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The Adjusted Research Excellence Index 2018

Methodology Report

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Author

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Abstract

The Adjusted Research Excellence Index is a composite indicator selected by the European Research Area Council (ERAC) as the headline measure to monitor country performance with respect to ERA Roadmap Priority 1, 'Effective national research systems' (European Commission, 2017). It combines four dimensions that characterize effective research systems, in terms of scientific and technological research excellence (the "production" of high-impact publications and valued patents), and the ability of institutes to attract outstanding research grants and participate in researcher exchanges to pave the way for future excellence and develop efficient research capacity. This report describes the methodology used to compute the latest scores for 43 countries (EU Member States and Horizon 2020 Associated Countries) and the EU28 for 4 time points: 2016, 2013, 2011 and 2010. The results show that Switzerland excels in having the most effective national research system, followed by Denmark, the Netherlands, Sweden and the United Kingdom. Most of the countries show a welcome growth of the composite score over the last period, however it is important to keep in mind that growth is, to a large extent, driven by the overall increase in the value of ERC grants. Country ranks were found to be rather robust, with uncertainty in the modelling choices having only limited impact (3-4 rank positions shifts) on the ranks of the majority of the countries.

1 Introduction

The Adjusted Research Excellence Index is a composite indicator selected by the European Research Area Council (ERAC) as the headline measure to monitor country performance with respect to ERA Roadmap Priority 1, 'Effective national research systems' (European Commission, 2017a,b). It combines four dimensions that characterize effective research systems, in terms of scientific and technological research excellence (the "production" of high-impact publications and valued patents), and the ability of institutes to attract outstanding research grants and participate in researcher exchanges to pave the way for future excellence and develop efficient research capacity. The four dimensions are defined [and henceforth referred to] as:

- The share of top 10 % most highly cited publications per total publications [HICIT]
- PCT patent applications per population [PCT]
- ERC grants per public R&D [ERC], and
- Participation in Marie Skłodowska-Curie actions: the number of MSCA researchers hosted per national MSCA researcher) [MSCA];

This brief report presents the latest scores for 43 countries (EU Member States and Horizon 2020 Associated Countries) and the EU28 total for the purposes of the upcoming ERA Progress Report. In order to monitor progress over time, scores were produced using the most recently available data (2016), as well as using historical data for earlier time points (2010 and 2013). It thus updates the scores and trends published in the ERA Progress Report 2016.

The focus of this report are the methodological aspects of computing the Adjusted Research Excellence Index (AREI), which should be seen as complementary to the more comprehensive discussions of research performance at the level of countries and the EU, which is provided in the ERA Progress Report. The definition and quantification of the concept of scientific and technological research excellence, or its impact – which continues to be at the focus of scholarly attention – remains outside the scope of this methodology report.[1]

The AREI, as any composite indicator, aims to provide the "big picture" with respect to the phenomenon of interest in the form of a summary score. Users of the index are invited to explore not merely the aggregate scores and ranking of countries, but also scores of the underlying components (as two countries may achieve a similar score by having a different distribution of strengths and weaknesses) as well as the measurable uncertainty in the modelling choice that may influence the aggregate ranking. This report, therefore, goes beyond merely presenting the aggregation methods and aggregate scores; the robustness section (3.2) also presents the outcomes of the uncertainty analysis, which should help users a richer understanding of how countries compare with one another in terms of scientific and technological research excellence, and what are the trends over time.

[1] For a more detailed discussion on the complexities related to the conceptualization and measurement of scientific and technological research excellence, see, among others, Tijssen (2003), Hardeman et al (2013), Sorensen et al (2016), or Ferretti et al (2018).

2 Methods and comparability with previous editions

The methodology to compute the Adjusted Research Excellence Index is presented in Vértesy (2015) and is rooted in that of a previous version of the Research Excellence Index developed by the JRC. As some refinements were necessary due to data availability and changes in definition of the source variable, the steps taken to compute the indicator (following OECD-JRC 2008) are described below.

Table 1 Collection of data from multiple sources and multiple time points

Component	Numerator	Denominator	Sources	Sources Detailed
HICIT	Nr. of publications among the top 10% most highly cited (field normalized)	Total nr. of publications	CWTS	CWTS, Leiden (and SciVal for AM, GE, TN)
PCT	PCT patent applications by inventor country and priority year	Total Population	OECD, World Bank	OECD_MSTI, OECD_PATS, OECD REGPAT microdata (AL, ME, RS), World Bank World Development Indicators
ERC	Total value of ERC grants received by host organization in a country; (multi-year programmes spread equally between start and end dates)	Public R&D (GOVRD+HERD, constant Eurs PPS)	DG RTD, Eurostat, OECD	Special tabulation from Horizon 2020 and FP7 Corda data; rd_e_gerdfund (OECD data for IL)
MSCA	Nr. of MSCA researchers hosted	Nr. nationals participating in MSCA	DG EAC	Marie Skłodowska-Curie Action statistics / country fiches, multiple editions[2]

1. **Data collection:** The data sources are described in **Table 1**. In case data was missing, figures available for the same country from a neighboring year was used. Data was initially also collected for OECD and BRICS countries, however, it was not used in this calculation due to issues of comparability (ERC and MSCA only meaningful for countries that are part of ERA or associated to Horizon 2020). As a result, scores could be computed for all EU Member States and H2020 Associated countries, with the exception of the Feroer Islands and Liechtenstein (due to restrictions of data availability and comparability).

   Considering the joint availability of data for the four components across time, four time points were identified for which scores could be computed to meet a fair balance between principles of timeliness and alignment of indicators to the same year. The two main issues addressed were 1) the lag in the HICIT and PCT scores due to citation window and administrative issues of patenting (last available year: 2015); and the 2) unavailability of comparable MSCA scores between country fact sheets released in 2014 and mid-2018. As a compromise, HICIT and PCT scores were "shifted ahead" by 1 year (so that actual 2015 scores represent the 2016 "nominal" values, and so forth), and MSCA figures were shifted back by 1.5 years (thus mid-2018 scores represent 2016). Considering also the fact that ERC and MSCA were introduced with FP7 and the frequency of MSCA data availability, the four time points for which comparable scores could be computed were identified as: 2010, 2011, 2013 and 2016. The Appendix provides a detailed overview of the original indicator values, as well as the actual and nominal years used. Descriptive statistics on the variables are available in **Table 3**.

[2] URL: https://ec.europa.eu/research/mariecurieactions/msca-numbers_en (retrieved: Jul 2018 and Apr 2016)

2. **Treatment of outliers**: outliers were detected for indicators that showed absolute skewness and kurtosis for the pooled dataset of 220 country-year observations (including OECD and BRICS countries discarded subsequently) above the threshold values of 2.2 and 3.5, respectively – in the case of ERC and MSCA. Outliers were treated by winsorization, a method identified as the one causing the least intervention to actual data points. As a result, 6 values were adjusted for ERC (affecting IL, CY, UK, CH at various time points), and 4 values for MSCA (LU and CH).

3. **Normalization of data**: for each variable, the pooled dataset of all country-year combinations were normalized using the min-max method to obtain a comparable range of 10-100 using the formula below. (The minimum was set to 10 rather than 0 in order to accommodate the geometric aggregation.) Data was pooled for multiple years in order to be able to measure trend over time.

$$I_{qc} = \frac{x_{qc} - \min_c(x_q)}{\max_c(x_q) - \min_c(x_q)} * 90 + 10 \quad (1)$$

   Where x_{qc} is the value of a component variable q for a country c. The normalized scores for each country and indicator are available in the Appendix.

4. **Multivariate statistical analyses** were performed to test the correlation between the components and the presence of a single latent dimension. A strong, positive correlation and the presence of a single latent dimension were in fact found, similar to past years' results. The details of the findings of the principal component analysis (PCA) and correlation table are available in the 'Robustness' section 3.2 below.

5. **Aggregation of country scores:** the 2018 Adjusted Research Excellence Index scores were computed by taking the geometric mean (with equal weights) of the four normalized components. This method does not allow full compensation of relatively weaker performance in one component with strong performance in another one, but encourages countries to address bottlenecks.

6. Finally, **sensitivity and robustness analyses** were carried out to identify the statistical relationship between the components and the composite, and to test the impact of modelling choices on country rankings.

3 Results

The resulting composite scores are reported in **Figure 1** for 44 countries (EU Member States, Horizon 2020 Associated Countries and the EU28) for three time points, and in **Table 2** for all time points. Results show that Switzerland excels in having the most effective national research system, followed by Denmark, the Netherlands, Sweden and the United Kingdom.

Most of the countries show a welcome growth of the composite score over the last period, however, it is important to keep in mind that growth is largely driven by the overall increase in the value of ERC grants. Three of the countries, Greece, Bosnia and Herzegovina and Montenegro show a slight decline in scores the last period. (Note that the decline for Switzerland should be read with caution and not considered as a warning sign, as this may be affected by the outlier treatment.)

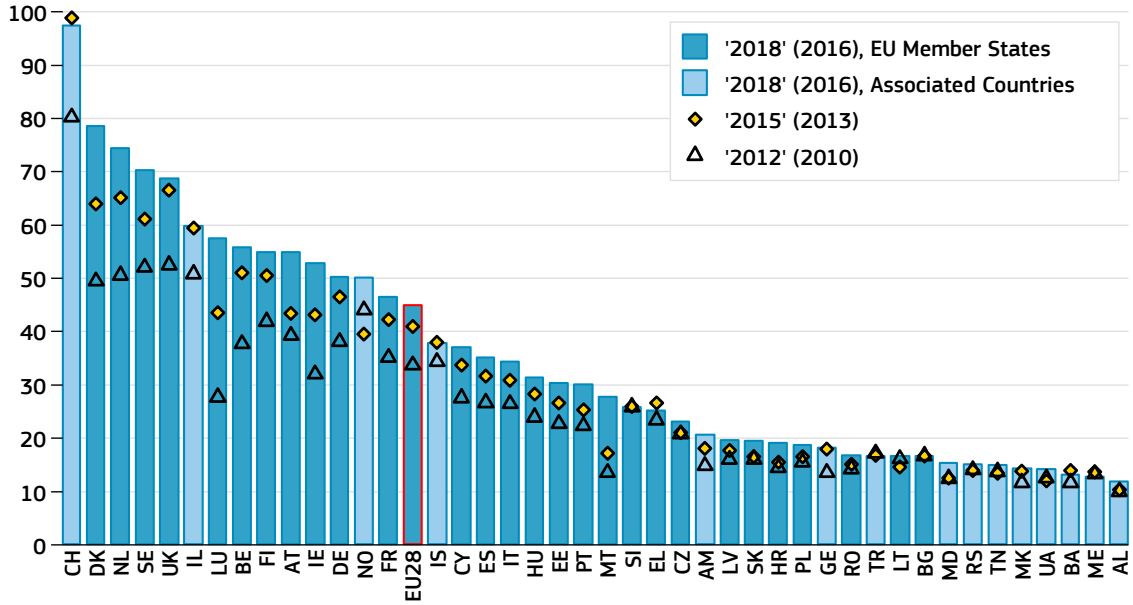
Scores for the individual components are shown in the Appendix.

Table 2 Adjusted Research Excellence Scores, "2018"

Group	Country	Code	2010	2011	2013	2016	CAGR over past 3 years
EU28	EU-28	EU28	33.7	36.5	41.0	45.0	3%
	Austria	AT	39.3	41.6	43.5	54.9	8%
	Belgium	BE	37.8	42.5	51.1	55.8	3%
	Bulgaria	BG	16.7	17.2	16.7	16.6	0%
	Cyprus	CY	27.6	29.2	33.7	37.1	3%
	Czech Republic	CZ	20.8	21.1	21.1	23.2	3%
	Germany	DE	38.2	42.8	46.5	50.3	3%
	Denmark	DK	49.5	53.9	64.0	78.6	7%
	Estonia	EE	22.7	25.4	26.6	30.4	5%
	Greece	EL	23.4	23.9	26.6	25.2	-2%
	Spain	ES	26.7	29.0	31.7	35.1	4%
	Finland	FI	41.9	44.9	50.5	54.9	3%
	France	FR	35.2	38.0	42.3	46.6	3%
	Hungary	HU	24.0	26.0	28.3	31.4	4%
	Croatia	HR	14.5	14.3	15.5	19.1	7%
	Ireland	IE	32.0	35.9	43.1	52.9	7%
	Italy	IT	26.5	28.6	30.9	34.4	4%
	Lithuania	LT	16.2	17.3	14.7	16.7	4%
	Luxembourg	LU	27.7	38.7	43.5	57.5	10%
	Latvia	LV	16.0	15.5	17.8	19.6	3%
	Malta	MT	13.6	16.8	17.2	27.8	17%
	Netherlands	NL	50.6	52.3	65.1	74.5	5%
	Poland	PL	15.5	15.6	16.6	18.7	4%
	Portugal	PT	22.3	23.7	25.3	30.1	6%
	Romania	RO	14.3	14.1	15.1	16.8	4%
	Sweden	SE	52.0	55.4	61.1	70.3	5%
	Slovenia	SI	25.9	25.7	26.0	25.9	0%
	Slovakia	SK	16.1	15.9	16.5	19.5	6%
	United Kingdom	UK	52.5	57.0	66.6	68.7	1%
Associated	Albania	AL	10.0	12.1	10.3	11.9	5%
	Armenia	AM	14.9	15.2	18.0	20.7	5%
	Bosnia and Herzegovina	BA	11.7	11.1	13.9	13.2	-2%
	FYRO Macedonia	MK	11.7	11.9	13.9	14.3	1%
	Georgia	GE	13.5	15.6	17.9	18.2	1%
	Iceland	IS	34.4	36.5	38.0	37.9	0%
	Israel	IL	50.8	57.5	59.5	59.9	0%
	Moldova	MD	12.5	12.7	12.6	15.4	7%
	Montenegro	ME	13.3	12.3	13.7	12.8	-2%
	Norway	NO	44.1	47.6	39.6	50.2	8%
	Serbia	RS	14.0	14.6	14.0	15.2	3%
	Switzerland	CH	80.3	86.9	98.9	97.5	0%
	Tunisia	TN	13.7	13.5	13.5	15.0	4%
	Turkey	TR	17.2	16.9	16.8	16.7	0%
	Ukraine	UA	12.5	12.4	12.0	14.3	6%

Source: JRC Calculations. *Note:* CAGR = Compound annual average growth rate

Figure 1 Adjusted Research Excellence index scores, 2018 edition



Source: JRC calculations; *Notes:* The Research Excellence index is a composite of four components: share of top 10% most highly cited publications per total publications (data source: CWTS); PCT patent applications per population (OECD, World Bank); Participation in Marie Skłodowska-Curie Actions (DG-EAC); ERC grants per public R&D (DG-RTD, Eurostat, OECD).

3.1 Data reliability

We note that countries on the ERA periphery with a low number of publications and PCT patents show a high degree of fluctuation for the HICIT and PCT components. We noticed that PCT data should be considered unreliable for some or all of the years for the following countries: AL, AM, BA, CY, EE, GE, LT, LV, MD, ME, MK, MT, TN. It is also important to note that the trend of AREI score growth over time is driven, to a large extent, by the expansion of the ERC program. This gives reason to treat growth over time with caution and use as a benchmark the compound average growth (CAGR) figures of the EU28.

3.2 Robustness

A strong, positive correlation was found between the components (Pearson's coeff. 0.52-0.72). Principal Component Analysis (PCA) confirms the presence of one single latent dimension that explains 72% of variance in the data (4 components, 44 countries, 4 time points). The PCA shows a relatively balanced loading for all components, although the ERC component a slightly weaker. (This is also apparent from the pairwise correlation across the variables, presented in **Table 3**.) We do note at the same time that over time, the ERC component is showing the greatest increase, driving most of the overall observed growth of the composite scores.

Table 3 Descriptive statistics and Correlations for the components

Descriptive Statistics (min-max normalized dataset)					Correlation table (N=176)			
	Mean	**S.D.**	**Min**	**Max**	**HICIT**	**PCT**	**MSCA**	**ERC**
HICIT	0.08	0.04	0.0	0.16	1			
PCT	72.2	92.3	0.0	329.8	0.71	1		
MSCA	1.16	1.42	0.0	6.30	0.72	0.66	1	
ERC	5,375.3	7,458.2	0.0	28,290.0	0.58	0.58	0.52	1

Source: JRC calculations

Similar conclusions can be drawn from the sensitivity analysis that was carried out using two methods to test the extent to which a component explains variation in the aggregate scores, which is a measure of the importance of a component.[3] The sensitivity indices obtained from the linear method (Pearson correlation squared) and a non-linear spline fitting method (**Table 4**) shows that composite scores are driven by each of the component in a fairly balanced manner; with the strongest indices shown by the PCT component and the weakest by the ERC component. It is important to keep in mind, nevertheless, that while the ERC is relatively the weakest contribution to the variance in the results, it does have an important contribution to change over time, given the fact that ERC scores show a greater increasing trend over time than any of the other components.

Table 4 Sensitivity indices

Components	Si Linear method	Si Polynomial method
HICIT	0.714	0.738
PCT	0.776	0.811
MSCA	0.723	0.801
ERC	0.630	0.704

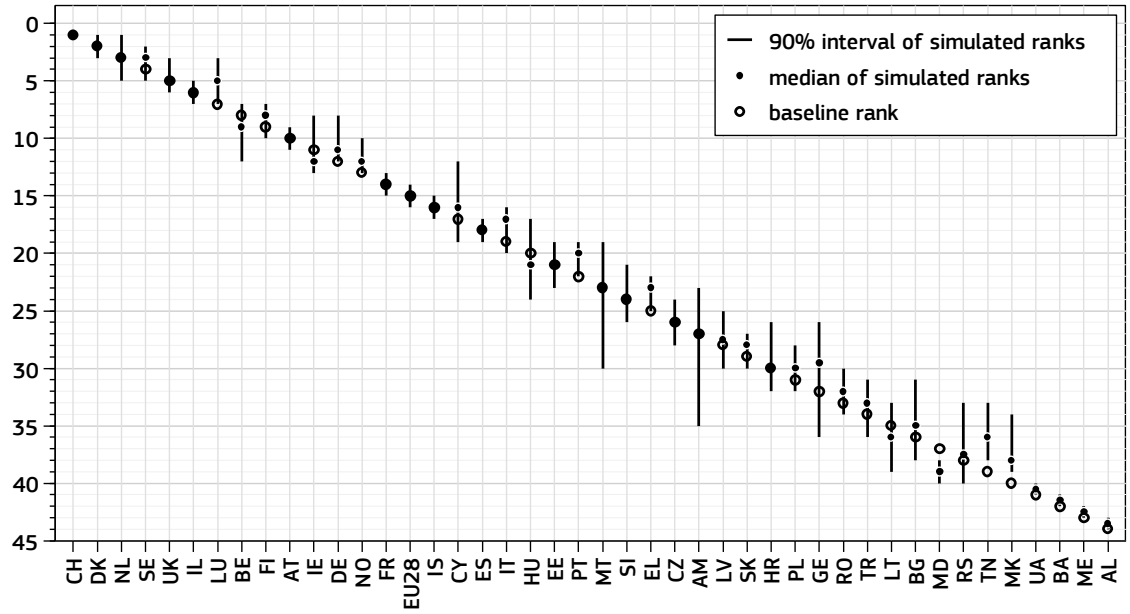
Note: JRC calculation; components were min-max method, MSCA and ERC: outliers winsorized. Sensitivity indices (Si) range between 0 and 1 and show the extent to which a component drives the variation in composite scores.

In the **uncertainty analysis**, we tested the impact of uncertainty in the composite indicator development methodology on the ranking of countries. We considered uncertainty in three of the modelling choices, as described below:

- the weighting of the four components: AREI components are equally weighted; our tests considered a perturbation of these weights by +/- 25%;
- the average applied: AREI is a geometric average of components, but many composite indicators apply the fully compensatory arithmetic average; ,
- finally, the treatment of outliers in the ERC component: as an alternative to the established method of treating outliers by winsorization, one may consider log-normalizing this component given the increasing trend over time in this component, which is suppressed by the winsorization for the best performing country.

[3] For details, see Paruolo et al, 2013 and Becker et al, 2017.

Figure 2 Robustness of Research Excellence index ranks



Source: JRC calculations; *Notes:* Ranks for 2016 obtained from 1,000 Monte-Carlo simulation runs addressing uncertainty in weights (+/-25% vs. equal), average used to aggregate scores (arithmetic vs. geometric), treatment of outliers in ERC (log-normal vs. winsorization).

We considered these uncertainties simultaneously, following i.e. Saisana *et al* (2011), and computed 1,000 simulated country rankings for the latest time point. The simulations help quantify the uncertainty by effectively adding confidence intervals to the baseline country rankings, as shown **Figure 2**. The uncertainty analysis reveals that the baseline rank corresponds to the median obtained from 1,000 Monte-Carlo simulation runs in 16 of the 44 countries ranked, and the difference is less than 3 positions in all country cases but Georgia and Tunisia. In 93% of the cases (exc. MD, TN and MK), the baseline rank falls within the 90% confidence interval. Users of any index are discouraged to take ranks at face value given the modelling uncertainties, it is nevertheless important to note that the 90% interval range of the simulated ranks for about 19 countries is not more than 3 positions, and for another 18 countries it is not more than 4 positions. Ranks are relatively most volatile for Armenia, Malta, Georgia, Cyprus, Bulgaria and Serbia.

4 Conclusions

This report presented the adjusted research excellence index scores, which updates the scores published in the 2016 ERA Progress Report. The existing methodology remains applicable for the 2018 update, no further methodological adjustments were necessary.

The multivariate analysis showed that the indicator continues to reflect a single latent dimension, sensitivity analysis shows a fairly balanced contribution of the four component to the variation of the final scores. For analysing score changes over time, users are reminded that most of the score increases are due to the growing trend of the ERC component.

Results show that Switzerland continues to excel in having the most effective national research system, and that Europe shows a Northwest – Southeast divide, with also strong performance shown by Denmark, the Netherlands, Sweden and the United Kingdom. Country ranks were found to be rather robust, with uncertainty in the modelling choices having only limited impact (3-4 rank positions shifts) on the ranks of the majority of the countries. Nevertheless, users of the aggregate ranks are reminded that when a country rank is taken at face value, the inherent uncertainty in how it was obtained is not considered. The confidence intervals obtained in the uncertainty analysis after running 1,000 Monte-Carlo simulations serve the purpose of showing the possible range of research excellence ranks a country can obtain should some of the assumptions change.

References

Becker, W., Saisana, M., Paruolo, P., & Vandecasteele, I. (2017). Weights and importance in composite indicators: Closing the gap. *Ecological Indicators*, 80(2017), 12-22. [doi:10.1016/j.ecolind.2017.03.056]

European Commission (2017a) ERA Progress Report 2016. Report from the Commission to the Council and the Parliament, COM(2017)35

European Commission (2017b) ERA Progress Report 2016. Technical Report. Data gathering and information for the 2016 ERA monitoring. Luxembourg: Publications Office of the European Union. [doi: 10.2777/352654]

Ferretti, F., Pereira, Â. G., Vértesy, D., Hardeman, S. (2018) Research excellence indicators: time to reimagine the 'making of'? *Science and Public Policy*, 45(5), 731-741 [doi: 10.1093/scipol/scy007]

Hardeman, S., Van Roy V., Vertesy, D., and Saisana M. (2013): *An analysis of national research systems (I): A Composite Indicator for Scientific and Technological Research Excellence*. Luxembourg: Publications Office of the European Union. [doi: 10.2788/95887]

OECD-JRC (2008) Handbook on constructing composite indicators: methodology and user guide. Paris: OECD publishing [doi: 10.1787/533411815016.]

Paruolo P., Saisana M., Saltelli A., 2013. Ratings and Rankings: Voodoo or Science?, *Journal Royal Statistical Society*, A176(3), 609-634 [doi:10.1111/j.1467-985X.2012.01059.x]

Saisana, M., d'Hombres, B., & Saltelli, A. (2011). Rickety numbers: Volatility of university rankings and policy implications. *Research policy*, *40*(1), 165-177. [doi: 10.1016/j.respol.2010.09.003]

Sorensen, M., Bloch, C. and Young, M. (2016). Excellence in the knowledge-based economy: from scientific to research excellence. *European Journal of Higher Education*, 6(3), 217-236. [doi: 10.1080/21568235.2015.1015106]

Tijssen, R. (2003). Scoreboards of research excellence. *Research Evaluation, 12*(2), 91-103. [doi: 10.3152/147154403781776690]

Vértesy, D. (2015). Technical note on the robustness of a modified research excellence index: A Feasibility Study for the European Research Area Committee (Technical report No. EUR 27669 EN). Luxembourg: Publications Office of the European Union [doi: 10.2760/81642]

List of abbreviations and definitions

AREI Adjusted Research Excellence Index

CAGR compound average growth rate

ERA European Research Area

ERAC European Research Area Council

ERC European Research Council; also the abbreviation used for a component of the Adjusted Research Excellence Index where it refers to ERC grants per public R&D

HICIT A component of the Adjusted Research Excellence Index, referring to the share of top 10 % most highly cited publications per total publications

JRC Joint Research Centre

MSCA Marie Skłodowska-Curie Actions; also the abbreviation used for a component of the Adjusted Research Excellence Index where it refers to the number of MSCA researchers hosted per national MSCA researcher

PCA Principal component analysis

PCT Patent Cooperation Treaty; also the abbreviation used for a component of the Adjusted Research Excellence Index, where it refers to PCT patent applications per population

(For country abbreviations, please refer to **Table 2**.)

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Appendix: Original and Normalized Indicator scores

	Year	HICIT				PCT				MSCA				ERC			
H2020	**Nominal**	**2010**	**2011**	**2013**	**2016**	**2010**	**2011**	**2013**	**2016**	**2010**	**2011**	**2013**	**2016**	**2010**	**2011**	**2013**	**2016**
Group	*Actual*	*2009*	*2010*	*2012*	*2015*	*2009*	*2010*	*2012*	*2015*	*2011*	*2012*	*2014*	*2017*	*2010*	*2011*	*2013*	*2016*
EU28	**EU28**	10.3%	10.5%	10.5%	10.6%	95.0	97.9	100.1	102.8	1.3	1.3	1.2	1.2	3,040.5	5,018.7	9,728.6	15,054.1
EU28	**AT**	10.5%	11.4%	11.0%	11.1%	153.7	168.8	166.9	177.2	1.5	1.1	0.8	2.0	3,639.0	5,766.4	10,049.5	14,852.5
EU28	**BE**	12.6%	12.5%	12.9%	12.6%	106.0	114.9	107.9	108.6	1.6	1.9	2.3	2.2	3,078.6	5,180.1	12,310.4	20,019.8
EU28	**BG**	4.5%	4.2%	3.6%	4.2%	3.7	4.0	7.8	8.3	0.3	0.3	0.2	0.4	1,955.7	3,031.1	3,026.4	935.7
EU28	**CY**	7.0%	8.3%	7.7%	9.0%	11.0	5.5	7.3	13.6	0.9	0.8	0.8	1.0	9,950.4	13,747.0	32,612.4	41,690.3
EU28	**CZ**	6.2%	6.5%	6.6%	6.6%	17.1	14.6	20.5	23.7	1.0	1.0	0.8	0.7	698.3	944.6	975.3	3,246.5
EU28	**DE**	11.1%	11.5%	11.3%	11.3%	211.2	226.2	223.0	221.1	1.3	1.5	1.5	1.4	1,868.1	3,361.1	6,344.9	9,988.7
EU28	**DK**	13.8%	14.1%	13.7%	13.4%	204.2	206.2	206.1	222.6	3.1	3.2	3.7	5.5	2,955.7	5,076.2	11,503.2	19,915.0
EU28	**EE**	6.4%	7.5%	7.4%	8.2%	37.1	37.3	13.4	20.3	1.5	1.2	1.3	1.1	0.0	1,805.6	5,191.1	9,561.8
EU28	**EL**	8.7%	8.5%	9.1%	9.0%	9.8	8.2	10.5	10.0	0.8	0.7	0.7	0.5	3,022.5	4,481.7	7,377.9	6,489.0
EU28	**ES**	9.2%	9.2%	9.3%	9.3%	38.3	40.9	37.4	38.3	0.9	1.0	0.9	1.0	2,725.6	4,278.7	8,123.2	13,299.9
EU28	**FI**	10.2%	10.6%	10.4%	10.8%	281.0	292.6	305.4	236.3	1.1	1.1	1.1	1.5	3,626.6	5,262.2	9,471.7	14,785.2
EU28	**FR**	10.7%	10.8%	11.2%	11.0%	108.3	110.9	117.8	122.0	1.4	1.4	1.2	1.5	2,943.8	4,753.4	8,995.9	12,794.2
EU28	**HU**	7.2%	7.3%	7.3%	6.9%	23.4	24.4	24.0	26.8	0.6	0.6	0.5	0.5	4,047.9	6,424.4	11,333.4	20,114.3
EU28	**HR**	3.9%	3.8%	3.6%	4.6%	9.9	10.8	10.7	9.9	0.2	0.1	0.2	0.4	0.0	0.0	1,296.3	3,287.4
EU28	**IE**	11.0%	11.7%	12.5%	12.6%	83.8	74.6	81.2	93.2	1.3	1.2	1.2	1.9	1,911.1	5,534.0	12,463.0	20,849.4
EU28	**IT**	9.6%	9.8%	10.1%	10.4%	53.1	53.1	55.9	59.9	0.5	0.6	0.5	0.5	2,647.4	4,397.4	6,808.2	11,225.7
EU28	**LT**	6.0%	7.1%	3.3%	4.3%	4.5	6.4	15.3	16.7	0.4	0.4	0.3	0.5	0.0	0.0	0.0	0.0
EU28	**LU**	10.5%	13.0%	10.8%	13.1%	109.9	111.0	130.2	135.6	0.9	4.1	4.9	7.2	0.0	0.0	1,347.4	5,746.9
EU28	**LV**	3.4%	3.5%	4.1%	6.2%	14.7	6.4	16.1	15.2	0.7	0.7	0.4	0.3	0.0	0.0	1,772.4	2,171.0
EU28	**MT**	4.3%	5.9%	5.2%	10.7%	5.4	15.7	18.3	32.0	0.0	0.3	0.5	2.6	0.0	0.0	0.0	0.0
EU28	**NL**	14.2%	14.8%	14.8%	14.6%	196.4	177.1	209.0	218.5	2.3	1.8	2.1	2.7	5,341.7	8,943.3	19,416.1	28,290.0
EU28	**PL**	4.2%	4.2%	4.4%	5.1%	6.7	7.3	9.7	14.0	0.3	0.3	0.3	0.5	549.9	627.7	1,247.7	1,704.4
EU28	**PT**	9.3%	8.8%	9.4%	9.0%	13.2	12.8	13.8	21.2	0.7	0.9	0.6	0.7	1,512.4	2,556.9	4,880.9	11,134.7
EU28	**RO**	4.3%	4.1%	5.2%	4.8%	2.1	2.1	3.2	3.8	0.2	0.2	0.2	0.4	0.0	0.0	0.0	1,276.0
EU28	**SE**	11.7%	11.8%	11.6%	12.1%	306.2	303.6	329.8	329.1	2.1	2.0	2.0	3.3	5,165.9	8,144.0	12,652.3	14,536.4
EU28	**SI**	7.5%	8.0%	8.7%	8.6%	64.1	65.7	61.3	40.0	1.3	1.0	0.6	0.7	511.5	824.1	1,860.4	2,959.4
EU28	**SK**	5.7%	5.2%	5.1%	6.2%	6.7	9.1	8.4	11.2	0.3	0.3	0.3	0.9	0.0	0.0	516.2	532.3
EU28	**UK**	13.8%	14.1%	14.2%	15.0%	91.2	91.7	90.5	96.5	5.4	4.8	4.8	3.9	5,993.5	10,449.2	22,116.4	34,606.6
Associated	**AL**	1.1%	2.8%	1.2%	2.1%	0.3	0.3	0.4	0.1	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
Associated	**AM**	7.0%	7.7%	15.4%	11.6%	2.1	1.7	2.7	2.5	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0
Associated	**BA**	2.3%	1.8%	4.1%	3.3%	2.3	1.4	2.2	1.7	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0
Associated	**MK**	1.8%	2.2%	4.9%	6.1%	1.4	0.0	0.2	0.8	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0
Associated	**GE**	4.7%	8.5%	15.0%	11.3%	1.3	2.0	2.8	0.7	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0
Associated	**IS**	8.9%	13.6%	10.6%	10.8%	111.8	85.4	103.5	117.4	1.3	1.3	1.5	1.4	3,415.6	3,648.1	4,879.1	4,390.7
Associated	**IL**	9.5%	10.0%	10.3%	10.0%	225.8	222.5	254.6	267.1	1.0	1.1	1.0	1.0	16,994.0	26,926.4	49,229.4	70,615.5
Associated	**MD**	3.3%	3.6%	3.4%	4.7%	0.5	0.5	1.0	1.4	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0
Associated	**ME**	3.8%	2.6%	4.9%	3.2%	6.5	6.5	1.6	5.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Associated	**NO**	11.1%	10.9%	11.1%	10.7%	155.0	150.6	142.0	125.5	3.4	3.5	0.8	3.2	2,319.2	4,520.5	7,251.1	8,861.4
Associated	**RS**	4.6%	5.4%	4.4%	4.1%	3.2	2.8	3.9	4.9	0.1	0.1	0.1	0.2	0.0	0.0	0.0	782.6
Associated	**CH**	15.3%	15.1%	15.5%	15.3%	287.8	301.6	328.4	310.9	6.8	7.2	7.6	6.3	12,335.9	17,601.7	28,100.0	35,370.1
Associated	**TN**	5.1%	4.6%	4.7%	5.8%	0.9	1.5	0.6	1.2	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
Associated	**TR**	5.6%	5.1%	4.8%	4.7%	6.5	7.7	8.8	13.7	0.6	0.6	0.6	0.3	39.7	36.1	155.9	677.3
Associated	**UA**	3.2%	2.9%	2.5%	3.6%	2.3	3.5	3.9	3.3	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0

Appendix (cont'd): Normalized Scores

	HICIT				PCT				MSCA				ERC			
	2010	**2011**	**2013**	**2016**	**2010**	**2011**	**2013**	**2016**	**2010**	**2011**	**2013**	**2016**	**2010**	**2011**	**2013**	**2016**
	2009	*2010*	*2012*	*2015*	*2009*	*2010*	*2012*	*2015*	*2011*	*2012*	*2014*	*2017*	*2010*	*2011*	*2013*	*2016*
EU28	67.2	68.4	68.6	69.0	34.9	68.4	36.3	37.0	28.1	35.7	27.6	27.8	19.7	28.1	41.0	57.9
AT	68.9	74.5	71.5	72.6	50.3	74.5	53.8	56.5	31.8	54.3	22.1	38.8	21.6	26.2	42.0	57.3
BE	81.4	81.3	83.7	81.5	37.8	81.3	38.3	38.5	33.3	40.1	43.3	42.1	19.8	37.6	49.2	73.7
BG	31.6	29.4	25.9	29.4	11.0	29.4	12.1	12.2	13.9	11.0	12.6	16.4	16.2	13.7	19.6	13.0
CY	46.9	54.7	51.2	59.2	12.9	54.7	11.9	13.6	23.0	11.4	21.2	23.6	41.7	21.6	100.0	100.0
CZ	42.1	44.0	44.5	44.5	14.5	44.0	15.4	16.2	25.0	13.8	22.0	19.6	12.2	25.0	13.1	20.3
DE	72.3	74.8	73.8	73.8	65.4	74.8	68.5	68.0	28.2	69.3	30.7	30.6	15.9	31.1	30.2	41.8
DK	89.0	91.3	88.8	86.4	63.6	91.3	64.1	68.4	54.6	64.1	63.3	88.0	19.4	55.1	46.6	73.4
EE	43.4	49.7	49.5	54.6	19.7	49.7	13.5	15.3	31.0	19.8	28.1	25.3	10.0	26.9	26.5	40.4
EL	57.4	56.1	59.9	59.5	12.6	56.1	12.8	12.6	21.3	12.1	19.7	17.5	19.6	19.7	33.5	30.6
ES	60.7	60.8	61.1	61.1	20.0	60.8	19.8	20.0	22.3	20.7	23.1	23.7	18.7	23.7	35.8	52.3
FI	67.0	69.2	68.0	70.7	83.7	69.2	90.1	72.0	25.6	86.7	26.4	31.4	21.5	25.4	40.1	57.0
FR	70.1	70.6	72.8	71.7	38.4	70.6	40.9	42.0	29.4	39.1	27.8	30.9	19.4	30.0	38.6	50.7
HU	48.3	48.5	49.0	46.3	16.1	48.5	16.3	17.0	18.5	16.4	17.4	16.8	22.9	18.9	46.1	74.0
HR	27.3	26.9	26.0	32.2	12.6	26.9	12.8	12.6	12.9	12.8	12.3	15.9	10.0	12.0	14.1	20.5
IE	71.5	76.3	81.3	81.4	32.0	76.3	31.3	34.5	28.6	29.6	27.4	36.5	16.1	26.5	49.6	76.3
IT	63.1	64.4	66.1	68.2	23.9	64.4	24.7	25.7	17.8	23.9	17.8	17.4	18.4	18.2	31.7	45.7
LT	40.4	47.5	23.9	30.1	11.2	47.5	14.0	14.4	15.1	11.7	13.8	17.8	10.0	16.1	10.0	10.0
LU	68.5	84.1	70.7	84.5	38.8	84.1	44.2	45.6	22.2	39.1	80.3	100.0	10.0	68.3	14.3	28.3
LV	24.2	25.3	28.7	41.9	13.8	25.3	14.2	14.0	19.5	11.7	15.6	14.9	10.0	19.5	15.6	16.9
MT	29.9	40.0	35.8	69.8	11.4	40.0	14.8	18.4	10.0	14.1	16.6	46.5	10.0	14.1	10.0	10.0
NL	91.7	95.5	95.6	94.0	61.5	95.5	64.8	67.3	43.0	56.5	40.5	48.6	27.0	36.0	71.8	100.0
PL	29.4	29.5	30.5	34.8	11.8	29.5	12.5	13.7	14.3	11.9	14.1	16.8	11.7	14.2	14.0	15.4
PT	61.3	58.2	62.0	59.5	13.5	58.2	13.6	15.6	20.4	13.4	19.0	19.6	14.8	22.3	25.5	45.4
RO	29.9	28.9	36.0	33.2	10.6	28.9	10.8	11.0	13.1	10.5	13.4	15.4	10.0	13.1	10.0	14.1
SE	75.8	76.6	75.7	78.5	90.3	76.6	96.5	96.3	40.5	89.6	38.1	57.4	26.4	38.1	50.3	56.2
SI	49.8	53.2	57.7	56.5	26.8	53.2	26.1	20.5	29.0	27.2	19.1	20.0	11.6	24.0	15.9	19.4
SK	38.6	35.4	35.3	41.8	11.8	35.4	12.2	12.9	14.7	12.4	14.8	22.7	10.0	14.6	11.6	11.7
UK	89.3	91.0	91.8	96.5	33.9	91.0	33.7	35.3	86.6	34.1	79.1	65.4	29.1	78.6	80.4	100.0
AL	10.0	21.1	11.0	16.3	10.1	21.1	10.1	10.0	10.0	10.1	10.0	12.5	10.0	10.0	10.0	10.0
AM	46.6	50.9	98.9	75.1	10.6	50.9	10.7	10.7	10.0	10.4	10.0	22.9	10.0	10.0	10.0	10.0
BA	17.6	14.6	28.7	23.9	10.6	14.6	10.6	10.4	10.0	10.4	12.4	12.0	10.0	10.0	10.0	10.0
MK	14.4	16.7	33.9	41.2	10.4	16.7	10.1	10.2	12.4	10.0	10.8	10.0	10.0	11.8	10.0	10.0
GE	32.3	56.2	96.6	73.5	10.3	56.2	10.7	10.2	10.0	10.5	10.0	14.8	10.0	10.0	10.0	10.0
IS	58.4	87.7	69.0	70.5	39.3	87.7	37.2	40.8	29.0	32.4	31.8	30.0	20.9	29.0	25.5	24.0
IL	62.5	65.7	67.1	65.7	69.2	65.7	76.8	80.0	24.1	68.3	24.3	24.4	64.1	25.4	100.0	100.0
MD	23.9	25.6	24.2	32.4	10.1	25.6	10.3	10.4	10.0	10.1	10.0	16.6	10.0	10.0	10.0	10.0
ME	27.0	19.6	33.9	23.4	11.7	19.6	10.4	11.3	10.0	11.7	10.0	10.0	10.0	10.0	10.0	10.0
NO	72.5	70.9	72.3	70.0	50.6	70.9	47.3	42.9	59.1	49.5	21.7	55.3	17.4	60.0	33.1	38.2
RS	32.2	36.9	30.6	29.0	10.8	36.9	11.0	11.3	11.1	10.7	11.4	12.9	10.0	11.6	10.0	12.5
CH	98.5	97.1	100.0	98.6	85.5	97.1	96.1	91.5	100.0	89.1	100.0	100.0	49.2	100.0	99.4	100.0
TN	34.8	31.7	32.6	39.3	10.2	31.7	10.2	10.3	10.0	10.4	10.0	12.5	10.0	10.0	10.0	10.0
TR	38.3	35.0	33.3	32.6	11.7	35.0	12.3	13.6	19.1	12.0	18.4	14.4	10.1	19.3	10.5	12.2
UA	23.3	21.4	18.7	25.8	10.6	21.4	11.0	10.9	10.0	10.9	10.0	14.7	10.0	10.0	10.0	10.0

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