

## **RA Report Chapter 5 - WACC**

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## List of Abbreviations

	<b>Q</b>
	QE <i>Quantitative Easing</i>
<b>C</b>	<b>R</b>
CoD <i>Cost of Debt</i>	
<b>D</b>	RFR <i>Risk Free Rate</i>
DMS <i>Dimson, Marsh, Staunton</i>	<b>S</b>
<b>E</b>	S&P <i>Standard &amp; Poor Credit Rating Agency</i>
ERP <i>Equity Risk Premium</i>	<b>T</b>
<b>M</b>	TMI <i>Total Market Index</i>
MSCI <i>Morgan Stanley Capital International</i>	TMR <i>Total Market Return</i>

## 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 2019 RA report (BoR (19) 240) provided an update of the information reported since BoR (17) 169 both for parameter values and methodologies with a cut-off date of 1<sup>st</sup> April 2019. The current 2020 report presents an up to date version of the WACC benchmark with a cut-off date of 1<sup>st</sup> April 2020.

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. The WACC notice is an instrument for the review of national notifications in the EU electronic communication sector. In 2020 BEREC calculated for the first time the main WACC parameters according to the methodology foreseen in the non-binding WACC Notice (BoR (20) 116).

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, whilst the importance of consistent application of the methodology foreseen in the Notice is acknowledged, 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. 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 the 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) 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 Report 2020 (BoR (20) 116), 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 as showing the evolution over time, in line with previous versions.

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

- parameter values to evaluate the WACC;

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

- 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 both for fixed and mobile markets and the following main parameters of the WACC formula based on CAPM methodology – in force as at April 2020: 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 and mobile 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). The cells marked “X” indicate that in that year single values of each WACC parameter were collected in the RA EWG data base. Colours provide information on the years where NRAs have taken a decision for the fixed market WACC since 2008: green marks decisions, orange public consultations<sup>3</sup>, grey decisions in force in 2020 but taken after the cut-off date of the 1<sup>st</sup> April 2020.

For the mobile market information on NRAs that calculate a specific mobile WACC is provided. Column “2019” reports the values in force in 2019 independent from the year of the adoption, while the “2020” column reports only the cases where updated values are in force.

Information on WACC methodologies and values for the fixed market are recorded for 32 NRAs<sup>4</sup>. Most of the NRAs (20) update the WACC in line with their market analysis or when pricing decision are taken. In these cases, a market-specific WACC may be in force for 2 or more years. Some NRAs update yearly (10), but in some cases the update only comes into force when new pricing decisions are taken.

The dataset used for the following analysis takes into consideration 89 observations of all 6 parameters previously listed and 1 final value based on information collected and related to the period 2008-2020. The data collected refers to information provided by NRAs and is updated for the 2020 year 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 information provided. Technical adjustments are also reported.

The 2020 report, in line with the 2019 version, also provides statistics on WACC values and methodologies for the mobile market.

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, a general reduction of the dispersion for all values may be observed: mainly for RFR and, to a lesser extent, ERP<sup>5</sup>, CoD, beta and gearing.

<sup>3</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 2020 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>4</sup> For this year’s report IS, LI, refer to previous year’s reports as no change has been reported since last year. The same applies to the UK which left the EU on 31<sup>st</sup> Jan. 2020 and is therefore no longer a BEREC member. EE states that its final WACC value is obtained using a benchmark of other NRAs, rather than applying a formula. For the first time data was provided from ARKEP (XK), Kosovo\*, \*this designation is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo declaration of independence.

<sup>5</sup> For ERP a reduction of “outlier” values is more evident in this year’s report.

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(19) 240). The information is reported for all countries that have provided information and separately for EU member states.<sup>6</sup>

Figure 1 - WACC database and frequency of update/calculation<sup>7</sup>

		Fixed Market (Year of adoption)														Mobile Market			Frequency Update
		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020		2019	2020		
EU member state	AT		X			X			X							X			MA/RP
	BE	X		X					X				X			X	X		MA/RP
	BG						X			X						X			MA/RP
	CY				X				X		X	X	X	X		X	X		MA/RP
	CZ									X			X			X			MA/RP
	DE				X						X	X	X	X					YEARLY
	DK								X	X	X	X	X	X		X			YEARLY
	EE																		
	EL						X		X		X	X			X	X	X		MA/RP
	ES		X				X			X	X	X	X			X			YEARLY
	FI		X				X				X					X			MA/RP
	FR					X		X		X		X				X			MA/RP
	HR						X			X					X	X	X		MA/RP
	HU								X	X	X	X	X			X	X		YEARLY
	IE		X						X	X	X	X	X			X			MA/RP
	IT			X					X				X			X			MA/RP
	LT								X			X	X						YEARLY
	LU									X				X		X			MA/RP
	LV										X					X			
	MT					X								X		X	X		MA/RP
NL					X				X					-	X	X		MA/RP	
PL										X	X	X	X					YEARLY	
PT								X	X	X		X			X			YEARLY	
RO						X							X					MA/RP	
SE												X	X		X	X		MA/RP	
SI							X						X					MA/RP	
SK						X		X		X		X	X		X	X		YEARLY	
NO EU member	CH	X					X				X	X	X						YEARLY
	IS											X							
	LI							X				X							MA/RP
	MT		X												X				
	NO						X				X	X			X				MA/RP
	RS							X	X	X	X	X	X		X				YEARLY
	UK			X					X			X	X		X				MA/RP
XX								X								X			
Number of observations Totals		2	5	3	2	4	9	5	11	12	12	16	18	5		24	9		

X	Available in the RA database
	Adopted decision
	Public consultation
	In charge for the year report, but adopted after the cut off date of 1 April

Source: BEREC RA database 2020

<sup>6</sup> The table (Figure 1) reports the year of adoption [April N-1 to April N], or, when different, of application.

<sup>7</sup> BNetzA 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 SE the last current fixed market WACC was adopted on 1 October 2018, but according to the cut-off date, has been classified for 2019.

## 5.2 WACC Nominal pre-tax synthetic value

Figure 2 reports the main statistics related to nominal pre-tax WACC for all NRAs which provided information in 2020 (31 for fixed and 25 for mobile) and, separately, for the EU members states (24 and 20 respectively) which are subject to the same Regulatory framework (including the EU WACC Notice).

Figure 2 - Main statistics nominal pre-tax WACC

	Average	Median	Standard Deviation	Relative Standard Deviation	Maximum	Minimum
<b>WACC fixed Nominal Pre-tax; 31 NRAs (2019-32)(2018-32)</b>	<b>7.22%</b> (7.71%) (7.96%)	<b>7.1%</b> (7.28%) (7.73%)	<b>2.06%</b> (2.23%) (2.34%)	<b>28.53%</b> (28.87%) (29.39%)	<b>13.40%</b> (13.45%) (14.30%)	<b>3.33%</b> (4.04%) (4.04%)
<b>WACC mobile Nominal Pre-tax; 25 NRAs (2019-26)(2018-26)</b>	<b>8.03%</b> (8.59%) (8.73%)	<b>7.58%</b> (8.11%) (8.11%)	<b>1.88%</b> (2.17%) (2.21%)	<b>23.42%</b> (25.27%) (25.37%)	<b>14.02%</b> (14.29%) (14.29%)	<b>5.55%</b> (5.55%) (5.66%)
<b>WACC fixed Nominal Pre-tax; 24 EU NRAs (2019-26)(2018-26)<sup>8</sup></b>	<b>7.07%</b> (7.60%) (7.86%)	<b>7.13%</b> (7.28%) (7.73%)	<b>1.40%</b> (1.87%) (1.96%)	<b>19.81%</b> (24.60%) (25.00%)	<b>10.68%</b> (13.45%) (14.30%)	<b>4.54%</b> (4.62%) (14.30%)
<b>Wacc mobile Nominal Pre-tax; 20 EU NRAs (2019-23)(2018-23)</b>	<b>7.31%</b> (8.22%) (8.34%)	<b>7.17%</b> (7.63%) (7.89%)	<b>0.96%</b> (1.89%) (1.92%)	<b>13.17%</b> (23.03%) (22.97%)	<b>9.33%</b> (14.29%) (14.29%)	<b>5.55%</b> (5.55%) (5.66%)

Source: BEREC RA database 2020

The average WACC value currently in force for fixed and mobile markets decreased in comparison to the previous year (values in brackets)<sup>9</sup>. Also the relative standard deviation is decreasing mainly due to less outliers, as reported in the box-plot in Figure 4.<sup>10</sup>

In Figure 3 WACC values for fixed and mobile markets have been sorted (from lowest to highest including the year of the adoption for the fixed market) and also provides current country credit ratings (source: S&P). Of the 31 NRAs where fixed WACC values are available, 23 also provided information on the mobile market. Among the 23 NRAs that estimate a mobile market WACC, 3 NRAs estimate a single WACC for fixed and mobile markets; 16 estimate a higher WACC for the mobile market (on average +0.69 % (+0.96 %)); and 4 NRAs estimate a lower mobile WACC (on average -0.14% (-0.37 %)).

It is possible to observe that the number of NRAs that calculate mobile WACC is decreasing.

On the whole, the differences between fixed and mobile estimation are decreasing (on average) compared to previous year's values.

<sup>8</sup> The information related to EU Member States refer to AT, BE, BG, CY, CZ, DE, DK, EL, ES, FI, FR, HR, HU, IE, IT, LT, LU, MT, PL, PT, RO, SE, SI, SK. EE and LV did not provide information, NL did not evaluate a fixed WACC in a formal decision recently due to the fact that fixed regulatory framework has been annulled. For this reason there is no fixed WACC in charge until the regulation is restored (in figure 1 the following indication “-” has been included for this reason).

<sup>9</sup> In the tables the information of the previous year report statistics is also given providing year of estimation and the corresponding number of countries included.

<sup>10</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.



Figure 3 - Nominal pre-tax WACC - fixed and mobile markets



Source: BEREC RA database 2020

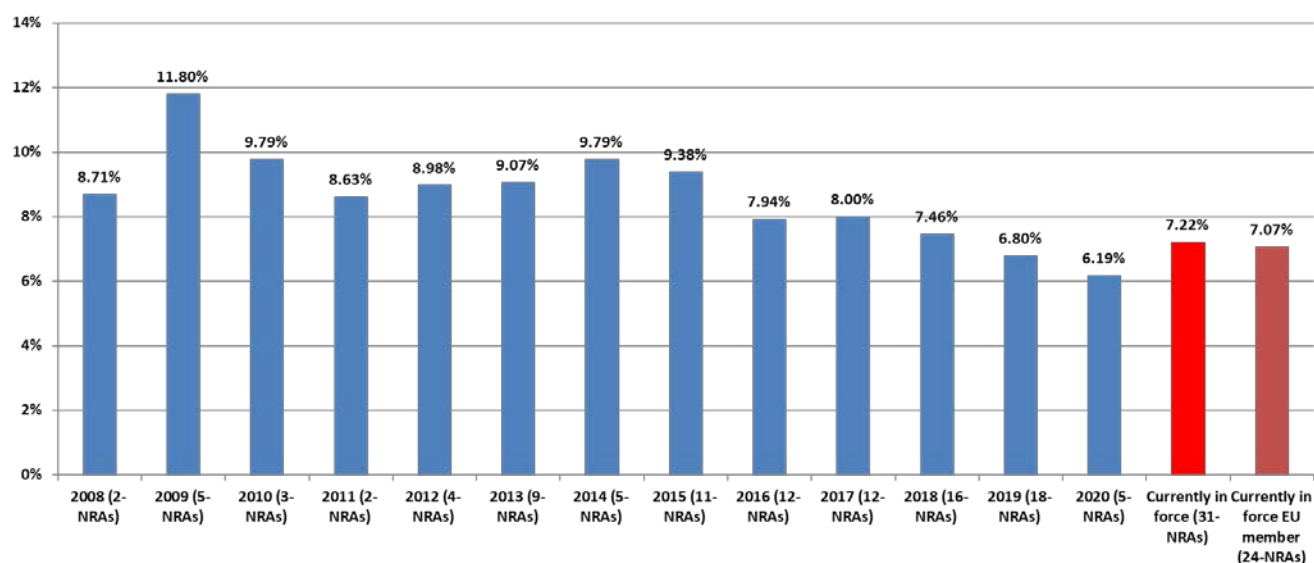
Figure 4 shows the average year-by-year values and the corresponding box plot of the nominal pre-tax WACC for the fixed market. The box plot in this figure only provides information about the dispersion between values where the average value is reported in figure 2. The objective is to provide information on how the average value is build up.

The average value currently in force is derived by averaging values that are in use at the date of the questionnaire's replies (independent of the year of the decision).<sup>11</sup>

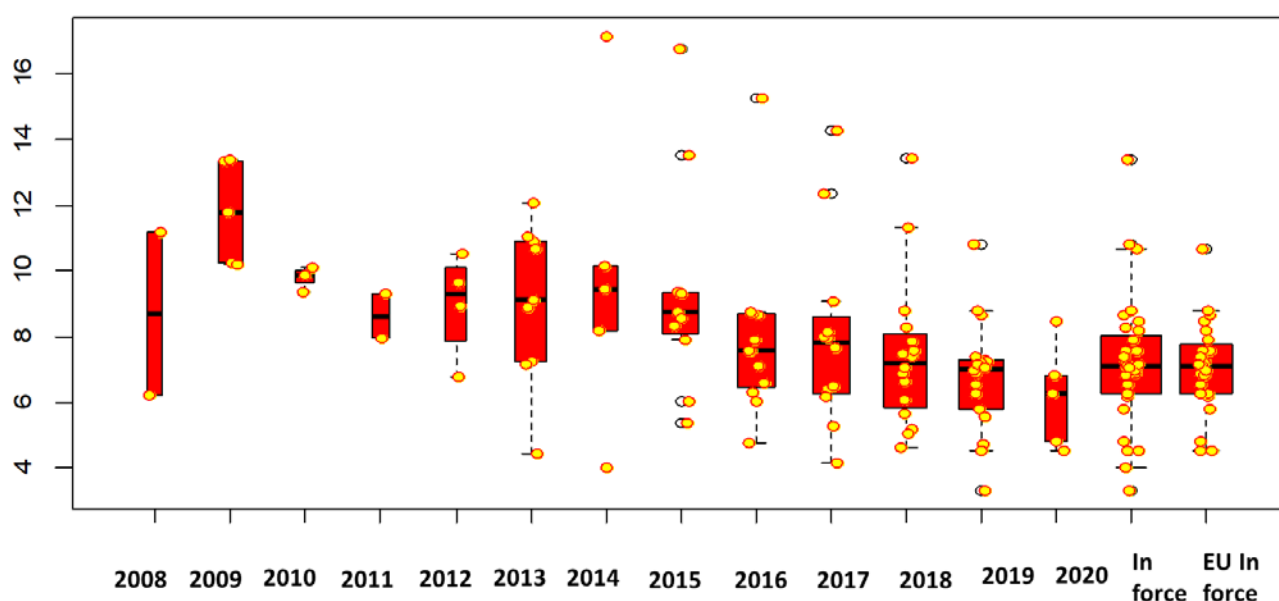
<sup>11</sup> DE: the real pre-tax fixed WACC in force (after exponential smoothing) equals 4,39%. DK: a real pre-tax WACC of 4.9% is used in the LRAIC mobile model.



Figure 4 - Nominal pre-tax WACC (fixed market 2008-2020)



### WACC Nominal pre-tax (%)



Source: BEREC RA database 2020

In order to explore the WACC parameters' weight with respect to the final WACC values, we updated the regression exercise presented in BoR (17) 169 and in BoR (19) 240 (see Appendix II). Updating the regression exercise can provide a quantitative approach useful to 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 exercises – that the differences of the final WACC values over time are mainly explained by parameters in the WACC calculation that are more “country specific” such as the RFR, ERP and Tax rate, with a less relevant role for parameters such as beta, gearing and debt

premium. This is consistent with survey results on “methodologies used” that confirm that beta, gearing and debt premium are estimated mainly on a “notional” basis (see also Appendix II).

The regression analysis in combination with descriptive statistics of the dispersion of the distribution of each parameter shows that the ERP is increasing in relevance (in relation to the variation of other parameters) when trying to explain variations in the final WACC value; at the same time a decrease of the dispersion of the distribution of absolute values of the parameter is observed for all parameters. That means that even if the dispersion among values adopted by NRAs is decreasing for all parameters, this decrease in the dispersion is lower for ERP in comparison to - for instance - RFR. This highlights that the ERP is still the main element of differentiation among NRAs in a general scenario of harmonisation. Analysing the dataset for EU-only member states the last conclusion is still more relevant. A somewhat smaller contribution is provided by beta and debt premium.

## 5.2.1 Risk Free Rate

see BoR (17) 169<sup>12</sup>, BoR (18) 167<sup>13</sup> and BoR (20) 116<sup>14</sup> for definition and general financial theory

Main output from the survey.

Based on the replies provided for the 2020 survey the following statistics were derived for all responding NRAs and for EU NRAs separately (2019-2018 values in brackets).<sup>15</sup>

Figure 5 – Nominal Risk Free Rate

2020	Average	Median	Standard Deviation	Relative Standard Deviation	Maximum	Minimum
<b>Nominal RFR-fixed market; 31 NRAs (2019-32)(2018-32)</b>	<b>2.52%</b> (2.70%) (3.00%)	<b>2.30%</b> (2.50%) (2.59%)	<b>1.95%</b> (1.90%) (2.11%)	<b>77.28%</b> (70.18%) (70.54%)	<b>10.04%</b> (10.04%) (10.04%)	<b>0%</b> (0.31%) (-0.17%)
<b>Nominal RFR-mobile market: 25 NRAs (2019-26)(2018-26)</b>	<b>2.73%</b> (3.11%) (3.18%)	<b>2.38%</b> (2.58%) (2.72%)	<b>1.86%</b> (1.92%) (2.02%)	<b>68.03%</b> (61.94%) (63.43%)	<b>10.04%</b> (10.04%) (10.04%)	<b>0.82%</b> (0.91%) (0.48%)
<b>Nominal RFR-fixed market EU: 24 EU NRAs (2019-26)(2018-26)</b>	<b>2.24%</b> (2.34%) (2.70%)	<b>2.27%</b> (2.34%) (2.59%)	<b>1.26%</b> (1.32%) (1.71%)	<b>56.34%</b> (56.18%) (63.30%)	<b>6.39%</b> (6.39%) (7.21%)	<b>0.27%</b> (0.31%) (-0.17%)
<b>Nominal RFR mobile market EU: 20 EU NRAs (2019-23)(2018-23)</b>	<b>2.16%</b> (2.68%) (2.74%)	<b>2.22%</b> (2.54%) (2.54%)	<b>0.86%</b> (1.24%) (1.37%)	<b>40.03%</b> (46.25%) (49.85%)	<b>3.73%</b> (6.39%) (6.39%)	<b>0.82%</b> (0.91%) (0.48%)

Source: BEREC RA database 2020

Even though the number of NRAs in 2020 is lower than in the two previous years the average value of the nominal RFR currently in force is moderately decreasing in comparison to the 2019 survey, following the international downward trend of interest rate evolution - even if the differences among countries remain relatively stable. It should be noted that differences are more pronounced when non-EU members are included in the sample.

<sup>12</sup> [https://berec.europa.eu/eng/document\\_register/subject\\_matter/berec/reports/7316-berec-report-regulatory-accounting-in-practice-2017](https://berec.europa.eu/eng/document_register/subject_matter/berec/reports/7316-berec-report-regulatory-accounting-in-practice-2017).

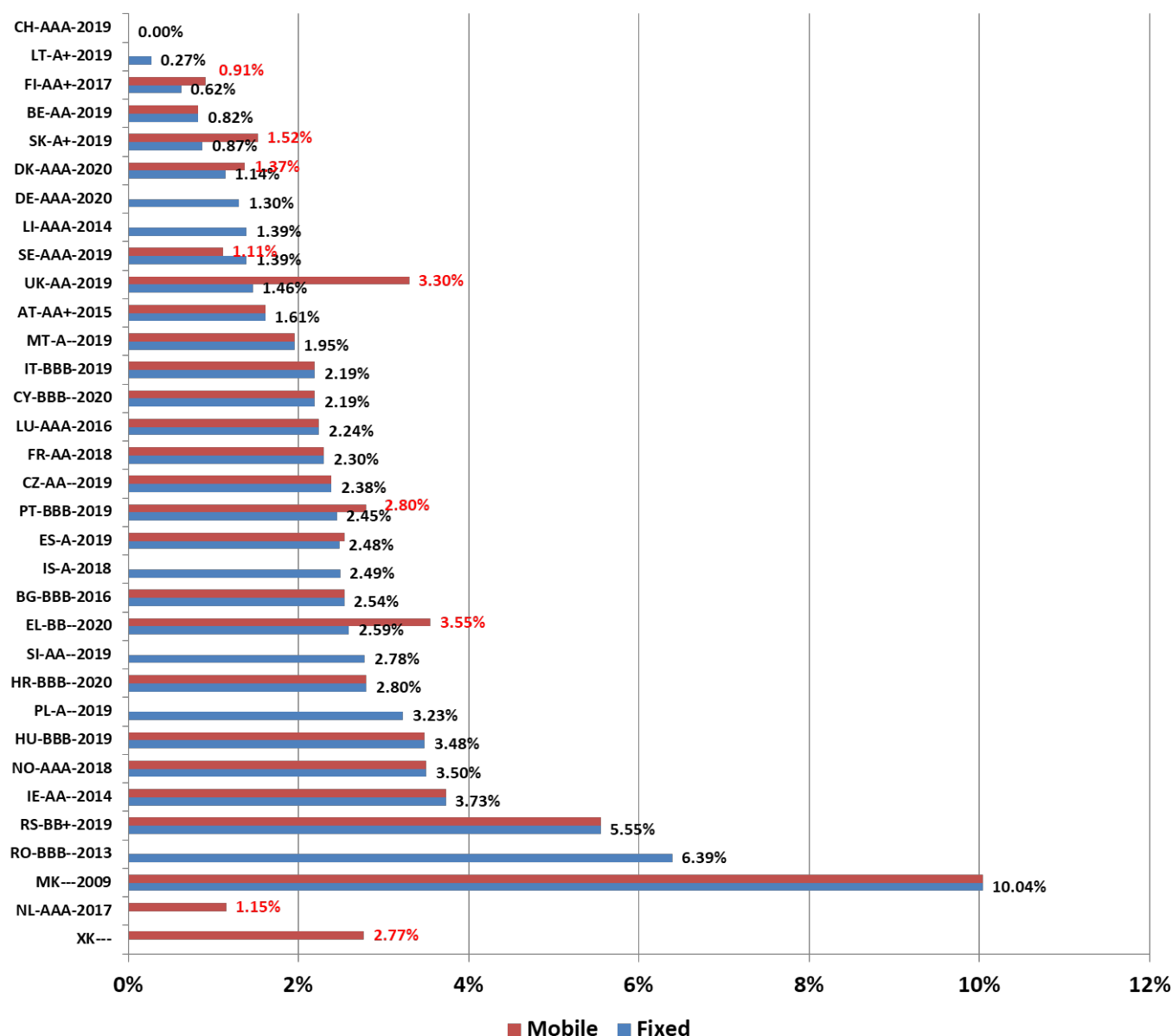
<sup>13</sup> [https://berec.europa.eu/eng/document\\_register/subject\\_matter/berec/opinions/8257-berec-position-paper-input-to-the-commission8217s-wacc-consultation-2018](https://berec.europa.eu/eng/document_register/subject_matter/berec/opinions/8257-berec-position-paper-input-to-the-commission8217s-wacc-consultation-2018).

<sup>14</sup> [https://berec.europa.eu/eng/document\\_register/subject\\_matter/berec/download/0/9364-berec-report-on-wacc-parameter-calculation\\_0.pdf](https://berec.europa.eu/eng/document_register/subject_matter/berec/download/0/9364-berec-report-on-wacc-parameter-calculation_0.pdf).

<sup>15</sup> Data includes adjustments that can be attributed to RFR, as declared by NRAs, consistent with the final WACC estimation.

In Figure 6 the nominal risk free rate is reported for fixed and mobile markets (where available). Eight NRAs that estimate both fixed and mobile WACC have a different value for the RFR and this is due mainly to different years of estimation<sup>16</sup> rather than a different methodology or application of the methodology.

Figure 6 – Nominal Risk Free Rate (fixed and mobile markets)<sup>17</sup>



Source: BEREC RA database 2020

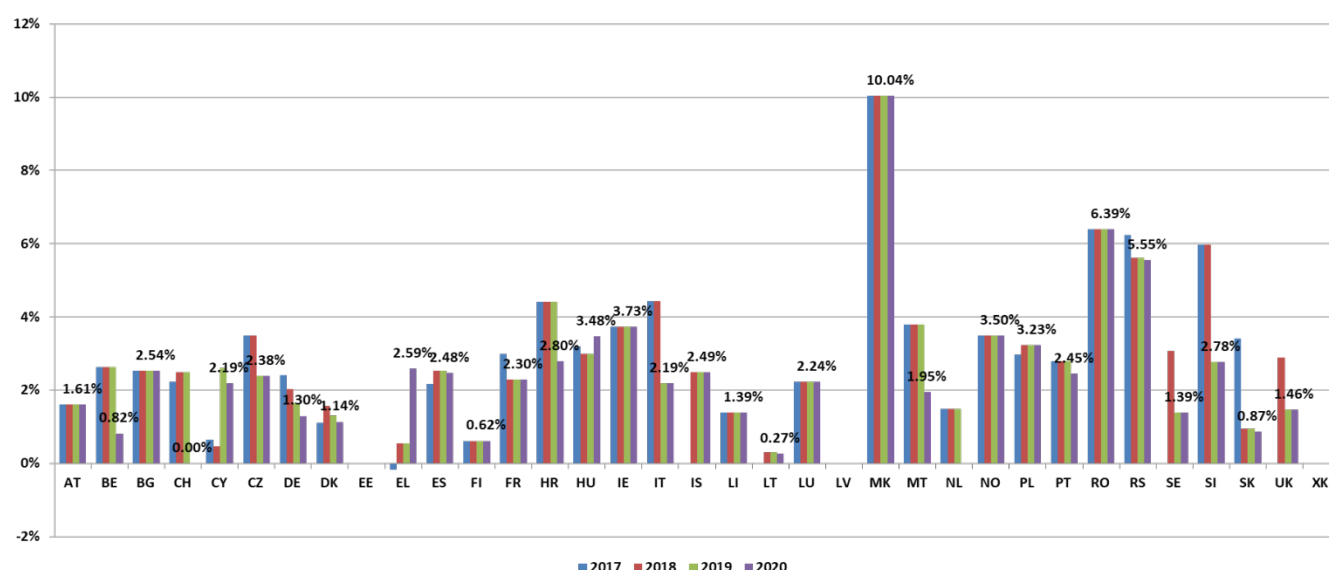
In Figure 7 the evolution of the RFR values for 2017-2020 is reported for the fixed market, taking into account information on the RFR in force according to the data reported in Figure 1.<sup>18</sup>

<sup>16</sup> On the y-axis the date of the estimation for the fixed market is reported in line with the data provided in the RA EWG database as reported in Figure 1.

<sup>17</sup> Specifically for CZ the 2017 value reported in BoR (17) 169 includes a country risk premium, not included in the RFR data of the 2018 report. The country risk premium for CZ in 2018 is highlighted separately as an adjustment to the cost of equity as reported in the next section.

<sup>18</sup> In Fig. 4 missing data for the specific year means that the value is not available in the RA database as it is shown in Fig. 1 (notwithstanding to the value applied by NRAs for that year).

Figure 7 - Nominal Risk Free Rate (fixed market 2017-2020)



Source: BEREC RA database 2020

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

Figure 8 - Main methodology in use to estimate RFR

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

Source: BEREC RA database 2020

Figure 9 and Figure 10 show the complete summary of the methodologies currently applied by NRAs for estimating the RFR for the fixed and mobile market. Red figures report the most frequent approach (in comparison, 2019 and 2018 data in brackets).

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		-if benchmarking is indicated in the methodology section please indicate the average used from other countries	
Nominal Risk Free Rate	Yes	7 (7) (7)	domestic bond	23(21) (21)	1 year	0	Daily	14 (15) (14)	Spot rate	1 (1) (1)	Arithmetic average	23 (24) (23)	Yes	3 (2) (2)	Arithmetic average	0
	No	21 (23)(23)	country specific bond	4 (4) (4)	3 years	0	Weekly	1 (1) (1)	3 months	1 (1) (2)	Geometric Average	0	No	19 (20) (21)	Geometric Average	0
			other	4 (7) (7)	5 years	0	Monthly	10 (10) (10)	6 months	1 (1) (2)	Moving Average	1 (1)(2)	Comment	3 (3) (2)	Moving Average	0
			benchmarking	0	10 years	24 (26) (26)	Other	4 (4) (3)	1 Year	5 (7) (7)	Median	1 (1) (1)			Median	0
					20 years	1 (1) (0)			2 Years	2 (3) (3)	Other	3 (2) (2)			Other	0
					Other	4 (4) (5)			3 Years	5 (5) (5)						
									5 Years	10 (9) (7)						
						10 Years	3 (3) (3)									
						Others	0 (0) (1)									

Source: BERC RA database 2020

Figure 10 - Methodology used to estimate RFR (mobile 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		-if benchmarking is indicated in the methodology section please indicate the average used from other countries	
Nominal Risk Free Rate	Yes	6 (5) (-)	domestic bond	17 (16) (16)	1 year	1 (0)	Daily	12 (11) (11)	Spot rate	1 (1) (1)	Arithmetic average	16 (18) (18)	Yes	3 (2) (2)	Arithmetic average	(0)
	No	15 (18) (18)	country specific bond	3 (2) (2)	3 years	(0)	Weekly	1 (1) (1)	3 months	0 (1) (1)	Geometric Average	0 (0)	No	15 (17) (17)	Geometric Average	(0)
			other	4 (7) (7)	5 years	(0)	Monthly	7 (8) (7)	6 months	1(1) (2)	Moving Average	2 (2) (2)	Comment	2 (2) (2)	Moving Average	(0)
			benchmarking	(0)	10 years	18 (20) (21)	Other	1 (2) (2)	1 Year	3 (3) (3)	Median	1 (1) (1)			Median	(0)
					20 years	1 (1) (0)			2 Years	2 (3) (3)	Other	2 (1) (1)			Other	(0)
				Other	3 (3) (3)			3 Years	4 (5) (5)							
								5 Years	6 (5) (4)							
				10 Years	3 (3) (3)											
										Others	1 (0) (2)					

Source: BERC RA database 2020

With reference to the most frequent methodologies in use, the situation is stable in comparison to the previous year (few NRAs have changed methodology in 2019 e. g. CY, RS, SI, UK)<sup>19</sup> and a few NRAs have changed methodologies since last year (BE, HR, EL). Specifically, HR and EL moved from a country specific or mix of methodologies to a methodology based on a national country bond. One NRA (HU)

<sup>19</sup> CY: adopted a 20 year German bond (a 10 year bond used last year); RS: due to low liquidity of their own country bonds and low values compared to previous estimations, decided to use the ECB European bond estimation based on AAA countries, adjusted for country risk premium. UK: placed more emphasis on short term averaging periods in last estimation, taking into account a long term effect of QE also on the cost of debt, and arguing that "while the principle of stability referred to in the framework could support the use of longer averaging periods, we consider that placing greater weight on more recent yields would help ensure that our estimates of the cost of equity provide efficient price and investment signals, i.e. they would more closely reflect the current financial market conditions facing investors". Due to this UK reduced the RFR by 1,3 percentage points from their 2018 estimation in line with an averaging window of 5 years from an estimation that was based on a longer average time window (see [https://www.ofcom.org.uk/data/assets/pdf\\_file/0021/149340/pimr-bcmr-llcc-draft-statement-annexes-1-25.pdf](https://www.ofcom.org.uk/data/assets/pdf_file/0021/149340/pimr-bcmr-llcc-draft-statement-annexes-1-25.pdf) (page 326)).

explicitly mentioned as motivation for the chosen methodology the recent Commission WACC Notice 2019/C 375/01 and the main change was specifically in the time windows chosen.

No different from the 2019 report, most NRAs use a nominal estimation of the RFR without first evaluating a real risk-free rate. A real risk-free rate is estimated in the fixed market by 7 NRAs (BE, IE, IS, MT, NO, PL, UK).

A consistent approach among NRAs in terms of the main methodologies used for estimating the RFR is evident, apart from the averaging window, for which there is a less clear “most frequent” choice by NRAs. In comparison to previous years the number of NRAs that use a “5 years” time-windows as averaging period has increased.<sup>20</sup> At the same time RFR estimation can be influenced by country specific issues such as exchange rates and expected inflation.<sup>21</sup>

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 11).<sup>22</sup>

Figure 11 - Main methodology and time windows (frequency, number of NRAs)<sup>23</sup>

RFR		Geographical scope			Total
		Domestic bond	Country specific	Other	
Time windows	<=1	7 (8)	0 (1)	1 (1)	8 (10)
	<=3	3 (2)	2 (1)	2 (5)	7 (8)
	>=5	11 (10)	1 (1)	1 (1)	13 (12)
	Total	21 (20)	3 (3)	4 (7)	28 (30)

RFR		Geographical scope			Total
		Domestic bond	Country specific	Other	
Time windows	<=1	BG,ES,FI,LT, MT,PL,SK		MK	8
	<=3	CH, HR,PT	IE, BE	AT,RO	7
	>=5	CZ,DE,DK,FR, HU,IS,IT,LU,S E,SI,UK	LI	RS	13
	Total	21	3	4	28

Source: BEREC RA database 2020

Two main groups (7 and 11 NRAs respectively) use domestic bonds and time windows that are: i) less than 1 year (BG, ES, FI, LT, MT, PL, SK) or ii) greater than or equal to 5 years (CZ, DE, DK, FR, HU, IS, IT, LU, SE, SI, UK).

<sup>20</sup> In Figure 9 and 10, replies of “7 years” (SE) and “6 years” (DK) were included in the category “5 years” for statistical reasons.

<sup>21</sup> When regressing categorical variables collected in the survey in the last years with the final value of the RFR no statistical significance can be detected between different methodologies used and the RFR final value. On the other hand it is observed that RFR can be influenced by exchange rate issues between Eurozone and non-Eurozone countries.

<sup>22</sup> NRAs that have a different approach in comparison to previous year's report are shown in red.

<sup>23</sup> In the matrix figures (e. g. Figure 9), the first figure indicates the frequency of the methodological mix, the second mentions NRAs. NRAs listed in red have a different category in comparison to the previous year, in blue the NRAs with changed methodology in 2019. In brackets the number of NRAs for each category in the previous year.

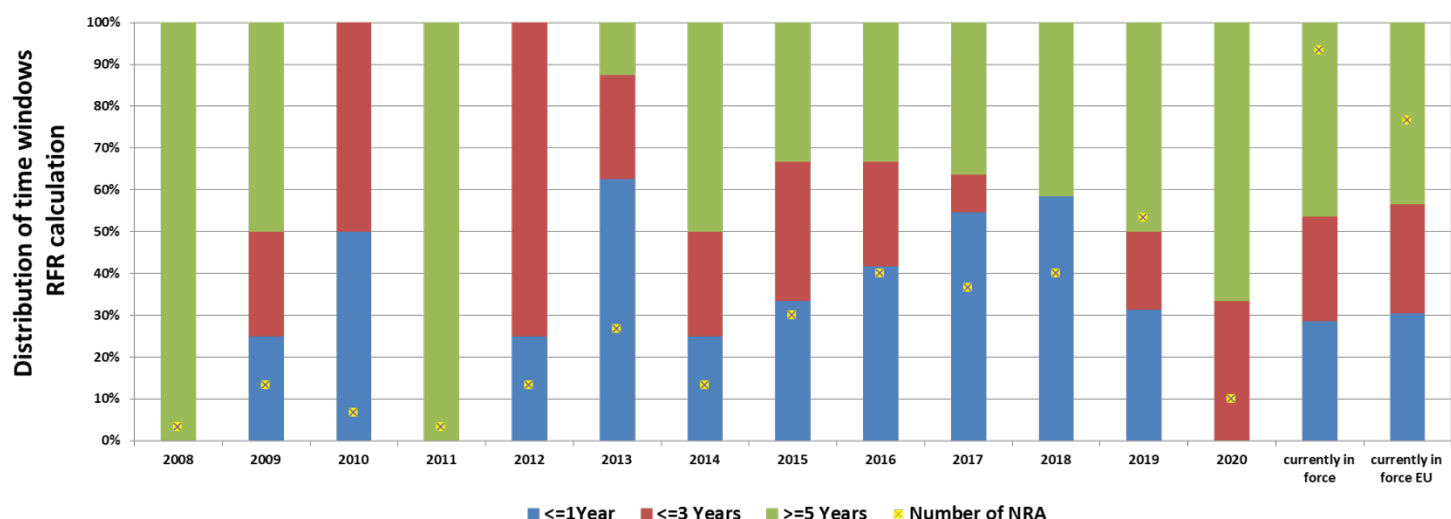
Note that when “country specific” or “Other” is chosen as the main category for RFR, a “country risk premium” is generally included in the cost of equity, time windows are less relevant in this case.

In any case values currently in force are also influenced by the time of estimation as shown by the corresponding figure.

Most NRAs use an average window greater than 1 and less than 3 years in combination with “other” as the main methodology. In case of a heavy impact of the financial crisis, some countries state that they use German government bonds as a benchmark: these bonds are in fact less affected by fluctuations in short-term interest rates which may influence price control for 3 to 5 years.

Looking at the distribution of the “time windows” used by NRAs in 2013-2020, a period where many NRAs have updated WACC, an increase in the number of NRAs that choose time windows  $\geq 5$  especially in the last two years (2019-2020), when the Commission WACC Notice was published.

Figure 12 - Distribution of time windows RFR (fixed market)



Source: BEREC RA database 2020

Some countries apply adjustments to the estimation of the RFR as reported in the following figure. The year of update is also provided.



Figure 13 - Adjustments applied to RFR (fixed market)

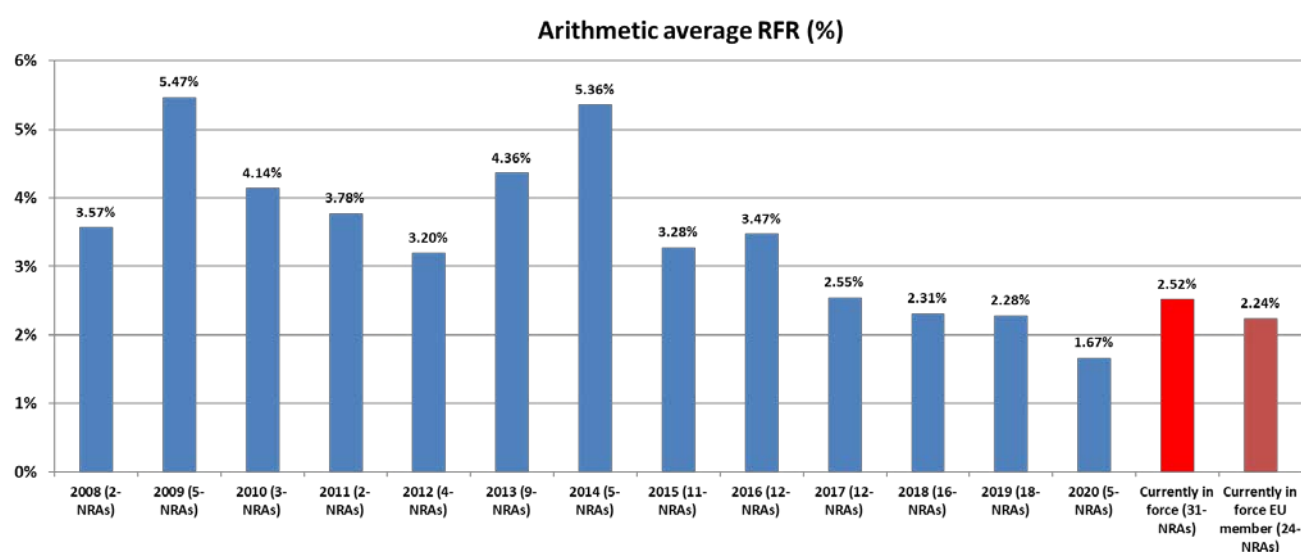
	Nominal RFR	Nominal risk free rate without adjustment	Country risk premium (%)	Size premium value (%)	Consistency with ERP estimation (hystorical data on ERP on different bond length)	Other adjustment: Size of adjustment (%)	Description of adjustment and how the adjustment was made
CY-2020 (previous report)	2.19% (2.62%)	0.63% (1.09%)	1.56% (1.53%)				
DK-2020 (previous report)	1.14% (1.32%) (1.56%)	0.66% (0.84%) (1.10%)			0.4% (0.4%) (0.4%)	0.08% (0.076%) (0.076%)	QE
ES-2019 (previous report)	2.48% (2.54%) (2.18%)	1.48% (1.54%) (1.18%)				1% (1%) (1%)	QE
IE-2013	3.73%	3.63%				0.10%	Aiming up
RO-2013	6.39%	3.19%	3.20%				Damodaran
MK-2009	10.04%	4.49%	4.19%	1.36%			

Source: BEREC RA database 2020

In Figure 14 the average year-by-year nominal RFR adopted includes only NRAs that have indicated an update for the WACC value in the corresponding year. The average value currently in force comes from averaging values in line with the information provided in Figure 1.

The RFR is slightly decreasing over the years in line with the experience of lower yields of own country bonds, also due to QE purchase programs. Looking at QE, two NRAs that have updated their WACC last year have taken this explicitly into account (DK, ES). In two other cases (FR, UK) QE has been indirectly taken into account without an explicit adjustment. One NRA (UK), even without making an explicit adjustment to time windows for this effect, explains that QE is one reason for preferring longer term average yields rather than spot rates. One NRA (IE) explains that using long time periods and taking account of the relationship with GDP growth implicitly adjusts for QE effects.

Figure 14 - RFR evolution over time (fixed market)



Source: BEREC RA database 2020

In conclusion:

- NRAs that use domestic bonds as a methodology for estimating the RFR together with a less than one-year time window explain 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. It should be considered that the frequency of updating the WACC can have an influence on the approach used: among the 8 NRAs that use short time windows 4 update the WACC yearly (ES, LT, PL, SK).
- NRAs that use domestic bonds and a time window average greater than 5 years explained their approach with the pursuing of “regulatory objectives” - thus granting predictability, consistency and transparency - and overcoming the effects of QE.<sup>24</sup> The choice of longer averaging bond windows seems to reflect the aim of estimating a “country risk premium” when this cannot be included in any other way. That is to say, within the current period of very low yields, the emphasis on longer data series aims at mitigating the risk of underestimating the WACC.

As to the main motivations behind the choice of the averaging windows, they are: i) to maintain regulatory predictability (e. g. a consistent approach over time or taking long term averages to limit variations between market reviews); ii) to avoid putting too much weight on factors which may distort current yields (e. g. QE); iii) consistency with the country-specific regulatory period; iv) consistency with the investment life cycle.

## 5.2.2 Equity Risk Premium (ERP)

see BoR (17) 169, BoR (18) 167 and BoR (20) 116 for definition and general financial theory

### Main output from the survey.

Based on the replies to the 2020 survey the following statistics were derived for all responding NRAs and for EU NRAs separately (2019 values in brackets).

Figure 15 - ERP values (fixed and mobile markets)

	Average	Median	Standard Deviation	Relative Standard Deviation	Maximum	Minimum
<b>Equity Risk Premium (fixed; 31 NRAs (2019-32)(2018-32))</b>	5.76% (5.93%) (5.90%)	5.75% (5.63%) (5.45%)	0.77% (1.52%) (1.90%)	13.29% (25.57%) (32.14%)	7.25% (13.14%) (14.46%)	4.55% (4.55%) (3.10%)
<b>Equity Risk Premium (mobile): 25 NRAs (2019-26)(2018-26)</b>	6% (5.95%) (5.90%)	5.86% (5.80%) (5.60%)	1.28% (1.40%) (1.69%)	21.28% (23.47%) (28.55%)	11.10% (11.88%) (11.88%)	4.55% (4.55%) (3.10%)
<b>Equity Risk Premium EU (fixed): 24 EU NRAs (2019-26)(2018-26)</b>	5.77% (6.05%) (6.03%)	5.85% (5.79%) (5.60%)	0.76% (1.65%) (2.07%)	13.18% (27.27%) (34.42%)	7.14% (13.14%) (14.46%)	4.55% (4.55%) (3.10%)
<b>Equity Risk Premium EU (mobile): 20 EU NRAs (2019-23)(2018-23)</b>	5.75% (5.96%) (5.93%)	5.86% (5.85%) (5.70%)	0.76% (1.48%) (1.78%)	13.24% (24.77%) (29.99%)	7.13% (11.88%) (11.88%)	4.55% (4.55%) (3.10%)

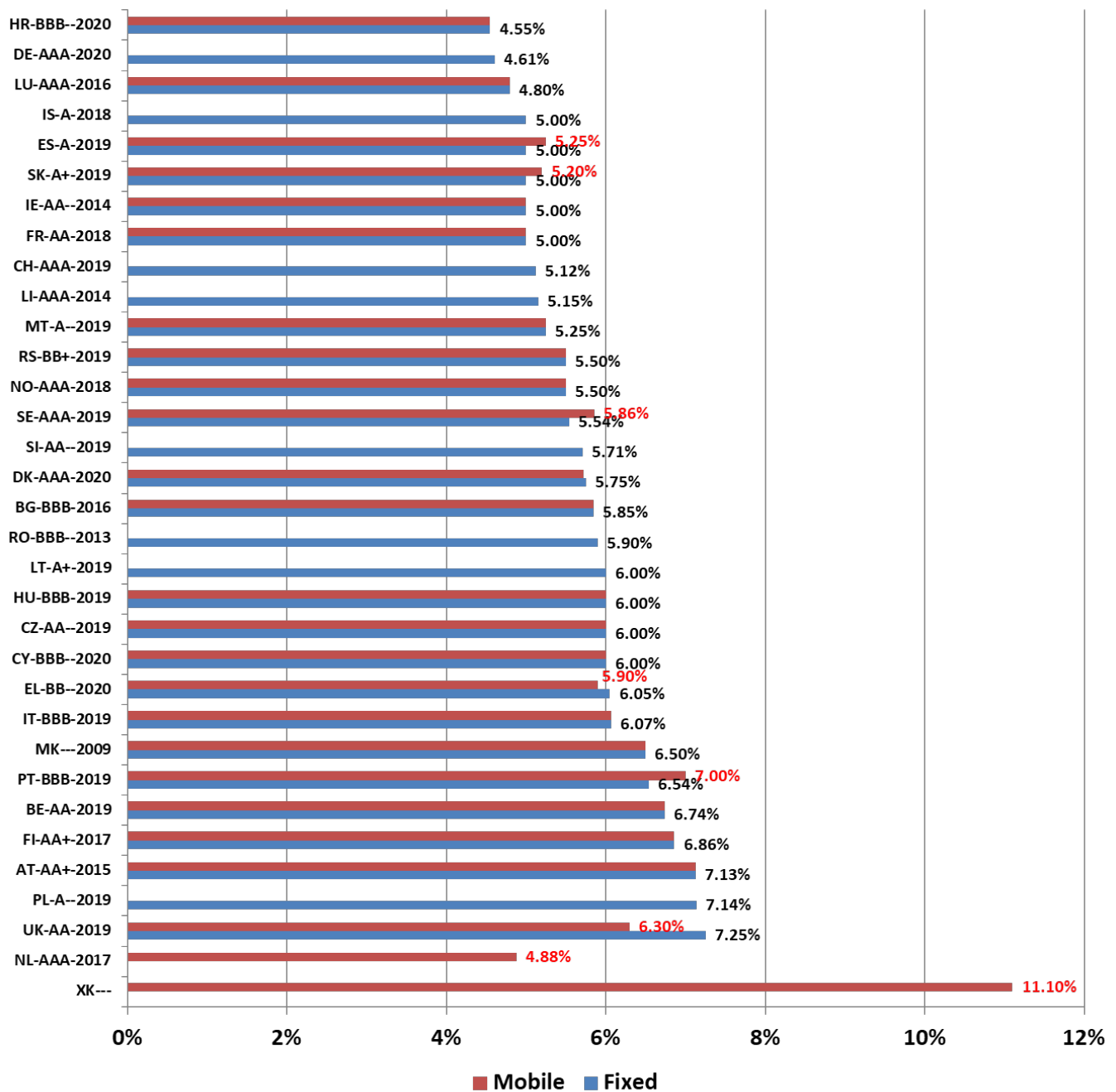
Source: BERC RA database 2020

The average and median values for ERP in the fixed market and their deviation are decreasing in relation to the previous year.

Figure 16 reports ERP ranking with the indication of individual Country Rating (S&P).

<sup>24</sup> One NRA (DE) declared that a high fluctuation of the regulatory WACC over time is not in line with the requirements of the German legislation. Therefore an exponential smoothing procedure has been applied since 2009 which consists of attributing a weight of 30 % to the current WACC estimation and 70 % to the WACC estimation of the previous period.

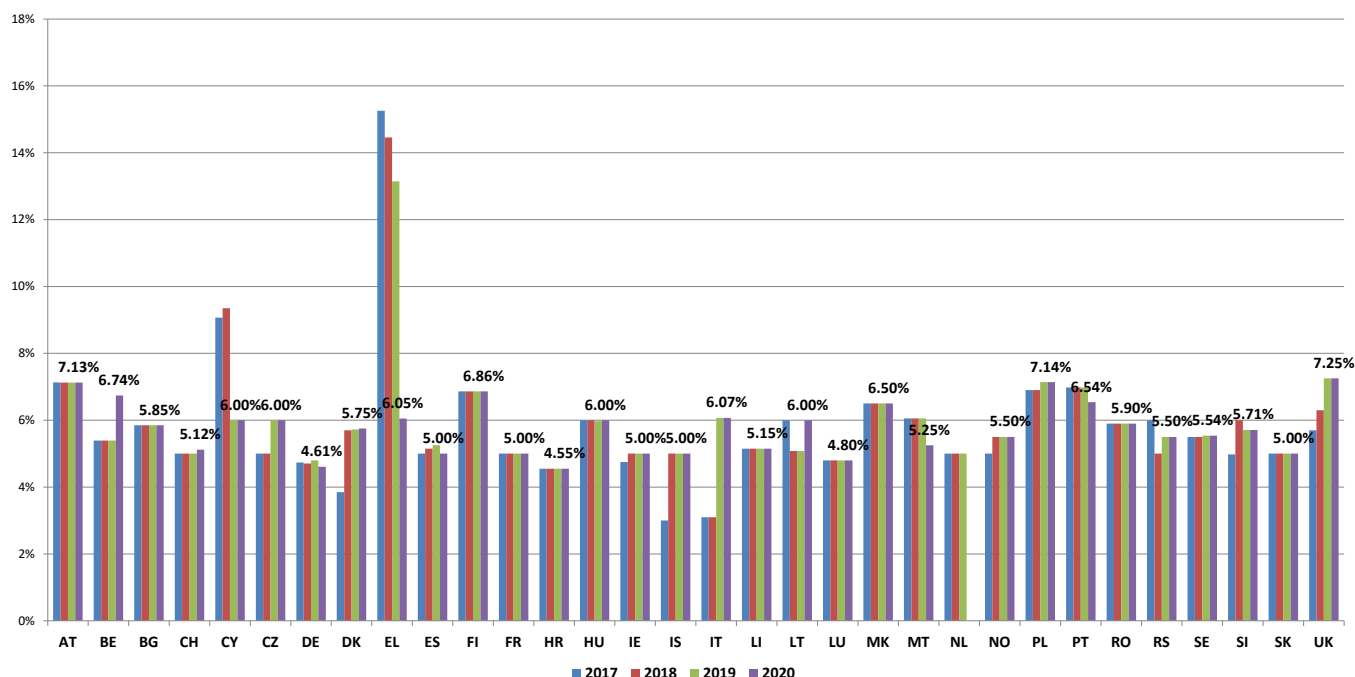
Figure 16 - ERP (fixed and mobile markets)



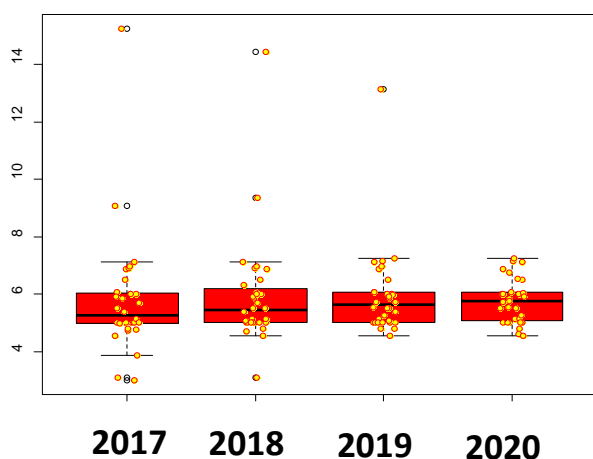
Source: BEREC RA database 2020

Figure 16 shows that where a separate mobile WACC is estimated, the ERP is equal for fixed and mobile markets; only 7 out of 25 NRAs have provided differing values, mainly due to different times of adoption of the decision (as in the case of the RFR).

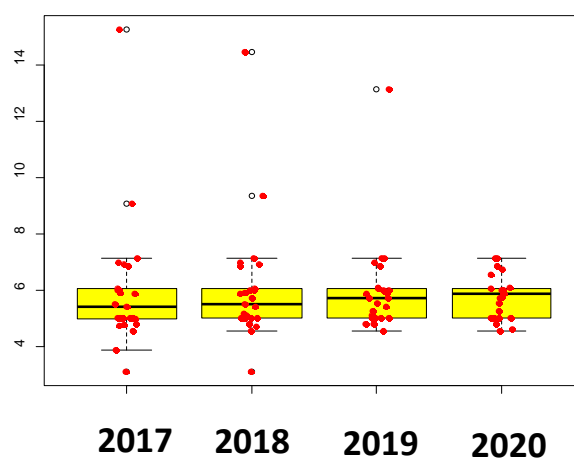
Figure 17 - ERP currently in force (fixed market 2017-2020)



ERP fixed market (%)



ERP fixed market EU member (%)



Source: BEREC RA database 2020

Figure 17 portrays the evolution of ERP over time (years 2017 to 2020) 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 18 and Figure 19 compare the main approaches used by NRAs to estimate the ERP for fixed and mobile markets. The answers were based on a set of pre-defined alternatives.

Figure 18 – Methodologies for estimating ERP (fixed market)

	Methodology (General)		Specific Methodology		-If historical data Average methodology		-if benchmarking is indicated in the methodology section please indicate the average used from other countries	
Equity risk premium	Notional value	9 (10) (10)	Historical data	15 (14) (13)	Arithmetic average	11 (13) (12)	Arithmetic average	0
	country specific	10 (10) (11)	Dividend grow model	0	Geometric Average	0 (0) (1)	Geometric Average	0
	other	8 (10) (9)	Historical+DGM	1 (3) (2)	Moving Average	(0)	Moving Average	0
	benchmarki ng	3 (1)(1)	Historical+DGM+Suvey	2 (2) (3)	Median	1 (0)	Median	0
					Other	2 (2)(7)	Other	0
			Historical+Survey	6 (6) (6)	Arithmetic and Geometric	6 (6)		

Source: BEREC RA database 2020

Figure 19 - Methodologies for estimating ERP (mobile market)

	Methodology (General)		Specific Methodology		-If historical data Average methodology		-if benchmarking is indicated in the methodology section please indicate the average used from other countries	
Equity risk premium	Notional value	7 (11) (9)	Historical data	10 (11) (11)	Arithmetic average	8 (11) (10)	Arithmetic average	0 (0)
	country specific	7 (6) (7)	Dividend grow model	(0) (0)	Geometric Average	(0) (1)	Geometric Average	0 (0)
	other	7 (6) (7)	Historical+DGM	1 (2) (2)	Moving Average	(0)(0)	Moving Average	0 (0)
	benchmarki ng	2 (1) (1)	Historical+DGM+Suvey	3 (3) (1)	Median	1(0) (0)	Median	0 (0)
					Other	2(3) (5)	Other	0 (0)
			Historical+Survey	5 (6) (6)	Arithmetic and Geometric	3 (3)		

Source: BEREC RA database 2020

In terms of the geographical scope of the methodology, no clear-cut preferences emerges. In 2020, roughly one third of NRAs adopted a notional approach mixing evidence from different countries. One third of NRAs chose a country-specific ERP (own country ERP) and one third opted for a methodological mix of own and foreign evidence (i. e. “other”). Three NRAs adopted a benchmarking approach based on values from other NRAs (BG, EL, MT). This situation has been consistent over the last years.

According to some NRAs, a notional approach is generally preferred due to unreliable/missing own country-specific data and also because it may be able to 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 where NRAs use a clear cut methodology for ERP

estimation, this is generally compared with other sources of evidence as a safeguard/sanity check (even if these further sources are not directly used for the estimation of the final value).

The largest group of NRAs use historical data alone (15); the second largest group use historical data together with a survey and/or a DGM-Survey approach (10 NRAs); 2 NRAs estimate ERP only through surveys.

In Figure 20 the main indicators on the “geographical scope” (notional vs. country specific) and the kind of information used in terms of weight given to the past is compared.<sup>25</sup> Countries in red are the ones which declared to have changed methodology in comparison to the previous year, in blue the countries that have changed methodology within the last two years of this report. This is largely unchanged in comparison to last year, only one NRA has changed methodology (MT from notational to benchmarking)..

NRAs that use only historical data generally take into account long-time series.<sup>26</sup> Where a mixed approach is chosen for the geographical scope (“other”), the estimation generally takes into account many sources, also from different European countries. .

Figure 20 - Methodologies used to determine ERP (fixed and mobile markets)<sup>27</sup>

Fixed					Mobile				
	Historical data	Historical data + DGM/Survey	Survey	Total		Historical data	Historical data + (DGM/Survey)	Survey	Total
Notional	6 (5) (3)	2 (4) (5)	0 (1) (1)	8 (11) (9)	Notional	4 (4)	3 (6)	0 (1)	8 (11)
Country specific	5 (5) (6)	3 (3) (3)	1 (1) (1)	9 (8) (10)	Country specific	3 (3)	3 (2)	1 (1)	7 (6)
Other	4 (4) (3)	4 (5) (4)	0 (0) (1)	8 (8) (6)	Other	3 (4)	4 (3)	(0)	6 (7)
Total	15 (14) (12)	9 (12) (11)	1 (2) (3)	25 (27)(26)	Total	10 (11)	10 (11)	1 (2)	20 (24)

	Historical data	Historical data + DGM/Survey	Survey			Historical data	Historical data + DGM/Survey	Survey	
Notional	CZ,FR,HR, RO,SI, <b>RS</b>	CY,LU			Notional	CZ,FR,HR, RS	CY,LU NL		
Country specific	AT,CH,IE, IT,LI	PT, ES,UK	FI		Country specific	AT,IE,IT	ES,PT,UK	FI	
Other	DE,MK,NO, <b>SK</b>	BE, DK,HU,SE			Other	MK,NO,SK	BE, DK,HU,SE		

Source: BEREC RA database 2020

Relatively weak correlations, in terms of the main motivations behind NRAs methodological choices in defining ERP, may be observed from the data collected<sup>28</sup>.

<sup>25</sup> Note that not all NRAs have provided specific information on each methodological category.

<sup>26</sup> More than 100 years, taking as source DMS time series, Damoradan, Duff & Phelps, Pickett, as well as national bank sources. In some cases more than one source is used.

<sup>27</sup> In parentheses the information from the 2019 report is provided for the fixed market. For the fixed market countries that have changed methodology in comparison to last year's report are shown in red. For the mobile market only those NRAs that apply a different methodology for fixed and mobile markets are shown in red.

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. Where a notional approach is 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 21 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.

Figure 21- Methodologies used to determine ERP and RFR (fixed and mobile markets)

Fixed						
		ERP				Total
		Notional	Country specific	Other	Benchmarking	
RFR	Domesic bond	6(6) (7)	7(7) (8)	6(6) (4)	3 (1) (1)	22 (19) (20)
	Country specific	1 (1) (0)	2 (2) (2)	1 (1) (2)	(0) (0)	4 (4) (4)
	Other	2 (4) (3)	1 (1) (1)	1 (2) (2)	(0) (0)	4 (8) (6)
Total		9 (11) (10)	10 (10) (11)	8 (9) (8)	3 (1) (1)	30 (31) (30)

Mobile						
		ERP				Total
		Notional	Country specific	Other	Benchmarking	
RFR	Domesic bond	4 (5)	5 (5)	5 (4)	2 (1)	16 (16)
	Country specific	1 (1)	1 (1)	1 (0)	(0)	3 (2)
	Other	2 (4)	1 (1)	1 (2)	(0)	4 (7)
Total		7 (10)	7 (7)	7 (6)	2 (1)	23 (24)

		ERP			
		Notional	country specific	Other	Benchmarking
RFR	Domesic bond	CZ,FR,HR,LT,LU,SI	CH,ES,FI,IT,IS,PT,UK	DE,DK,HU,NO,SE,SK	BG,EL,MT
	Country specific	CY	IE,LI	BE	
	Other	RO,RS	AT	MK	

		ERP			
		Notional	country specific	Other	Benchmarking
RFR	Domesic bond	CZ,FR,HR,LU	ES,FI,IT,PT,UK	DK,HU,NO,SE,SK	BG,MT
	Country specific	CY	IE	BE	
	Other	NL,RS	AT	MK	

Source: BEREC RA database 2020

The comparison shows that some NRAs that use their own country specific ERP also estimate RFR with domestic bonds, providing the same geographical scope for the equity component RFR and ERP (7 NRAs), 6 NRAs use domestic bonds and a notional approach for the ERP.

Another relevant point is the relation between the “time windows” considered for estimating the RFR and the “data source” (historical vs forward-looking approach) for ERP estimation (Figure 20). This may be relevant in order to understand if a clear picture emerges showing the preference of NRAs for a forward-looking approach on RFR estimation (i. e. shorter time windows) rather than on ERP.

<sup>28</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 22 - Time windows used for ERP/RFR (fixed and mobile markets)<sup>29</sup>

Fixed Market						Mobile Market					
		ERP			Total			ERP			Total
		Historical data	Historical data + other	Survey				Historical data	Historical data + other	Survey	
RFR	<= 1 year	2 (3) (2)	1 (2) (3)	1 (1) (2)	4 (7) (7)	RFR	<= 1 year	1(2)	1(2)	1(1)	3(5)
	<= 3 year	5 (4) (4)	2 (5) (4)	0 (0)(0)	7 (8) (8)		<= 3 year	3(4)	3(3)	0(1)	6(7)
	>= 5 years	7 (6) (5)	5 (4) (5)	0 (1) (0)	12 (10) (10)		>= 5 years	4(4)	5(4)	0(1)	9(9)
Total		14 (12) (12)	8 (11) (11)	1 (2) (2)	23 (25) (25)	Total		8(10)	9(8)	1(3)	18(21)

		ERP			Total			ERP			Total
		Historical data	Historical data + other	Survey				Historical data	Historical data + other	Survey	
RFR	<= 1 year	MK,SK	ES	FI		RFR	<= 1 year	MK	ES	FI	
	<= 3 year	AT,CH,HR,IE,RO	BE,PT				<= 3 year	AT,HR,IE	BE,NL, PT		
	>= 5 years	CZ,DE,FR,IT,LI,SI,RS	DK,HU,LU,SE,UK				>= 5 years	CZ,FR,IT,RS	DK,HU,LU,SE,UK		

Source: BEREC RA database 2020

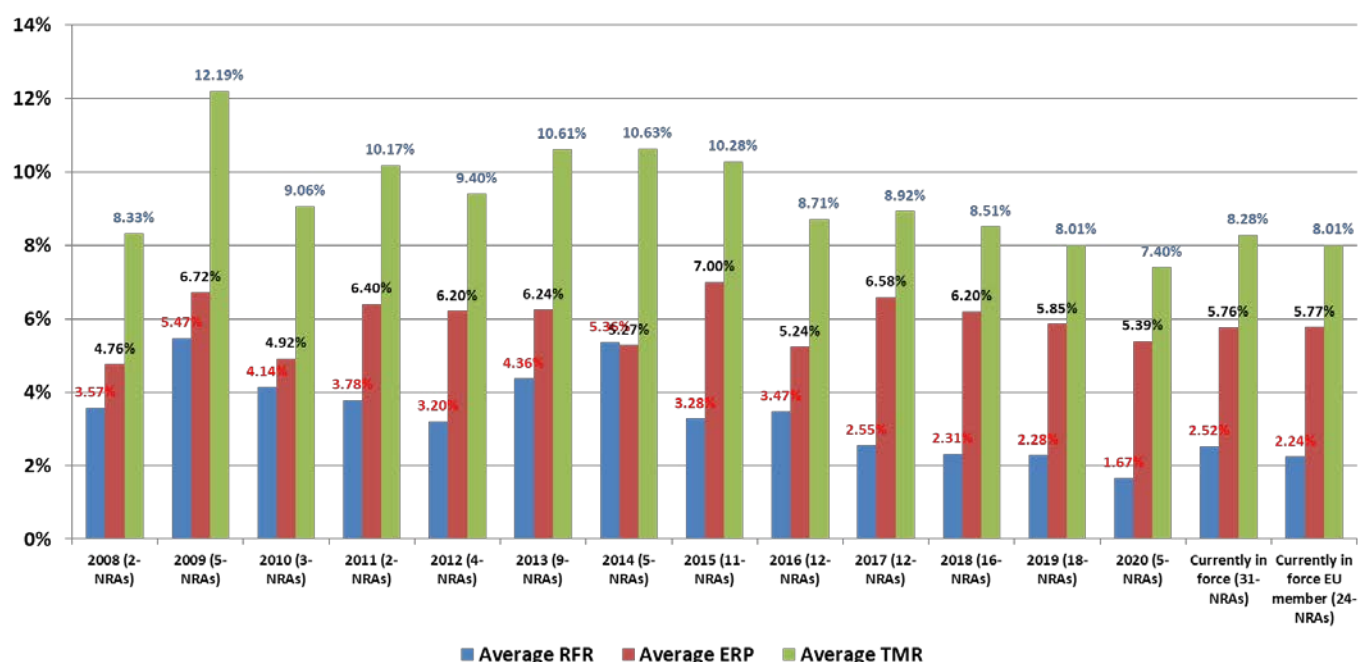
Relating to Figure 22 the situation appears quite stable. The most frequent approach, which represents just one-fifth of the sample, is to estimate the RFR on the basis of a 3 or 5 year time window and the ERP based on historical time series. NRAs that choose this approach aim to be consistent with past WACC decisions. 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. Corresponding to last year, the use of pure historical data for the ERP seems to be the preferred approach for the final value estimation. Since the publication of the Commission Notice two NRAs have moved to benchmarking or have explicitly applied the Commission Notice approach (MT and SK).

Figure 23 considers the average evolution over time of ERP, RFR<sup>30</sup> and TMR (ERP+RFR). In the period 2008-2020 ERP has had a lower relative standard deviation over time with respect to RFR. The overall effect is a more stable result for the total cost of equity.

<sup>29</sup> The first figure indicates the frequency of the methodological mix, the second mentions NRAs, the third gives the arithmetic average values for main methodology combinations.

<sup>30</sup> This analysis is independent to the fact that NRAs take into account TMR estimation in their ERP/RFR calculation. Therefore values of TMR shown are obtained from RFR+ERP provided by NRAs for the WACC calculation. One NRA explicitly takes into account the calculation of TMR = ERP+RTR in their RFR and ERP estimation.

Figure 23 – Evolution ERP/RFR/TMR over time (2008-2020 fixed market)



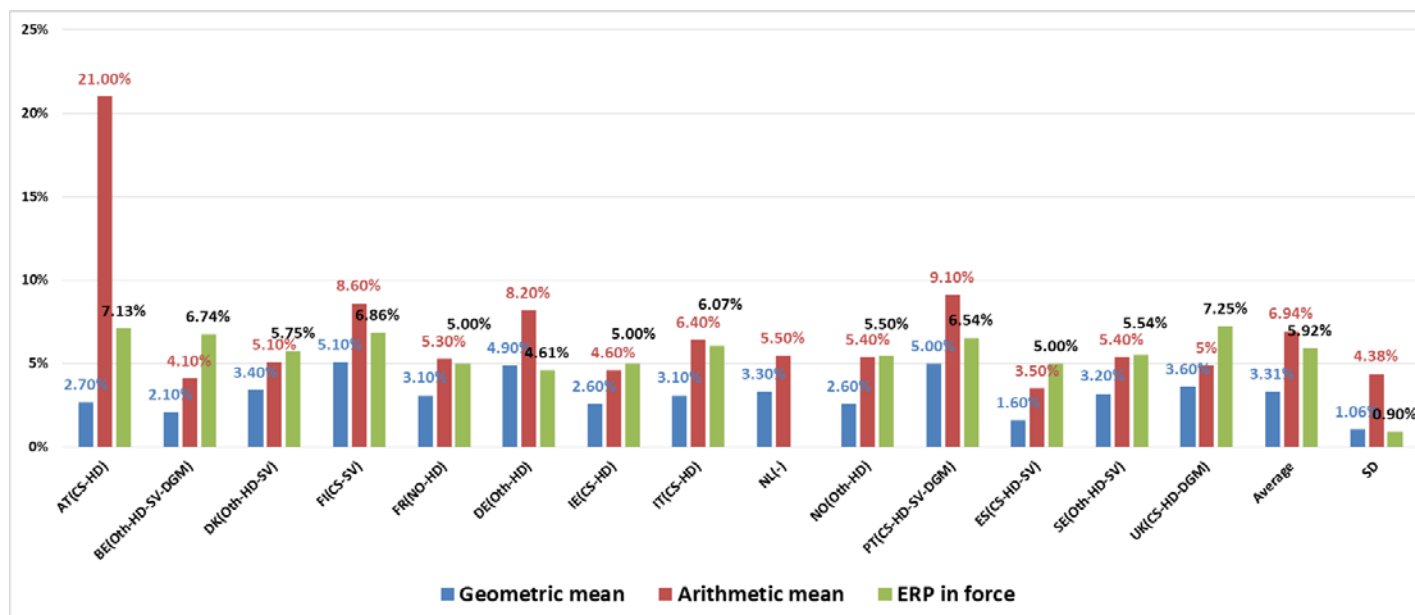
Source: BEREC RA database 2020

Another element analysed in the questionnaire is the type of averaging method used when historical data are used. Most NRAs use an arithmetic average (11 NRAs for the fixed market), while a second group of NRAs use a mix of arithmetic and geometric average (6 NRAs for the fixed market).

A basic sensitivity analysis indicates that the choice of the “average” significantly affects the ERP value. Figure 24 shows the comparison of ERP actual values and values obtained “if” other types of averages were applied (e. g. data from the publicly available DMS database 1900-2019 were applied to some European countries).

The data in Figure 24 cannot be directly compared to the data provided by NRAs in the questionnaire. When geometric and arithmetic average is presented, data refer to the available DMS database updated until 2018, whereas the actual value is the one provided by the NRAs for the RA EWG survey 2019. The figures compare the actual values of ERP with ERP values using pure geometric or arithmetic averages, computed using public reference data.

Figure 24 - ERP values sub-set of countries (fixed market)



Source: BERC RA database 2020 and Dimson, Marsh, Staunton 1900-2019 as reported in Bor(20)116

ERP values are very sensitive to the choice of average type, especially when historical data are considered.

### 5.2.3 Beta

see BoR (17) 169, BoR (18) 167 and BoR (20) 116 for definition and general financial theory

#### Main results of the survey

Based on the replies provided for the 2020 survey the following statistics were derived for all responding NRAs and for EU NRAs separately (2019 and 2018 values in brackets).<sup>31</sup>

<sup>31</sup> Asset betas/Equity betas are calculated with reference to different market indexes, thus comparison should be considered in the light of this fact.

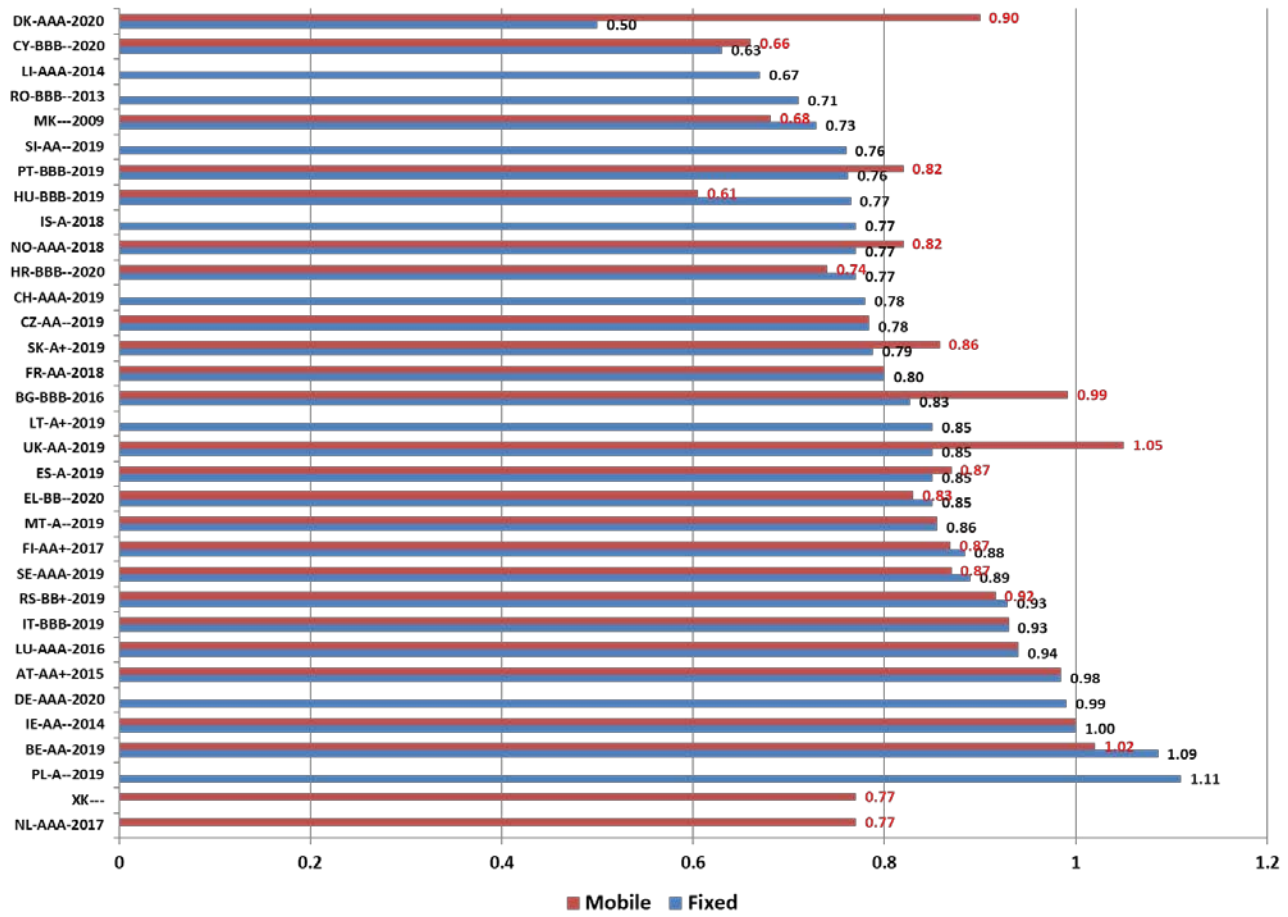
Figure 25 - Equity and Asset Beta values (fixed and mobile markets)

2019 Data		Average	Median	Standard Deviation	Relative Standard Deviation	Maximum	Minimum
Fixed Market	Equity beta - 31 NRAs (2019-32) (2018-32)	0.83 (0.84) (0.83)	0.83 (0.85) (0.82)	0.13 (0.13) (0.14)	15.36% (15.51%) (15.53%)	1.11 (1.11) (1.11)	0.5 (0.5) (0.5)
	Asset beta - 18 NRAs (2019-18) (2018-18)	0.55 (0.54) (0.53)	0.54 (0.55) (0.54)	0.06 (0.04) (0.06)	11.18% (7.55%) (12.06%)	0.71 (0.62) (0.64)	0.46 (0.43) (0.43)
	Beta debt - 4 NRAs (2019-3) (2018-3)	0.11 (0.14) (0.14)	0.1 (0.1) (0.1)	0.02 (0.07) (0.07)	18.18% (49.49%) (49.49%)	0.14 (0.22) (0.22)	0.1 (0.1) (0.1)
Mobile market	Equity beta - 25 NRAs (2019-26) (2018-26)	0.85 (0.84) (0.86)	0.85 (0.82) (0.82)	0.11 (0.11) (0.13)	13.33% (13.24%) (15.33%)	1.05 (1.05) (1.21)	0.60 (0.62) (0.62)
	Asset beta - 15 NRAs (2019-14) (2018-14)	0.59 (0.57) (0.58)	0.60 (0.60) (0.61)	0.09 (0.1) (0.09)	15.61% (16.98%) (15.82%)	0.81 (0.69) (0.69)	0.47 (0.33) (0.33)
	Beta debt - 4 NRAs (2019-3) (2018-3)	0.14 (0.16) (0.16)	0.12 (0.15) (0.15)	0.05 (0.06) (0.06)	34.82% (38.47%) (38.47%)	0.2 (0.22) (0.22)	0.1 (0.1) (0.1)
Fixed Market EU NRAs	Equity beta - 24 NRAs (2019-26) (2018-26)	0.85 (0.85) (0.84)	0.85 (0.86) (0.84)	0.14 (0.14) (0.13)	16.18% (16.04%) (16.02%)	1.11 (1.11) (1.11)	0.50 (0.50) (0.50)
	Asset beta - 12 NRAs (2019-14) (2018-14)	0.56 (0.55) (0.54)	0.55 (0.55) (0.55)	0.07 (0.06) (0.07)	12.78% (10.28%) (13.40%)	0.71 (0.64) (0.64)	0.46 (0.45) (0.43)
	Beta debt - 1 NRAs (2019-2) (2018-2)	0.14 (0.16) (0.16)	0.14 (0.16) (0.16)	0 (0.08) (0.08)	0 (53.03%) (53.03%)	0.14 (0.22) (0.22)	0.14 (0.1) (0.1)
Mobile Market EU NRAs	Equity beta - 20 NRAs (2019-23) (2018-23)	0.85 (0.85) (0.87)	0.86 (0.82) (0.82)	0.11 (0.11) (0.13)	12.87% (13.32%) (15.51%)	1.02 (1.05) (1.21)	0.60 (0.62) (0.62)
	Asset beta - 12 NRAs (2019-13) (2018-13)	0.58 (0.57) (0.58)	0.57 (0.60) (0.61)	0.1 (0.10) (0.09)	16.96% (17.37%) (15.82%)	0.81 (0.69) (0.69)	0.47 (0.33) (0.33)
	Beta debt - 1 NRAs (2019-2) (2018-2)	0.2 (0.16) (0.16)	0.2 (0.16) (0.16)	0 (0.08) (0.08)	0 (53.03%) (53.03%)	0.2 (0.22) (0.22)	0.2 (0.10) (0.10)

Source: BEREC RA database 2020

Average values for 2020 are stable. Considering fixed and mobile markets, no major differences can be detected.

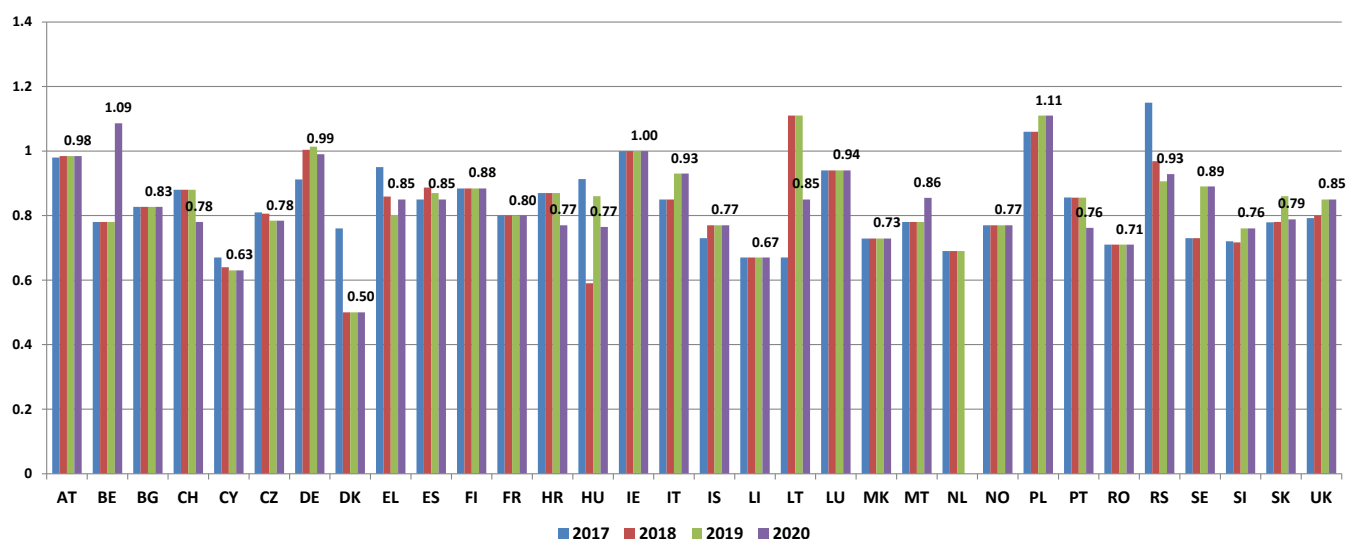
Figure 26 reports Equity Beta values estimated by each NRA sorted from lower to higher values.

Figure 26 – Equity Beta values and distribution (fixed and mobile markets)<sup>32</sup>

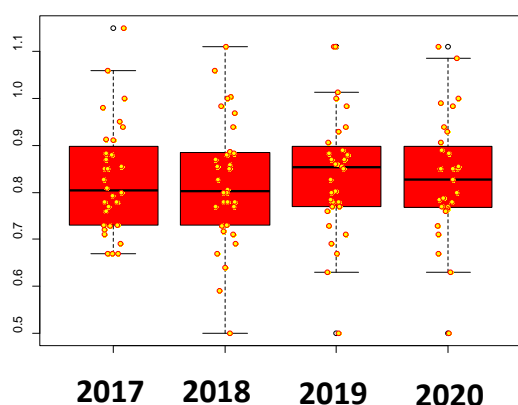
Source: BEREC RA database 2020

<sup>32</sup> UK mobile beta is the midpoint of a high low range.

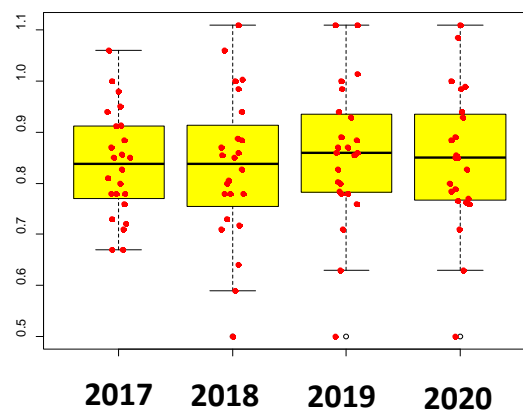
Figure 27 – Equity Beta values in fixed markets (2017-2020)



Equity beta fixed market



Equity beta fixed market EU



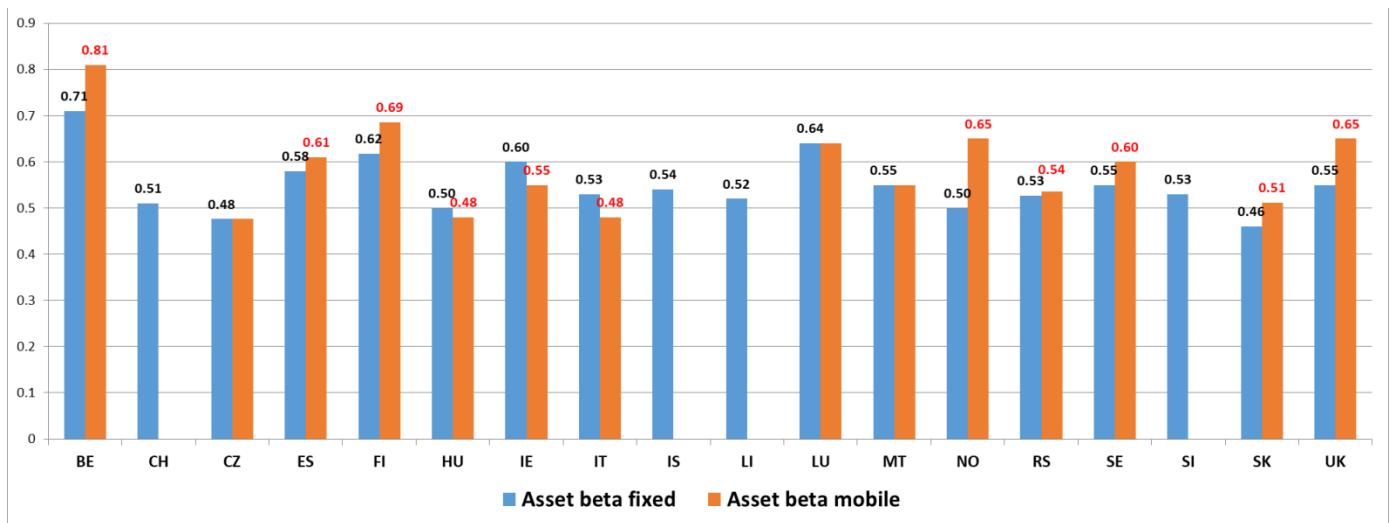
Source: BEREC RA database 2020

Among the 25 NRAs that evaluate a separate WACC for the mobile market, 7 NRAs estimate the same beta for the fixed and mobile market; 10 NRAs estimate a higher mobile beta (on average +0.027 (+0.11) (+0.15))<sup>33</sup>; 7 NRAs estimate a lower mobile beta (on average -0.12 (-0.072) (-0.14)).<sup>34</sup> In comparison to the previous year differences between fixed and mobile estimation are decreasing in line with empirical evidence that the risk parameters of fixed and mobile operators are not differing since most telecommunication operators are generally integrated in fixed and mobile markets.<sup>35</sup>

<sup>33</sup> “+” or “-” is referred to with respect to fixed beta.

<sup>34</sup> Information collected in 2019 and 2018 reported in brackets.

<sup>35</sup> S. Stephan and N. Wernet (2017) “The beta in the WACC for regulated fixed and mobile telecommunications services: its role and robust estimation” Passau, Germany, International Telecommunications Society.

Figure 28 - Asset Beta (fixed and mobile markets)<sup>36</sup>

Source: BEREC RA database 2020

The following figures summarises the different approaches used by NRAs to estimate the beta (mobile and fixed markets); 2019 and 2018 data in brackets.

Figure 29 – Methodologies for estimating Beta (fixed market)

	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 unlever 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)	23 (21) (20)	Arithmetic average	6 (6)(6)	daily	7 (8)(8)	1 week	(0)	Dimson	1 (0)	Own Country	4(4)(3)	yes	20(22)(20)	Modigliani-Miller	(13)(12)	Arithmetic average	(0)
	SMP Operator	3 (6)(6)	Geometric Average	(0)	weekly	8 (8)(8)	1 month	(0)	Bayesian	4(5)(5)	European	15(14)(14)	no	7(5)(6)	Miles & Ezzell	(0)	Geometric Average	(0)
	Other	3(3) (4)	Moving Average	(0)	monthly	5 (5)(4)	3 month	(0)	Blume	4(4)(4)	World	5(6)(7)			Hamada	(3)(3)	Moving Average	(0)
	benchmarking	2(2)(2)	Median	7 (5)(4)	other	1 (1)(1)	6 months	(0)	Vasicek	(1)(1)					Other	(5)(4)	Median	2(2)(2)
			Other	6 (6)(5)			12 months	1(1)(1)	Others	1(2)(2)							Other	(0)
							2 years	2(3)(5)	No Adjustment	10(9)(8)								
							3 years	6(7)(7)										
							5 years	12 (12)(8)										
							10 years	(0)										
							others	2(2)(2)										

Source: BEREC RA database 2020

<sup>36</sup> UK mobile asset beta is the midpoint of a high low range.



Figure 30 - Methodologies for estimating Beta (mobile market)

	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 unlever 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)	20 (19) (17)	Arithmetic average	7 (6) (5)	daily	7(8) (7)	1 week	0(0) (0)	Dimson	1(0)	Own Country	3(3) (3)	yes	16(17) (16)	Modigliani-Miller	10 (11) (11)	Arithmetic average	0(0)
	SMP Operator	0 (1) (2)	Geometric Average	0(0) (0)	weekly	6(6) (6)	1 month	0(0) (0)	Bayesian	4(5)(5)	European	13 (11) (10)	no	4 (4) (4)	Miles & Ezzell	0(0) (0)	Geometric Average	0(0)
	Other	3 (4) (5)	Moving Average	0(0) (0)	monthly	3(3) (3)	3 month	0(0) (0)	Blume	3(3)(2)	World	1(4)(5)			Hamada	2(1) (2)	Moving Average	0(0)
	benchmarking	1 (1) (1)	Median	5(3) (3)	other	1(1) (1)	6 months	0(0) (0)	Vasicek	0(0)(0)					Other	4 (5)(4)	Median	0(1) (1)
			Other	2(5) (5)			12 months	1(1) (1)	Others	1(2)(2)							Other	0(0)
							2 years	2(1) (2)	No Adjustment	7(6)(6)								
							3 years	6(7) (7)										
							5 years	7 (8) (6)										
							10 years	0(0) (0)										
							others	1(0) (1)										

Source: BEREC RA database 2020

The most frequent methodology used by NRAs to estimate a notional beta is based on a peer group of Telecom comparators (23 NRAs for the fixed market) growing constantly. When “Other” is declared (3 NRAs) it generally refers to a hybrid approach that takes into account different sources of estimation; it can be either closer to a notional approach or to an estimation of an SMP beta.

Figure 31 - Main Beta estimation methodologies and values (fixed and mobile markets 2020)<sup>37</sup>

	Fixed Market			Mobile Market		
	Equity beta	Asset Beta	Countries	Equity beta	Asset Beta	Countries
SMP Operator	0.81 (0.83) (0.84)	0.54 (0.53) (0.50)	BG,LT,SI	- (0.74) (0.68)	- (0.55) (0.46)	
notional (generic operator)	0.84 (0.85) (0.82)	0.55 (0.55) (0.54)	AT,BE,CH,CY,CZ,DK,ES,FI,FR,HR,HU,IE,IT,IS,LU,MK,MT,PL,PT,RO,RS,SE,SK	0.84 (0.82) (0.82)	0.60 (0.50) (0.65)	AT,BE,BG,CY,CZ,D K,ES,FI,FR,HR,HU,IE,LU,MK,MT,NL,PT,RS,SE,S K, XK
Other	0.87 (0.88) (0.83)	0.61 (0.53) (0.51)	DE,NO,UK	0.93 (0.93) (0.98)	0.57 (0.59) (0.61)	DE,IT,NO,UK
benchmarking	0.76 (0.73) (0.73)	0.52 (0.51) (0.51)	EL,LI	0.83 (0.78)	- (0.50)	EL

Source: BEREC RA database 2020

Where a notional approach is chosen the number of comparable operators varies between 7 and 20, mainly European. Some NRAs choose the peer group in line with their main business: fixed, mobile or broadcasting.

<sup>37</sup> In one case the Stoxx Europe Telecommunications TMI is regressed as dependent variable with the Stoxx Europe TMI being the independent variable (DE), the comparison between the SMP and own country operators are benchmarked with other groups of comparable operators (UK, NO).

One NRA, in order to differentiate the Beta for fixed and mobile, applies a regression directly to the equity beta of each peer group member, considering as weight the percentage of revenues in each sector (fixed and mobile and other revenues) (DK).

Another NRA (LU) proved that no difference between fixed and mobile beta were found by applying a regression on asset beta finding no statistical significance between the estimated beta and the weights of revenues failing the corresponding beta decomposition.<sup>38</sup> One NRA (RS) applied the peer group reported in the BEREC WACC parameters Report BoR (20) 116.

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

Figure 32 - Beta notional methodology (fixed market)

Contry	Methodology	Number of peers	Average used
BE	notional (generic operator)	SMP + 8 EU peers	Other
CH	notional (generic operator)	12 historical telco companies (CH+EU)	Median
CZ	notional (generic operator)	19 telecom companies, criteria for selection: the shares of the firms are liquidly traded, the firms are active in telecom industry in European countries, market capitalization more that 1 billion EUR, and no acquisitions or mergers.	Median
DK	notional (generic operator)	14 operators. The beta for every operator is then regressed with the opearators share of mobil/fixed/other revenue to calculate the beta if the operator were 100 % mobile or 100 % fixed.	Arithmetic average
ES	notional (generic operator)	17 comparable operators, with similar business mix and listed in the stock exchange	Arithmetic average
FI	notional (generic operator)	15 telecom companies	Median
HR	notional (generic operator)	17 companies for peer group with head quateers in EU	
HU	notional (generic operator)	19, European operators listed on the stock exchanges	Median
IE	notional (generic operator)	7, European fixed-line incumbents	Other
IT	notional (generic operator)	10 European SMP operators	Arithmetic average
IS	notional (generic operator)	11 telecom companies in Western-Europe	Other
LU	notional (generic operator)	13 selected peers (integrated companies)	Arithmetic average
MK	notional (generic operator)	13 comparable fixed line operators in EU, selected by the following criteria: · provides fixed line telephony services; · generates majority of revenues from providing fixed line telephony services; · operates and is based in Europe; · has liquid common stock traded on a stock exchange in Europe; and · has readily available financial data;	Median
PT	notional (generic operator)	16 Eropean companies	Arithmetic average
RO	notional (generic operator)	17 countries peer group of operators based in Europe	Other
RS	notional (generic operator)	14 comparable companies which were approved by BEREC and main criteria for selection were: comparable industry, relatively similar products/services and geographical location.	-
SE	notional (generic operator)	12 European operators (integrated)	Arithmetic average
SK	notional (generic operator)	10, European telecom operators listed on the stock exchange	Median

Source: BEREC RA database 2020

Figure 33 shows that if a different beta is evaluated for fixed and mobile, in case a notional approach is applied, mostly the number and the kind of comparative values chosen reflect a specific mobile target. In other cases the difference in beta values is due just to different timing of the estimation.

<sup>38</sup> <https://assets.ilr.lu/telecom/Documents/ILRLU-1461723625-156.pdf>

Figure 33 - Beta Fixed and mobile notional methodology

Country	Methodolgy fixed	Number of peers	Kind of average	Methodolgy mobile	Number of peers	Kind of average
AT	notional (generic operator)			notional (generic operator)		
BE	notional (generic operator)	9 peers	Other	notional (generic operator)	6 peers	Other
BG	SMP Operator			notional (generic operator)		
CH	notional (generic operator)	12 peers	Median			
CY	notional (generic operator)			notional (generic operator)		
CZ	notional (generic operator)	19 peers	Median	notional (generic operator)	19 peers	Median
DE	Other		Other			
DK	notional (generic operator)	14 peers	Arithmetic average	notional (generic operator)	14 peers	Arithmetic average
ES	notional (generic operator)	17 peers	Arithmetic average	notional (generic operator)	17 peers	Arithmetic average
FI	notional (generic operator)	15 peers	Median	notional (generic operator)	6 peers	Median
FR	notional (generic operator)			notional (generic operator)		
HR	notional (generic operator)	17 peers		notional (generic operator)		
HU	notional (generic operator)	19 peers	Median	notional (generic operator)	9 peers	
IE	notional (generic operator)	7 peers	Other	notional (generic operator)		
IT	notional (generic operator)	10 peers	Arithmetic average	Other	4 peers	Arithmetic average
IS	notional (generic operator)	11 peers	Other			
LU	notional (generic operator)	13 peers	Arithmetic average	notional (generic operator)	13 peers	Arithmetic average
MK	notional (generic operator)	13 peers	Median	notional (generic operator)	8 peers	Median
MT	notional (generic operator)		Median	notional (generic operator)		Median
NL				notional (generic operator)	6 peers	Arithmetic average
PL	notional (generic operator)					
PT	notional (generic operator)	16 peers	Arithmetic average	notional (generic operator)	5 peers	Arithmetic average
RO	notional (generic operator)	17 peers	Other			
RS	notional (generic operator)	14 peers		notional (generic operator)	10 peers	
SE	notional (generic operator)	12 peers	Arithmetic average	notional (generic operator)		Arithmetic average
SK	notional (generic operator)	10 peers	Median	notional (generic operator)	10 peers	Median
XK				notional (generic operator)		

Source: BEREC RA database 2020

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 approach used as reported in Figure 34 (2019 and 2018 figures in brackets).

Figure 34 - Beta methodology for sampling period and time windows (fixed and mobile markets)

Fixed							Mobile						
Time windows							Time windows						
<=2 Years<=3 Years>=5 YearsOthersTotal							<=2 Years<=3 Years>=5 YearsOthersTotal						
Sampling period	daily	2(1) (2)	2(4) (3)	2(2) (2)	0(0)	6(7)(7)	Sampling period	daily	1(0)	2(4)	3(1)	(0)	6(5)
	weekly	0(1) (3)	3(2) (1)	5(5) (3)	0(0)	8(8)(7)		weekly	0(0)	2(3)	4(4)	(0)	6(7)
	monthly	0(0) (0)	0(0) (0)	5(5) (4)	0(0)	5(5)(4)		monthly	1(1)	0(0)	2(2)	(0)	3(3)
	Others	0(0) (0)	1(1) (1)	0(0) (0)	0(0)	1(1)(1)		Others	1(0)	1(1)	0(0)	(0)	2(1)
	Total	2(2) (5)	6(7) (5)	12(12)(9)	0(0)	20(21)(20)		Total	3(1)	5(8)	9(7)	(0)	17(16)

	Fixed market			Mobile market		
	Methodology	Sampling period	Time windows	Methodology	Sampling period	Time windows
BG	SMP Operator			notional (generic operator)		
LT	SMP Operator	monthly	5 years			
SI	SMP Operator	monthly	5 years			
DE	Other	daily	5 years			
UK	Other	daily	5 years	Other	daily	2 years
BE	notional (generic operator)	daily	2 years	notional (generic operator)	daily	2 years
CH	notional (generic operator)	weekly	3 years			
CZ	notional (generic operator)	weekly	5 years	notional (generic operator)	weekly	5 years
DK	notional (generic operator)	daily	3 years	notional (generic operator)	daily	3 years
ES	notional (generic operator)	weekly	5 years	notional (generic operator)	weekly	5 years
FI	notional (generic operator)	weekly	3 years	notional (generic operator)	weekly	3 years
FR	notional (generic operator)			notional (generic operator)		
HR	notional (generic operator)	other	3 years	notional (generic operator)	other	3 years
HU	notional (generic operator)	weekly	5 years	notional (generic operator)	weekly	5 years
IE	notional (generic operator)	daily	2 years	notional (generic operator)	-	-
IT	notional (generic operator)	weekly	5 years	Other	daily	5 years
LU	notional (generic operator)	daily	3 years	notional (generic operator)	daily	3 years
MK	notional (generic operator)	weekly	3 years	notional (generic operator)	weekly	3 years
PT	notional (generic operator)	monthly	5 years	notional (generic operator)	monthly	12 months
RO	notional (generic operator)	daily, weekly	12 months, 3 years			
RS	notional (generic operator)	monthly	5 years	notional (generic operator)	monthly	5 years
SE	notional (generic operator)	weekly	5 years	notional (generic operator)	weekly	5 years
SK	notional (generic operator)	monthly	5 years	notional (generic operator)	monthly	5 years
NL	-	-	-	notional (generic operator)	daily	3 years
XK	-	-	-	notional (generic operator)	other	12 months

Source: BEREC RA database 2020

With reference to the time 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 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 view of beta.

The time 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 35). In comparison to last year's report the tendency is to have a longer time window both for the RFR and Beta estimation.

Figure 35 - Beta/RFR time windows (fixed and mobile markets)

Fixed Market						Mobile Market					
		Beta (Time windows)						Beta (Time windows)			
		<=2 Years	<=3 Years	>=5 Years	Total			<=2 Years	<=3 Years	>=5 Years	Total
RFR (time windows)	<=1 Year	1 (2) (3)	2 (2) (1)	3 (4) (5)	6 (8) (9)	RFR (time windows)	<=1 Year	(0)	2(2)	2(3)	4(5)
	<=3 Years	2 (1) (0)	2 (3) (3)	1 (1) (1)	5 (5) (4)		<=3 Years	2(1)	2(3)	(0)	4(4)
	>=5 Years	0 (0) (3)	2 (2) (2)	8 (7) (4)	10 (8) (9)		>=5 Years	1(1)	2(2)	5(5)	8(8)
	Total	3 (3) (6)	6 (7) (6)	12 (12) (10)	21 (22) (22)		Total	3(2)	6(7)	7(8)	16(17)

		Beta (Time windows)						Beta (Time windows)			
		<=2 Years	<=3 Years	>=5 Years	Total			<=2 Years	<=3 Years	>=5 Years	Total
RFR (time windows)	<=1 Year	PL	FI,MK	ES,LT,SK	6	RFR (time windows)	<=1 Year		FI,MK	ES,SK	4
	<=3 Years	BE,IE	BE,CH,HR	PT	5		<=3 Years	BE,PT	HR,NL		4
	>=5 Years			CZ,DE,HU ,IT,RS,SE,SI ,UK	10		>=5 Years	UK	DK,LU	CZ, HU,IT,RS,SE	8
	Total	3	6	12	21		Total	3	6	7	16

Source: BEREC RA database 2020

A choice of time window for beta  $\geq 5$  years and differing from the one for the RFR is mainly motivated by predictability, reliability and stability objectives reducing variability over time, but also by theoretical reasons such as to have enough data to reduce the standard error in the estimation (i. e. in case a sampling period is longer than daily).

Concerning the adjustment used for estimating the equity beta of SMP or comparable companies (Figure 36), there is no clear view. some others (4 NRAs, fixed market) instead use a Bayesian/Blume adjustment. Some NRAs apply the Blume/Bayesian adjustment explaining their choice (i) to report evidence from an academic study,<sup>39</sup> (ii) remarking that in case of "off the shelf" data provided by Bloomberg, the Blume adjustment is applied, (iii) stating that the Blume adjustment reflects future risk. Other NRAs (8 NRAs), do not make any adjustments considering that there is no reason for applying it. Generally, the application of an adjustment is done 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 can be less reliable.

<sup>39</sup> Pablo Fernández, Beta used by professors: A survey with 2500 answers, IESE CIIF, Business School, University of Navarra, Working Paper, WP-822, September, 2009.

Figure 36 - Time window adjustments to Equity Beta (fixed and mobile markets)

Fixed					Mobile				
	Time Windows					Time Windows			
	<=2 Years	<=3 Years	>=5 Years	Total		<=2 Years	<=3 Years	>=5 Years	Total
No Adjustment	1(2) (2)	2(1) (1)	5(5) (5)	8(8) (8)	No Adjustment	1(1)	2(2)	3(3)	6(6)
Blume	1(1) (2)	1(1) (1)	2(2) (1)	4(4) (4)	Blume	0(0)	1(1)	2(2)	3(3)
Vasiecek	0(0) (0)	1(1) (1)	0(0) (0)	1(1) (1)	Vasiecek	0(0)	0(0)	0(0)	0(0)
Bayesian	0(0) (0)	1(2) (2)	2(2) (2)	3(4) (4)	Bayesian	0(0)	1(2)	2(2)	3(4)
Dimson	1(0) (0)	0(0) (0)	0(0) (0)	1(0) (0)	Dimson	1(0)	0(0)	0(0)	1(1)
Others	1(0) (1)	0(1) (1)	1(1) (0)	2(2) (2)	Others	1(1)	0(1)	0(0)	1(2)
Total	4(3) (5)	5(6) (6)	10(10) (8)	19(19) (19)	Total	3(2)	4(5)	7(7)	14(14)

Source: *BEREC RA database 2020*

Most NRAs apply an unlevered beta before estimating the final equity beta (20 NRAs). Concerning the unlevering formula the most widely used is the Modigliani-Miller formula (Miller being the same formula without tax<sup>40</sup>). Only four NRAs apply a beta debt in the levering/un-levering procedure. Generally, this is done when an “SMP” beta, rather than a notional one, is estimated.

Concerning the market index, most NRAs (15 NRAs) use a European index (STOXX Europe TMI Telecommunications; STOXX Europe TMI, MSCI Europe Index). Some estimate the equity beta for each comparable on a specific country index (e. g. every comparable beta is estimated on its own country market index). In case of a World index, the MSCI is used by several NRAs (5 NRAs). A country specific index is typically used mainly when the beta is evaluated only for the SMP operator (4 NRAs).

The chosen approach is generally motivated by the fact that the specific index provides a reliable data source and is consistent with earlier decisions.

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.

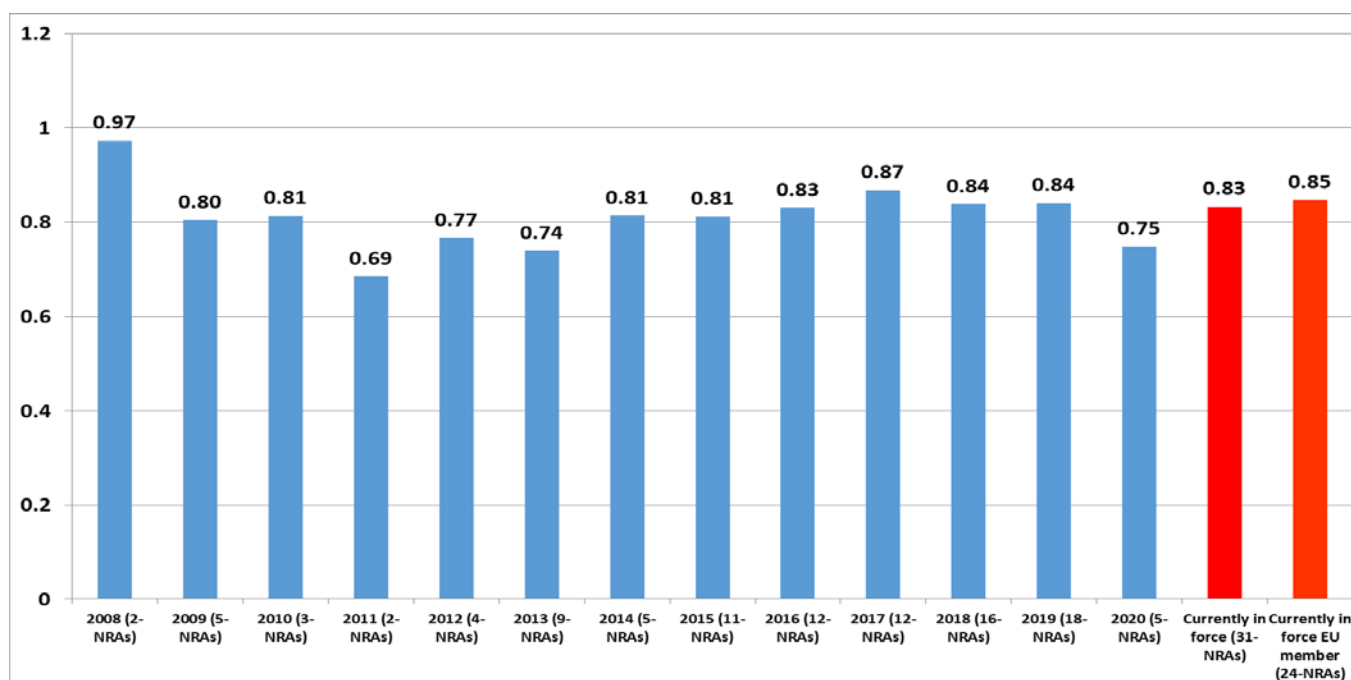
Overall, in the period 2008-2020, estimated beta values have remained relatively stable<sup>41</sup>.

<sup>40</sup> Sometimes the same formula is referred to as “Hamada formula”.

<sup>41</sup> The variability may be explained by the number of observations (e. g. one NRA in 2011).



Figure 37 - Equity Beta evolution over time (fixed market)



Source: BEREC RA database 2020

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 and BoR (20) 116 for definition and general financial theory

### Main output from the survey.

Based on the replies provided for the 2020 survey the following statistics were derived for all responding NRAs and for EU NRAs separately (2019 and 2018 values in brackets).

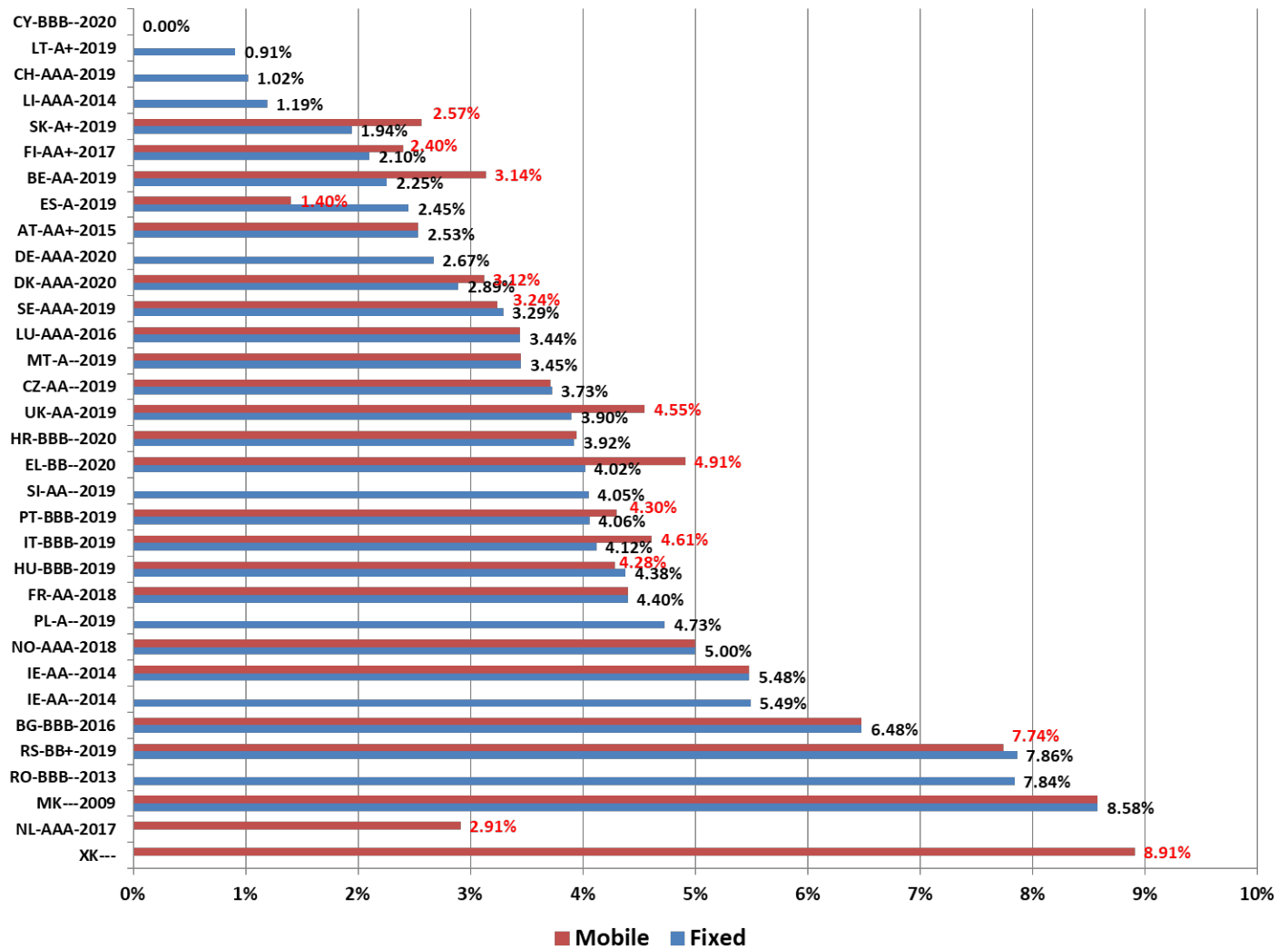
Figure 38 – Cost of debt values

	Average	Median	Standard Deviation	Relative Standard Deviation	Maximum	Minimum
Cost of debt fixed market 31 NRAs (2019-32) (2018-32)	3.81% (4.00%) (4.30%)	3.90% (3.98%) (4.43%)	2.03% (2.03%) (2.08%)	53.33% (50.89%) (48.31%)	8.58% (8.58%) (8.77%)	0.00% (0.00%) (0.00%)
Cost of debt mobile market 27 NRAs (2019-26) (2018-26)	4.20% (4.44%) (4.60%)	3.94% (4.35%) (4.35%)	2.07% (2.00%) (2.06%)	49.21% (45.12%) (44.77%)	8.91% (8.58%) (8.58%)	0.00% (0.00%) (0.00%)
Cost of debt fixed market 24 EU NRAs (2019-26) (2018-26)	3.55% (3.79%) (4.12%)	3.59% (3.81%) (4.39%)	1.67% (1.74%) (1.74%)	47.11% (45.92%) (42.14%)	7.84% (7.84%) (7.84%)	0.00% (0.00%) (0.00%)
Cost of debt mobile market 20 EU NRAs (2019-23) (2018-23)	3.52% (4.09%) (4.25%)	3.45% (4.16%) (4.16%)	1.43% (1.78%) (1.82%)	40.58% (43.54%) (42.87%)	6.48% (7.84%) (7.84%)	0.00% (0.00%) (0.00%)

Source: BEREC RA database 2020

In Figure 39 the cost of debt currently estimated for the fixed and mobile market is shown. The respective credit rating and its year of estimation is also reported.

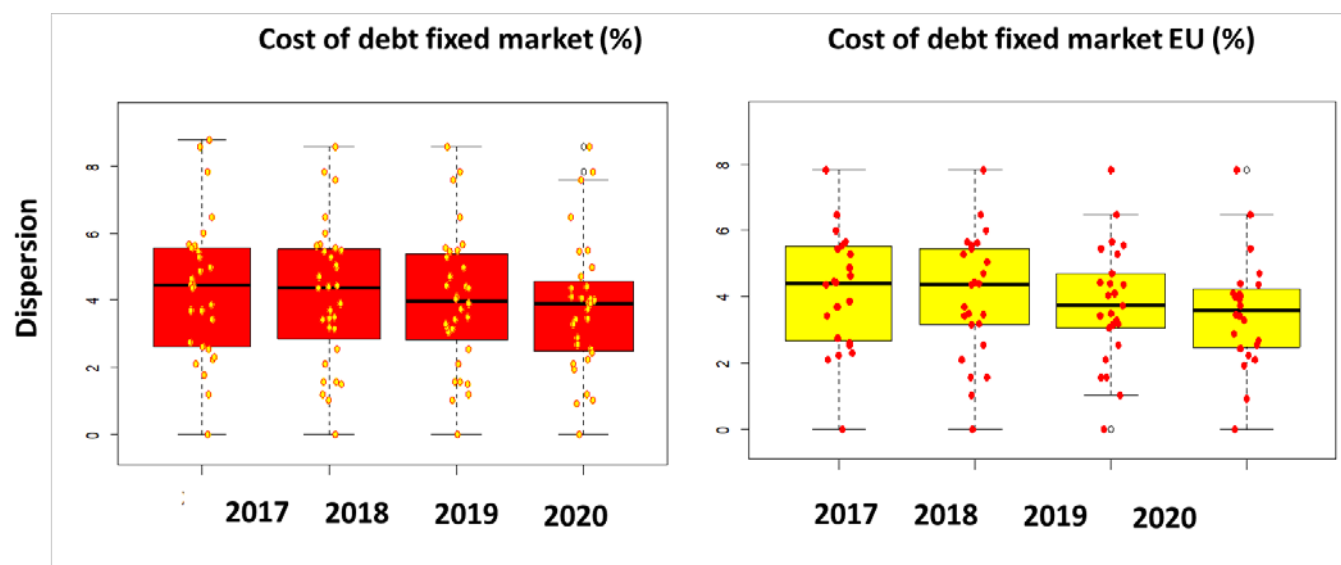
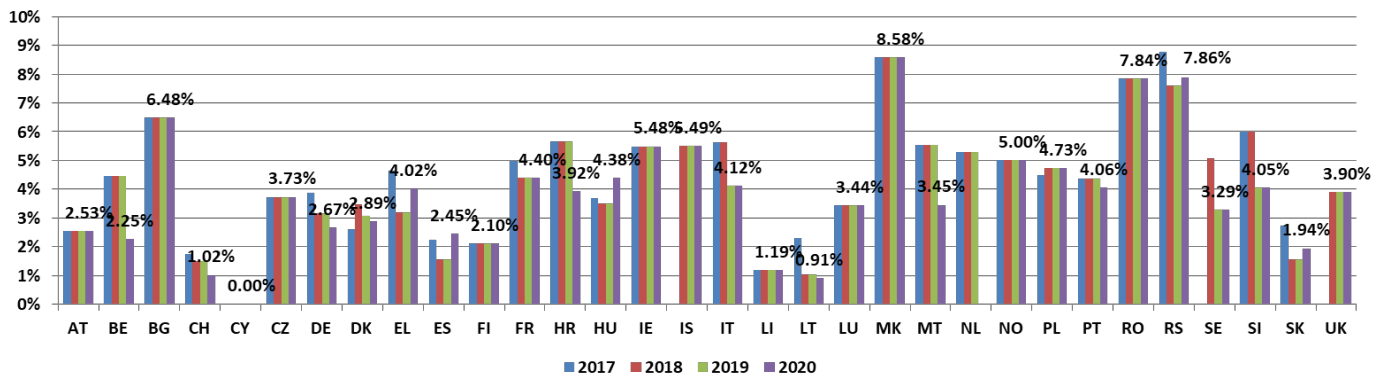


Figure 39 - Cost of debt value and distribution (fixed and mobile markets)<sup>42</sup>

Source: BEREC RA database 2020

<sup>42</sup> UK mobile number is midpoint of a range.

Figure 40 - Evolution of cost of debt over time (2018-2020)



S

Source: BEREC RA database 2020

The overall situation is quite stable from year to year.

The following figures summarise the different approaches used by NRAs to estimate the cost of debt for fixed and mobile markets.

Figure 41 - Methodology used for estimating cost of debt (fixed market)

	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 hystorical series included in the Average window)		-if benchmarking is indicated in the methodology section please indicate the average used from other countries	
Cost of debt (RFR+ Debt premium)	notional (generic operator)	14 (13) (12)	Debt premium	22(21) (20)	Book value	1(2) (3)	Secondary traded market	6(5) (5)	1 year	(0) (0)	Spot rate	3(3) (3)	Arithmetic average	11(11) (11)	Arithmetic average	(0)
	SMP Operator	4(5) (5)	Cost of Debt	7(8) (9)	Market Value (Company bond)	21(19) (17)	Nominal bond yield	8(8) (9)	3 years	(0) (0)	3 months	0(1) (0)	Geometric Average	0(0)(0)	Geometric Average	(0)
	Other	11(11) (10)			Other	2(4) (5)	Other	5(5) (4)	5 years	2(2) (2)	6 months	1(1) (1)	Moving Average	1(0) (0)	Moving Average	(0)
	benchmarking	0(1) (1)							10 years	9(8) (7)	1 Year	2(1) (3)	Median	0(0) (0)	Median	(0)
									20 years	1(1) (0)	2 Years	1(1) (2)	Other	3(2) (1)	Other	0(1) (1)
									Hybrid	2(1) (1)	3 Years	3(2) (0)				
									Other	5(5) (6)	5 Years	2(1) (1)				
										10 Years	3(4) (4)					
										Others	3(3) (1)					

Source: BEREC RA database 2020

Figure 42 - Methodology used for estimating cost of debt (mobile market)

	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 hystorical series included in the Average window)		-if benchmarking is indicated in the methodology section please indicate the average used from other countries				
Cost of debt (RFR+ Debt premium )	notional (generic operator)	10(10) (9)	Debt premium	17 (19) (17)	Book value	0 (0) (0)	Secondary traded market	3(3) (3)	1 year	1(1) (1)	Spot rate	2(3) (3)	Arithmetic average	9(9) (8)	Arithmetic average	(0) (0)			
	SMP Operator	2(2) (2)	Cost of Debt	5 (4) (6)	Market Value (Company bond)	15(16) (16)	Nominal bond yield	7(8) (8)	3 years	0(0) (0)	3 months	0(0) (1)	Geometric Average	(1) (1)	Geometric Average	(0) (0)			
	Other	11(11) (12)				Other	4(4) (4)	Other	5(3) (4)	5 years	3(1) (1)	6 months	1(1) (1)	Moving Average	(0) (0)	Moving Average	(0) (0)		
	benchmarking	0(1) (1)										10 years	7(7) (7)	1 Year	1(1) (2)	Median	(0) (0)	Median	(0) (0)
									20 years	0(0) (0)	2 Years	0(0) (0)	Other	1(0) (0)	Other	0(1) (1)			
									Hybrid	0(0) (0)	3 Years	4(2) (1)							
				Other	4(5) (5)	5 Years	1(1) (1)												
									10 Years	2(3) (3)									
									Others	3(3) (2)									

Source: BEREC RA database 2020

For the fixed market, the most frequent approach used by NRAs is a notional approach (14 NRAs), the category "Other" is chosen by 11 NRAs which reflects a mix of approaches (SMP and notional). This is followed by the estimation of the SMP cost of debt (4 NRAs).

Most NRAs estimate a debt premium instead of estimating the cost of debt directly, mostly when a notional approach is used (see Figure 43). On the other hand, when the cost of debt refers to the SMP operator, a direct cost of debt is generally estimated. Within a notional approach, NRAs generally use peer groups in line with the peer group used for estimating beta and gearing according to a specific credit rat-

ing (at least BBB-).<sup>43</sup> Most NRAs use bond windows or time to maturity in line with those used for RFR (generally 10 year average)

In general there is a large consistency between fixed and mobile markets; few NRAs have a marginally different approach to fixed and mobile markets.

Figure 43 - Cost of debt calculated through debt premium (fixed and mobile markets)

Fixed			Mobile		
	Cost of debt calculated through debt premium	Cost of Debt		Cost of debt calculated through debt premium	Cost of Debt
Notional (generic operator)	14 (12) (11)	0(1) (1)	Notional (generic operator)	10(10)	0(0)
SMP operator	1(1) (1)	3(4) (4)	SMP operator	1(1)	1(1)
Other	7(7) (7)	3(3) (4)	Other	6(6)	4(3)
Benchmarking	0(1) (1)	0(0) (0)	Benchmarking	0(1)	(0)

	Cost of debt calculated through debt premium	Cost of Debt		Cost of debt calculated through debt premium	Cost of Debt
Notional (generic operator)	BE, CH, CZ, DK, FI, FR, HR, HU, I S, LI, PT, RO, RS, SE		Notional (generic operator)	BE, CZ, DK, FI, FR, HR, HU, PT, RS, SE	
SMP operator	AT	BG, IT, LT	SMP operator	AT	BG
Other	DE, IE, LU, MT, NO, SI SK	ES, PL, UK	Other	IE, LU, MT, NO, SK, UK	ES, IT, NL, XK
Benchmarking			Benchmarking		

Source: BEREC RA database 2020

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

Concerning the bond windows, 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.

Figure 44 - Bond lengths used for estimating cost of debt/RFR (fixed and mobile markets)

Fixed		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)	9(8) (7)	1(1)	2(1) (1)	4(5) (4)	
	20 Years	0	0	0	0	0	0	0	
	Other	0	0	0	0	0	0	1(1) (2)	

Mobile		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(1)	7(7)	0	0	3(3)	
	20 Years	0	0	0	0	0	0	0	
	Other	0	0	0	0	0	0	1(1)	

Source: BEREC RA database 2020

NRAs generally choose time windows in accordance with their choice of time windows used for the RFR. "Other" is chosen for the time windows 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"

<sup>43</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.

is chosen, 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 the BoR (18) 167 where BEREC understands the need for consistency in the time windows used for the cost of debt and RFR, but also recognises a necessity for some NRAs to be flexible due to the problem of data availability.

Figure 45 - RFR/cost of debt time windows (fixed and mobile markets)

Fixed					Mobile				
		Cost of debts					Cost of debts		
		<=1 Year	<=3 years	>= 5 Years			<=1 Year	<=3 years	>= 5 Years
RFR	<=1 Year	2(2) (4)	0(0) (1)	1(1) (1)	RFR	<=1 Year	1(2)	0(0)	0(0)
	<=3 Years	1(1) (1)	2(1) (1)	2(2) (2)		<=3 Years	0(1)	2(1)	1(2)
	>= 5 Years	3(2) (2)	2(2) (1)	4(4) (3)		>= 5 Years	3(2)	2(1)	2(3)
	Total	6(5) (7)	4(3) (3)	7(7) (6)		Total	5(5)	4(2)	3(5)
		<=1 Year	<=3 years	>= 5 Years			<=1 Year	<=3 years	>= 5 Years
RFR	<=1 Year	ES,SK		PL	RFR	<=1 Year	ES		
	<=3 Years	RO	BE,PT	CH,HR		<=3 Years		BE,NL	HR
	>= 5 Years	CZ,HU,RS	LU,SE	FR,UK,IT,SI		>= 5 Years	CZ,RS	LU,SE	FR,UK

Source: BEREC RA database 2020

Concerning specific adjustments to the Cost of debt, two NRAs apply the following:

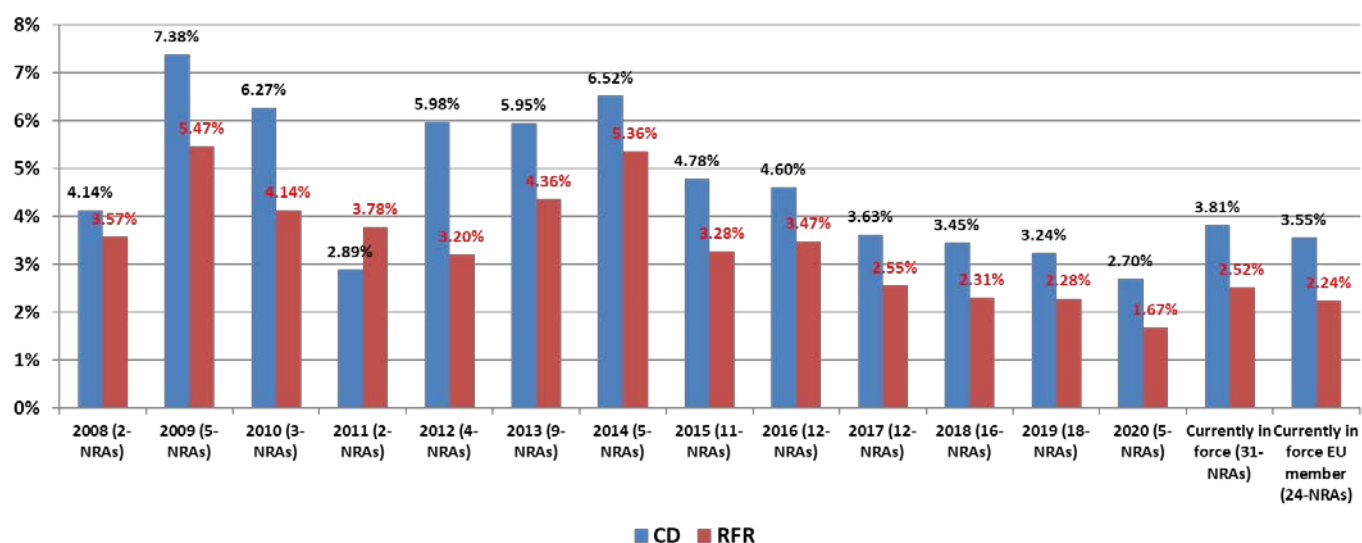
Figure 46 - Adjustments to cost of debt

Adjustment	Cost of debt	Cost of debt without adjustment	Adjustment	Motivation
IE (2014)	5.48%	5.18%	0.30%	Aiming up
RS (2019)	7.86% (7.61%)(8.77%)	6.85% (6.48%)(7.23%)	1.02% (1.13%) (1.54%)	Adjustment is made using the inflation rate for Serbia and Eurozone, since the initial value of cost debt is in EUR. Inflation adjustment was made using Fisher equation: Pretax Cost of debt*(1+Projected Inflation Rate for RS)/(1+Projected Inflation Rate for Eurozone)

Source: BEREC RA database 2020

The next figure shows the evolution over time of the cost of debt and the RFR (fixed market).

Figure 47 - Evolution of cost of debt over time (fixed market)



Source: BEREC RA database 2020

## 5.2.5 Gearing Ratio

see BoR (17) 169, BoR (18) 167 and BoR (20) 116 for definition and general financial theory

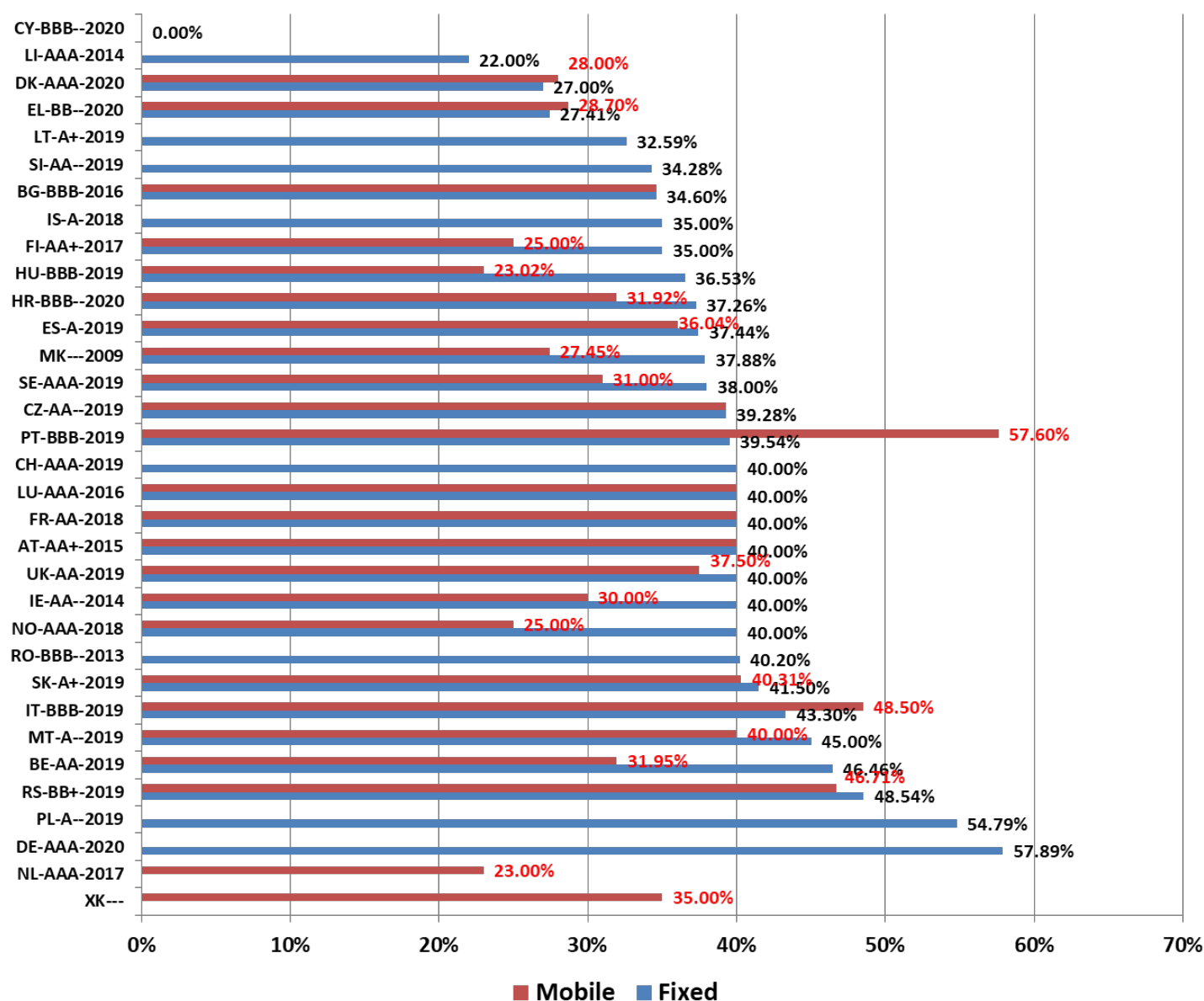
### Main results of the survey.

Based on the replies provided for the 2020 survey the following statistics were derived for all responding NRAs and for EU NRAs separately (2019 and 2018 values in brackets).

Figure 48 - Gearing ratio (fixed and mobile markets)

	Average	Median	Standard Deviation	Relative Standard Deviation	Maximum	Minimum
<b>Gearing fixed market –31 NRAs (2019-32) (2018-32)</b>	37.79% (37.70%) (37.28%)	39.54% (39.93%) (39.85%)	9.99% (9.71%) (10.04%)	26.44% (26.76%) (26.93%)	57.89% (54.79%) (55.62%)	0.00% (0.00%) (0.00%)
<b>Gearing mobile market 27 NRAs (2019-26) (2018-26)</b>	33.62% (33.53%) (33.34%)	34.60% (34.55%) (33.25%)	10.91% (12.34%) (12.50%)	32.44% (36.79%) (37.50%)	57.60% (57.60%) (57.60%)	0.00% (0.00%) (0.00%)
<b>Gearing fixed market 24 EU NRAs (2019-26)(2018-26)</b>	37.84% (37.24%) (37.27%)	39.41% (40%) (40%)	10.65% (10.61%) (10.65%)	28.14% (28.48%) (28.58%)	57.89% (55.62%) (55.62%)	0.00% (0.00%) (0.00%)
<b>Gearing mobile market 20 EU NRAs (2019-23)(2018-23)</b>	33.45% (33.95%) (33.85%)	34.28% (34.60%) (34.50%)	11.59% (12.91%) (13.13%)	34.66% (38.02%) (38.78%)	57.60% (57.60%) (57.60%)	0.00% (0.00%) (0.00%)

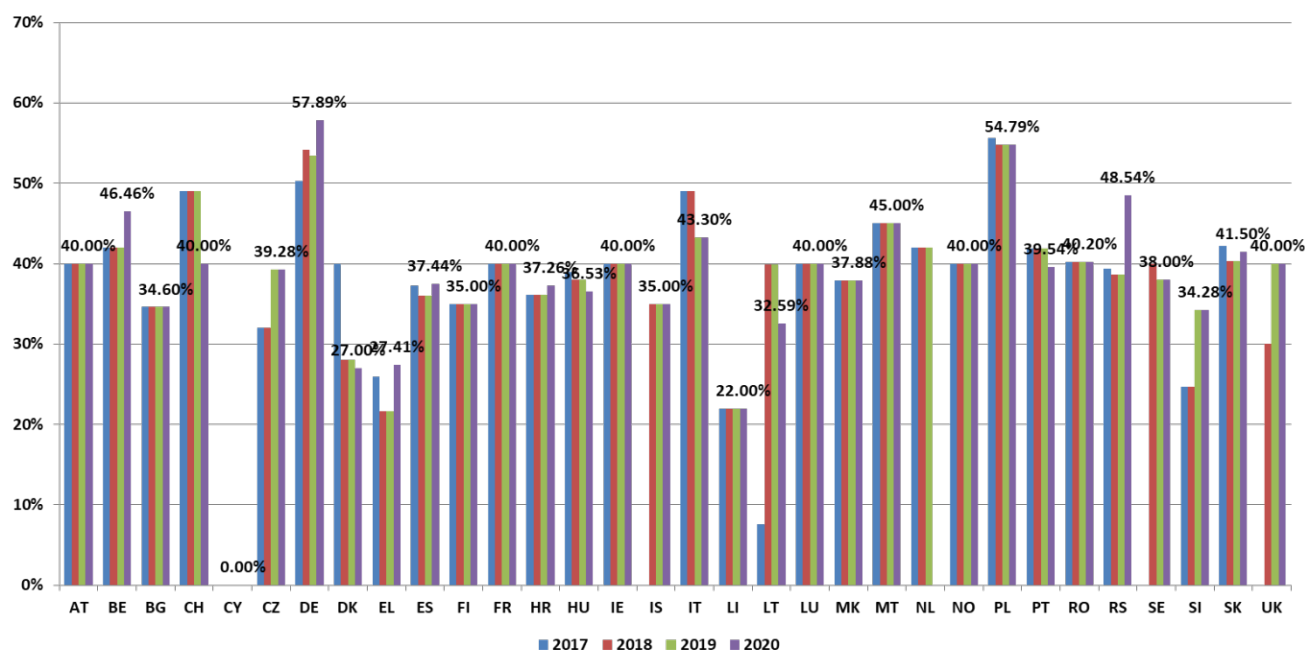
Source: BEREC RA database 2020

Figure 49 - Gearing values (fixed and mobile markets)<sup>44</sup>

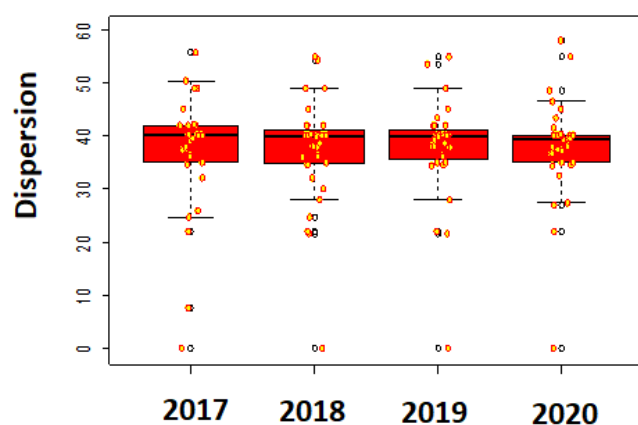
Source: BEREC RA database 2020

<sup>44</sup> UK mobile number is midpoint of a range.

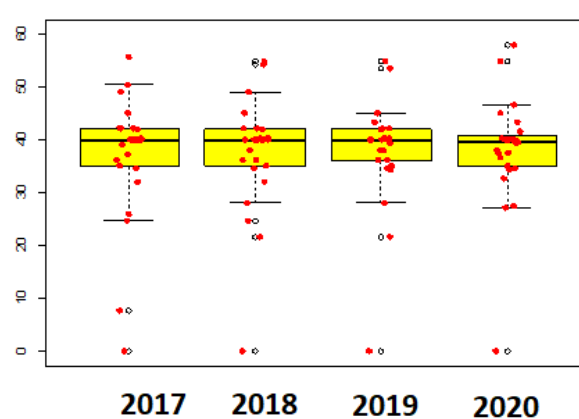
Figure 50 - Gearing values (fixed market 2017-2019)



Gearing fixed market (%)



Gearing fixed market EU (%)



Source: BEREC RA database 2020

The following figures summarise the different approaches used by NRAs to estimate the gearing parameters (fixed and mobile markets).



Figure 51 - Gearing methodology (fixed market)

	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)	19 (18)(18)	Book value	10 (8)(8)	Book value	1(1)(1)	Arithmetic average	8(7) (7)	Arithmetic average	0
	SMP Operator	6(7)(6)	Market Value	6(6)(5)	Market Value	15 (13)(12)	Geometric Average	(0)	Geometric Average	0
	Other	4(4)(5)	Other	1(2)(2)	Other	1(2)(2)	Moving Average	(0)	Moving Average	0
	benchmarking	0(0)(0)					Median	3(4) (4)	Median	0
							Other	3(2) (2)	Other	0

Source: BEREC RA database 2020

Figure 52 - Gearing methodology (mobile market)

	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)	19 (14) (14)	Book value	6(7) (6)	Book value	(0)	Arithmetic average	9(7) (7)	Arithmetic average	0
	SMP Operator	1(2) (2)	Market Value	6(4) (4)	Market Value	12(11) (10)	Geometric Average	(0) (0)	Geometric Average	0
	Other	3(6) (7)	Other	1(1) (1)	Other	1(1) (1)	Moving Average	(0) (0)	Moving Average	0
	benchmarking	(0)					Median	2(4) (4)	Median	0
							Other	2(2) (2)	Other	0

Source: BEREC RA database 2020

The vast majority of NRAs use a “notional” approach, and, in general, do not adjust the gearing according to national circumstances. Instead they use the value of the notional gearing to unlever the beta. The gearing is generally estimated taking into account the same time windows used for beta estimation. In line with last year’s report, most NRAs use a notional approach equal to their approach for estimating the beta.

Concerning their data source, most NRAs use book value for the debt component and market value for the equity component. Where the SMP operator’s gearing is considered, the estimation of the equity component is often computed using the book value (Figure 53).

When the debt component is estimated via the book value, generally long term and short term debt without netting off the cash is considered.<sup>45</sup>

<sup>45</sup> Cash is considered useful to operate the business (rather than being available to pay off debt).

Figure 53 - Gearing methodology (fixed and mobile markets)

Fixed Market						
	Debt component			Equity component		
	Book value	Market value	Other	Book value	Market value	Other
notional (generic operator)	6(4) (4)	4(4) (3)	1(2) (2)	(0) (0)	10(8) (7)	1(2) (2)
SMP Operator	2(2) (2)	1(1) (0)	0(0) (0)	1(1) (1)	2(2) (1)	0(0) (0)
Other	2(2) (2)	1(1) (1)	0(0) (0)	0(0) (0)	3(3) (3)	0(0) (0)
benchmarking	(0) (0)	(0) (0)	(0) (0)	(0) (0)	(0) (0)	(0) (0)
Total	10(8) (8)	6(6) (4)	1(2) (2)	1(1) (1)	15(13) (11)	1(2)(2)

Mobile Market						
	Debt component			Equity component		
	Book value	Market value	Other	Book value	Market value	Other
notional (generic operator)	5(5)	5(2)	1(1)	(0)	10(7)	1(1)
SMP Operator	(0)	(0)	(0)	(0)	(0)	(0)
Other	1(2)	1(2)	(0)	(0)	2(4)	(0)
benchmarking	(0)	(0)	(0)	(0)	(0)	(0)
Total	6(7)	6(4)	1(1)	(0)	12(11)	1(1)

	Debt Component			Equity component		
	Book value	Market value	Other	Book value	Market value	Other
notional (generic operator)	DK,EL,HR,IT,LU,SE	BE,ES,HU,SK	IE	BE,DK,EL,ES,HR,HU,IT,LU,SE,SK		IE
SMP Operator	CH,LI	SI		LI	CH,SI	
Other	DE,UK	MK		DE,MK,UK		
benchmarking						
Total	10	6	1	1	15	1

	Debt Component			Equity component		
	Book value	Market value	Other	Book value	Market value	Other
notional (generic operator)	DK,EL,HR,IT,LU	BE,ES,HU,SE,SK	IE		BE,DK,EL,ES,HR,HU,IT,LU,SE,SK	IE
SMP Operator						
Other	UK	MK			MK,UK	
benchmarking						
Total	6	6	1		12	1

Source: BEREC RA database 2020

Figure 54 and Figure 55 indicate that the gearing methodology is influenced mainly by the main methodology in use for the beta estimation, while gearing also influences the debt premium estimation.

Considering the methodologies used by all NRAs for 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 unlever and re-lever the beta, (iii) it influences the size of the cost of debt.

Figure 54 - Methodology gearing and cost of debt estimation (fixed and mobile markets)

**Fixed**

		Cost of debt				
		notional (generic operator)	SMP Operator	Other	Benchmarking	Total
Gearing	notional (generic operator)	12 (12) (11)	2(2) (2)	4(4) (5)	0(0) (0)	18(18) (18)
	SMP Operator	2(1) (1)	2(3) (3)	2(3) (2)	0(0) (0)	6 (7) (6)
	Other	0(0) (0)	0(0) (0)	3(2) (3)	0(1) (1)	3 (3)(4)
	Benchmarking	0	0	0	0	0
Total		14(14) (12)	4(5) (5)	9(9) (10)	0(1)(1)	27(28) (28)

		Cost of debt				
		notional (generic operator)	SMP Operator	Other	Benchmarking	Total
Gearing	notional (generic operator)	BE,CZ,DK,FI, FR,HR,HU,IS, PT,RO,RS,SE	AT,IT	ES,IE,LU,SK		19
	SMP Operator	CH,LI	BG,LT	PL,SI		6
	Other			DE,MT,UK		3
	Benchmarking					0
Total		14	4	9	0	27

**Mobile**

		Cost of debt				
		notional (generic operator)	SMP Operator	Other	Benchmarking	Total
Gearing	notional (generic operator)	10(9)	1(1)	7(5)	0(0)	18 (15)
	SMP Operator	0(0)	1(1)	0(1)	0(0)	1(2)
	Other	0(1)	0(0)	3(3)	0(1)	3(5)
	Benchmarking	0	0	0	0	0
Total		10(10)	2(2)	10(9)	0(1)	22(22)

		Cost of debt				
		notional (generic operator)	SMP Operator	Other	Benchmarking	Total
Gearing	notional (generic operator)	BE,CZ,DK,FI, FR,HR,HU, PT,RS,SE	AT	ES,IE,IT,LU, NL, SK,XK		18
	SMP Operator		BG			1
	Other			DE,MT,UK		3
	Benchmarking					0
Total		10	2	10	0	22

Source: BEREC RA database 2020

Figure 55 - Methodology gearing and beta estimation (fixed and mobile markets)

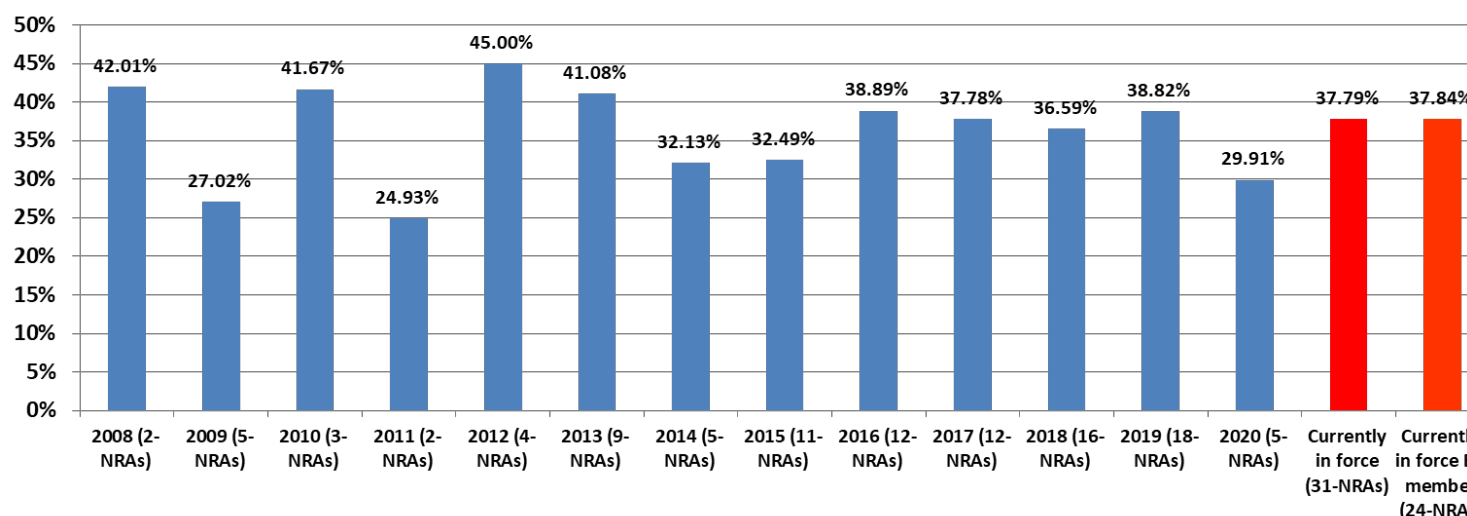
Fixed						
		Beta				
		notional (generic operator)	SMP Operator	Other	Benchmarking	Total
Gearing	notional (generic operator)	18 (18) (17)	0(0) (0)	0(0) (1)	0(0) (0)	18(18)(18)
	SMP Operator	2 (1) (1)	3(5) (4)	0(0) (0)	1(1) (1)	6(7)(6)
	Other	2(1) (0)	0(0) (1)	2(2) (2)	0 (1) (1)	4(4)(4)
	Benchmarking	0(0) (0)	0(0) (0)	0(0) (0)	0 (0) (0)	0(0) (0)
	Total	22(21) (18)	3 (5) (5)	2(2) (3)	1 (2)(2)	28(29)(28)
		Beta				
		notional (generic operator)	SMP Operator	Other	Benchmarking	Total
Gearing	notional (generic operator)	AT, BE, CZ, DK, ES, FI, FR, HR, HU, IE, IT, IS, LU, PT, RO, RS, SE, SK				18
	SMP Operator	CH, PL	BG, LT, SI		LI	6
	Other	MK, MT		DE, UK		4
	Benchmarking					0
	Total	22	3	2	1	28

Mobile						
		Beta				
		notional (generic operator)	SMP Operator	Other	Benchmarking	Total
Gearing	notional (generic operator)	16 (16)	0(0)	1(1)	0(0)	17 (17)
	SMP Operator	1 (1)	0(1)	(0)	0(0)	1 (2)
	Other	2 (1)	0(0)	1(2)	0(1)	3 (4)
	Benchmarking	(0)	0(0)	0(0)	0(0)	0(0)
	Total	19 (18)	0(1)	2(3)	0(1)	21(23)
		Beta				
		notional (generic operator)	SMP Operator	Other	Benchmarking	Total
Gearing	notional (generic operator)	AT, BE, CZ, DK, ES, FI, FR, HR, HU, IE, LU, NL, PT, RS, SE, SK		IT		17
	SMP Operator	BG	BE			1
	Other	MK, MT		UK		2
	Benchmarking					0
	Total	19	1	2	1	21

Source: BEREC RA database 2020

The evolution over time of the gearing estimation is reported in Figure 56.

Figure 56 – Evolution of gearing over time



Source: BEREC RA database 2020

## 5.2.6 Tax rate

Concerning the corporate tax rate in use the following statistics emerge (2019 figures in brackets):

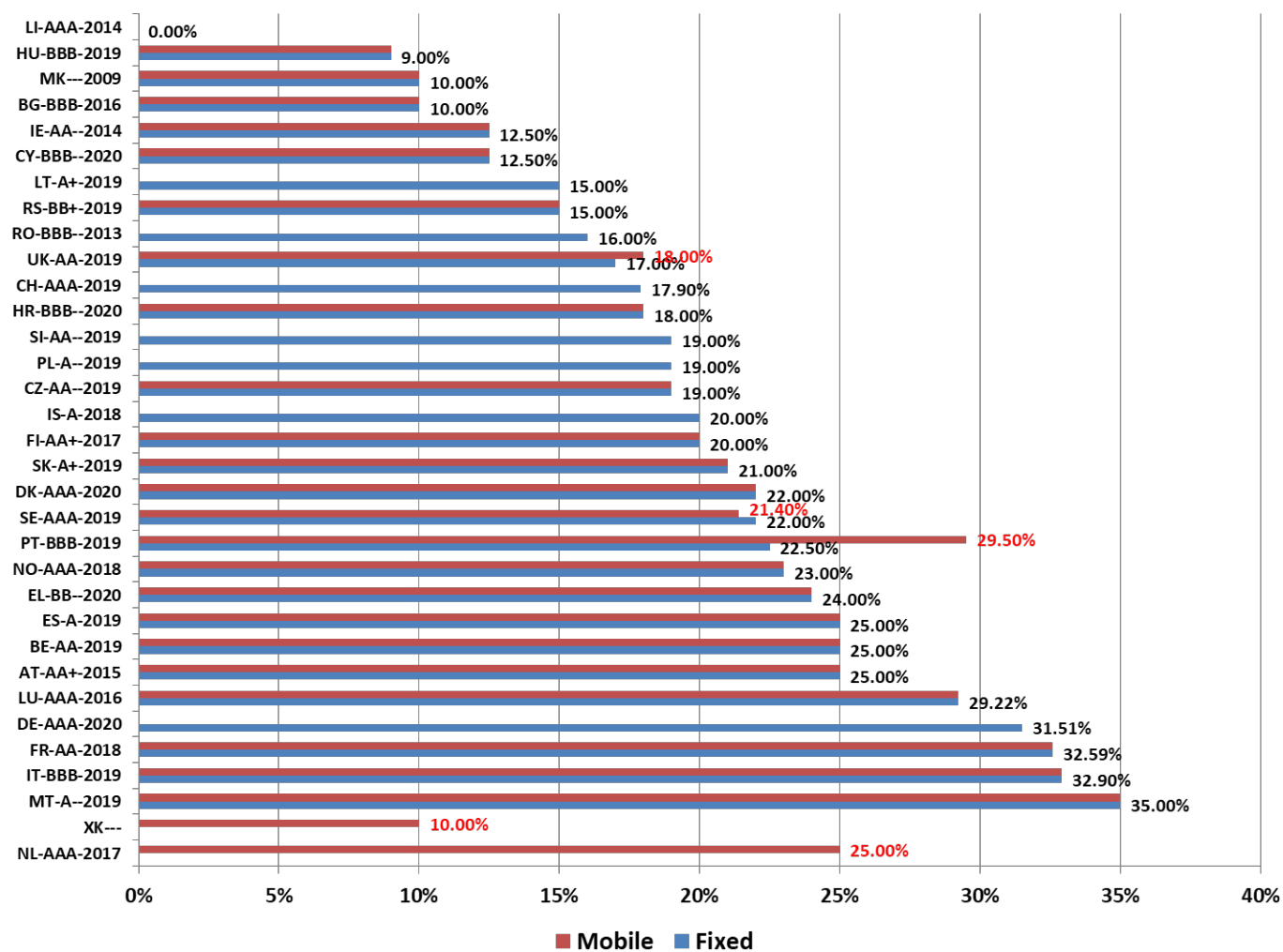
Figure 57 - Corporate tax rate (fixed and mobile markets)

	Average	Median	Standard Deviation	Relative Standard Deviation	Maximum	Minimum
<b>Tax rate fixed market 31 NRAs (2019-32) (2018-32)</b>	<b>20.02%</b> (21.07%) (21.09%)	<b>20.00%</b> (20.45%) (20.45%)	<b>7.75%</b> (8.34%) (8.48%)	<b>38.72%</b> (39.57%) (40.19%)	<b>35.00%</b> (35.00%) (36.00%)	<b>0.00%</b> (0.00%) (0.00%)
<b>Tax rate mobile market 27 NRAs (2019-26) (2018-26)</b>	<b>21.17%</b> (21.81%) (22.93%)	<b>21.40%</b> (21.00%) (21.00%)	<b>7.66%</b> (7.83%) (8.03%)	<b>36.19%</b> (35.87%) (36.60%)	<b>35.00%</b> (35.00%) (36.00%)	<b>9.00%</b> (9.00%) (9.00%)
<b>Tax rate fixed market 24 EU NRAs (2019-26)(2018-26)</b>	<b>21.57%</b> (22.51%) (22.54%)	<b>21.50%</b> (21.50%) (22.00%)	<b>7.21%</b> (7.73%) (7.91%)	<b>33.43%</b> (34.33%) (35.08%)	<b>35.00%</b> (35.00%) (36.00%)	<b>0.00%</b> (9.00%) (9.00%)
<b>Tax rate mobile market 20 EU NRAs (2019-23)(2018-23)</b>	<b>22.43%</b> (22.57%) (22.70%)	<b>21.40%</b> (22.00%) (22.00%)	<b>7.66%</b> (7.78%) (7.99%)	<b>36.19%</b> (34.45%) (35.21%)	<b>35.00%</b> (35.00%) (36.00%)	<b>9.00%</b> (9.00%) (9.00%)

Source: *BEREC RA database 2020*

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 that it is not a parameter that NRAs have an influence over.

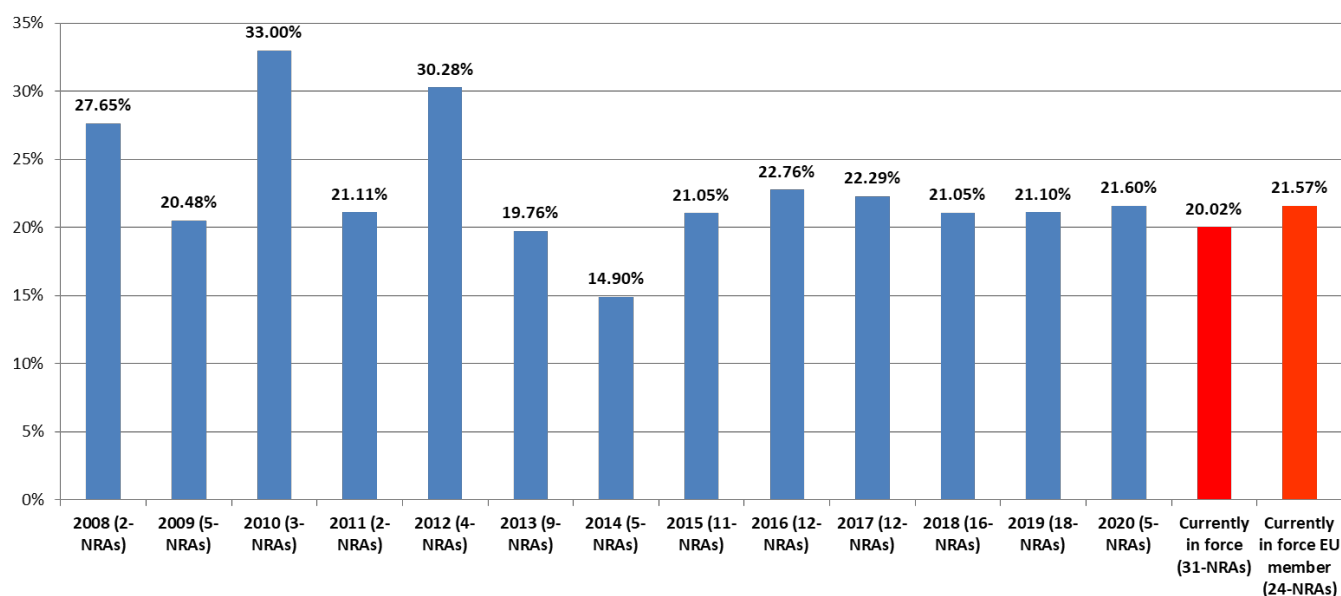
Figure 58 - Tax rate currently in use (fixed and mobile markets)



Source: BEREC RA database 2020

The time evolution of the tax rate adopted is reported in Figure 59.

Figure 59 - Evolution of tax rate over time (fixed market 2008-2020)



Source: BEREC RA database 2020

## 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 2020 questionnaire on technical adjustments on single parameters estimation and, in general, on the cost of equity.

In Figure 60, NRAs that apply an adjustment to the cost of equity are listed ( in bracket the adjustment applied in 2019 and 2018).<sup>46</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 year only SI completely eliminated their adjustment to the cost of equity.

<sup>46</sup> In Figure 60 only fixed market adjustments are shown.

Figure 60 - Adjustments to the cost of equity

	Adjustmet for cost of equity	Motivation
BE	0.00% (0.51%)(0.51%)	
CZ	0.64% (0.64%)(0.42%)	<p>The country risk premium captures risks connected with investments in the local (Czech) market that are directly included neither into the risk free rate nor into the equity risk premium derived from the developed stock markets. The specific calculation method for estimating the country risk premium was based on a widely accepted approach developed by prof. Damodaran and represents the difference between the product of a country default risk and ratio of stock and bond markets volatility and a country default risk. The formula for that calculation is as follows:</p> $CRP = RS * (\sigma_c / \sigma_b) - RS$ <p>Where:</p> <p>CRP country risk premium RS country default risk <math>\sigma_c</math> standard deviation of stock market revenues <math>\sigma_b</math> standard deviation of bond market revenues</p>
DE	-0.63% (-0.88%)(-0.92%)	The adjustment is obtained considering a different equity ratio for the estimation of the weight of cost of Equity, including for the gearing calculation also the non-interest bearing debt
HU	0.00% (0.35%)	
NO	0.35% (0.35%)	
RS	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.
SK	1.94% (1.94%) (1.94%)	Size premium

Source: BEREC RA database 2020

The number of NRAs that apply adjustment to the cost of equity are decreasing, since last year two NRAs (BE and HU don't apply any more adjustment to the cost of equity; in other cases when applied the dimension is generally lower compared to previous years. Technical adjustments are generally more frequent when "RFR" and/or "ERP" are estimated not using a pure country-specific approach.



## Appendix II - 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 has been updated in order to identify parameters that may better explain WACC variations on a historical basis. Along the years this exercise gives information on 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 2020):<sup>47</sup>

$WACC_{i,k} = \text{Constant} + \beta_1 RFR_{i,k} + \beta_2 \text{Equity Beta}_{i,k} + \beta_3 ERP_{i,k} + \beta_4 \text{gearing}_{i,k} + \beta_5 \text{Debt premium}_{i,k} + \beta_6 \text{Tax}_{i,k}$  (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>48</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

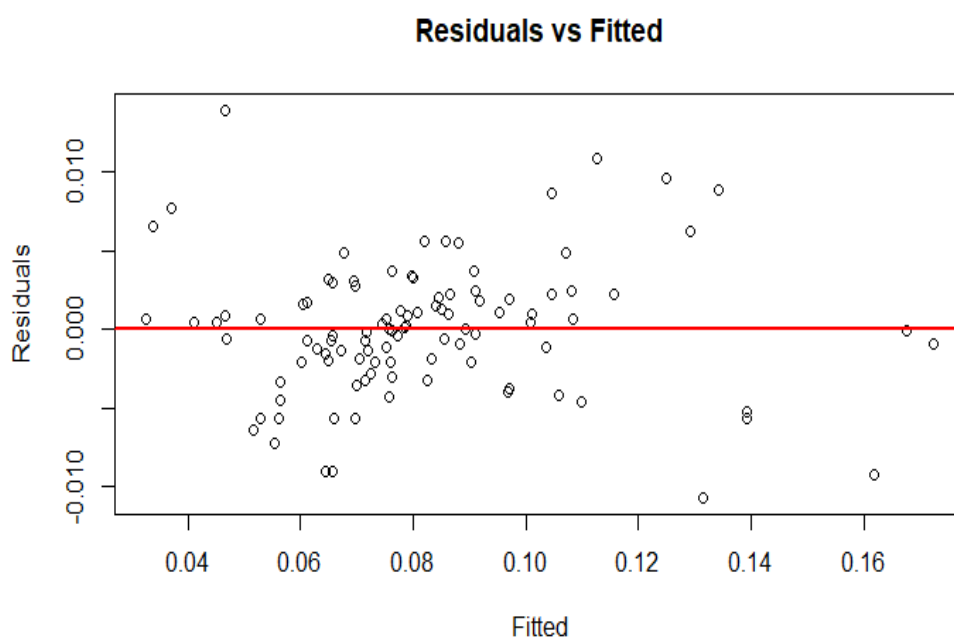
A first verification of the validity of the linear approximation is to detect if some path can be identified in the residual plot (y-axis) with respect to the expected values (x-axis). Points should be distributed symmetrically around a horizontal line in relation to an intercept equal to zero. Different trends indicate at first point the presence of some non-linearity in the model (Figure 62)<sup>49</sup>. The assumption that the average error  $E(\epsilon)$  is zero everywhere implies that the regression surface accurately reflects the dependency of  $Y$  on the  $X$ 's.

<sup>47</sup> The parameters have been analysed not including adjustment not attributed to single parameters.

<sup>48</sup> “Statistics for business and economics” Heinz Kohler 1994.

<sup>49</sup> The residual of an observed value is the difference between the observed value and the estimated value of the quantity of interest.

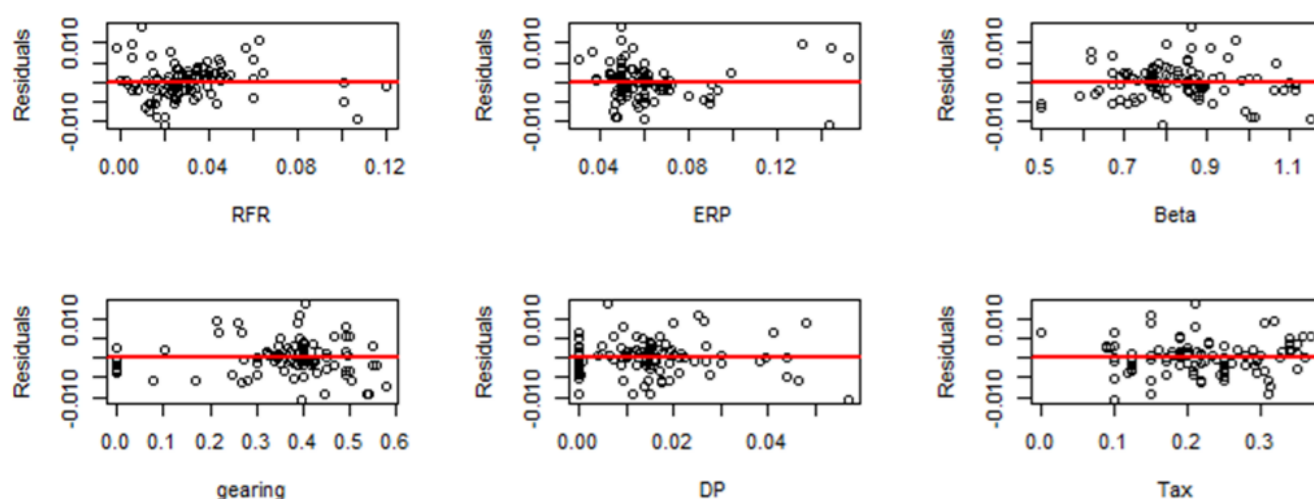
Figure 61 - Linear approximation



Source: BEREC RA database 2020

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).

Figure 62 - Non-linear effects



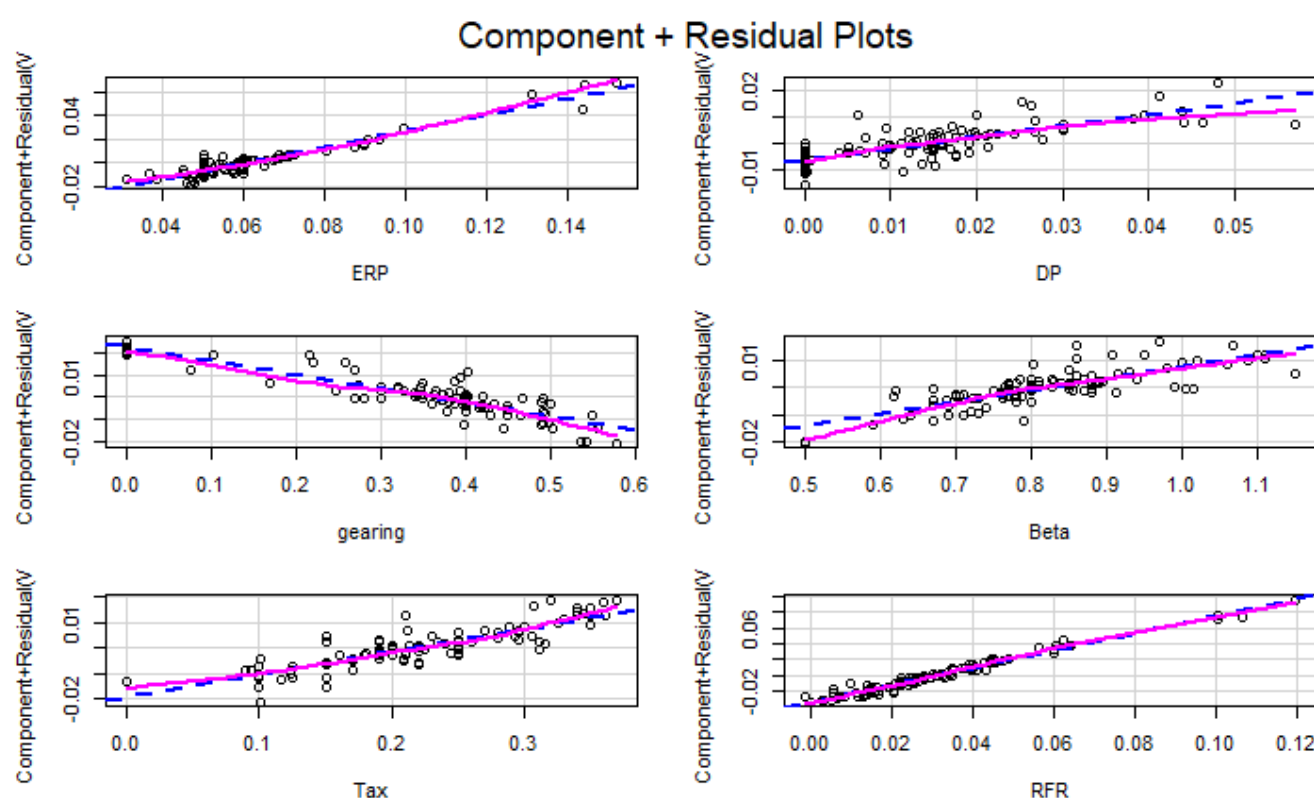
Source: BEREC RA database 2020

Another relevant measure to detect non-linearity in the model is provided through the use of the par-

tial residual plot<sup>50</sup> (Figure 64), 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>51</sup> (correlation measure).

In Figure 64 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.

Figure 63 - Nonparametric fitting



Source: BEREC RA database 2020

### Normality, multicollinearity, homoscedasticity

In Figure 65 summarised statistics are provided showing that all regressors are statistically significant with an adjusted R squared of 0.98. 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 62); (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.

<sup>50</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"  $E(i)$  are plotted versus  $X_j$ , meaning that  $\beta_j$  is the slope of the simple regression of  $E(i)$  on  $X_j$ . Through this plot both monotone and non-monotone non linearity can be detected.

<sup>51</sup> Regressing each independent variable with the dependent variable like a bi-variate model.

Figure 64 - Nominal panel data statistics

MODEL INFO:

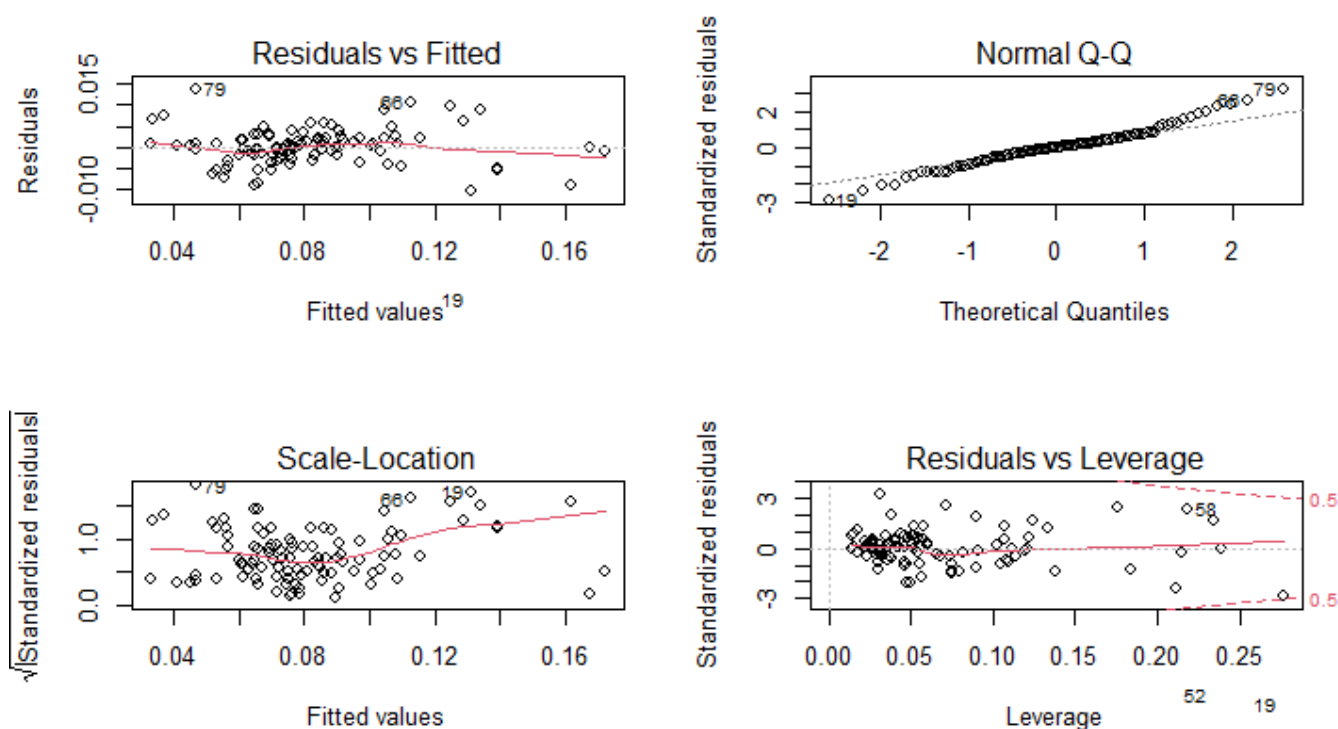
observations: 103

Dependent variable: wacc

Type: OLS linear regression

MODEL FIT: $F(6,96) = 632.80, p = 0.00$  $R^2 = 0.98$ Adj.  $R^2 = 0.97$ Standard errors: OLS

	Est.	S.E.	t val.	p	VIF
(Intercept)	-0.03	0.00	-9.51	0.00	
ERP	0.68	0.03	24.10	0.00	1.80
DP	0.43	0.04	9.90	0.00	1.45
gearing	-0.06	0.01	-12.16	0.00	2.23
Beta	0.04	0.00	11.16	0.00	1.54
Tax	0.09	0.01	14.24	0.00	1.31
RFR	1.09	0.02	50.07	0.00	1.14



Source: BEREC RA database 2020

We hence show the same model without five possible outlier observations, by still finding similar results, as shown in Figure 66.<sup>52</sup>

<sup>52</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.

Figure 65 - Nominal panel data statistics without outliers

**MODEL INFO:**

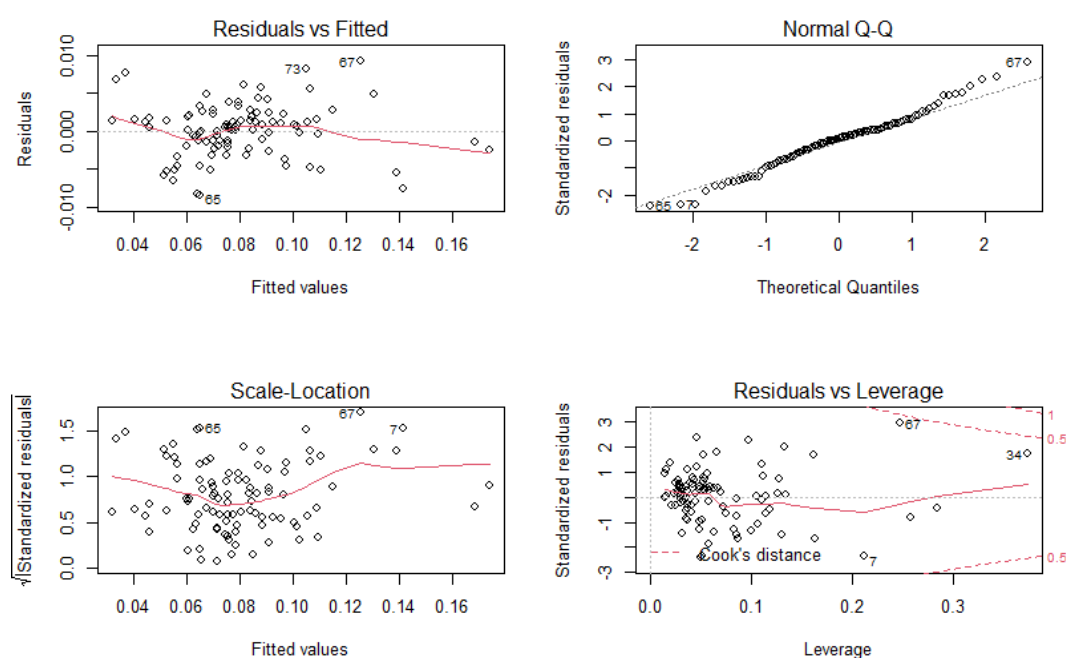
Observations: 98

Dependent Variable: wacc

Type: OLS linear regression

**MODEL FIT:** $F(6,91) = 762.49, p = 0.00$  $R^2 = 0.98$ Adj.  $R^2 = 0.98$ **Standard errors: OLS**

	Est.	S.E.	t val.	p	VIF
(Intercept)	-0.03	0.00	-11.22	0.00	
ERP	0.71	0.03	26.34	0.00	1.58
DP	0.41	0.04	10.94	0.00	1.24
gearing	-0.06	0.00	-13.18	0.00	2.38
Beta	0.04	0.00	12.32	0.00	1.56
Tax	0.09	0.01	16.00	0.00	1.34
RFR	1.11	0.02	56.56	0.00	1.10



Source: BEREK RA database 2020

Figure 67 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 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 vari-

ables in the model. We further estimate the Akaike Information Criterion,<sup>53</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 67 we report statistics from the three analysis done, when all the observations are taken into account (n=103), when possible 5 “outliers” have been deleted (n=98), when only EU members are included (n=80).

Figure 66 - WACC Nominal pre-tax R<sup>2</sup> adjusted variations / AIC variations

Number of observation 103	Total	RFR	ERP	Tax	gearing	beta	CD
R <sup>2</sup>	97.38%	67.70%	15.66%	5.45%	3.97%	3.34%	2.62%
AIC	-1112.28	-337.92	-199.13	-114.97	-94.06	-83.66	-70.49
Number of observation 98	Total	RFR	ERP	Tax	gearing	beta	CD
R <sup>2</sup>	97.92%	72.26%	15.65%	5.76%	3.90%	3.41%	2.68%
AIC	-1094.07	-349.61	-209.14	-129.13	-102.69	-94.21	-80.31
EU memeber state Number of observation 80	Total	RFR	ERP	Tax	gearing	beta	CD
R <sup>2</sup>	97.36%	61.07%	27.37%	8.86%	6.09%	5.68%	3.19%
AIC	-904.08	-253.86	-193.63	-116.92	-94.88	-91.01	-62.62

Source: BEREC RA database 2020

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.

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>54</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

<sup>53</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.

<sup>54</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.

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.

Figure 68 - WACC Nominal pre-tax R<sup>2</sup> adjusted variations / AIC variations

Number of observation 78	Total	RFR	ERP	Tax	beta	gearing	CD
R <sup>2</sup>	96.48%	71.57%	15.68%	5.82%	3.66%	3.49%	3.52%
AIC	-848.48	-240.85	-133.11	-76.15	-55.4	-53.51	-53.88
EU member state Number of observation 62	Total	RFR	ERP	Tax	beta	gearing	CD
R <sup>2</sup>	96.78%	67.24%	22.43%	10.92%	5.95%	5.63%	3.49%
AIC	-696.3	-190.48	-127.82	-90.91	-64.01	-61.85	-44.68

Source: BEREC RA database 2020