

# RA Report Chapter 5 - WACC

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## List of Abbreviations

### C

CoD *Cost of Debt*

### D

DMS *Dimson, Marsh, Staunton*

### E

ERP *Equity Risk Premium*

### M

MSCI *Morgan Stanley Capital International*

### Q

QE *Quantitative Easing*

### R

RFR *Risk Free Rate*

### S

S&P *Standard & Poor Credit Rating Agency*

### T

TMI *Total Market Index*

TMR *Total Market Return*

## 5. The Weighted Average Cost of Capital (WACC)

### 5.1 Introduction and main goals of the section

A specific in-depth focus on WACC in BEREC's Regulatory Accounting reports started with Chapter 5 of the 2017 RA Report (BoR (17) 169), which surveyed legacy WACC values, benchmarking final rates and methodologies for single parameters estimation within the WACC formula computed by NRAs - specifically in market 3a and, more in general, in fixed markets.<sup>1</sup> It also provided information on the evolution of the WACC value over time.

The 2020 and 2021 RA report (BoR (20) 210, BoR (21) 161) provided an update of the information reported since BoR (17) 169 both for parameter values and methodologies with a cut-off date respectively of 1<sup>st</sup> April 2020 and 2021 including a monitoring exercise of the adoption of the Commission notice. The current 2022 report presents an up to date version of the WACC benchmark with a cut-off date of 1<sup>st</sup> April 2022.

Theoretical and practical issues concerning WACC were also covered in the opinion BoR (18) 167<sup>2</sup> issued by BEREC in response to the public Consultation launched by the European Commission.

During 2019 BEREC also provided further input to the Commission's considerations for the non-binding WACC Notice for legacy infrastructure which was published on 7 Nov. 2019 (hereinafter referred to as WACC Notice). The WACC Notice is an instrument for the review of national notifications in the EU electronic communication sector. In 2020, 2021 and 2022 BEREC calculated the main WACC parameters according to the methodology foreseen in the non-binding WACC Notice (BoR (20) 116) (BoR (21) 86 and BoR (22) 70).

In line with the before mentioned BEREC input to the Commission consultation on the non-binding WACC Notice, (BoR (18) 167), it is important to point out that NRAs must retain flexibility within the multidimensional details of their WACC estimation depending on national economic conditions, availability of data, the degree of wholesale and retail competition (which influences the beta), regulatory goals/strategy, judicial reviews, etc., whilst the importance of consistent application of the methodology foreseen in the Notice is acknowledged. NRAs must, of course, be able to substantiate individual approaches to the Commission, the regulated entity, competitors and other market participants, not least to provide legal certainty of their decisions. The Notice aims to ensure a consistent calculation of the WACC by NRAs – which is a core element of any regulatory pricing decision NRAs take - thereby contributing to the development of the internal electronic communications market. The BEREC report on WACC parameter calculations (BoR (20)116, BoR (21) 86, BoR(22)70) provides a specific guidance on the application of the Notice to NRAs, providing single values for the RFR and ERP and range of values for the beta, gearing and cost of debt.

Compared to the BEREC WACC parameters Reports (BoR (20)116, BoR (21) 86, BoR (22) 70), the present BEREC Regulatory Accounting Report WACC chapter is of a more descriptive nature, aiming at reporting and analysing NRAs WACC calculations “as is” as well at showing the evolution over time, in line with previous versions.

<sup>1</sup> The information collected and presented in the report refers to market 3a. In some cases, due to country specificity issues, data provided can refer to the fixed market (i.e. market 1, market 3b, market 4). Where different data sets have been provided by NRAs this will be highlighted in the text.

<sup>2</sup> [https://BERECBEREC.europa.eu/eng/document\\_register/subject\\_matter/BERECBEREC/opinions/8257-BERECBEREC-position-paper-input-to-the-commission8217s-wacc-consultation-2018](https://BERECBEREC.europa.eu/eng/document_register/subject_matter/BERECBEREC/opinions/8257-BERECBEREC-position-paper-input-to-the-commission8217s-wacc-consultation-2018).

The following analysis is based on an updated questionnaire targeted to collect information on:

- parameter values to evaluate the WACC;
- main methodologies currently used to estimate each parameter (based on predefined options) and adjustments that NRAs may apply to their standard approach in order to take into account country specificity;
- evolution over time of methodologies and parameter values used by NRAs.

The questionnaire asked NRAs to provide updated information on pre-tax WACC for legacy copper network and other fixed products if calculated (i.e. civil infrastructures)<sup>3</sup> and the following main parameters of the WACC formula based on CAPM methodology – in force in April 2022: i) Risk Free Rate (RFR); ii) Cost of Debt (CoD); iii) Beta; iv) Equity Risk Premium (ERP); v) Gearing; vi) Tax.

In Figure 1 the year of information available for the recorded fixed market WACC calculation is reported for each country as well as their general frequency of updating (the RA EWG started to collect in-depth information about single parameters and the WACC calculation in 2016).

Figure 1 displays the information collected for each country (the cut-off date is 1<sup>st</sup> April).<sup>4</sup> The cells marked “X” indicate that in that year single values of each WACC parameter were collected in the RA EWG data base and new value is in charge with respect to the past. Colours provide information on the years where NRAs have taken a decision for the fixed market WACC since 2008: green marks for decisions, red for public consultations<sup>5</sup>, blue for decisions in force in 2022, but taken after the cut-off date of the 1<sup>st</sup> April 2022, orange for the cases where NRAs declared that a regulated WACC is not any more in charge<sup>6</sup>.

WACC methodologies and values for the fixed market are recorded for 32 NRAs<sup>7</sup>. Most NRAs (18) update the WACC in line with their market analysis or when pricing decisions have been taken. In these cases, a market-specific WACC may be in force for 2 or more years. Some NRAs update yearly (9), but in some cases the update only comes into force when new pricing decisions will be taken.

The dataset used for the following analysis takes into consideration 132 observations for fixed market of all 6 parameters previously listed and 1 final value based on information collected and related to the period 2008-2022. The collected data refers to information provided by NRAs and is updated for the 2022 report.

All values provided by NRAs are consistent with their final nominal pre-tax WACC calculation meaning that in some cases parameters also contain country specific adjustments applied to the cost of equity - attributed mainly to RFR, ERP or Beta according to the provided information. Technical adjustments are also reported.

<sup>3</sup> From the replies no NRA calculates a different WACC for civil infrastructure access.

<sup>4</sup> The table (Figure 1 and 1c) reports the year of adoption [April N-1 to April N], or, when different, of application.

<sup>5</sup> In the following analysis the latest available information is displayed in line with each NRA's information on the appropriate value to be considered for the 2022 report. This approach allows the report to be updated taking into account the information on the current status and time of adoption of the information provided.

<sup>6</sup> This is the case of BG, DK and NL. BG doesn't evaluate the WACC any more, as all fixed markets (1 and 2) have been found competitive, DK declared that it is currently subject to a commitment period which has begun since 2021. The prices and the conditions are therefore framed in the applicable commitment periods in such a case. It means that a regulated WACC has not been calculated by the NRA for 2022. NL doesn't regulate fixed market any more due to court decision (see RA section) and so no WACC estimation is done.

<sup>7</sup> EE states that its final WACC value is obtained using a benchmark among other NRAs following Berec benchmark activity, rather than applying a formula.

The 2022 report, in line with the 2021 version, also provides statistics on NGA/VHCN WACC where separately evaluated by NRAs .

In line with 2021 report this year's report also focuses on the application of the WACC Notice and, for this reason, the current WACC in charge differentiates NRAs that completely apply the WACC Notice, NRAs that partially apply the WACC Notice and NRAs that do not (yet) apply the WACC Notice. Reasons given for non-application of the WACC Notice include: i) the WACC has been evaluated before the WACC Notice came into force; ii) NRAs have made use of the transition period specified within the WACC Notice; iii) other reasons.

In line with previous year's report a specific analysis on the dispersion of the values throughout the years is included by using box plot analysis. The main objective is to obtain a more detailed quantitative picture of the convergence path of the values. Taking into account the 25<sup>o</sup> percentile and 75<sup>o</sup> percentile of the values of each parameter distribution, with longer time series a general reduction of the dispersion for all values may be observed: mainly for RFR and, to a lesser extent, ERP<sup>8</sup>, CoD, beta and gearing

Appendix II of the current report contains a more in-depth analysis of WACC parameters in terms of causal correlations as a follow-up from last year's report (see appendix 2 of BoR (21) 161). The information is reported for all countries that have provided information and separately for EU member states.

Figure 1 - WACC database and frequency of update/calculation<sup>9</sup>

		Fixed Market (Year of adoption)															Frequency	
		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022		
EU member state	AT		x			x			x						x			MA/RP
	BE	x		x					x				x					MA/RP
	BG						x			x								
	CY				x			x		x	x	x	x	x	x	x	x	MA/RP
	CZ									x			x				x	MA/RP
	DE				x						x	x	x	x	x	x	x	YEARLY
	DK								x	x	x	x	x	x				
	EE																	
	EL						x		x		x	x		x				MA/RP
	ES		x				x			x	x	x	x	x	x	x		YEARLY
	FI		x				x				x							MA/RP
	FR					x	x			x		x				x		MA/RP
	HR						x				x				x			MA/RP
	HU								x	x	x	x	x	x	x	x	x	YEARLY
	IE		x						x						x			MA/RP
	IT			x					x				x					MA/RP
	LT								x			x	x	x	x	x		YEARLY
	LU									x						x		MA/RP
	LV															x	x	
	MT					x							x					MA/RP
NL					x				x									
PL											x	x	x	x	x		YEARLY	
PT								x	x	x		x	x	x	x		YEARLY	
RO						x							x				MA/RP	
SE												x	x		x		MA/RP	
SI							x					x			x		MA/RP	
SK						x			x			x	x			x	YEARLY	
NO EU member	CH	x					x				x	x	x					YEARLY
	IS											x						
	LI							x										MA/RP
	MK		x															
	ME															x		
	NO						x				x	x				x		MA/RP
	RS							x	x	x	x	x	x	x	x	x		YEARLY
UK			x					x				x	x				MA/RP	
Number of	2	5	3	2	4	10	4	11	12	12	16	18	13	15	5			

<sup>8</sup> For ERP a reduction of "outlier" values is more evident year by year.

<sup>9</sup> BNetZ WACC decisions are taken on the 30.06. of each year, therefore values stated are in use and valid for Q1/Q2 of the current year only. CH have provided updated information for 2017 (2018 RA report), 2018 (2019 RA report), and for 2019; in those cases WACC has been updated by the SMP operator even if no specific decision have been taken into account by the NRA: for this reason in figure 1 the corresponding cell is white (figures on WACC in the following refer to the last WACC figure provided for 2019). For FI due to supreme court decision (11/2020) price caps are no longer valid and WACC in force in fixed network is therefore no longer in charge from the year 2017. IT in November 2022 launched a public consultation including WACC fully in line with the Commission notice.

<b>X</b>	<b>New data reported with respect to 2021 RA report</b>
<b>x</b>	<b>Available in the RA database</b>
	<b>Adopted decision</b>
	<b>Public consultation</b>
	<b>In charge for the year report, but adopted after the cut off date of 1 April</b>
	<b>No Wacc in charge</b>

Source: BEREC RA database 2022

### Focus on the application of the WACC Notice

In line with the 2021 year report the present report provides also information about the application of the WACC Notice and on the use of the corresponding parameters estimated by BEREC Report BoR(20)116, BoR(21)86 and BoR(22)70.

The WACC Notice was adopted on 19<sup>th</sup> November 2019. Therefore most NRAs, that have updated their WACC since 2020 have fully or to partially taken into account the methodology proposed in the WACC Notice, even if making use of the transition period starting from the 1 July 2020 to 30 June 2021<sup>10</sup>.

The following table reports the main methodology for legacy WACC estimation available in the WACC Notice and the corresponding relevant values included in the BEREC WACC report BoR(20)116 BoR(21)86 and BoR(22)70<sup>11</sup>.

Figure 1b - WACC Notice approach and WACC BEREC report BoR(20)116 BoR(21)86, BoR(22)70 main values

	Commission Notice methodology (by points)	BEREC WACC BoR(20)116 (values)	BEREC WACC BoR(21)86 (values)	BEREC WACC BoR(22)70 (values)
RFR	-Own country bond; -10 Year bond, -weekly sampling period; -five years time windows for the average.	Eurostat based calculation on monthly data for each country	Eurostat based calculation on monthly data for each country	Eurostat based calculation on monthly data for each country
Debt premium	Peer group of companies usually including national SMP:  -maturities closer to 10 years, -weekly sampling period, -five years time windows for the average	14 comparable companies: 1.30% (arithmetic average); 3.02%(max); 0.42% (min)	14 comparable companies: 1.15% (arithmetic average); 3.12%(max); 0.44% (min)	15 comparable companies: 1.31% (arithmetic average); 3.17%(max); 0.41%(min)
ERP	Single European Equity risk premium based on historical data (arithmetic average of historical equity premium)	Single EU ERP: 5.31%	Single EU ERP: 5.50%	Single EU ERP: 5.70%

<sup>10</sup> Point 71 of the Notice: “When reviewing notifications under the Article 7 procedure, the Commission will, as a rule, use the methodology described in the present Notice from 1 July 2020. However, in justified cases and at the request of the notifying NRA, the Commission will not base its review of draft measures on this methodology during a transitional period of up to one year (starting from 1 July 2020). For example, this may be justified when the review based on this methodology, if applied by the national regulator, would result in significant changes in the WACC value undermining regulatory stability and predictability. During the transitional period of one year, the Commission will also take into consideration if the full set of WACC parameters to be published by BEREC is available and the possibility for the NRAs to rely on those parameters in their analysis”.

<sup>11</sup> This report refer also to the BEREC WACC report published in June 2022 as, even if published after the cut-off date of 1th of April 2022, one NRA adopted a WACC decision retroactively for all 2022, using last available data reported in Bor(22)70.

Equity Beta	Peer group of companies usually including national SMP -estimation starting from unlevered beta; - weekly sampling period, - five years time windows - European market index for regression estimation and - Miller formula including 0,1 for beta debt for beta levered and unlevered estimation	14 comparable companies: 0.52 (arithmetic average) asset beta; 0.69 (max) asset beta; 0.38 (min) asset beta; 0.79 (arithmetic average) equity beta; 1.12 (maximum) equity beta; 0.59 (minimum) equity beta.	14 comparable companies: 0.47 (arithmetic average) asset beta; 0.57 (max) asset beta; 0.33 (min) asset beta; 0.74 (arithmetic average) equity beta; 1.12 (maximum) equity beta; 0.42 (minimum) equity beta.	15 comparable companies: 0.41 (arithmetic average) asset beta; 0.5 (max) asset beta; 0.22 (min) asset beta; 0.67 (arithmetic average) equity beta; 1.02 (maximum) equity beta; 0.33 (minimum) equity beta.
Gearing	- Peer group of companies usually including national SMP Debt component from Book value (only long term debt); - Equity component through market value; - five years time windows; - weekly sampling period	14 comparable companies: 36.95% (arithmetic average); 63.8% (max); 13.51% (min).	14 comparable companies: 39.2% (arithmetic average); 63.24% (max); 13.61% (min).	15 comparable companies: 42.42% (arithmetic average); 70.52% (max); 13.28% (min).

Source: BEREC RA

26<sup>12</sup> NRAs have provided information on their final fixed market WACC estimation in the 2022 survey, in which 15 NRAs have provided updated values, as shown in Table 1 (AT, CY, CZ, DE, ES, HU, LT, LV, LU, NO, PT, RS, SE, SI, SK updated values reported in red), and then 11 NRAs of those 15 NRAs that updated the value since last year report fully apply the WACC Notice AT, CZ, ES, HU, LU, LV, NO, PT, SE, SI, SK and calculate parameters according to the corresponding BEREC parameters report. DE and CY apply the Notice and BEREC parameters report partially. Including the NRAs that have applied the Commission Notice since last year, 13 are the NRAs that fully apply the Notice and the corresponding relevant BEREC parameters estimation (AT, CZ, ES, FR, HU, LU, LV, NO, PL, PT, SE, SI, SK).

12 NRAs have notified the WACC to the Commission since the Commission Notice is in charge and in one case (where the Notice was only partially applied (DE)) the Commission has invited BNetzA to adjust the methodology to come in line with the five year averaging window for determining the risk free rate as early as possible.

Out of the EU NRAs, RO has notified the WACC to the Commission, making use of the transition period due to the fact that during their consultation period the BEREC parameter calculation was not yet available. Three NRAs (ME, EL, LT) have not (yet) applied the WACC Notice even though their decision has been taken during 2020 or 2021 (at a time when the transition period still applied). In EL the fixed WACC has been notified and adopted in 2020, for LT the national law regulates the WACC calculation.

In all other cases the WACC was adopted before the WACC Notice came into force. In one case (IE) the WACC was notified before 1<sup>st</sup> July 2020 and the consultation parameters were evaluated before the WACC Notice and the BEREC Report were available. In IE a new value is in charge, but it was adopted after the cut off date of 1 of April 2022, this new value is in line with the methodology prescribed in a decision of Comreg adopted in 2020 that doesn't follow the Commission Notice approach.<sup>13</sup> SK used Bor(22)70 as the relevant BEREC WACC report for parameter estimation even if though it was published later than the cut off date of 1st of April 2022, but the WACC estimation is in charge retroactively before the 1st of April 2022.

To summarise: in the present survey, the 13 NRAs that have estimated the WACC following both the Commission WACC Notice and the relevant BEREC WACC parameters report have followed it for all five parameters (RFR, ERP, Beta, gearing and debt premium) and thus they are considered to fully

<sup>12</sup> One NRA didn't reply to the questionnaire (ME) so value from last year survey is reported.

<sup>13</sup> <https://www.comreg.ie/media/2022/06/ComReg-2247.pdf>



apply the methodology and the BEREK parameter estimation. The five NRAs that partially apply the Commission Notice differentiate their approach: in case of DE the differentiation to a fully application is related to only one parameter (RFR) where the time windows for the average has been extended to 10 years instead of five years, all other parameters being in line with the BEREK parameters report; in case of CY only the ERP is in line with the ERP estimated by Bor(21)161; for RS the ERP and the Equity Beta are in line with BoR(21)86; specific methodology and adjustments for national circumstances are applied for other parameters; for HR the partial application is only related to the fact that the estimation of parameters is not deviating substantially the relevant BEREK report even if the methodology of the estimation of each parameter is different from the one described in the Commission Notice and the relevant BEREK report; RO estimated the WACC parameters before the first relevant BEREK report was published.

In the following table the information on all NRAs that fully or partially apply the Commission Notice and the relevant BEREK report are given. In the parameters picture a green label is used to highlight if the full application of the Notice is applied.

The following table summarises the situation before the 1<sup>st</sup> April 2022.

Figure 1c – Adoption of the WACC Notice<sup>14</sup>

Country	Year of adoption (last value provided for RA report 2022)	Did you apply the Commission Notice of 6th November 2019?	Did you use the transition period for not applying or partially applying the Notice?	Did you notify the WACC after the adoption of the Commission Notice	-if yes did you receive comments from the Commission?	Please provide further details on the comments received	Report Berec used
CY	2022	Yes Partially	Yes	No			
CZ	2022	Yes fully	No	Yes	No		Bor(21)86
DE	2022	Yes Partially	No	Yes	Yes	The Commission invites BNetzA to adjust to the use of the five year averaging window for determining the risk free rate as early as possible.	Bor(21)86
LT	2022	No	No	No			
LV	2022	Yes fully	No	No			Bor(21)86
SK	2022	Yes fully	No	No			Bor(22)70
AT	2021	Yes fully	No	Yes	No		Bor(21)86
ES	2021	Yes fully	No	Yes	No		Bor(21)86
FR	2021	Yes fully	No	Yes	No		Bor(20)116
HU	2021	Yes fully	No	No			Bor(21)86
LU	2021	Yes fully	No	Yes	No		Bor(20)116
PT	2021	Yes fully	No	Yes	Yes	Mainly related to the timeframe for updating reference offers.	Bor(21)86
SE	2021	Yes fully	No	Yes	No		Bor(20)116
SI	2021	Yes fully	No	Yes	No		Bor(20)116
NO	2021	Yes fully	No	Yes	No		Bor(21)86
RS	2021	Yes Partially	Yes				
EL	2020	No					
HR	2020	Yes Partially					
IE	2020	Value in charge before the issue of EC notice					
PL	2020	Yes fully	No	Yes	Yes	A commets from the Commission concern only formal procedure.	Bor(20)116
RO	2020	Yes Partially	Yes	Yes	Yes	EC considered ANCOM justification for non-application of the Notice (i.e. the BEREC WACC parameters report was not published when ANCOM calculated and nationally consulted the draft measure) a valid reason	NO
BE	2019	Value in charge before the issue of EC notice					
IT	2019	Value in charge before the issue of EC notice					
MT	2019	Value in charge before the issue of EC notice					
FI	2017	Value in charge before the issue of EC notice					
LI	2014	Value in charge before the issue of EC notice					

Source: BEREC RA database 2022

<sup>14</sup> In red are those NRAs that apply the full notice in blu the NRAs that apply only partially the notice in black the countries that don't apply the notice at all. .

## 5.2 WACC Nominal pre-tax synthetic value

Figure 2 reports the main statistics related to nominal pre-tax WACC for all NRAs that have provided information in 2022 (27 NRAs<sup>15</sup> for fixed) and, separately, for the EU members states (23 NRAs for fixed market) which are subject to the same Regulatory framework (including the WACC Notice). Main statistics for the 13 NRAs that fully apply the WACC Notice and the corresponding BEREC WACC Report (AT, CZ, ES, FR, HU, LU, LV, NO, PL, PT, SE, SI, SK) are highlighted in figures in green.

Figure 2 - Main statistics nominal pre-tax WACC

	Average	Median	Standard Deviation	Relative Standard Deviation	Maximum	Minimum
<b>WACC fixed Nominal Pre-tax 27 NRA;</b>	<b>5.82%</b>	<b>5.51%</b>	<b>1.62%</b>	<b>27.79%</b>	<b>9.73%</b>	<b>3.75%</b>
<b>(2021-29);</b>	<b>(6.58%)</b>	<b>(6.51%)</b>	<b>(1.50%)</b>	<b>(22.82%)</b>	<b>(10.28%)</b>	<b>(4.04%)</b>
<b>(2020-31)</b>	<b>(7.22%)</b>	<b>(7.1%)</b>	<b>(2.06%)</b>	<b>(28.53%)</b>	<b>(13.40%)</b>	<b>(3.33%)</b>
<b>(2019-32)(2018-32)</b>	<b>(7.71%)</b>	<b>(7.28%)</b>	<b>(2.23%)</b>	<b>(28.87%)</b>	<b>(13.45%)</b>	<b>(4.04%)</b>
<b>WACC fixed Nominal Pre-tax 23 NRAs</b>	<b>5.73%</b>	<b>5.51%</b>	<b>1.49%</b>	<b>26.02%</b>	<b>8.64%</b>	<b>3.75%</b>
<b>(2021-25 NRAs)</b>	<b>(6.47%)</b>	<b>(6.51%)</b>	<b>(1.28%)</b>	<b>(19.84%)</b>	<b>(8.64%)</b>	<b>(4.45%)</b>
<b>(2020-24 NRAs)</b>	<b>(7.07%)</b>	<b>(7.13%)</b>	<b>(1.40%)</b>	<b>(19.81%)</b>	<b>(10.68%)</b>	<b>(4.54%)</b>
<b>(2019-26)(2018-26)</b>	<b>(7.60%)</b>	<b>(7.28%)</b>	<b>(1.87%)</b>	<b>(24.60%)</b>	<b>(13.45%)</b>	<b>(4.62%)</b>
	<b>(7.86%)</b>	<b>(7.73%)</b>	<b>(1.96%)</b>	<b>(25.00%)</b>	<b>(14.30%)</b>	<b>(14.30%)</b>

Source: BEREC RA database 2022

The average WACC values currently in force for fixed markets have decreased in comparison to the previous year (values in brackets).<sup>16</sup> A dispersion diagram is reported in the box-plot in Figure 4.<sup>17</sup>

In Figure 3 WACC values for the fixed markets have been ranged (from lowest to highest including the year of the adoption for the fixed market). The current country credit ratings (source: Moody's)<sup>18</sup> are also shown. The thirteen NRAs that fully apply the WACC Notice as well as the BEREC parameters estimation in BoR (20)116, Bor(21)86 and BoR(22)70 have been highlighted in green. This year report no Mobile WACC is reported. It should be pointed out that estimating a different mobile WACC is becoming less relevant due to the introduction of the Delegated Act for mobile termination rates.<sup>19</sup> Nevertheless the RA EWG asked if other WACC values are in charge for other services other than the legacy WACC and NGA premium. Only two NRAs replied that they evaluate a different WACC for other services (BE and ES): BE estimates a different WACC for cable and mobile services; ES estimates a different WACC for Broadcasting services (which is out of the scope of the fixed market). No NRA evaluates a different WACC for civil infrastructure access other than legacy and NGA premium.

<sup>15</sup> AT, BE, CY, CZ, DE, EL, ES, FI, FR, HR, HU, IE, IT, LT, LV, LU, MT, PL, PT, RO, SE, SI, SK, NO, RS, ME, LI. The latest available values have been reported in case no reply have been given to last the annual survey (LT, ME)

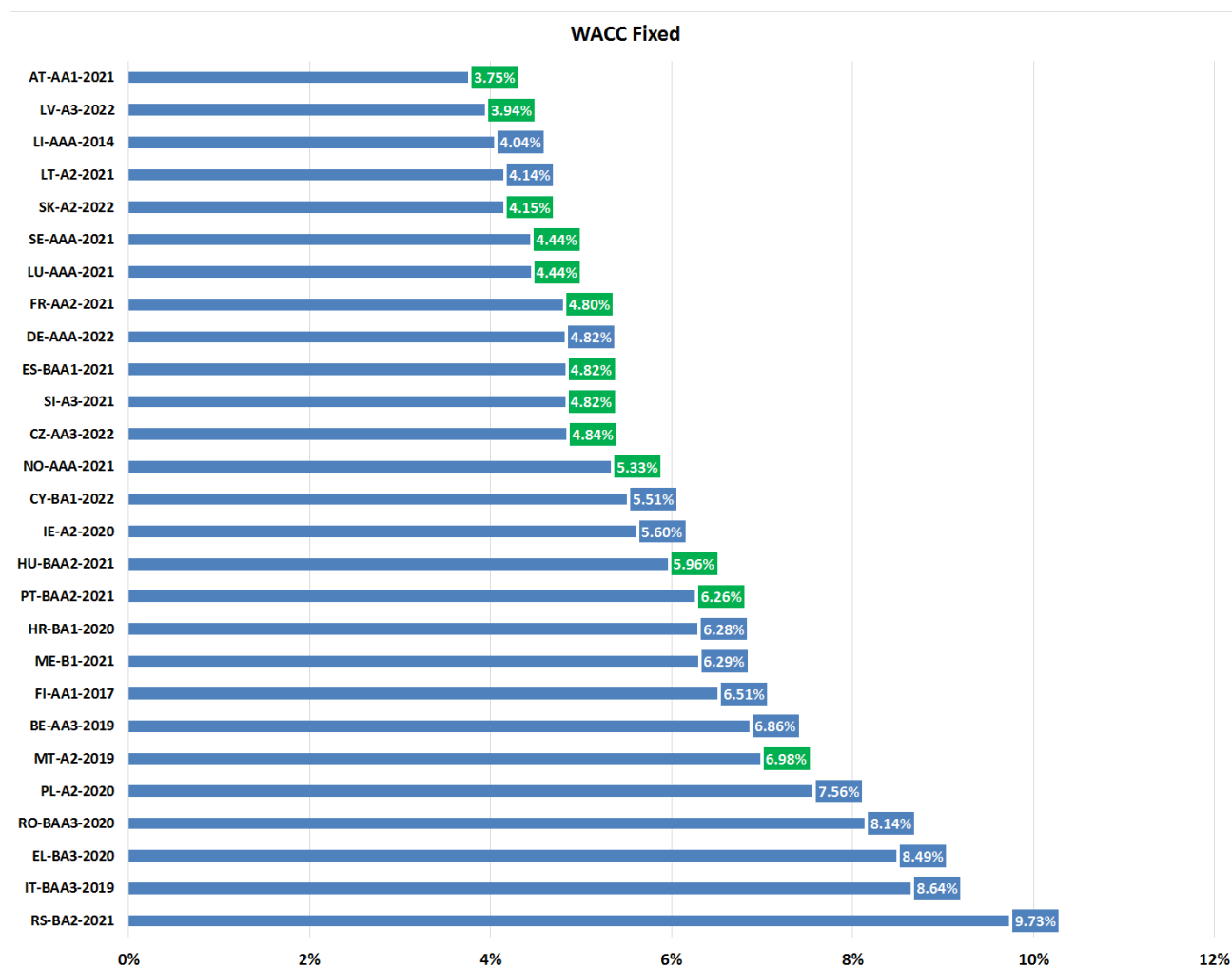
<sup>16</sup> In the tables the information of previous year's statistics are also given providing the year of estimation and the corresponding number of countries included.

<sup>17</sup> In descriptive statistics a box plot is a method for graphically depicting groups of numerical data through their quartiles. It represents the median (bold black line) the 25<sup>th</sup> and 75<sup>th</sup> percentiles of the distribution (upper and lower part of the red square) and the dotted lines indicates variability outside the upper and lower quartiles. Values are plotted as individual points (yellow dots), showing outliers.

<sup>18</sup> BoR(22)70.

<sup>19</sup> EUROPEAN COMMISSION Brussels, 18.12.2020 C(2020) 8703 final COMMISSION DELEGATED REGULATION (EU) /... of 18.12.2020 supplementing Directive (EU) 2018/1972 of the European Parliament and of the Council by setting a single maximum Union-wide mobile voice termination rate and a single maximum Union-wide fixed voice termination rate

Figure 3 - Nominal pre-tax WACC



Source: BEREC RA database 2022

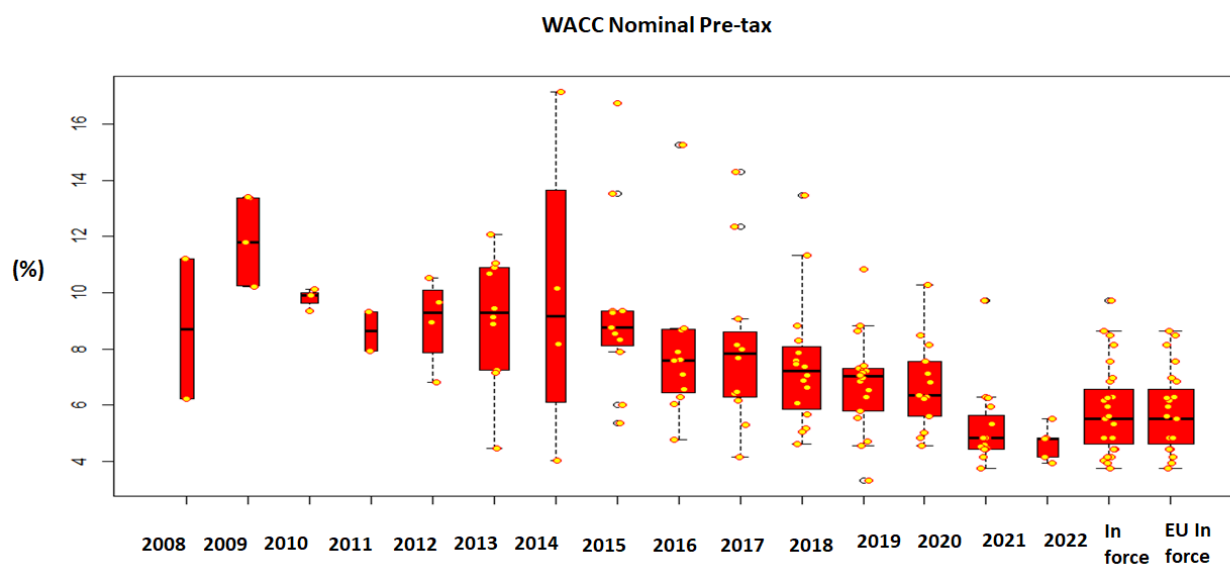
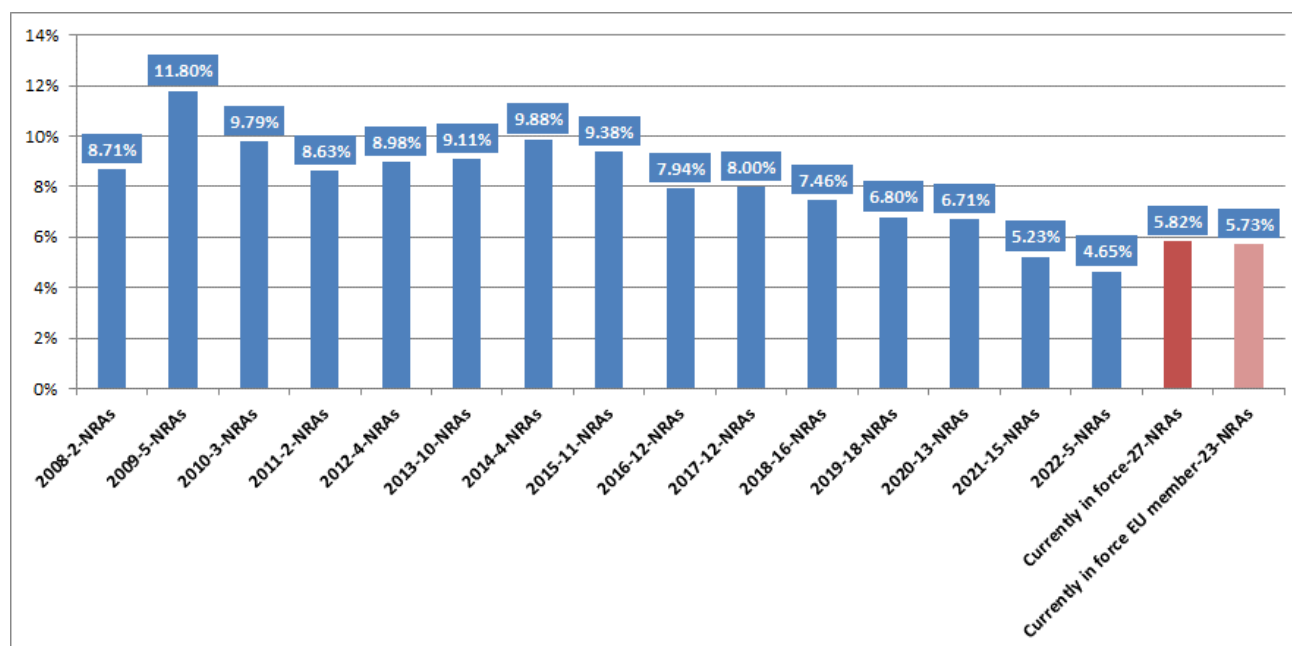
Figure 4 shows the average year-by-year values (NRAs that have calculated WACC in the corresponding year) and the resultant box plot of the nominal pre-tax WACC. The box plot in this figure only provides information about the dispersion between values while the average value is reported in figure 2. The objective is to provide information on the dispersion around the average value.

The average value currently in force is derived by averaging values that are in use at the cut-off date of the current report independent of the year of the decision.<sup>20</sup>

The average WACC has been continuously decreasing since 2017.

<sup>20</sup> DE: the real pre-tax fixed WACC in force equals 3.12%.

Figure 4 - Nominal pre-tax WACC (fixed market 2008-2022)



Source: BEREC RA database 2022

In order to explore the WACC parameters' weight with respect to the final WACC value, the regression presented in BoR (17) 169 and following Regulatory accounting reports was updated (see Appendix II). The regression can provide a quantitative approach useful for understanding the level of harmonisation of the parameters in light of the WACC Notice published by the Commission, taking into account that the harmonisation process relates to both the methodology and the values of some parameters. Data shows – in line with the previous exercise – that the differences of the final WACC values over time can be mainly explained by parameters in the WACC calculation that are more “country related” such as the RFR, ERP and Tax rate, with a less relevant role for sector specific parameters such as beta, gearing and debt premium. This is consistent with survey results on “methodologies applied” that

confirm that beta, gearing and debt premium were estimated mainly on a “notional” basis (see also Appendix II) even prior to the Notice.

This year 15 NRAs have provided new WACC values, i.e. nearly 50% of NRAs participating in the survey.

By taking into account only the most recent estimations along the time line (i.e. the three most recent values for each NRA) in the pooled regression analysis, the results show that the ERP, the second most relevant parameter after RFR in explaining WACC differences last year, is this year becoming less relevant than “Tax” parameters in explaining the differences in final WACC values.<sup>21</sup>

This result is in line with the fact that the ERP estimation through a notional approach by most NRAs (due to the application of the WACC Notice) is reducing its spread. This is reflected in recent time series panel data that has shown that the most relevant parameters are RFR and Tax to explain differences in WACC; typical country parameters, for the first time since 2017. ERP, beta, gearing and debt premium in this order of relevance provide a less important contribution to explaining differences in final WACC values if we take into account the most recent data estimation which shows that the application of the WACC Notice starts to have a material convergent effect.

### 5.2.1 Risk Free Rate

see BoR (17) 169<sup>22</sup>, BoR (18) 167<sup>23</sup> BoR(19)240<sup>24</sup>, BoR (20) 116<sup>25</sup> BoR (21)86<sup>26</sup> BoR(22)70 for definition and general financial theory

#### Main output from the survey.

Based on the replies provided in the 2022 survey the following statistics have been derived for all responding NRAs and for EU NRAs separately (2021-2018 values in brackets).<sup>27</sup>

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<sup>21</sup> This result should be read in the applied framework that show consistent and efficient estimation of the model parameters including the suppression of outlier values from the pool of observations (see Annex II for details).

<sup>22</sup> <https://www.berec.europa.eu/en/document-categories/berec/reports/berec-report-regulatory-accounting-in-practice-2017>.

<sup>23</sup> <https://www.berec.europa.eu/en/document-categories/berec/reports/berec-report-regulatory-accounting-in-practice-2018>.

<sup>24</sup> <https://www.berec.europa.eu/en/document-categories/berec/reports/berec-report-regulatory-accounting-in-practice-2019-including-wacc-chapter>

<sup>25</sup> <https://www.berec.europa.eu/en/document-categories/berec/reports/berec-report-on-wacc-parameter-calculations-according-to-the-european-commissions-wacc-notice>.

<sup>26</sup> <https://www.berec.europa.eu/en/document-categories/berec/reports/berec-report-on-wacc-parameter-calculations-according-to-the-european-commissions-wacc-notice-of-6-november-2019>

<sup>27</sup> Data includes adjustments that can be attributed to RFR, as declared by NRAs, consistent with the final WACC estimation.

Figure 5 – Nominal Risk Free Rate

2021	Average	Median	Standard Deviation	Relative Standard Deviation	Maximum	Minimum
<b>Nominal RFR-fixed market; Pre-tax 27 NRA; (2021-29) (2020-31) (2019-32)(2018-32)</b>	<b>1.55%</b> (1.96%) (2.52%) (2.70%) (3.00%)	<b>1.39%</b> (2.16%) (2.30%) (2.50%) (2.59%)	<b>1.06%</b> (1.07%) (1.95%) (1.90%) (2.11%)	<b>68.27%</b> (54.71%) (77.28%) (70.18%) (70.54%)	<b>3.84%</b> (4.62%) (10.04%) (10.04%) (10.04%)	<b>0.25%</b> (0.17%) (0%) (0.31%) (-0.17%)
<b>Nominal RFR-fixed market EU: Pre-tax 23 EU NRAs (25-2021) (24-2020) (2019-26)(2018-26)</b>	<b>1.38%</b> (1.76%) (2.24%) (2.34%) (2.70%)	<b>1.01%</b> (2.05%) (2.27%) (2.34%) (2.59%)	<b>0.94%</b> (0.89%) (1.26%) (1.32%) (1.71%)	<b>68.05%</b> (50.74%) (56.34%) (56.18%) (63.30%)	<b>2.93%</b> (3.01%) (6.39%) (6.39%) (7.21%)	<b>0.25%</b> (0.17%) (0.27%) (0.31%) (-0.17%)

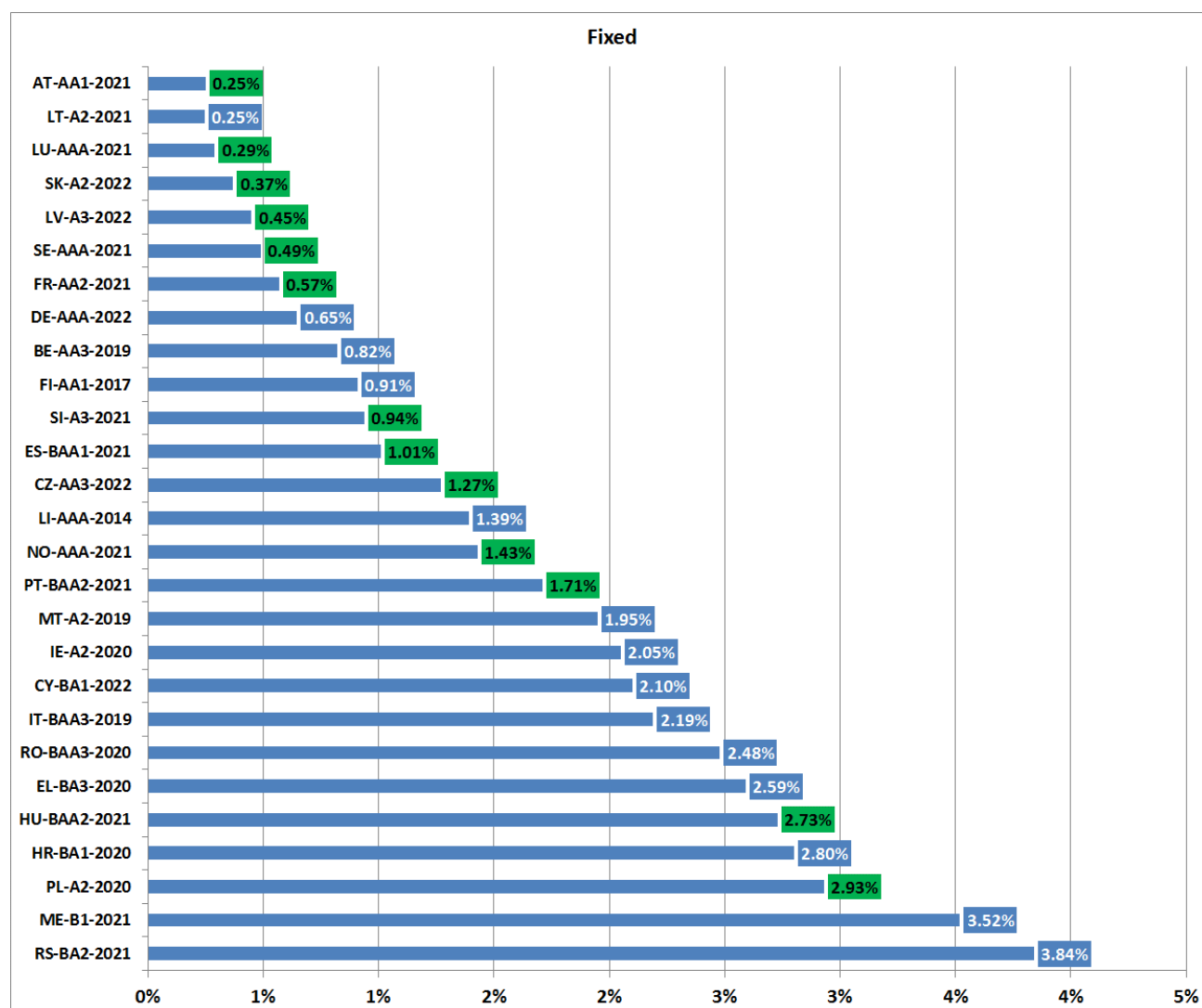
Source: BEREC RA database 2021

In line with previous years there has been a steady decrease of the RFR, following the international downward trend of interest rate evolution - even if the differences among countries have remained relatively stable. It should be noted that differences are more pronounced when non-EU members are included in the sample.

Considering the 13 NRAs that have fully applied the WACC Notice and corresponding BEREC Report, all NRAs have used the values available in the corresponding Berec report.<sup>28</sup>

<sup>28</sup> Only NO applied an updated RFR value applying Commission Notice methodology.

Figure 6 – Nominal Risk Free Rate



Source: BEREC RA database 2022

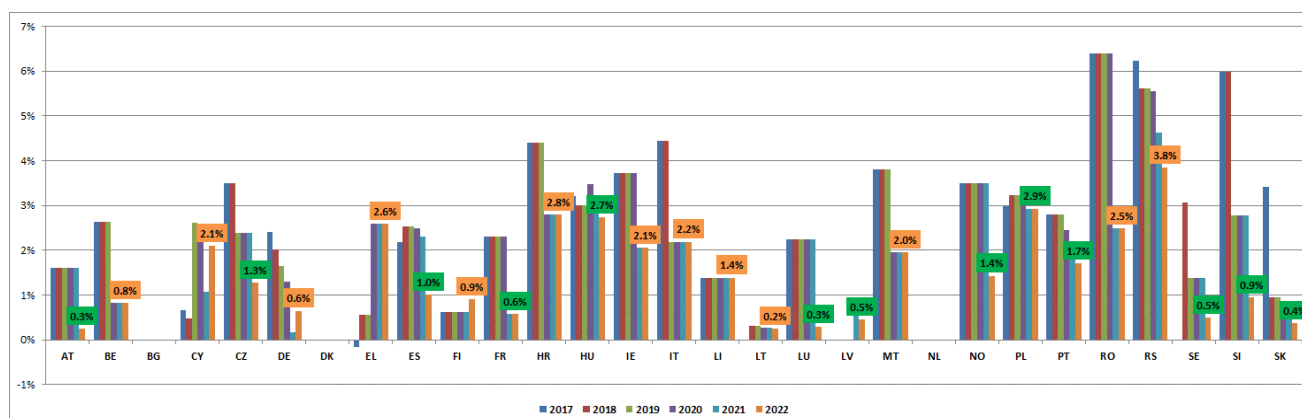
In Figure 7 the evolution of the RFR values for 2017-2022 is reported, taking into account current RFR values according to the data reported in Figure 1.<sup>29</sup> In green those NRAs that have fully adopted the Commission Notice, in blue the corresponding current value for the other NRAs. A decrease of the nominal RFR for the NRAs that applied the notice becomes apparent with a substantial change specifically in countries with a higher country credit rating; this is in line with the fact that countries with a higher country credit rating were more likely to adjust the averaging time window to more than five years in periods of low interest rates for stability reasons. This approach was less evident for countries with a lower country credit rating.<sup>30</sup>

<sup>29</sup> In Figure 7 missing data for the specific year means that the value is not available in the RA database as it is shown in Figure 1 (notwithstanding to the value applied by NRAs for that year).

<sup>30</sup> BNetzA has chosen a 10 year averaging period to determine the risk free rate and it will be applying a glide path over the consecutive years to arrive at an averaging window in compliance with the Commission Notice in 2024 (i.e. in 2022 65% of the value using a ten year and 33% using a 5 year averaging window, in 2023 33% of the value of a 10 year and 67% using a 5 year averaging window and in 2024 100% of the value using a five year averaging window).



Figure 7 - Nominal Risk Free Rate (fixed market 2017-2021) value in force



Source: BEREC RA database 2021

The following figures compare the main methodologies/approaches used by NRAs to estimate RFR. The answers have been based on a set of pre-defined alternatives as reported in the figure.

Figure 8 - Main methodology in use to estimate RFR

<b>Main methodology</b>	
<b>Domestic bond</b>	<b>Refers to the use of own country bond</b>
<b>Country-specific bond</b>	<b>Refers to the use of a specific bond from a different country</b>
<b>Other</b>	<b>A mix of methodologies and judgement is used to derive an estimate taking into account a mix of domestic and other country bond</b>
<b>Benchmarking</b>	<b>the RFR is estimated by referenced to RFR values used by other NRAs</b>

Source: BEREC RA database 2022

Figure 9 shows the summary of methodologies currently applied by NRAs for estimating the RFR. Marked in red are the most frequent approaches (in green those NRAs that fully apply the Commission Notice). Most NRAs have taken into account the main elements of the methodology outlined in the WACC Notice.<sup>31</sup> Moreover NRAs that have changed methodology since last year's report have now partially adopted the Commission Notice, moving to domestic and 10 year bonds instead of using a different approach (CY, IE)<sup>32</sup>.

<sup>31</sup> RS: due to the low liquidity of their own country bonds and low values compared to previous estimations, has decided to use the ECB European bond estimation based on AAA countries, adjusted for country risk premium.

<sup>32</sup> Both CY and IE removed adjustments of the RFR evaluation since 2020 year's report.

Figure 9 - Methodology used to estimate RFR (fixed market)

	Do you evaluate the Real Risk Free Rate in order to compute the Nominal Risk free Rate?		Methodology/Country bond	Bond length		Sampling period used		Averaging window		Average methodology		Quantitative Easing		
	Yes	4										Yes	1	
Nominal Risk Free Rate			domestic bond	7+13	1 year	2	Daily	5	Spot rate	0	Arithmetic average	8+13		
			country specific bond	3	3 years	0	Weekly	3	3 months	0	Geometric Average	0		
			other	1	5 years	0	Monthly	2+13	6 months	0	Moving Average	0		
			benchmarking	0	10 years	8+13	Other	1	1 Year	3	Median	1		
					20 years	0			2 Years	0	Other	2		
					Other	2			3 Years	3				
									5 Years	4+13				
								10 Years	1					
								Others	0					

Source: BEREC RA database 2022

As in 2021, most NRAs have used a nominal estimation of the RFR without first evaluating a real risk-free rate. A real risk-free rate has been estimated in the fixed market by 4 NRAs (BE, CY, IE, MT).

A more consistent approach among NRAs in terms of the main methodologies used for estimating the RFR is evident, also for the use of the averaging window. In comparison to previous years, the number of NRAs that use a 5 year averaging windows has increased. RFR estimation can be influenced by country specific issues such as exchange rates and expected inflation.

Combining the approaches in terms of general methodology (geographical scope: domestic or country-specific) and time windows (the more differentiated parameters to estimate the RFR), the following statistics emerge (Figure 10).<sup>33</sup>

<sup>33</sup> NRAs that have a different approach in comparison to previous year's report are shown in red.

Figure 10 - Main methodology and time windows (frequency, number of NRAs) <sup>34</sup>

RFR		Geographical scope			
		Domestic bond	Country specific	Others	Total
Time windows	≤1	3	0	0	3
	≤3	0	2	1	3
	≥5	3+ 13	1	1	18
	Total	19	3	2	24

RFR		Geographical scope		
		Domestic bond	Country specific	Others
Time windows	≤1	FI,LT,MT		
	≤3		BE,RO	HR
	≥5	AT,CZ,ES,FR,HU, LU,LV,NO,PL,PT,SE ,SI,SK, DE,IE,IT	LI	RS

Source: BEREC RA database 2022

16 NRAs (11 in 2020) have used domestic bonds and time windows that are greater than or equal to 5 years. 13 NRAs which are included in this category fully apply the Commission Notice.

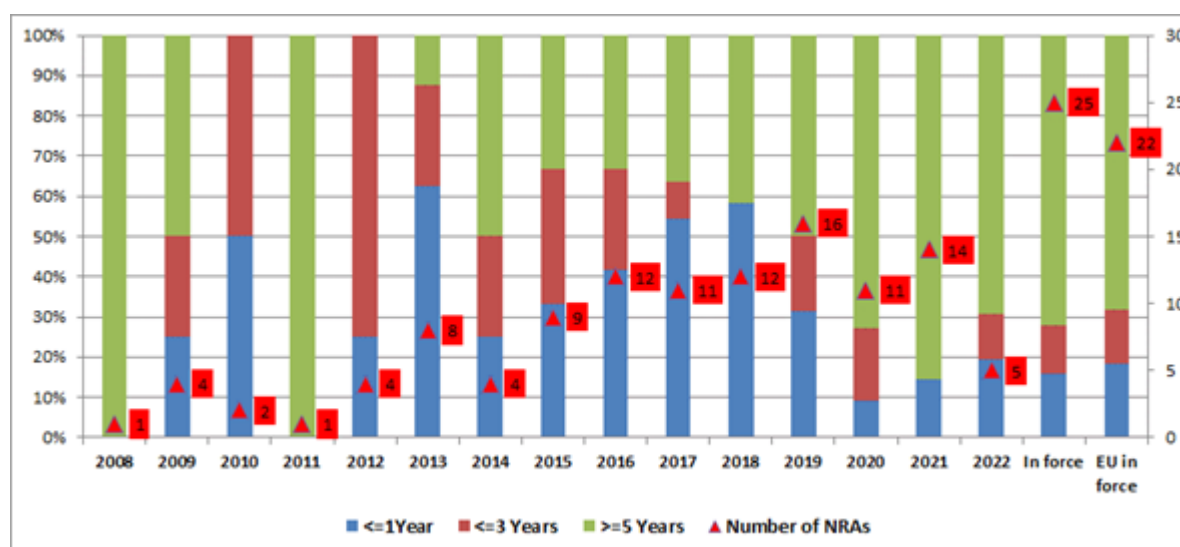
Note that when “country specific” or “Other” is chosen as the main category for RFR, a “country risk premium” is generally included in the cost of equity and time windows are less relevant in this case.

Values currently in force have also been influenced by the time of estimation as shown in the corresponding figure.

Looking at the distribution of the “time windows” used by NRAs during 2013-2022 when many NRAs have updated the WACC, an increase in the number of NRAs that have chosen time windows  $\geq 5$  has become apparent especially in the last three years (2019-2021), when the Commission WACC Notice was published; about 70% of NRAs have used a time windows equal to 5 years for the estimation of the WACC in line with the WACC Notice.

<sup>34</sup> In the matrix the first figure indicates the frequency of the methodological mix, the second mentions NRAs. In green the NRAs that have fully adopted the WACC Notice.

Figure 11 - Distribution of time windows RFR (fixed market)



Source: BEREC RA database 2022

One NRA has applied adjustments to the estimation of the RFR as reported in the following figure. The year of update is also provided. It should be pointed out that the number of NRAs that apply an adjustment has been reducing year by year, converging to a more constant application of the approach.

Figure 12 - Adjustments applied to RFR (fixed market)

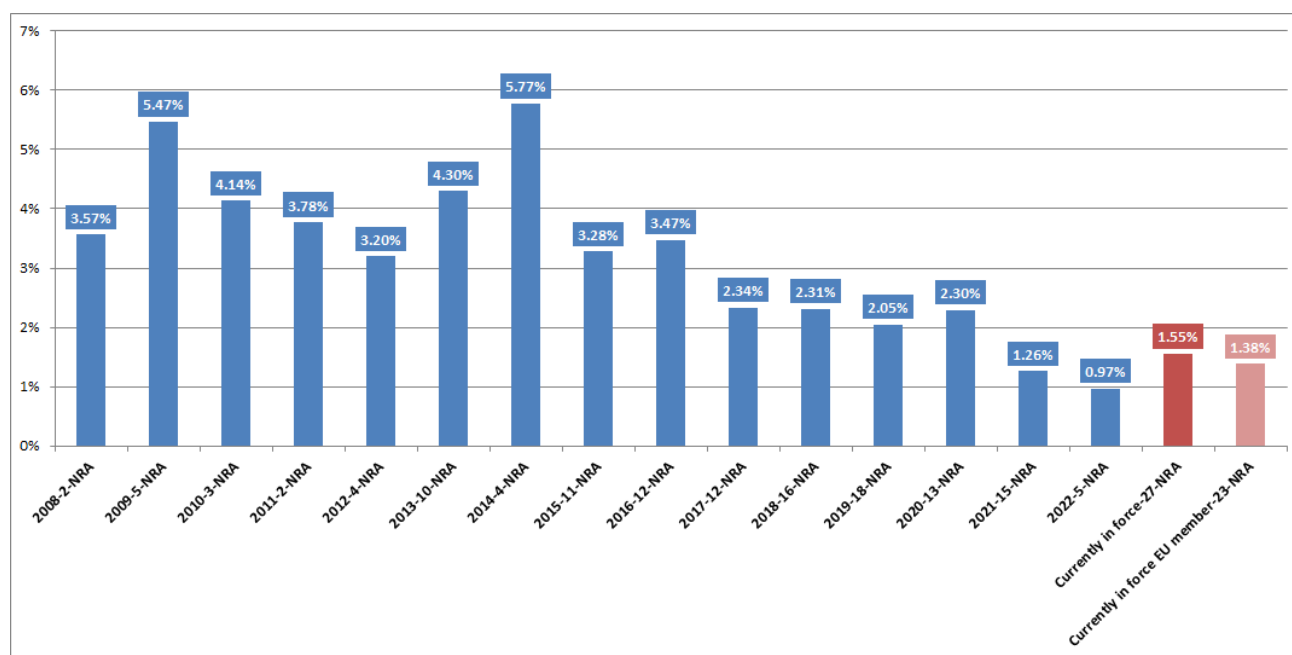
	Nominal RFR	Nominal risk free rate without adjustment	Country risk premium (%)	Size premium value (%)	Consistency with ERP estimation (historical data on ERP on different bond length)	Other adjustment: Size of adjustment (%)	Description of adjustment and how the adjustment was made
RO-2020	2.48% (6.39%)	0.31% (3.19%)	2.17% (3.20%)				Damodaran

Source: BEREC RA database 2022

In Figure 13 the adopted average year-by-year nominal RFR includes only NRAs that have indicated an update for the WACC value in the corresponding year. The average value currently in force is derived by averaging values in line with the information provided in Figure 1.

The RFR has slightly decreased over the years in line with lower yields of domestic bonds, also due to quantitative easing (QE) purchase programs.

Figure 13 - RFR evolution over time (fixed market)



Source: BEREC RA database 2022

In conclusion: NRAs that use domestic bonds as a methodology for estimating the RFR together with a less than one-year averaging window explained their approach by aspiring to achieve consistency with a forward looking approach with respect to the financial situation. In this case, the deviation from the spot rate is a way to overcome short term volatility. The number of NRAs that use a short averaging windows has decreased over time, additionally the WACC Notice motivated NRAs to harmonise their approach. The progressive application of the Commission Notice over time leads to a more consistent methodological approach to the parameter estimation.

## 5.2.2 Equity Risk Premium (ERP)

see BoR (17) 169, BoR (18) 167, Bor(19)240, BoR (20) 116, Bor(21)86, BoR (22) 70 for definition and general financial theory

### Main output from the survey.

Using the replies to the 2022 survey the following statistics have been derived for all responding NRAs and for EU NRAs separately (2021-2018 values in brackets).

Figure 14 - ERP values

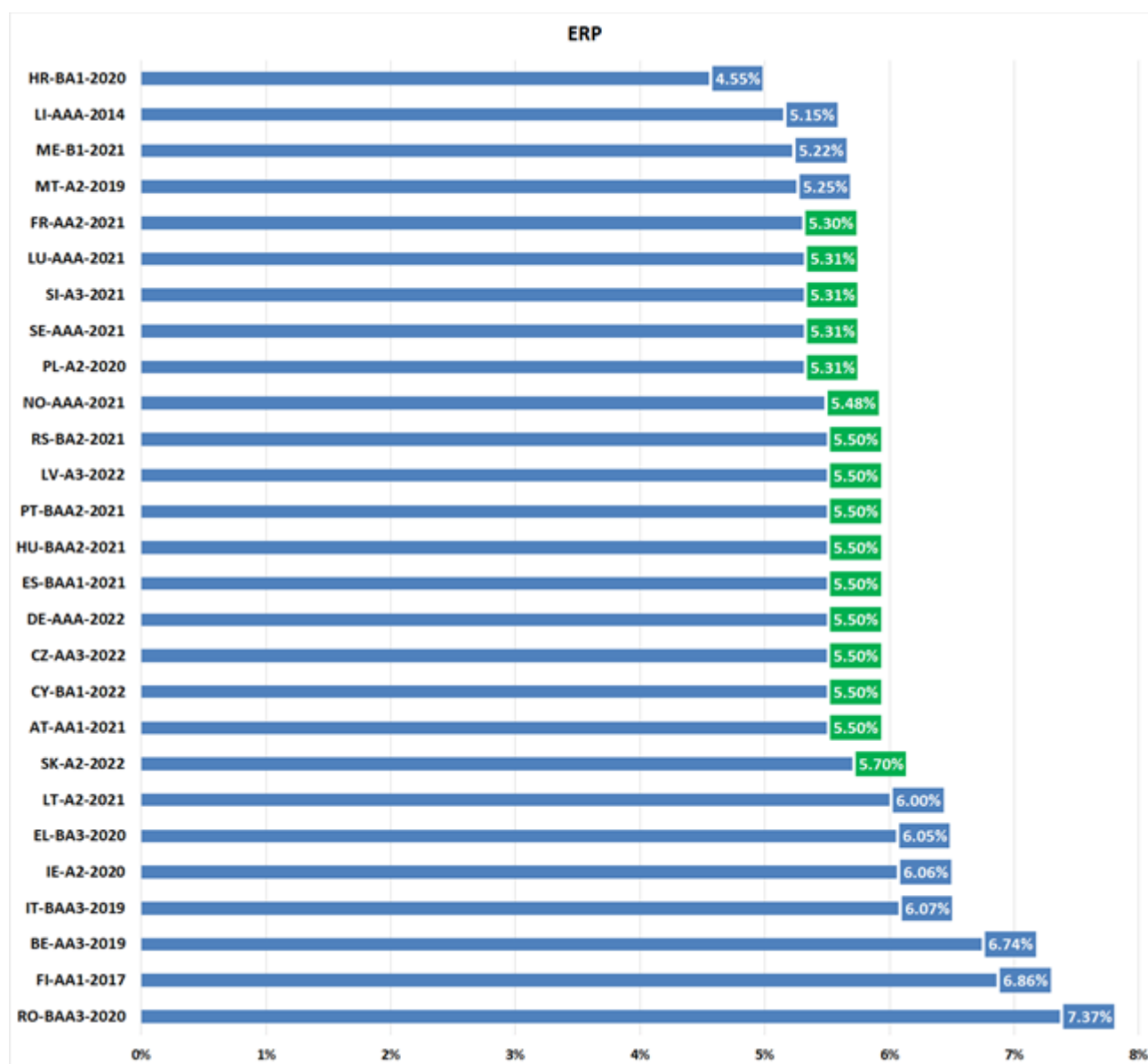
	Average	Median	Standard Deviation	Relative Standard Deviation	Maximum	Minimum
<b>Equity Risk Premium (fixed); 27- NRAs (2021-29) (2020-31) (2019-32)(2018-32)</b>	<b>5.65%</b> (5.80%) (5.76%) (5.93%) (5.90%)	<b>5.50%</b> (5.71%) (5.75%) (5.63%) (5.45%)	<b>0.58%</b> (0.72%) (0.77%) (1.52%) (1.90%)	<b>10.33%</b> (12.43%) (13.29%) (25.57%) (32.14%)	<b>7.37%</b> (7.37%) (7.25%) (13.14%) (14.46%)	<b>4.55%</b> (4.55%) (4.55%) (4.55%) (3.10%)
<b>Equity Risk Premium EU EU 23- NRAs (fixed): (2021-25) (2020-24) (2019-26)(2018-26)</b>	<b>5.70%</b> (5.81%) (5.77%) (6.05%) (6.03%)	<b>5.50%</b> (5.75%) (5.85%) (5.79%) (5.60%)	<b>0.61%</b> (0.72%) (0.76%) (1.65%) (2.07%)	<b>10.77%</b> (12.30%) (13.18%) (27.27%) (34.42%)	<b>7.37%</b> (7.37%) (7.14%) (13.14%) (14.46%)	<b>4.55%</b> (4.55%) (4.55%) (4.55%) (3.10%)

Source: BEREC RA database 2022

The average and median values for ERP have remained stable and their deviations are decreasing over time. For this parameter it can be observed that 16 NRAs have applied the WACC Notice using the single EU ERP value as calculated by BEREC in BoR(20)116, BoR(21)86 or BoR(22)70 depending on the year of update.

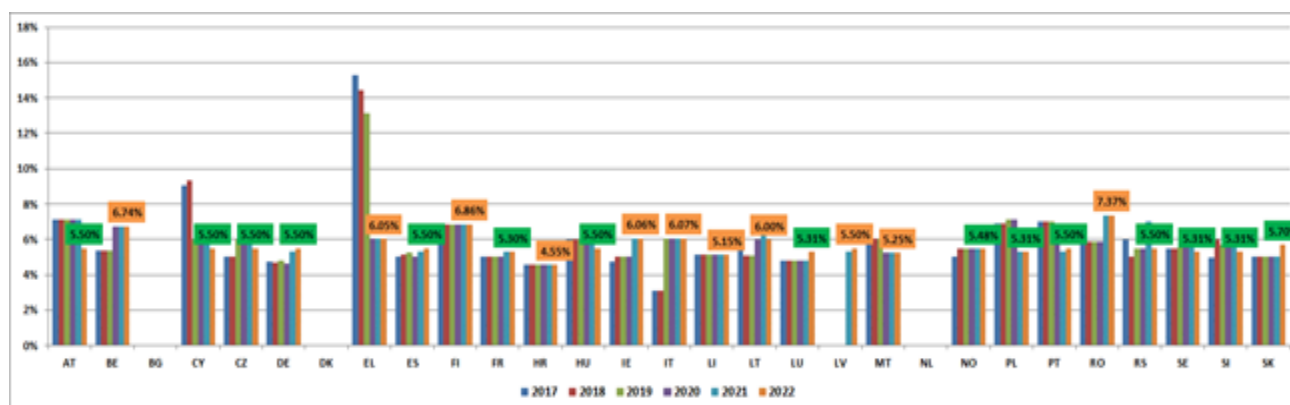
Figure 15 reports ERP ranking with the indication of individual Country Credit Ratings (Moody's).

Figure 15 - ERP

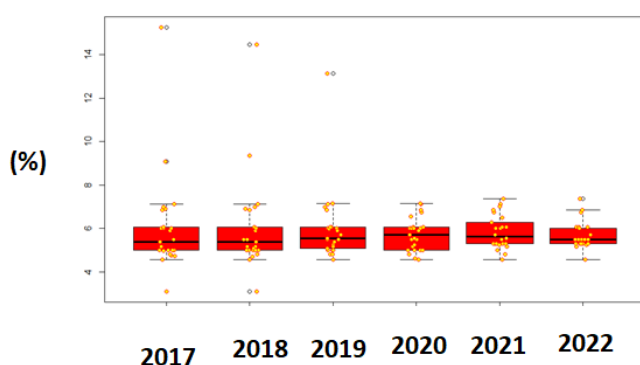


Source: BEREC RA database 2022

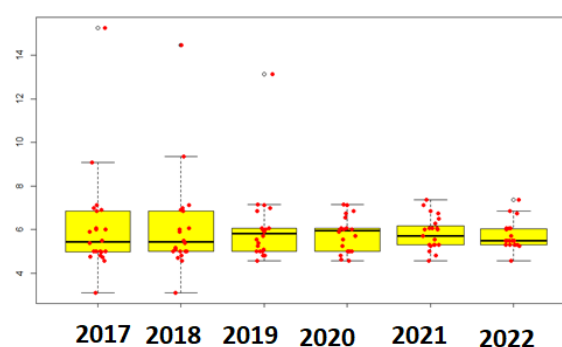
Figure 16 - ERP currently in force (fixed market 2017-2022)



ERP-All (2017-2022)



ERP-EU NRAs(2017-2022)



Source: BEREC RA database 2022

Figure 16 portrays the evolution of ERP over time (years 2017 to 2022) as well as the dispersion of the distribution of the ERP; it is decreasing in combination with a decreasing number of NRAs that estimate a value which can be considered an outlier.

Figure 17 and **Error! Reference source not found.** compare the main approaches used by NRAs to estimate ERP. The answers have been based on a set of pre-defined alternatives. The 16 (13 NRAs that fully apply the Notice and BEREC Report for all parameters plus 3 NRAs that partly apply the Notice) and BEREC calculation for this parameter (CY, DE, RS) NRAs that fully apply the WACC Notice are marked in green.



Figure 17 – Methodologies for estimating ERP (fixed market)

	Methodology (General)		Specific Methodology		-If historical data Average methodology	
Equity risk premium	Notional value	2+16	Historical data	4+16	Arithmetic average	1+16
	country specific	5	Dividend grow model		Geometric Average	
	other	2	Historical+DGM		Moving Average	
	benchmarking	1	Historical+DGM+Suvey	1	Median	
			Survey	2	Other	3
			Historical+Survey		Arithmetic and Geometric	1

Source: BEREC RA database 2022

In terms of the geographical scope of the methodology, differently from the previous situation reported in past RA reports, a clear preference emerges with a notional European ERP thanks to the adoption of the WACC Notice, with 66% of NRAs adopting a notional approach (while in 2020 roughly one third of NRAs adopted a notional approach). As last year, one NRA has adopted a benchmarking approach based on values from other NRAs (MT). Considering the methodology applied, historical data alone is the most frequently used methodology (this was prevalent even before the adoption of the WACC Notice).

According to some NRAs, a notional approach is generally preferred due to unreliable/missing own country-specific data and also because this approach may provide more reliable results.

In terms of the weight given to historical data, the ERP estimation by NRAs generally derives from a combination of data and judgement. Even in cases when NRAs use a clear cut methodology for ERP estimation, this is generally compared with other sources of evidence such as a safeguard/sanity check (even if these further sources are not directly used for the estimation of the final value).

In Figure 18 the main indicators of the “geographical scope” (notional vs. country specific) and the kind of information used in terms of weight given to the past are compared.<sup>35</sup> The situation is largely unchanged in comparison to last year, only one NRA has changed methodology.

NRAs that have only used historical data generally have taken long-time series into account.<sup>36</sup> When a mixed approach has been chosen for the geographical scope (“other”), the estimation generally has taken into account many sources, also from different European countries.

<sup>35</sup> Note that not all NRAs have provided specific information on each methodological category.

<sup>36</sup> More than 100 years, taking as source DMS time series, Damoradan, Duff & Phelps, Picket, as well as national bank sources. In some cases more than one source is used.

Figure 18 - Methodologies used to determine ERP <sup>37</sup>

	Historical data	Historical data + (DGM/Survey)	Survey	Total
<b>Notional</b>	<b>1+ 16</b>	<b>0</b>	<b>0</b>	<b>17</b>
<b>Country specific</b>	<b>3</b>	<b>0</b>	<b>2</b>	<b>5</b>
<b>Other</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>1</b>
<b>Total</b>	<b>20</b>	<b>1</b>	<b>2</b>	<b>23</b>

	Historical data	Historical data + (DGM/Survey)	Survey	Total
<b>Notional</b>	AT,CZ,CY,DE,ES,FR,HU,LU,LV,NO,PL,PT,RS,SE,SI,SK + HR			<b>17</b>
<b>Country specific</b>	IE,IT,LI		FI,RO	<b>5</b>
<b>Other</b>		BE		<b>1</b>
<b>Total</b>	<b>20</b>	<b>1</b>	<b>2</b>	<b>23</b>

Source: BEREC RA database 2022

A clear preference for notional with historical data can be seen. Relatively weak correlations, in terms of the main motivations behind NRAs methodological choices in defining ERP, may be observed from the data collected<sup>38</sup>.

Predictability and transparency objectives are the main motivations behind a stronger emphasis on historical data. According to some NRAs, a notional approach is generally preferred in case of unreliable/missing own country-specific data. When a notional approach has been used in combination with historical data and other methodologies (DGM/Survey) this is generally motivated by the desire to combine predictability with a forward-looking perspective in the ERP estimation. The use of a pure forward-looking approach to estimate ERP is generally motivated by trying to include more country specificity in terms of macroeconomic conditions.

Figure 19 reports and compares the motivations behind the choice of parameters that contribute to the cost of equity (ERP and RFR) for the last two years.

<sup>37</sup> In green the 16 NRAs that have fully applied the Commission Notice. The first table indicates the frequency of the methodological mix the second shows NRAs.

<sup>38</sup> Main motivations behind NRAs methodological choices in defining ERP set in the questionnaire were: i) Regulatory predictability; ii) Consistency with RFR estimation and overall Total Market Return (TMR); iii) Reflect country specific conditions; iv) Consistency with market index used to estimate beta; v) Availability of evidence; vi) Other regulatory decisions.

Figure 19- Methodologies used to determine ERP and RFR<sup>39</sup>

ERP					
		Notional value	country specific	other	benchmarking
RFR	domestic bond	1+15	3	1	1
	country specific bond		2	1	
	other	2			

ERP					
		Notional value	country specific	other	benchmarking
RFR	domestic bond	AT,CY,CZ,DE,ES,FR,HU,LU,LV,NO,PL,PT,SE,SI,SK,LT	FI,IE,IT	EL	MT
	country specific bond		LI,RO	BE	
	other	HR,RS			

Source: BEREC RA database 2022

The comparison shows that 3 NRAs that have used their own country specific ERP have also estimated RFR with domestic bonds, providing the same geographical scope for the equity component RFR and ERP, while 16 NRAs have used domestic bonds and a notional approach for estimating ERP.

Another relevant aspect is the relation between the “averaging windows” considered for estimating the RFR and the “data source” (historical vs forward-looking approach) for ERP estimation (Figure 22). This may be relevant in order to understand if a clear picture emerges showing the preference of NRAs for a forward-looking approach for RFR estimation (i. e. shorter averaging windows) rather than for ERP.

<sup>39</sup> In green the 15 NRAs that have fully applied the Commission Notice for this couple of parameters. The first table indicates the frequency of the methodological mix the second shows NRAs.

Figure 20 - Time windows used for ERP/RFR

ERP					
		Historical data	Historical data + other	Survey	Total
RFR	≤ 1 year	0	0	1	1
	≤ 3 year	1	1	1	3
	≥ 5 years	5+ 13	0	0	18
Total		19	1	2	21

ERP				
		Historical data	Historical data + other	Survey
RFR	≤ 1 year			FI
	≤ 3 year	HR	BE	RO
	≥ 5 years	AT,CZ,ES,FR, HU,LU,LV,N O,PL,PT,SE,S I,SK,DE,IE,IT, LI,RS		

Source: BEREC RA database 2022

Figure 20 shows that the most frequent approach (increasing) is to estimate the RFR on the basis of a 5 year averaging window and the ERP using historical time series. Deviations from pure historical time series are mainly due to the choice of adding more data sources (“sanity check”) in order to estimate the parameter.

Another element analysed in the questionnaire is the type of averaging method used when historical data are used. Most NRAs use an arithmetic average (17 NRAs).

### 5.2.3 Beta

see BoR (17) 169, BoR (18) 167, BoR(19)240, BoR (20) 116, Bor(21)86, BoR (22) 70 for definition and general financial theory

#### Main results of the survey

Using the replies provided for the 2022 survey the following statistics have been derived for all responding NRAs and for EU NRAs separately (2021-2018 values in brackets).<sup>40</sup>

<sup>40</sup> Asset betas/Equity betas are calculated with reference to different market indexes, thus comparison should be considered in the light of this fact.

Figure 21 - Equity and Asset Beta values (fixed and mobile markets)

2021 Data		Average	Median	Standard Deviation	Relative Standard Deviation	Maximum	Minimum
Fixed Market	Equity beta 27- NRAs (2021-29) (2020-31) (2019-32) (2018-32)	0.77 (0.79) (0.83) (0.84) (0.83)	0.77 (0.79) (0.83) (0.85) (0.82)	0.12 (0.14) (0.13) (0.13) (0.14)	15.37% (17.13%) (15.36%) (15.51%) (15.53%)	1.09 (1.09) (1.11) (1.11) (1.11)	0.49 (0.45) (0.5) (0.5) (0.5)
	Asset beta – 17-NRAs (2021-16) (2020-18) (2019-18) (2018-18)	0.51 (0.53) (0.55) (0.54) (0.53)	0.48 (0.53) (0.54) (0.55) (0.54)	0.07 (0.08) (0.06) (0.04) (0.06)	14% (14.73%) (11.18%) (7.55%) (12.06%)	0.71 (0.71) (0.71) (0.62) (0.64)	0.40 (0.43) (0.46) (0.43) (0.43)
	Beta debt – 8- NRAs (2021-5) (2020-4) (2019-3) (2018-3)	0.11 (0.11) (0.11) (0.14) (0.14)	0.1 (0.1) (0.1) (0.1) (0.1)	0.01 (0.02) (0.02) (0.07) (0.07)	13.47% (15.31%) (18.18%) (49.49%) (49.49%)	0.14 (0.14) (0.14) (0.22) (0.22)	0.1 (0.1) (0.1) (0.1) (0.1)
Fixed Market EU NRAs	Equity beta 23-NRAs (2021-25) (2020-24) (2019-26) (2018-26)	0.78 (0.81) (0.85) (0.85) (0.84)	0.78 (0.79) (0.85) (0.86) (0.84)	0.11 (0.13) (0.14) (0.14) (0.13)	14.40% (16.16%) (16.18%) (16.04%) (16.02%)	1.09 (1.09) (1.11) (1.11) (1.11)	0.49 (0.45) (0.50) (0.50) (0.50)
	Asset beta – 14 NRAs (2021-12) (2020-12) (2019-14) (2018-14)	0.51 (0.54) (0.56) (0.55) (0.54)	0.50 (0.53) (0.55) (0.55) (0.55)	0.08 (0.08) (0.07) (0.06) (0.07)	14.78% (14.73%) (12.78%) (10.28%) (13.40%)	0.71 (0.71) (0.71) (0.64) (0.64)	0.40 (0.43) (0.46) (0.45) (0.43)
	Beta debt – 7 NRAs (2021-4) (2020-1) (2019-2) (2018-2)	0.11 (0.11) (0.14) (0.16) (0.16)	0.1 (0.10) (0.14) (0.16) (0.16)	0.02 (0.02) (0) (0.08) (0.08)	14.30% (18.18%) (0) (53.03%) (53.03%)	0.14 (0.14) (0.14) (0.22) (0.22)	0.1 (0.1) (0.14) (0.1) (0.1)

Source: BEREC RA database 2022

Average values for 2022 are slightly lower compared to the previous year. In relation to the 14 NRAs that have declared to apply the WACC Notice for estimating this parameter<sup>41</sup> (AT, CZ, ES, FR, HU, LU, LV, NO, PL, PT, SE, SI, SK, DE), the following is seen: i) One NRA (AT) directly applies the value of the national SMP operator as evaluated in the relevant BEREC report; in this case there is no need to lever and relever the beta; ii) one NRA (SE) applies the arithmetic average of the asset beta evaluated by BEREC and the gearing of the national SMP operator to derive the equity beta (beta levered) including a beta debt of 0.1, as indicated by the Commission Notice; iii) One NRA (DE) uses the weighted average for capitalisation from the BEREC report and the weighted average of the gearing for estimating the levered beta including a beta debt of 0.1; iv) five NRAs (CZ, ES, FR, HU, LV) use the arithmetic average for the asset beta provided by BEREC and the corresponding arithmetic average of the gearing, from which (including a beta debt of 0.1) they have derived the corresponding notional levered beta; v) the other 6 NRAs (LU, NO, PL, PT, SI, SK), that apply the notice fully, use the arithmetic average of the equity beta estimated by BEREC for the corresponding peer group without levering and relevering the beta passing through the average of the asset beta provided.

<sup>41</sup> The Commission notice doesn't prescribe a specific approach for estimating the beta from the peer group and doesn't prevent to use directly the SMP operator parameter if inside an efficient range, moreover at point 48-50 of the Commission Notice dealing with the asset beta (operating beta) of a peer group provides the best estimation of the corresponding systematic risk of an hypothetically efficient operator in the industry represented by the peers. Considering directly the equity beta of a peer group can slightly polarise the estimation of the systematic risk due to the fact that the levered beta of each company also includes the risk related to the level of gearing of the specific company, which is not related to the risk of the operating business.

In this latter case the arithmetic average of the equity beta has been derived from the following formula using the arithmetic average of the asset beta of the peers reported in BoR(20)116 or BoR(21)86 of 0.53 and 0.47 respectively, a corresponding average gearing of 37% and 39% respectively and a beta debt of 0.1 arriving at an equity beta of 0.78 and 0.71 respectively.

$$\beta_E = (\beta_A - \beta_D * g) * \frac{1}{1 - g}$$

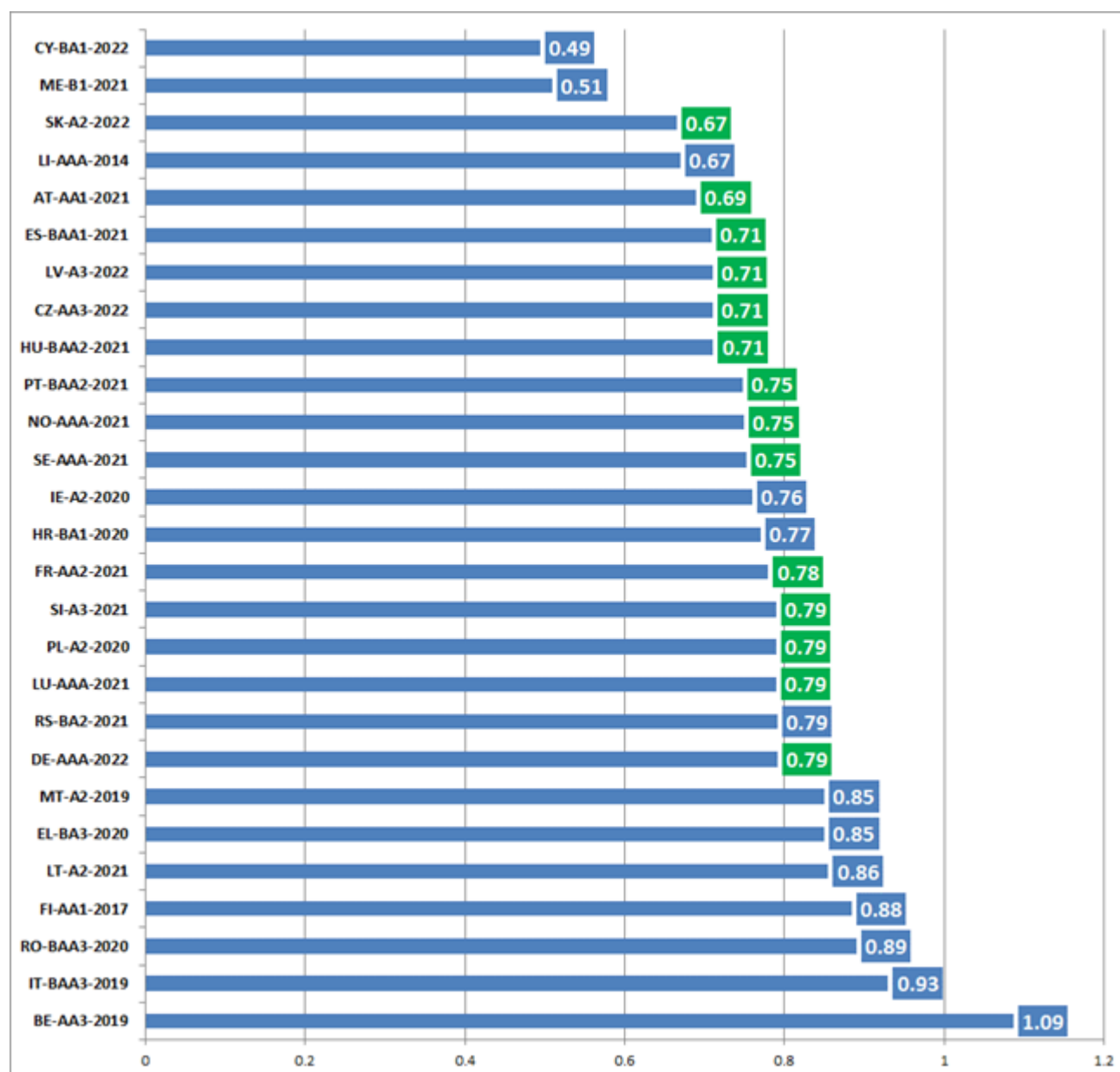
Excluding AT (using the value of the national SMP operator) NRAs that have applied the notice generally did not modify the peer group of companies identified in the relevant BEREC Report.<sup>42</sup>

Figure 22 reports Equity Beta values estimated by each NRA ranging from lower to higher values.

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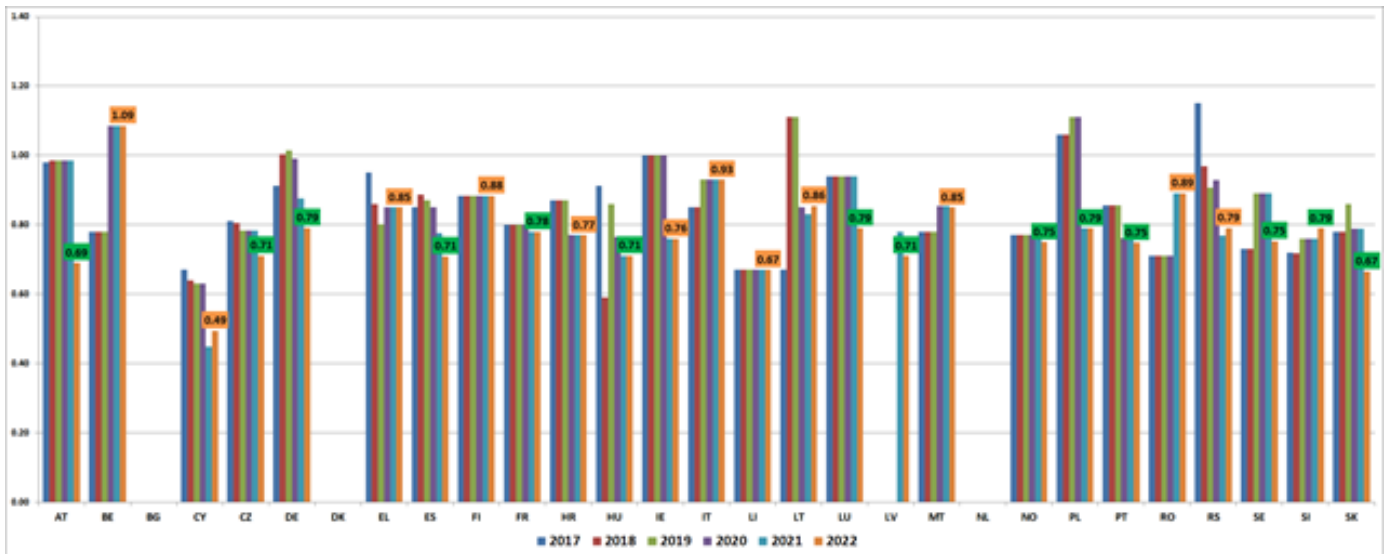
<sup>42</sup> SK that has estimated the WACC for 2022 using the BoR(22)70 doesn't include the operator NOS in the peer group as not all parameters were available (ex. Debt premium).

Figure 22 – Equity Beta values and distribution

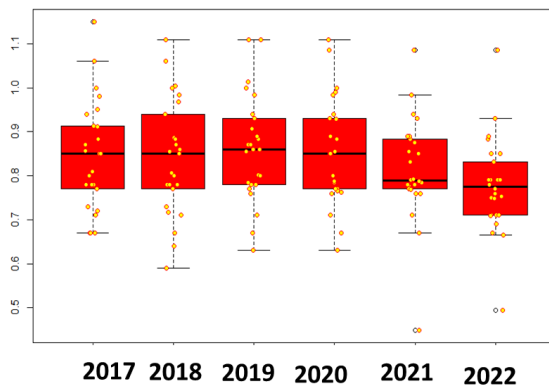


Source: BEREC RA database 2022

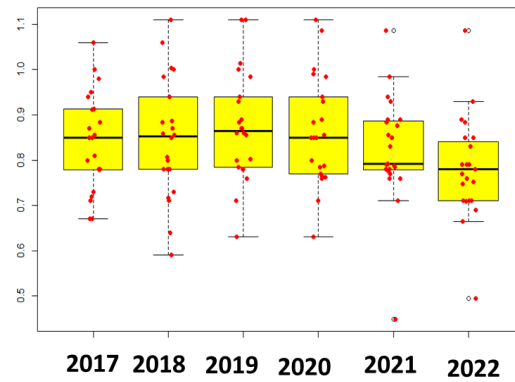
Figure 23 – Equity Beta values in fixed markets (2017-2022)



Equity beta All

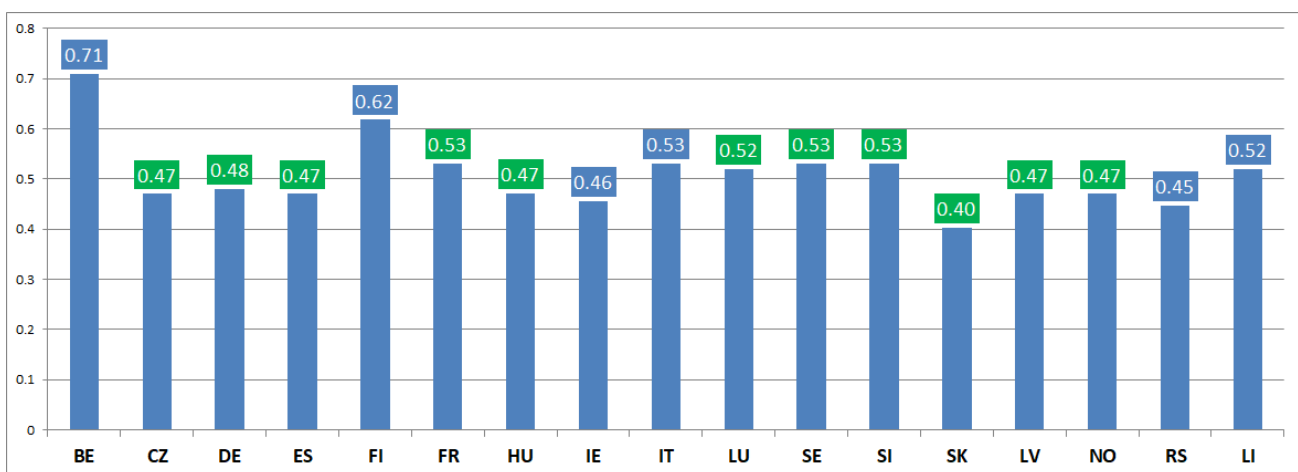


Equity beta EU



Source: BEREC RA database 2022

Figure 24 - Asset Beta



Source: BEREC RA database 2022



The following figures summarises the different approaches used by NRAs to estimate the beta; in green the 14 NRA that fully apply the WACC Notice.

Figure 25 – Methodologies for estimating Beta

	Methodology		-if notional/others (if applicable) please indicate the average used (average to get the asset/equity beta from the comparable)		Sampling period		Time window		Adjustment Used		Market reference index used		Do you un-lever your beta?		- if yes which formula do you apply?		-if benchmarking is indicated in the methodology section please indicate the average used from other countries	
Beta (equity)	notional (generic operator)	8+13	Arithmetic average	6+3	daily	1	1 week	0	Dimson	1	Own Country	0	yes	6+14	Modigliani-Miller	5+14	Arithmetic average	1
	SMP Operator	1+1	Weighted Average	0	weekly	5+14	1 month	0	Bayesian	0	European	7+14	no	3	Miles & Ezzell	0	Geometric Average	0
	Other	3	Median	5	monthly	1	3 month	0	Blume	2	Word	1			Hamada	1	Moving Average	0
	benchmarking	4	Other	2	other	2	6 months	0	Vasicek	0					Other	0	Median	1
							12 months	1	others	2							Other	0
							2 years	1	No Adjustment	4+14								
							3 years	2										
							5 years	4+14										
						10 years	0											
						others	0											

Source: BEREC RA database 2022

The most frequent methodology used by NRAs to estimate a notional beta is based on a peer group of Telecom comparators (21 NRAs in line with the past year).

Figure 26 - Main Beta estimation methodologies and values (fixed)<sup>43</sup>

	Fixed Market		
	Equity beta	Asset Beta	Countries
SMP Operator	0.76 (0.81) (0.83) (0.84)	(0.54) (0.53) (0.50)	AT,LT
notional (generic operator)	0.77 (0.84) (0.85) (0.82)	0.48 (0.55) (0.55) (0.54)	BE,CY,CZ,DE,ES,FI,FR,HR,HU,IE,IT,LU,LV,MT,NO,PL,PT,RS,SE,SI,SK
benchmarking	0.80 (0.76) (0.73) (0.73)	(0.51) (0.51)	EL,LI, RO

Source: BEREC RA database 2022

Where a notional approach has been chosen, the number of comparable operators varies between 7 and 20, mainly European.

The way the average beta is estimated from the peer group may differ according to the different kinds of averaging methods chosen. The median is more frequently chosen in case of a higher number of comparative values.

Figure 27 - Beta notional methodology<sup>44</sup>

Countries	Methodology	Number of peers	Average used
BE	notional (generic operator)	SMP + 8 EU peers	Other
FI	notional (generic operator)	15 telecom companies	Median
HR	notional (generic operator)	17 companies for peer group with head quaters in EU	
IE	notional (generic operator)	12, European operator	Other
IT	notional (generic operator)	10 European SMP operators	Arithmetic average
RS	notional (generic operator)	14 European SMP operators as the one reported in the Berec report	Arithmetic average

Source: BEREC RA database 2022

Concerning the sampling period, daily and weekly sampling are the most frequent approaches used. In general, the choice of the sampling period does not seem to be correlated with the time window used as reported in Figure 28 (2019 and 2021 figures in brackets). The application of the WACC Notice serves to reduce methodological differences between NRAs approach on estimating the corresponding parameters.

<sup>43</sup> In green the NRAs that fully apply the Commission Notice.

<sup>44</sup> NRAs that have provided information on all elements are shown. All NRAs that fully apply the WACC Notice are not reported separately due to the fact that no modifications have been made to the peer group included in the relevant BEREC report.

Figure 28 - Beta methodology for sampling period and time windows<sup>45</sup>

Fixed					
		Time windows			
		≤2 Years	≤3 Years	≥5 Years	Total
Sampling period	daily	1(1)(2)(1)	0(1)(2)(4)	0(2)(2)(2)	1(4)(6)(7)
	weekly	0(0)(0)(1)	1(2)(3)(2)	3+14(11)(5)(5)	18(13)(8)(8)
	monthly	0(0)(0)(0)	0(0)(0)(0)	1(3)(5)(5)	1(3)(5)(5)
	Others	0(0)(0)(0)	1(1)(1)(1)	0(0)(0)(0)	1(1)(1)(1)
	Total	1(1)(2)(2)	2(4)(6)(7)	18(16)(12)(12)	21(21)(20)(21)

	Fixed market		
	Methodology	Sampling period	Time windows
BE	notional (generic operator)	daily	2 years
FI	notional (generic operator)	weekly	3 years
HR	notional (generic operator)	other	3 years
IE	notional (generic operator)	weekly	5 years
IT	notional (generic operator)	weekly	5 years
LT	SMP Operator	monthly	5 years
RS	notional (generic operator)	weekly	5 years

Source: BEREC RA database 2022

With reference to the averaging windows chosen for the estimation of the beta, the approach among NRAs is more variable with three main clusters (two, three and five years). The number of NRAs that use an averaging windows of less than 5 years is decreasing over time.

The motivation behind these choices is related (i) to the importance given to a theoretical approach for providing a reliable estimation of the beta, (ii) to the need to be consistent with the estimation of other parameters such as the RFR, (iii) to the availability of data from referenced sources such as Bloomberg and (iv) a shorter time period is more relevant for the purpose of forming a forwards-looking beta.

The averaging windows used for estimating RFR and Beta are the same in 12 cases out of 21 for the fixed market where information is available for all indicators (Figure 29). In comparison to last year's report the tendency is to have a longer averaging window both for the RFR and Beta estimation. Also in this case the adoption of the WACC Notice methodology lead to an increased harmonisation of the approach adopted by NRAs.

<sup>45</sup> NRAs that have provided information on all elements are shown. The 14 NRAs that fully apply the WACC Notice are not reported separately.

Figure 29 - Beta/RFR time windows <sup>(46)</sup>

## Fixed Market

		Beta (Time windows)			
		≤2 Years	≤3 Years	≥5 Years	Total
RFR (time windows)	≤1 Year	0(0) (1) (2)	1(1) (2) (2)	1(2) (3) (4)	2(3)(6) (8)
	≤3 Years	1(1) (2) (1)	1(1) (2) (3)	0(0) (1) (1)	2(2)(5) (5)
	≥ 5 Years	0(0) (0) (0)	0(2)(2) (2)	3+14(14)(8) (7)	17(16)(10) (8)
	Total	1(1) (3) (3)	2(4) (6) (7)	18(16) (12) (12)	21(21) (21) (22)

		Beta (Time windows)			
		≤2 Years	≤3 Years	≥5 Years	Total
RFR (time windows)	≤1 Year		FI	LT	2
	≤3 Years	BE	HR		2
	≥ 5 Years			IE,IT,RS	17
	Total	1	2	18	21

Source: BEREC RA database 2022

Since the adoption of the Commission Notice there has been a clear convergence for a coherent averaging time window.

Concerning the adjustment used for estimating the equity beta of SMP operators or comparable companies (Figure 30), there is a clear tendency not to use adjustments; this approach has strongly increased since the adoption of the Commission Notice. Only few NRAs still apply adjustments to the standard OLS estimation for the Equity beta due to the fact that the estimation has been done before the Commission Notice was in charge. The application of the WACC Notice has thus increased the consistency of NRAs in not applying any adjustment.

Generally, the application of an adjustment is made where a shorter time windows for beta estimation is in use; this is consistent with the idea that with less data available, the estimation of the equity beta may be less reliable.

<sup>46</sup> NRAs that have provided information on all element are shown. The NRAs that fully apply the WACC Notice are not reported separately.

Figure 30 - Time window adjustments to Equity Beta<sup>47</sup>

	Time Windows			
	<=2 Years	<=3 Years	>=5 Years	Total
No Adjustment	(0)(1)(2)	0(1)(2)(1)	3+14(11)(5)(5)	17(12)(8)(8)
Blume	(0)(1)(1)	1(1)(1)(1)	1(2)(2)(2)	2(3)(4)(4)
Vasiecek		0(0)(1)(1)		0(0)(1)(1)
Bayesian		0(1)(1)(2)	(1)(2)(2)	0(2)(3)(4)
Dimson	1(1)(1)(0)			1(1)(1)(0)
Others	(0)(1)(0)	1(1)(0)(1)	(1)(1)(1)	1(2)(2)(2)
Total	1(1)(4)(3)	2(4)(5)(6)	18(15)(10)(10)	21(20) (19)(19)

Source: BEREC RA database 2022

Most NRAs apply an unlevered beta before estimating the final equity beta (20 NRAs) including NRAs that apply the WACC Notice. Concerning the unlevering formula the most widely used is the Modigliani-Miller formula (Miller being the same formula without tax<sup>48</sup>).

Concerning the market index, most NRAs (21 NRAs) use a European index (STOXX Europe TMI Telecommunications; STOXX Europe TMI, MSCI Europe Index) which is a trend that have increased year by year.

Sensitivity analysis on the time windows, adjustments and the choice of market index shows a relevant variability of the estimation (see annex 1 of BoR (17) 169). A notional approach can reduce a certain level of variability.

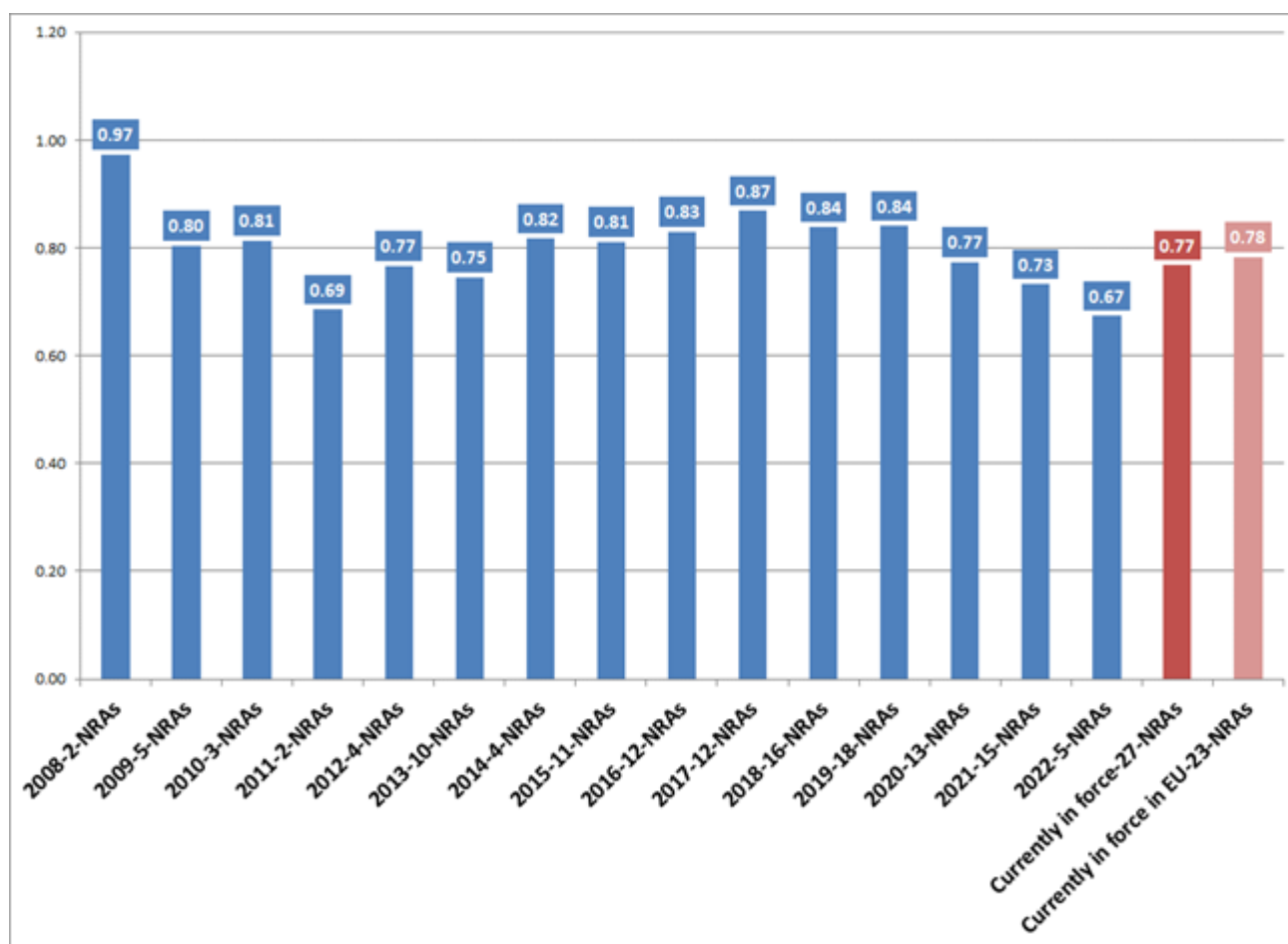
Overall, in the period 2008-2022, estimated beta values have remained relatively stable<sup>49</sup>.

<sup>47</sup> NRAs that have provided information on all elements are shown. The NRAs that fully apply the WACC Notice are not reported separately.

<sup>48</sup> Sometimes the same formula is referred to as "Hamada formula".

<sup>49</sup> The variability *inter alia* may be explained by the number of observations (e. g. one NRA in 2011).

Figure 31 - Equity Beta evolution over time



Source: BEREC RA database 2022

Concerning the principle of “internal consistency”, a slight correlation can be found in the choice of the beta and gearing approach with respect to the price control methodology. Generally, if a BU approach is in use as cost allocation method, a “notional beta” is applied (this relation is missing for the cost of debt).

### 5.2.4 The cost of debt

see BoR (17) 169, BoR (18) 167, BoR(19)240, BoR (20) 116, BoR(21)86, BoR (22) 70 for definition and general financial theory

#### Main output from the survey.

Using the replies provided for the 2022 survey the following statistics have been derived for all responding NRAs and for EU NRAs separately (2021- 2018 values in brackets).

Figure 32 – Cost of debt values

	Average	Median	Standard Deviation	Relative Standard Deviation	Maximum	Minimum
<b>Cost of debt fixed market</b>						
<b>27-NRAs</b>	<b>2.71%</b>	<b>2.40%</b>	<b>1.55%</b>	<b>57.08%</b>	<b>7.69%</b>	<b>0.00%</b>
(2021-29)	(3.22%)	(3.44%)	(1.56%)	(48.44%)	(7.67%)	(0.00%)
(2020-31)	(3.81%)	(3.90%)	(2.03%)	(53.33%)	(8.58%)	(0.00%)
(2019-32) (2018-32)	(4.00%)	(3.98%)	(2.03%)	(50.89%)	(8.58%)	(0.00%)
	(4.30%)	(4.43%)	(2.08%)	(48.31%)	(8.77%)	(0.00%)
<b>Cost of debt fixed market 23-EU NRAs</b>	<b>2.49%</b>	<b>2.25%</b>	<b>1.19%</b>	<b>47.69%</b>	<b>4.23%</b>	<b>0.00%</b>
(2021- 25)	(3.00%)	(3.29%)	(1.26%)	(42.05%)	(5.83%)	(0.00%)
(2020-24)	(3.55%)	(3.59%)	(1.67%)	(47.11%)	(7.84%)	(0.00%)
(2019-26)(2018-26)	(3.79%)	(3.81%)	(1.74%)	(45.92%)	(7.84%)	(0.00%)
	(4.12%)	(4.39%)	(1.74%)	(42.14%)	(7.84%)	(0.00%)

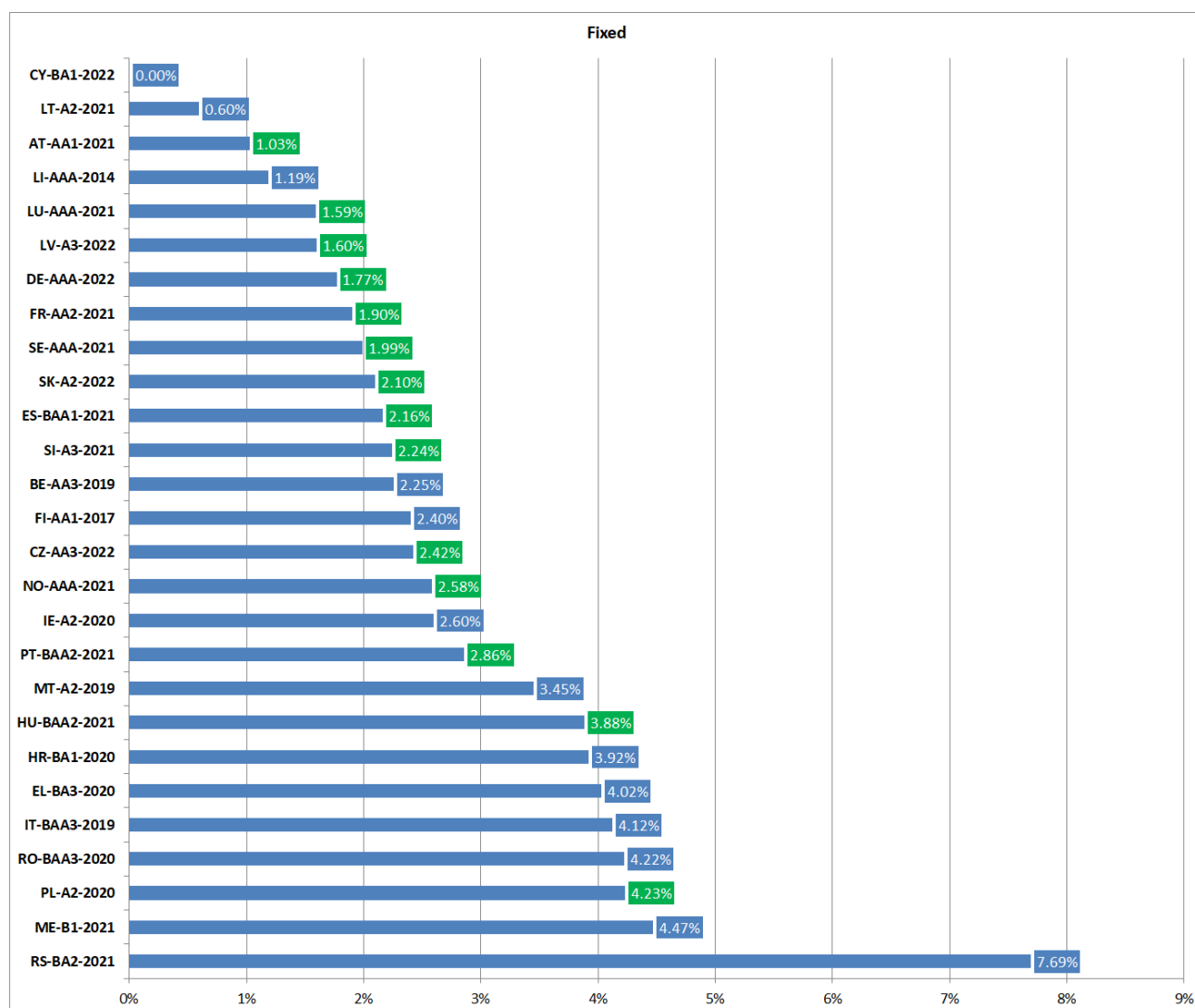
Source: BEREC RA database 2022

In Figure 33 the currently estimated cost of debt is shown. The respective Credit Rating and its year of estimation is also reported.

14 NRAs fully apply the Commission Notice for estimating this parameter: AT, CZ, DE, ES, FR, HU, LU, LV, NO, PL, PT, SE, SI, SK. The flexibility provided by the Notice has given the following outcome: i) One NRA (AT) has used the debt premium of the national SMP operator; ii) One NRA (DE) has used the weighted Average over market cap provided by BEREC in the relevant WACC report for the debt premium; iii) all other NRAs that fully apply the Commission Notice (CZ, ES, FR, HU, LU, LV, NO, PL, PT, SE, SI, SK) have used the Arithmetic average provided by BEREC without excluding any peers from the BEREC peer group.<sup>50</sup>

<sup>50</sup> SK that has estimated the WACC for 2022 using the BoR(22)70 doesn't include the operator NOS in the peer group as not all parameters were available (ex. Debt premium). SK has estimated directly the cost of debt instead of the debt premium using the AM of the cost of debt estimated by Berec peer group table 4 Bor(22)70.

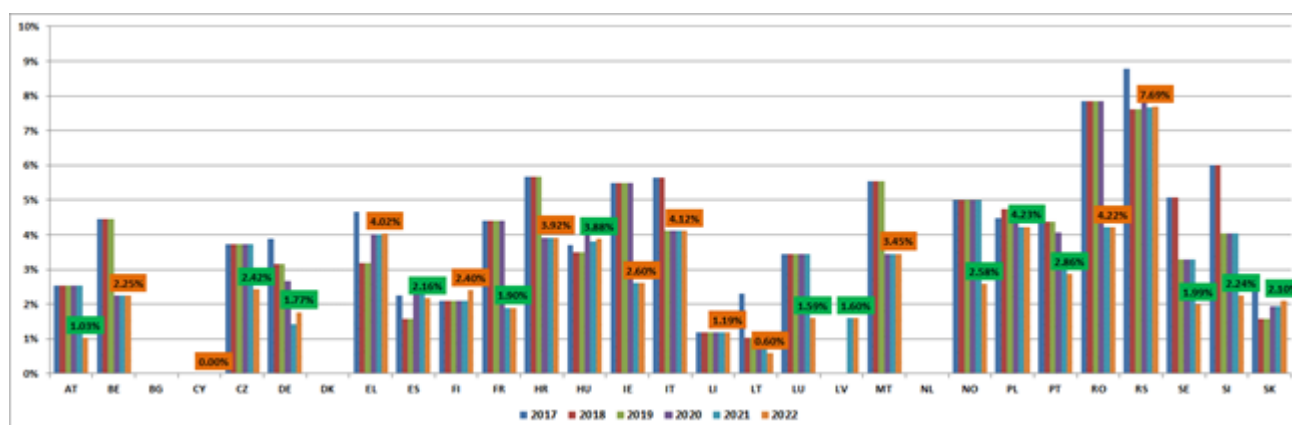
Figure 33 - Cost of debt value and distribution



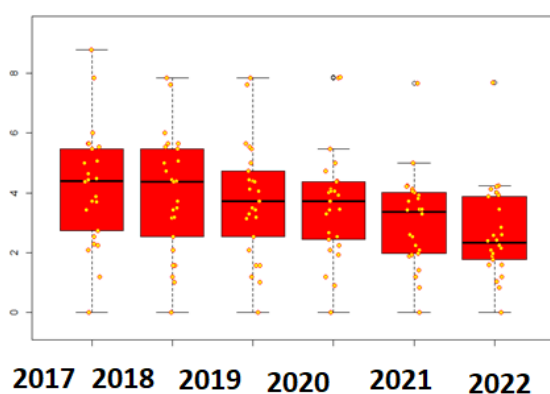
Source: BEREC RA database 2022



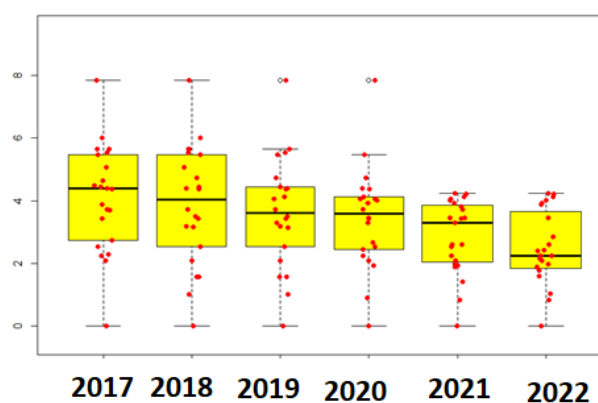
Figure 34 - Evolution of cost of debt over time (2018-2020)



Cost of debt 17-22 all (%)



Cost of debt 17-22 EU (%)



Source: BEREC RA database 2022

The overall situation is quite stable over time even if the decrease in the level of the averages is evident in last years mainly due to the corresponding decrease of the RFR that is included in the corresponding cost of debt.

The following figures summarise the different approaches used by NRAs to estimate the cost of debt for fixed markets. The approach outlined in the WACC Notice is the most frequent one; the effort by BEREC in evaluating the debt premium from the secondary traded market data (not freely available) has shifted the most frequent approach about how the market value of debt is taken into account by NRAs.

Figure 35 - Methodology used for estimating cost of debt

	Methodology	Cost of debt/debt-premium		Market/book value		-if "Market value"/"Other" (if applicable) Source data		-if "Market value"/"Other" (if applicable) bond window		-if "Market value"/"Other" (if applicable) Average window		-if "Market value"/"Other" (if applicable) Average methodology (with respect to the historical series included in the Average window)		If notional approach is used for the peer group please indicate the average used		
Cost of debt (RFR+ Debt premium)	notional (generic operator)	6+13	Debt premium	6+13	Book value	1	Secondary traded market	14	1 year	0	Spot rate	1	Arithmetic average	4+14	Arithmetic	13
	SMP Operator	2+1	Cost of Debt	4+1	Market Value (Company bond)	5+14	Nominal bond yield	2	3 years	0	3 months	0	Geometric Average	0	Median	0
	Other	1			Other	2	Other	3	5 years	2	6 months	0	Moving Average	0	Weighted Average	1
	benchmarking	1							10 years	3+14	1 Year	0	Median	0	Other	0
									20 years	0	2 Years	0	Other	1		
									Hybrid	1	3 Years	1				
									Other	2	5 Years	1+14				
										10 Years	1					
										Others	2					

Source: BEREC RA database 2022

The most frequent approach used by NRAs is a notional one (19 NRAs, 14 last year), the category "Other" is now chosen by only 1 NRA which reflects a mix of approaches (SMP and notional); the SMP cost of debt is considered by 2 NRAs including one that fully apply the notice. It should be highlighted that the Commission Notice allows the use of the SMP value directly if this value is efficient and well in the range of the evaluated peer group, at the same time it should be considered that the majority of NRAs apply the average values Arithmetic and Weighted average (DE) indicated by BEREC using a notional approach instead of the SMP operator value.

The application of the WACC Notice has considerably increased the consistency in the corresponding methodological approach applied by NRAs.

Almost all NRAs estimate a debt premium instead of estimating the cost of debt directly, mostly when using a notional approach (see Figure 36). On the other hand, when the cost of debt refers to the SMP operator, a direct cost of debt is generally estimated. When using a notional approach, NRAs generally use the same peer group used for estimating beta and gearing according to a specific credit rating (at least BBB).<sup>51</sup> Most NRAs use bond windows or time to maturity in line with those used for RFR (generally 10 year average).

<sup>51</sup> One NRA declared that the level of debt of the SMP operator is negligible and for this reason it is considered equal to 0.

Figure 36 - Cost of debt calculated through debt premium<sup>52</sup>

## Fixed

	Cost of debt calculated through debt premium	Cost of Debt
Notional (generic operator)	5+12(16)(14) (12)	1+1(1)(0 )(1)
SMP operator	1(1)(1)(1)	2(3)(3)(4)
Other	1(1)(7)(7)	0(3)(3)(3)
Benchmarking	0(0)(0)(1)	1 (1)(0)(0)

	Cost of debt calculated through debt premium	Cost of Debt
Notional (generic operator)	BE,FI,HR,IE,LI	RS
SMP operator		IT,LT
Other	MT	
Benchmarking		RO

Source: BEREC RA database 2022

With reference to the data source used, most NRAs use the market value of peer group companies'. A book value approach is used typically in case of SMP cost of debt.

Concerning the bond lengths, the most common approach is to use 10 year bonds, in line with the bond length used to estimate RFR, as shown in the next figure the methodology transition and convergence in methodologies are evident specifically in last years.

Figure 37 - Bond lengths used for estimating cost of debt/RFR

		Bond length						
		1 Year	3 Years	5 Years	10 Years	20 Years	Hybrid	Other
RFR	1 Year	0	0	0	0	0	0	0
	3 Years	0	0	0	0	0	0	0
	5 Years	0	0	0	0	0	0	0
	10 Years	0	0	(2)(2)(2)	3+14(11)(9)(8)	(1)(1)(1)	1(2)(2)(1)	2(2)(4)(5)
	20 Years	0	0	0	0	0	0	0
	Other	0	0	0	0	0	0	(1)(1)

Source: BEREC RA database 2022

NRAs generally choose averaging windows in accordance with their choice of averaging windows used for the RFR. "Other" is chosen only when the cost of debt is estimated based on the nominal bond yield and not when the secondary traded market is used as a source. Moreover, when "other" is chosen,

<sup>52</sup> NRAs that have provided information on all elements are shown. The NRAs that fully apply the WACC Notice are not reported separately.

NRAs generally consider in their calculation all bonds not yet expired that are emitted in a range of time that cannot strictly correspond with the time windows used for the RFR estimation.

In every case the results of the methodological survey are in line with the general principle expressed in BoR (18) 167 where BEREC understands the need for consistency in the averaging windows used for the cost of debt and RFR, but also recognises the necessity for NRAs to be flexible due to the fact that it is not easy to have perfect matching between the ten years bond maturity of the companies with corresponding time to maturity of country bonds for the five year averaging windows (i.e. point 98 BoR(18)167). In the BEREC WACC parameters report a specific criterion has been selected to trade off expected methodological provision of the Commission notice and the availability of the data for the parameter estimation (paragraph 4.3 Bor(22)70).

Figure 38 - RFR/cost of debt time windows<sup>53</sup>

		Cost of debts			
		<=1 Year	<=3 years	>= 5 Years	Total
RFR	<=1 Year	(1)(2)(2)	(0)(0)	(0)(1)(1)	(1)(3)(3)
	<=3 Years	0(1)(1)	1(1)(2)(1)	1(1)(2)(2)	2(2)(5)(4)
	>= 5 Years	1(3)(3)(2)	0(2)(2)(2)	2+14(9)(4)(4)	17(14)(9)(8)
Total		1(4)(6)(5)	1(3)(4)(3)	17(10)(7)(7)	19(17)(17)(15)

		Cost of debts		
		<=1 Year	<=3 years	>= 5 Years
RFR	<=1 Year			
	<=3 Years		BE	HR
	>= 5 Years	RS		IE,IT

Source: BEREC RA database 2022

Concerning specific adjustments to the cost of debt, three NRAs have applied the following:

<sup>53</sup> NRAs that have provided information on all elements are shown. The NRAs that fully apply the WACC Notice are not reported separately.

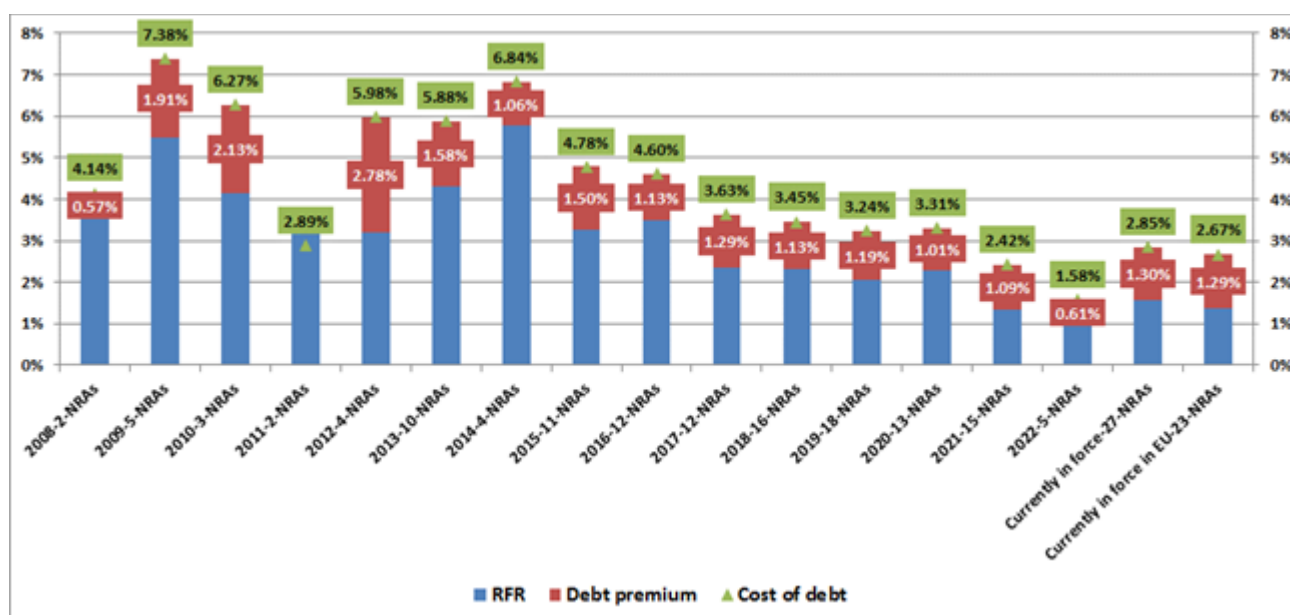
Figure 39 - Adjustments to cost of debt

	Cost of debt	Cost of debt without adjustment	Adjustment (%)	Motivation
PL-2020	5.44%	4.23%	1.21%	Tax shield treatment
RS-2021	7.69%	5.64%	2.05%	Adjustment is made using the inflation rate for Serbia and Eurozone, since the initial value of cost of debt is in EUR. Inflation adjustment was made using Fisher equation: $\text{Pretax Cost of debt} \times (1 + \text{Projected Inflation Rate for RS}) / (1 + \text{Projected Inflation Rate for Eurozone})$
	(7.67%)	(6.27%)	(1.65%)	
	(7.86%)	(6.85%)	(1.02%)	
	(7.61%)	(6.48%)	(1.13%)	
	(8.77%)	(7.23%)	(1.54%)	

Source: BEREC RA database 2021

The next figure shows the evolution over time of the cost of debt and the RFR.

Figure 40 - Evolution of cost of debt over time



Source: BEREC RA database 2022

## 5.2.5 Gearing Ratio

see BoR (17) 169, BoR (18) 167, BoR(19)240, BoR (20) 116, BoR(21)86, BoR (22) 70 for definition and general financial theory

Main results of the survey.

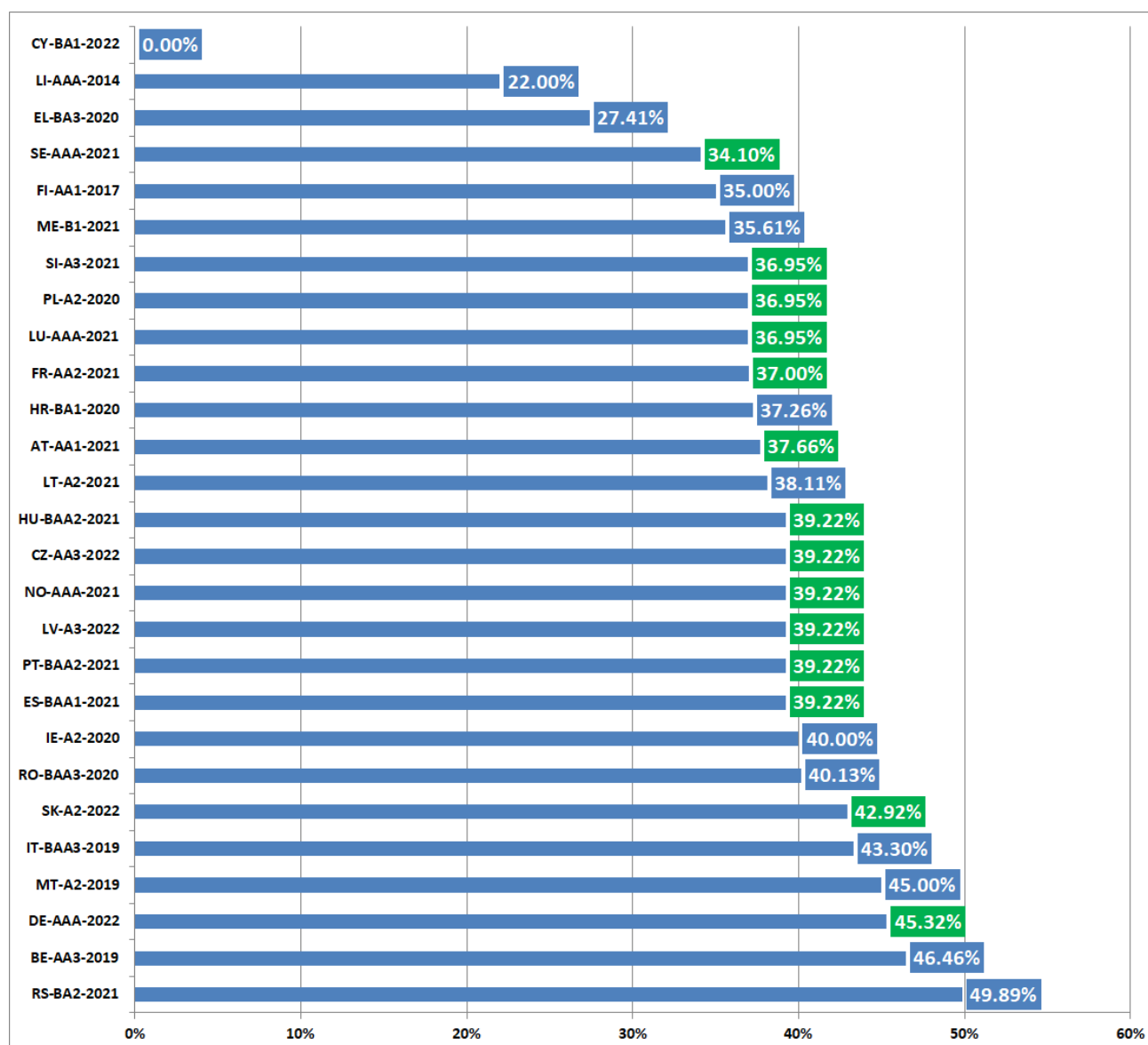
Using the replies provided for the 2022 survey the following statistics have been derived for all responding NRAs and for EU NRAs separately (2021-2018 values in brackets).

Figure 41 - Gearing ratio (fixed and mobile markets)

	Average	Median	Standard Deviation	Relative Standard Deviation	Maximum	Minimum
<b>Gearing fixed market – 27-NRAs</b>	<b>37.16%</b>	<b>39.22%</b>	<b>9.23%</b>	<b>24.83%</b>	<b>49.89%</b>	<b>0.00%</b>
(2021-29)	(36.51%)	(37.26%)	(9.39%)	(27.71%)	(53.04%)	(0.00%)
(2020-31)	(37.79%)	(39.54%)	(9.99%)	(26.44%)	(57.89%)	(0.00%)
(2019-32)	(37.70%)	(39.93%)	(9.71%)	(26.76%)	(54.79%)	(0.00%)
(2018-32)	(37.28%)	(39.85%)	(10.04%)	(26.93%)	(55.62%)	(0.00%)
<b>Gearing fixed market-EU 23-NRAs</b>	<b>37.24%</b>	<b>39.22%</b>	<b>9.08%</b>	<b>24.39%</b>	<b>46.46%</b>	<b>0.00%</b>
(2021-25)	(36.33%)	(37.26%)	(9.06%)	(24.93%)	(46.46%)	(0.00%)
(2020-24)	(37.84%)	(39.41%)	(10.65%)	(28.14%)	(57.89%)	(0.00%)
(2019-26)	(37.24%)	(40%)	(10.61%)	(28.48%)	(55.62%)	(0.00%)
(2018-26)	(37.27%)	(40%)	(10.65%)	(28.58%)	(55.62%)	(0.00%)

Source: BEREC RA database 2021

Figure 42 - Gearing values (fixed and mobile markets)

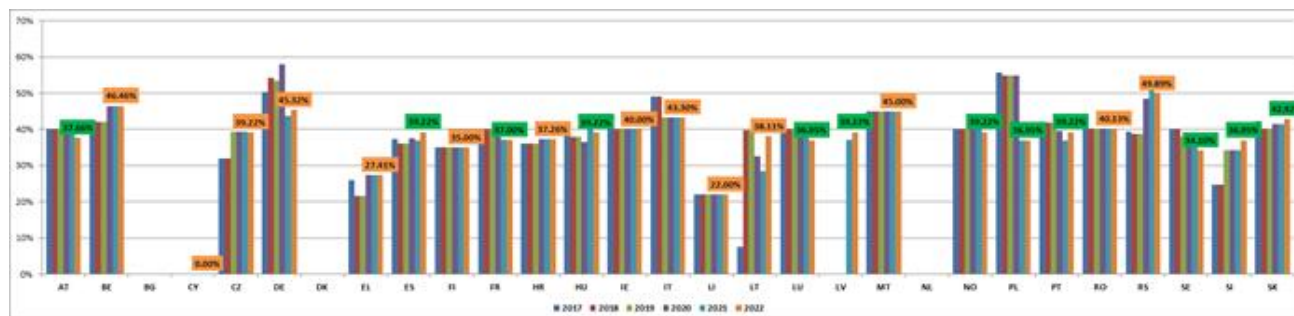


Source: BEREC RA database 2022

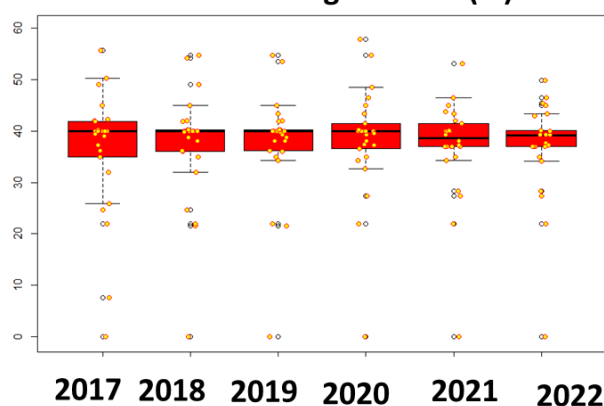
14 NRAs apply the Commission Notice the corresponding relevant BEREC report fully: ii) Two NRAs have used the gearing for the national SMP operator (AT, SE); ii) One NRA (DE) has used the weighted average for capitalisation as indicated by BEREC in the relevant report; iii) all other NRAs (CZ, ES, FR, HU, LU, LV, NO, PL, PT, SI, SK<sup>54</sup>) have directly applied the Arithmetic average evaluated in the relevant BEREC report.

<sup>54</sup> For SK the arithmetic average is evaluated from the cost of debt instead of the debt premium values of the peers not including NOS(table 4 BoR(22)70).

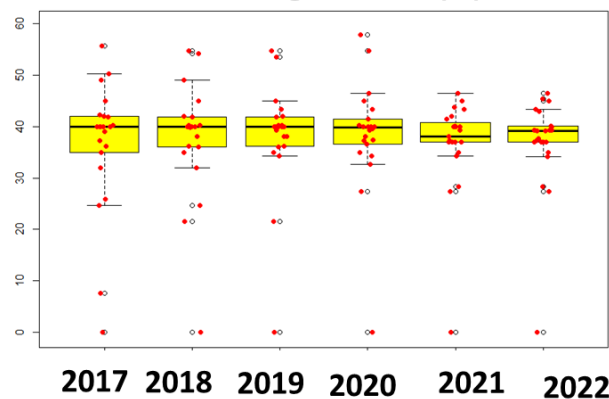
Figure 43 - Gearing values (fixed market 2017-2022)



Gearing all NRAs (%)



Gearing EU NRAs (%)



Source: BEREC RA database 2021

The following figures summarise the different approaches used by NRAs to estimate the gearing parameters. The adoption of the WACC Notice contributes to an increase in the weight of the most frequent approach in use by NRAs for estimating the gearing component.

Figure 44 - Gearing methodology

	Methodology	Debt component (if applicable)		Equity component (if applicable)		-if notional value "Average methodology"		-if benchmarking is indicated in the methodology section please indicate the average used from other countries		
Gearing	notional (generic operator)	6+12	Book value	2+14	Book value	1	Arithmetic	4+11	Arithmetic average	1
	SMP Operator	2+2	Market Value	1	Market Value	3+14	Median	2		
	Other	2	Other	0	Other	1	Weighted Average	1		
	benchmarking	1					Other	3		

Source: BEREC RA database 2022

The vast majority of NRAs have used a “notional” approach, and, in general, do not adjust the gearing according to national circumstances. Moreover when an unlevered beta unlevered is estimated the gearing which is used to unlever the beta is the same which is used for the weighted average of the



cost of equity and debt in the WACC formula. The gearing is generally estimated taking into account the same averaging window used for beta estimation. In line with last year's report, most NRAs have used a notional approach equal to their approach for estimating the beta. This is confirmed by NRAs that have fully applied the WACC Notice, two mentioned exceptions are reported (AT,SE).

Figure 45 - Gearing methodology<sup>55</sup>

	Debt component			Equity component		
	Book value	Market value	Other	Book value	Market value	Other
notional (generic operator)	1+12 (11)(4) (4)	1 (4)(4) (3)	(0)(2) (2)	(0) (0)	3+12(15)(8) (7)	(0)(2) (2)
SMP Operator	1+2(1)(2) (2)	(1)(1) (0)	(0)(0) (0)	1 (1)(1) (1)	2(1)(2) (1)	(1)(0) (0)
Other	(0)(2) (2)	(0)(1) (1)	(0)(0) (0)	(0)(0) (0)	(0)(3) (3)	(0)(0) (0)
benchmarking	(0)(0) (0)	(0)(0) (0)	(0)(0) (0)	(0)(0) (0)	(0)(0) (0)	(0)(0) (0)
Total	(12)(8) (8)	(5)(6) (4)	(0)(2) (2)	(1)(1) (1)	(16)(13) (11)	(1)(2)(2)

	Debt Component			Equity component		
	Book value	Market value	Other	Book value	Market value	Other
notional (generic operator)	IT	BE			BE,HR,IT	
SMP Operator	LI			LI		
Other						
benchmarking						

Source: BEREC RA database 2022

Figure 46 and **Error! Reference source not found.** indicate that the gearing methodology is influenced mainly by the main methodology used for the beta estimation, while gearing also influences the debt premium estimation.

Considering the methodologies used by all NRAs for estimating the cost of debt, gearing and beta (company/industry specific parameters) it becomes clear that the gearing estimation is important since (i) it determines the weight placed on the cost of equity and cost of debt, (ii) it is used to un-lever and re-lever the beta, (iii) it influences the size of the cost of debt. The adoption of the WACC Notice, as for the other parameters, is providing a reduction in the spread of the methodologies in accordance with a notional approach based on a peer group.

<sup>55</sup> NRAs that have provided information on all elements are shown. The NRAs that fully apply the WACC Notice are not reported separately.

Figure 46 - Methodology gearing and cost of debt estimation<sup>56</sup>

		Cost of debt				
		notional (generic operator)	SMP Operator	Other	Benchmarking	Total
Gearing	notional (generic operator)	5+12(15) (12) (12)	1(2)(2) (2)	0(2)(4)(4)	0(0)(0)(0)	18(19) (18)(18)
	SMP Operator	1+1(2)(2)(1)	1+1(2)(2)(3)	(1)(2)(3)	(0)(0)(0)	4(5)(6) (7)
	Other	(0)(0)(0)	(0)(0)(0)	1(1)(3)(2)	(0)(0)(1)	1(1)(3)(3)
	Benchmarking	(0)(0)(0)	(0)(0)(0)	(0)(0)(0)	1(1)(0)(0)	1(1)(0)(0)
Total		19(17)(14)(14)	3(4)(4)(5)	1(4)(9)(9)	1(1)(0)(1)	24(26)(27)(28)

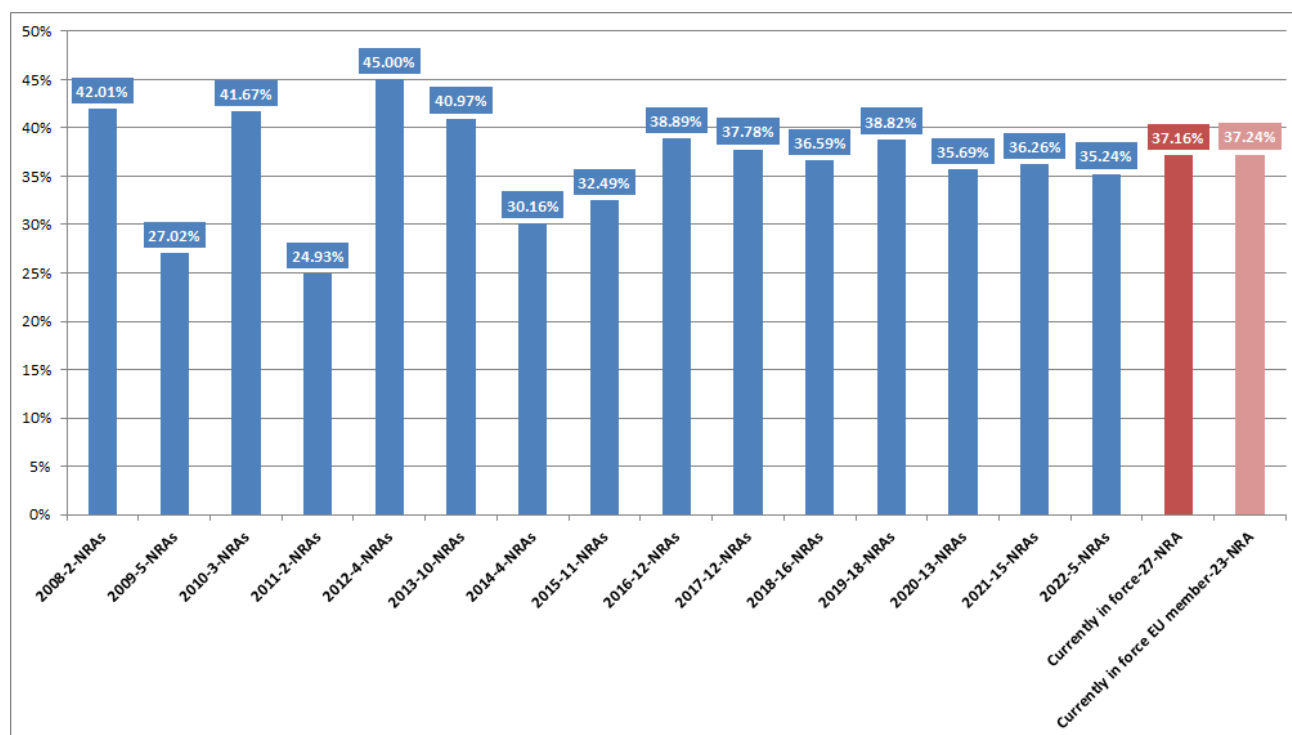
		Cost of debt			
		notional (generic operator)	SMP Operator	Other	Benchmarking
Gearing	notional (generic operator)	BE,FI,HR,IE,RS	IT		
	SMP Operator	LI	LT		
	Other			MT	
	Benchmarking				RO

Source: BEREC RA database 2022

The evolution over time of the gearing estimation is reported in Figure 47.

<sup>56</sup> NRAs that have provided information on all elements are shown. The NRAs that fully apply the WACC Notice fully are not reported separately.

Figure 47 – Evolution of gearing over time



Source: BEREC RA database 2022

## 5.2.6 Tax rate

Concerning the corporate tax rate in use the following statistics emerge (2018-2021 figures in brackets):

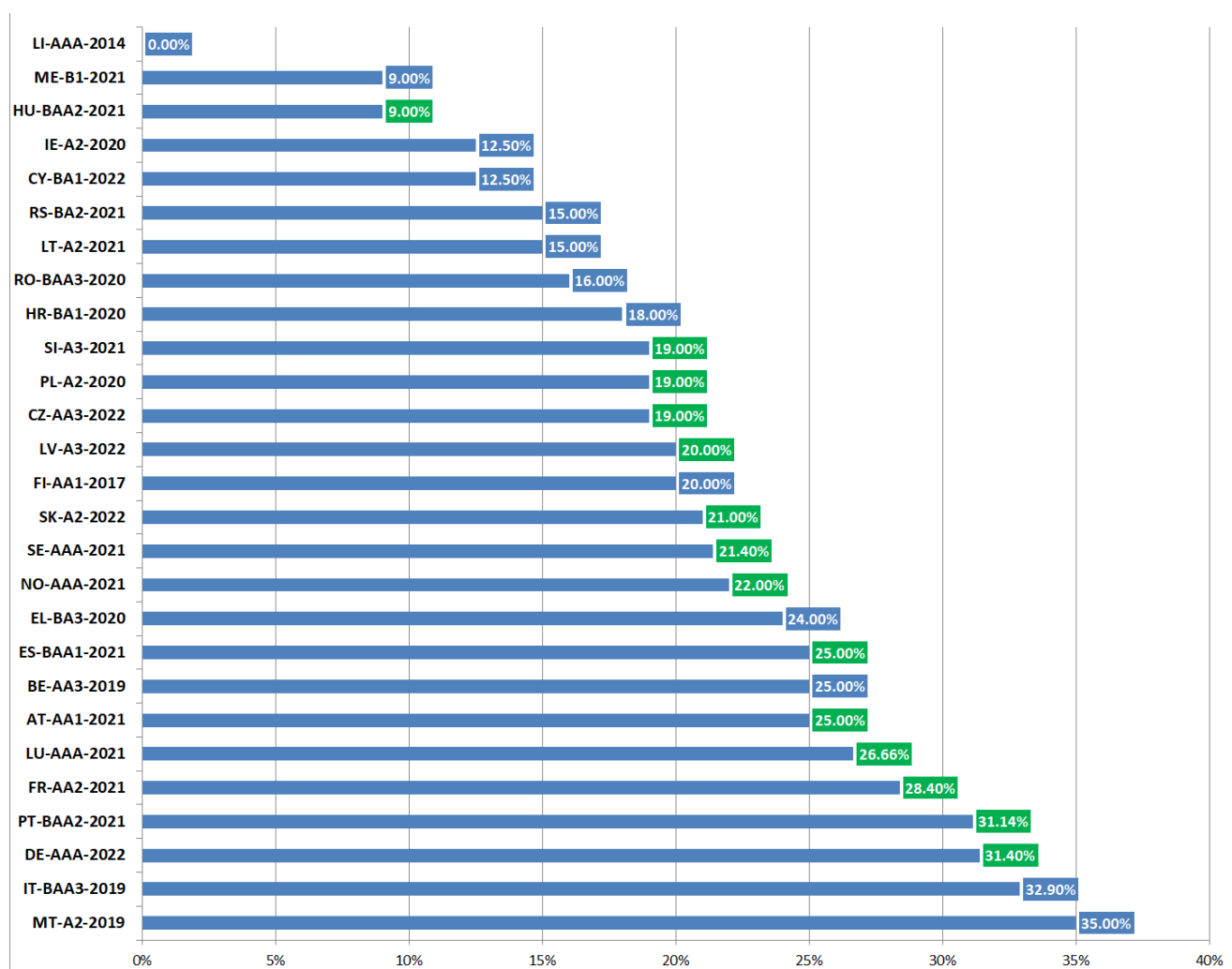
Figure 48 - Corporate tax rate

	Average	Median	Standard Deviation	Relative Standard Deviation	Maximum	Minimum
Tax rate fixed market 27-NRAs	20.48%	20.00%	8.04%	39.25%	35.00%	0.00%
(2021-29)	(20.31%)	(20.00%)	(8.09%)	(39.85%)	(35.00%)	(0.00%)
(2020-31)	(20.02%)	(20.00%)	(7.75%)	(38.72%)	(35.00%)	(0.00%)
(2019-32)	(21.07%)	(20.45%)	(8.34%)	(39.57%)	(35.00%)	(0.00%)
(2018-32)	(21.09%)	(20.45%)	(8.48%)	(40.19%)	(36.00%)	(0.00%)
Tax rate fixed market 23-EU NRAs	36.82%	39.22%	9.27%	25.17%	46.46%	0.00%
(2021-25)	(21.68%)	(21.00%)	(7.11%)	(32.77%)	(35.00%)	(9.00%)
(2020-24)	(21.57%)	(21.50%)	(7.21%)	(33.43%)	(35.00%)	(9.00%)
(2019-26)	(22.51%)	(21.50%)	(7.73%)	(34.33%)	(35.00%)	(9.00%)
(2018-26)	(22.54%)	(22.00%)	(7.91%)	(35.08%)	(36.00%)	(9.00%)

Source: BEREC RA database 2021

As already mentioned, taxation is also an important parameter to explain WACC variations between NRAs - it represents a typical country-specific parameter. Needless to say it is not a parameter that NRAs have an influence over.

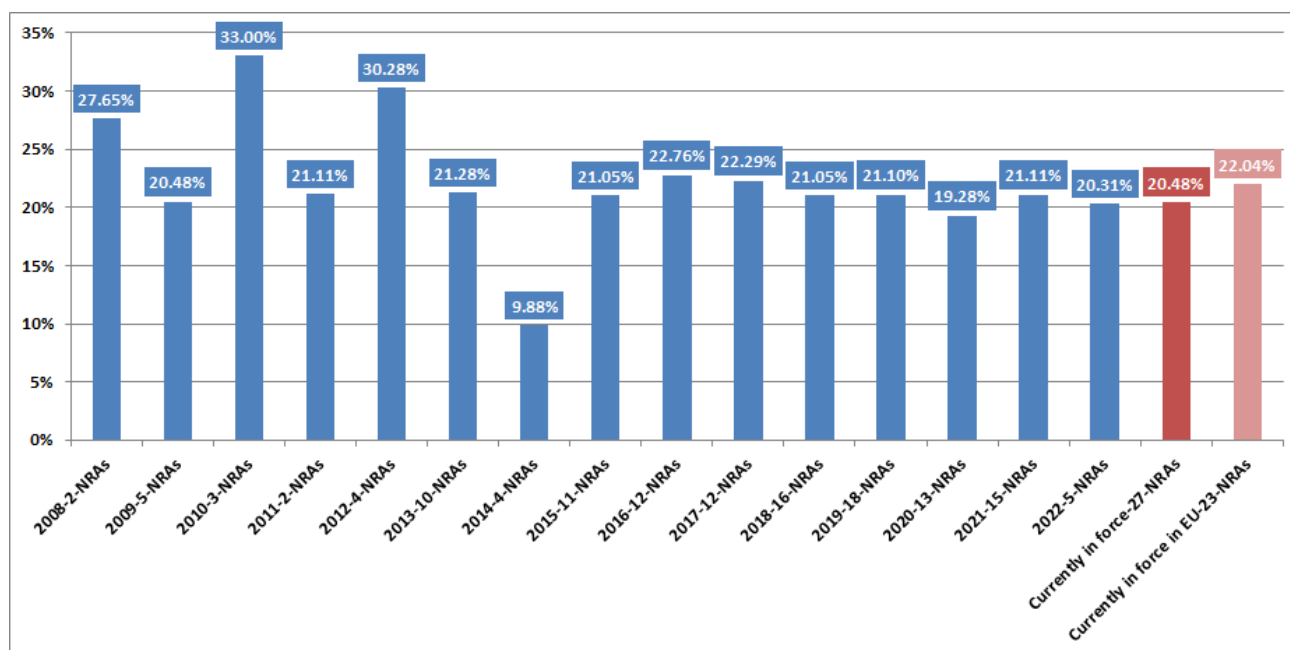
Figure 49 - Tax rate currently in use



Source: BEREC RA database 2022

The time evolution of the tax rate adopted is reported in Figure 50.

Figure 50 - Evolution of tax rate over time (fixed market 2008-2022)



Source: BEREC RA database 2022

## 5.2.7 Other Adjustments

The practice by some NRAs to adjust the value of WACC parameters posed an issue in some cases of Article 7/a evaluation processes by the European Commission.

In order to better understand the use of adjustments, specific questions have thus been addressed in the 2022 questionnaire on technical adjustments on single parameters estimation and, in general, on the cost of equity.

In Figure 51, NRAs that apply an adjustment to the cost of equity are listed ( in bracket the adjustment applied in 2020, 2019 and - 2018).<sup>57</sup>

Technical adjustments to the cost of equity are evaluated as: Post tax cost of equity (RFR+ Equity Beta\*ERP) + "Adjustment". The following adjustments do not include other adjustments reported in previous sections.

In comparison to the previous years the practice of using adjustments is decreasing over time with some NRAs (CZ, DE, NO, SK) having removed the adjustment. This tendency has been also enforced with the application of the WACC Commission Notice since last year report.

<sup>57</sup> In Figure 60 only fixed market adjustments are shown.

Figure 51 - Adjustments to the cost of equity

	Adjustmet for cost of equity	Motivation
RS	1.81% (1.25%) (0.91%) (1.01%) (1.38%)	As for the cost of debt Adjustment is made using the inflation rate for Serbia and Eurozone, since the initial values of cost of equity are in EUR. Infation adjustment was made using Fisher equation.

Source: BEREC RA database 2022

The number of NRAs that have applied adjustment to the cost of equity has decreased and a full adoption of the WACC Notice would no longer provide room for adjustments. The motivation for technical adjustments is generally to take into account national specificity with the main motivation being stability considerations.

### 5.3 NGA Risk premium

In this section an overview of NGA WACC estimation is provided without looking at the price control applied to the NGA wholesale regulated product for which the information is also available in the RA section of the report. More specifically, it provides an update on NGA risk premium calculations.

The following emerges from the survey: 10 NRAs have estimated a risk premium for FTTH networks currently in force, 2 NRAs have applied a risk premium to the FTTC services without differentiating the final value from the one applied to FTTH (LU, SI) since the regulation has been in charge for this product. Since last year two NRAs updated the risk premium (CZ, SI).

In general it is not possible to obtain a clear view of the corresponding systematic or non-systematic risk taken into account in this NGA risk premium. Uncertainty of demand is the main source of risk, but the general concerns reported in the NGA recommendation are: i) uncertainty relating to the costs of deployment; ii) uncertainty relating to technological progress; iii) uncertainty relating to market dynamics and the evolving competitive situation, such as the degree of infrastructure-based and/or cable competition; iv) macroeconomic uncertainty can have an influence about the level of risk included in the market. The risk is generally applied to all the kinds of infrastructure, both active and passive.

Figure 52 - Risk premium

	Do you apply an NGA premium?	Do you apply a premium to FTTC?	If yes, please provide the nominal %	Do you apply a premium to FTTB?	If yes, please provide the nominal %	Do you apply a premium to FTTH?	If yes, please provide the nominal %	What kind of risks do you take into account?	Which infrastructure do you apply the premium to?	How do you estimate the premium (please explain briefly)	How do you apply the premium (please explain briefly i.e. if you also include a premium for duct access products etc.)	Other comments
BE	Yes	No	0	Yes	1.59%	Yes	1.59%	other	Passive and Active	Increased beta and cost of debt and a worse credit rating; based on qualitative arguments	Different WACCs for different networks. We have a legacy WACC, a cable WACC, a FTTH WACC, and a mobile WACC	
CZ	Yes	No	-	Yes	0.94%	Yes	0.94%	Uncertainty relating to market dynamics, dependence on the business cycle, market size and capacity, intensity of competition, barriers to entry, position in relation to suppliers and customers, competitiveness of services, prices, regulatory and financial risks.		The NGA risk premium represents a risk difference between the NGA and legacy networks, assessed separately for all relevant criteria. For this exercise a special model of complex box method for cost of equity estimation published by prof. Mařík was used. This method segments the total risk into partial risks which are then assessed separately. Individual risks associated with NGA networks are not estimated in their absolute values but relatively to risks of legacy networks, i.e. whether the risk is the same, higher or lower than for the legacy networks. Consistent risk factor is a value of 100 %, higher risk factor is more than 100 % and lower risk factor is lower than 100 %. Finally was calculated the weighted average from percentage values of risks. This average value represents the risk ratio of NGA networks and other technologies.		The NGA risk premium was calculated as a difference between the WACC for legacy network and WACC for NGA network. When the value of the WACC for legacy was changed, the value of NGA risk premium was changed too (the risk coefficient is the same from 2019).  The steps of calculation (actual value) : WACC for legacy: 4.84% Risk coefficient: 119,375 % WACC for NGA: 5,78 % NGA rik premium: 0.94% (5,78-4,84)
FI	Yes					Yes	-		Passive and Active	Study made by KPMG. One standard deviation is added to copper beta in order to get beta for fiber.		
FR	Yes					Yes					No risk premium is applied in the asymmetrical regulation. However, in the symmetrical regulation, Arcep has issued some non-binding methodological documents about tariffing FttH networks in less dense areas, mentioning the use of a NGA premium, with an indicative value of +2% on the main segment	
HR	Yes	No		Yes	1.97%	Yes	1.97%	The additional risk premium should reflect the risks related to the demand, like the risks related to the use of broadband access services NGA speeds (speeds higher than 30 Mbit/s). The data shows a significant increase in the use of NGA speeds in	Passive and Active	Benchmark methodology based on currently available data on EU member states	NGA risk premium is applied on civil engineering assets need to be built to provide FTTH/FTTB infrastructure	

								the Republic of Croatia - at the end of 2018, about 330,000 users in Croatia used NGA speeds, which is a significant increase in the last three years (more than five times). Furthermore, the lower risk premium is justified given that other operators are willing to invest in fibre optic access networks, as evidenced by the significant increase in announcements of intentions to set up fibre optic distribution networks of alternative operators in the last two years.				
IT	Yes	No				Yes	3.20%	0	Passive and Active	Agcom evaluated through an option pricing model (mainly based on a DCF approach) the level of risk premium in a way to include two main risk factors: a) the "wait and see" option to postpone the investment when new information about demand/cost will be available b) the risk to open the network to third parties without having any first mover advantage. The two sources of risk are justified in Italy for FTTH, also for the next regulatory period 2019-2021, due to the specific conditions that show: i) already a national coverage with FTTC solution, achieved recently by the incumbent operator in combination with a low coverage of FTTH; ii) the fact that the investments in FTTH will be done at a national level by an alternative operator with a wholesale only model. The investment in FTTH solution in this context is not an independent choice by the SMP operator, but a reply to the competitive context.  This means that the fast deployment of FTTH is a source of increased systematic risk not only for the incumbent but also for a generic operator, due to the fact that every operator deploying VHCN networks face demand uncertainty at retail and wholesale level in combination with the need to find new sources for substantial capital (capital leverage) for asset investments.	In line with the objective of the NGA Recommendation the risk premium evaluated by AGCOM has been seen as an instrument to promote efficient investment by providing the right make or buy signal to the market taking into account the risks incurred by all investing undertakings. The level of the risk addressed is generally systematic and is related to speed up the investment in FTTH network in a context where there is uncertainty about demand for new services and no first mover advantage.	
LU	Yes	Yes	2.50%	Yes	2.50%	Yes	2.50%	other	Passive and Active	Benchmark + consideration of the evolution in the national broadband market (NGA coverage + demand for NGA products)	all NGA infrastructure	
PL	Yes	No		No		Yes	2.05%			As average premium from country, which uses NGA premium		
SI	Yes	Yes	1.50%	Yes	1.50%	Yes	1.50%	Demand risk	Passive and Active	benchmarking	a premium on WACC value for fixed network	

Source: BEREC RA database 2022



## Appendix I - WACC parameter quantitative analysis

Carried out since BoR(17)169, as new observations on WACC estimation become available, the time series on WACC estimation for causal inference analysis have been updated in order to identify parameters that may better explain WACC variations on a historical basis. Over time this exercise provides insight into the results of the evolution of the methodologies applied for each parameters. In this case, the independent variables (parameters for estimating WACC) are considered as causes of the dependent variable (WACC values). Causality exploration aims to determine whether a particular independent variable influences the dependent variable and to estimate the magnitude of the effect, if any.

We use the following regression model, which links the WACC values to six main parameters (data updated in 2022):<sup>58</sup>

$$\text{WACC}_{i_k} = \text{Constant} + \beta_1 \text{RFR}_{i_k} + \beta_2 \text{Equity Beta}_{i_k} + \beta_3 \text{ERP}_{i_k} + \beta_4 \text{gearing}_{i_k} + \beta_5 \text{Debt premium}_{i_k} + \beta_6 \text{Tax}_{i_k}$$

(where  $i$  is the year of the data and  $k$  identifies countries involved).

Regression analysis can provide a deep understanding and numerical information on the causality between the dependent variable and each independent variable, taking into account information provided by other independent variables.

This cannot be addressed by a simple correlation analysis between each independent and the dependent variable as this only considers a measure of the extent the two variables move together, independently with respect to the information on variation provided by all other independent variables (thus not being able to prove real causality).

Several checks are needed to validate the use of a linearized model in order to infer or predict<sup>59</sup>. In case of a panel data analysis using a linear regression model, it is necessary, *inter alia*, to address the following main elements: i) linearity of the relationship between dependent and independent variables; ii) multicollinearity between independent variables; iii) homoscedasticity (constant variance) of the errors; iv) normality of the error distribution.

In the following, “sanity checks” of the proposed linear model have been addressed analysing the residual output of the model before addressing the relevance of variables that better explain observed WACC values.

### Linearity

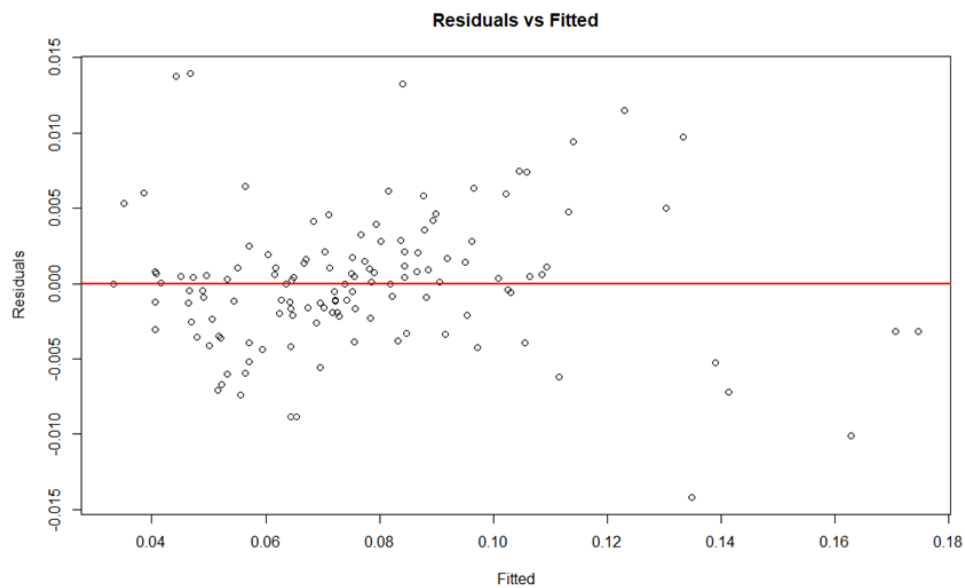
A first verification of the validity of the linear approximation is to detect if some path can be identified in the residual plot (y-axis) with respect to the expected values (x-axis). Points should be distributed symmetrically around a horizontal line in relation to an intercept equal to zero. Different trends indicate at first point the presence of some non-linearity in

<sup>58</sup> The parameters have been analysed not including adjustment not attributed to single parameters.

<sup>59</sup> “Statistics for business and economics” Heinz Kohler 1994.

the model (Figure 53)<sup>60</sup>. The assumption that the average error  $E(\varepsilon)$  is zero everywhere implies that the regression surface accurately reflects the dependency of Y on the X's.

Figure 53 - Linear approximation

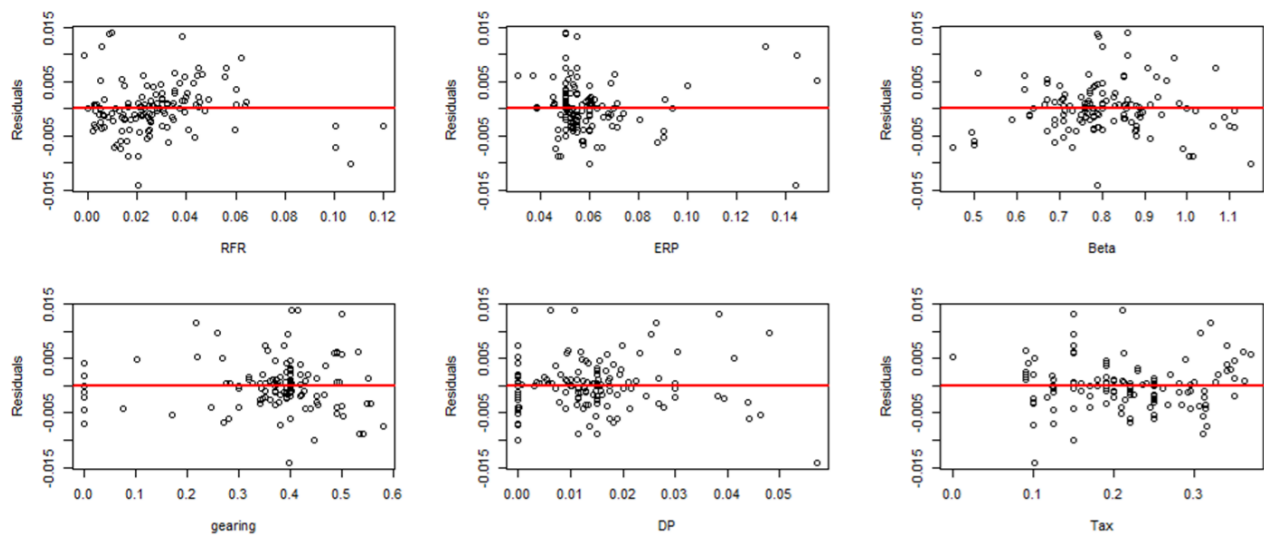


Source: *BEREC RA database 2022*

Moreover, a deeper analysis on each regressor should be considered plotting the residual previously represented with each independent variable. Also in this case non-linear effects could be detected when paths deviate from the “random” shape (visible in the residual plots).

<sup>60</sup> The residual of an observed value is the difference between the observed value and the estimated value of the quantity of interest.

Figure 54 - Non-linear effects



Source: BEREC RA database 2022

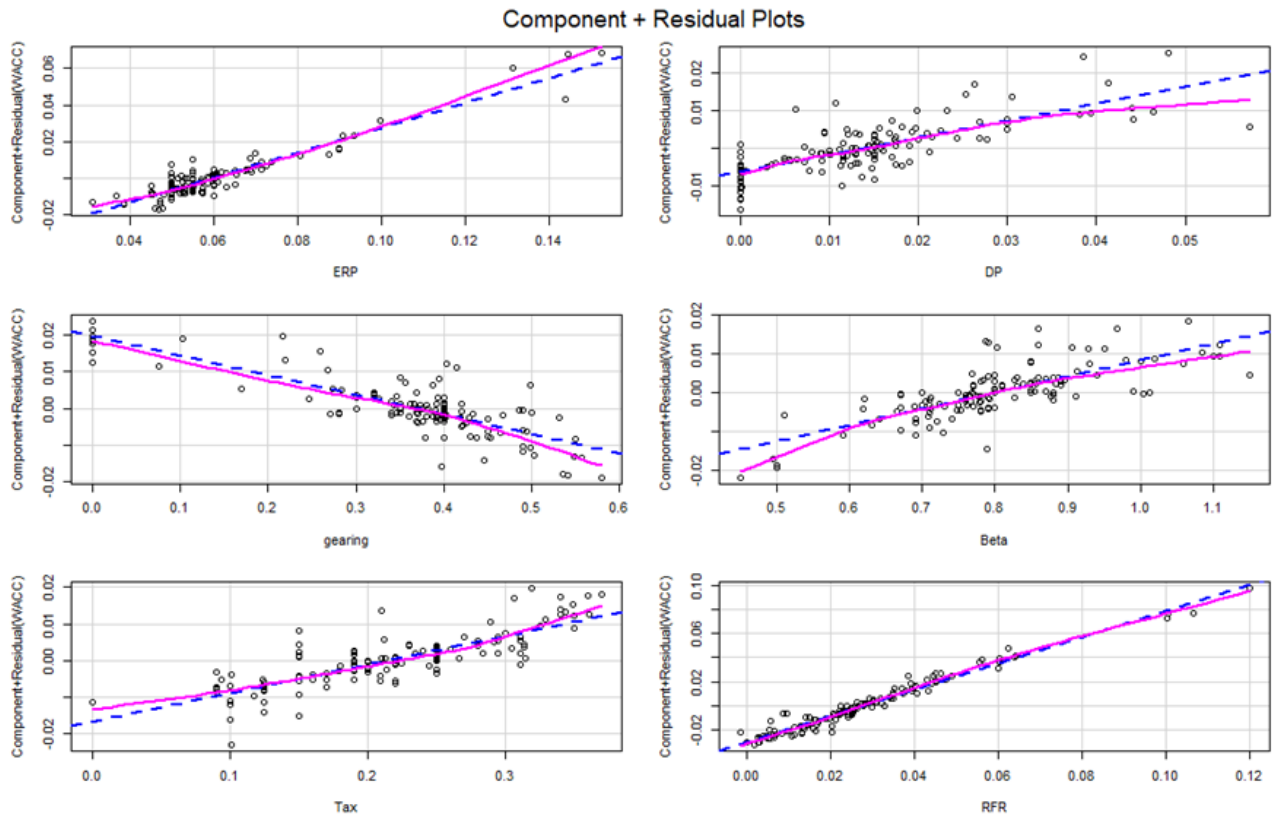
Another relevant measure to detect non-linearity in the model is provided through the use of the partial residual plot<sup>61</sup> (Figure 55), which, in case of multiple regression, shows the relationship between a given independent variable and the response variable, given that other independent variables are also in the model. Since in our case the dependent variable depends on six main parameters, the use of a partial residual plot is therefore more correct than simple single-variables scatter plots<sup>62</sup> (correlation measure).

In Figure 55 a nonparametric fitting (pink line) helps to assess whether the linear trend adequately captures the partial relationship between Y and X. The partial residual plot (blue line) highlights that linear approximation is good for each parameter.

<sup>61</sup> Partial residual plot includes  $E_{ij} = (\text{residual}_i + \beta_j \cdot x_{ij})$  vs  $x_{ij}$ . This simply adds the linear component of the partial regression between Y and  $x_i$  (which may be characterised by a nonlinear component) to the least squares residuals. The "partial residuals"  $E(j)$  are plotted versus  $X_j$ , meaning that  $\beta_j$  is the slope of the simple regression of  $E(j)$  on  $X_j$ . Through this plot both monotone and non-monotone non linearity can be detected..

<sup>62</sup> Regressing each independent variable with the dependent variable like a bi-variate model.

Figure 55 - Nonparametric fitting

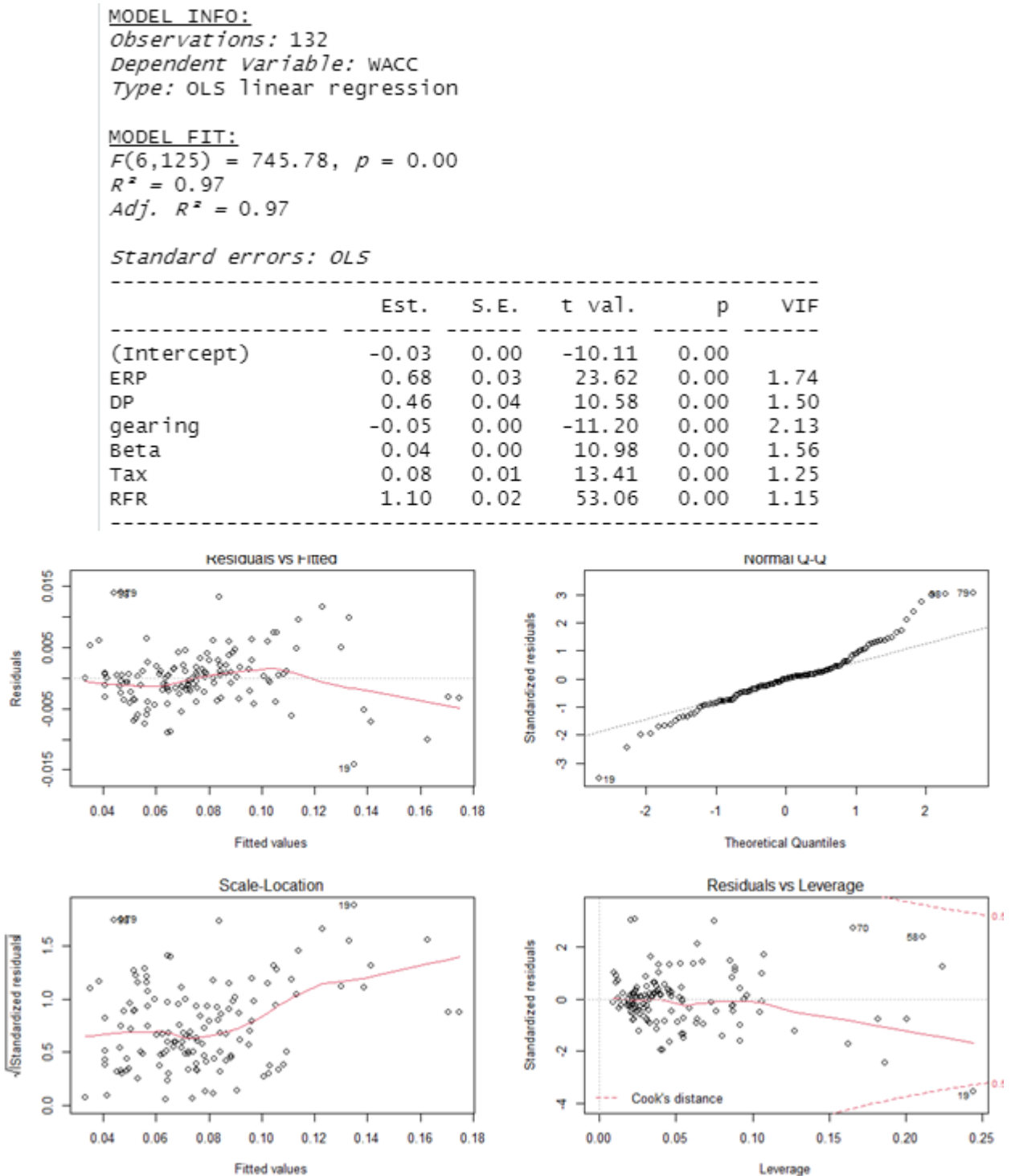


Source: BEREC RA database 2022

### Normality, multicollinearity, homoscedasticity

In Figure 56 summarised statistics are provided showing that all regressors are statistically significant with an adjusted R squared of 0.97. Moreover, the standard variance inflation factor (VIF) shows no multicollinearity among variables, thus further validating the model. We show hence (i) the residual graph against theoretical values, which looks completely casual, thus not revealing the existence of a residual systemic dependence among variables (already shown in Figure 53); (ii) the normal Q-Q plot of the standardised residues, which graphically verifies the assumption of normality of the erratic component of the linear model; (iii) the chart of square roots of standardised residues against theoretical values, and (iv) the graph of Cook distances, which let us identify three observations as possible outliers.

Figure 56 - Nominal panel data statistics



Source: BEREC RA database 2022

We hence show the same model without six possible outlier observations, by still finding similar results, as shown in

Figure 57.<sup>63</sup>

Figure 57 - Nominal panel data statistics without outliers

**MODEL INFO:**

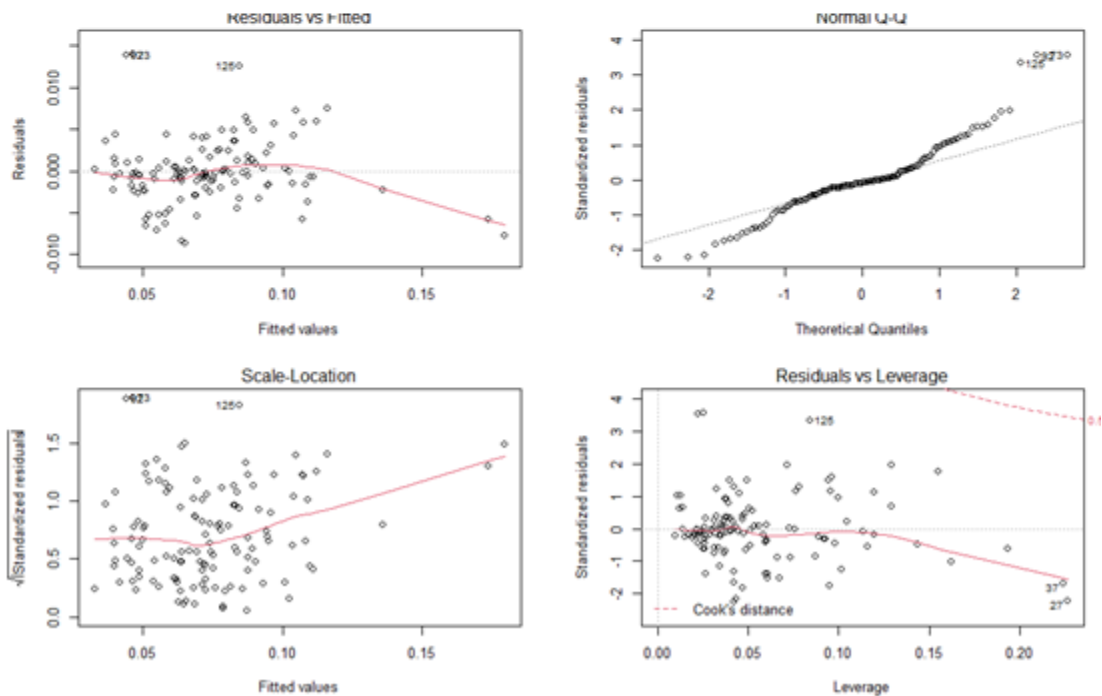
Observations: 126  
 Dependent Variable: WACC  
 Type: OLS linear regression

**MODEL FIT:**

$F(6,119) = 775.23, p = 0.00$   
 $R^2 = 0.98$   
 Adj.  $R^2 = 0.97$

*standard errors: OLS*

	Est.	S.E.	t val.	p	VIF
(Intercept)	-0.03	0.00	-8.36	0.00	
ERP	0.63	0.04	16.87	0.00	1.38
DP	0.42	0.04	10.57	0.00	1.28
gearing	-0.05	0.00	-11.81	0.00	2.24
Beta	0.04	0.00	12.04	0.00	1.56
Tax	0.07	0.01	13.29	0.00	1.27
RFR	1.14	0.02	56.12	0.00	1.15



Source: BEREC RA database 2022

Figure 58 shows the contribution to the increase in R-squared that each parameter produces when it is added to a model that already contains all of the other variables. Specifically, we include all N-1 variables in the model and we evaluate how well they fit in the model, like in a Backward

<sup>63</sup> Global test and Breush-Pagan test have been carry on with a result to discard the null Hypothesis of Non linearity, Skewness, Kurtosis, Kind of Model (categorical/continuous), Heteroscedasticity.

elimination selection rule in a stepwise regression, and comparing the results with the Model specified with the N independent variable.

Since the change in R-squared analysis considers each variable as the last one entered into the model, the change represents the percentage of the variance one single variable explains that the other variables in the model cannot explain. In other words, this change in adjusted R-squared represents the amount of *unique* variance that each variable explains above and beyond the other variables in the model. We further estimate the Akaike Information Criterion,<sup>64</sup> comparing the value obtained with a model with N independent variables and the values obtained with models composed by N-1 variables. This analysis confirms what the R-square analysis already highlighted, in terms of relevance of the parameters and provides that no model overfitting problem comes out. In figure 65 we report statistics from the three analysis done, when all the observations are taken into account (n=132), when possible 6 “outliers” have been deleted (n=126), when only EU members are included (n=103).

Figure 58 - WACC Nominal pre-tax R<sup>2</sup> adjusted variations / AIC variations (full time series analysis)

Number of observation: 132	Total	RFR	ERP	Tax	gearing	beta	CD
R <sup>2</sup> Adj	97.15%	63.61%	12.59%	4.04%	2.70%	2.81%	2.50%
AIC	-1413.94	-414.84	-222.17	-115.62	-89.67	-87.1	-82.39
Number of observation: 126	Total	RFR	ERP	Tax	gearing	beta	CD
R <sup>2</sup> Adj	97.38%	68.74%	6.19%	3.83%	3.02%	3.14%	2.42%
AIC	-1388.04	-415.42	-151.89	-112.62	-95.72	-98.38	-81.44
Number of observation EU NRAs: 103	Total	RFR	ERP	Tax	gearing	beta	CD
R <sup>2</sup> Adj	96.85%	73.02%	9.74%	6.16%	5.03%	5.20%	2.34%
AIC	-1151.18	-327.1	-144.11	-110.66	-97.34	-99.37	-56.18

Source: BEREC RA database 2022

The main conclusion prevails that most of the variability is explained by the RFR estimation and, to a lesser extent, by the ERP estimation. Looking at only EU member state countries, ERP is more relevant for understanding the causality variation of the final WACC value. All other parameters provide a much lower statistically significant explanation, beta is becoming more relevant with the new introduced observation; this can be seen by the fact that contrary to the past the new updated values are going to be different from the past, due to increased differences in the level of risk in the telecom sector with respect to the other sectors (see figure 35).

<sup>64</sup> The Akaike information criterion (AIC) is a measure of the relative quality of statistical models for a given set of data. Given a collection of models for the data, AIC estimates the quality of each model, relative to each of the other models. Hence, AIC provides a means for model selection. Given a set of candidate models for the data, the preferred model is the one with the minimum AIC value. 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.

In the sample there are some NRAs that update the WACC every year and others updating it only every market analysis. The outlined differences in the frequency of WACC estimation may produce an unbalanced sample that over/under-represents some countries in a way that can bias the estimation (intrinsic selection bias<sup>65</sup>). In fact, even if we have considered that each WACC estimation is an independent observation, some parameters can be linked to country specificities, producing a selection bias problem. Such consideration is useful for taking into account the temporal dimension in a more effective way. We have repeated the previous analysis limiting the number of estimations for each NRA to the three more recent observations. From this sample we observe that beta is slightly more explanatory with respect to gearing when also considering older estimations, but it is relevant to observe that ERP has become less relevant for explaining differences between WACC values applied by NRAs. Tax, which is a country parameter, not under NRAs control, has become more relevant in explaining differences with respect to ERP since last year. These results confirm also the fact that by taking into account more recent data ERP is already less relevant in explaining differences between NRAs WACC, in line with a notional approach to estimation. At the same time beta is becoming more relevant for explaining the difference in WACC values between NRAs due to asincronus update of the parameter and due to the fact that contrary to the past the variation of this parameter is more relevant than before.

Figure 59 - WACC Nominal pre-tax R<sup>2</sup> adjusted variations / AIC variations (reduced time series analysis)

Number of observation: 85 observations	Total	RFR	ERP	Tax	gearing	beta	CD
	R <sup>2</sup> Adj	96.44%	74.94%	3.60%	4.43%	2.33%	4.55%
AIC	-944.75	-262.05	-58.49	-67.81	-41.92	-69.11	-61.59
Number of observation: 70	Total	RFR	ERP	Tax	gearing	beta	CD
	R <sup>2</sup> Adj	96.76%	79.27%	4.05%	5.70%	2.67%	5.78%
AIC	-787.12	-225.79	-55.91	-70.18	-41.27	-70.82	-37.83

Source: BEREC RA database 2022

<sup>65</sup> The Selection bias is the bias introduced by the selection of individuals, groups or data for analysis in such a way that proper randomization is not achieved, thereby ensuring that the sample obtained is not representative of the population intended to be analysed. It is sometimes referred to as the selection effect. Selection bias may lead to the distortion of a statistical analysis, resulting from the method of collecting samples. If the selection bias is not taken into account, then some conclusions of the study may be false.