I11096US	Iceland Global Aggregate

The choice of the index for the bond return evaluation of Eastern European countries, Iceland and Luxemburg has been based on the family of homogeneous Bloomberg Barclays Global Aggregate indexes[179]. This choice is mainly guided by the fact that the Global Bloomberg Barclays index has a longer time series available at country level. The bond index return has

[179] https://data.bloomberglp.com/professional/sites/10/Bloomberg-Barclays-Methodology1.pdf

been evaluated (consistent with last year's report) using, for each country, the time series of the last price with a monthly sampling period, in line with the DMS time series, as P_t/P_(t-1) -1 with P_t the price at Year t and P_(t-1) the price in the Year t-1.

In this year's report the index chosen includes longer data series. The eligibility criteria of bonds' components in the Global aggregate index is mainly based on investment grade. Classes of indexes based on Emerging Market[180] or Inflation linked Indexes were excluded.

[180] Emerging market debts are specific indexes where the members are chosen based on certain rules and reviewed annually.