European Centre for the Development of Vocational Training

2024 European Skills Index

Technical report

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Note: The technical report was drafted during the update of the European Skills Index 2022.

Note: This is not an official Cedefop publication. For any further information please contact Cedefop Expert Ilias Livanos who has been responsible for developing the European Skills Index.

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Acronyms

CEDEFOP	European Centre for the Development of Vocational Training
ESI	European Skills Index
EU	European Union
EU-LFS	European Union Labour Force Survey
EU-SILC	European Union Statistics on Income and Living Conditions
ISCED	International Standard Classification of Education
ISCED	International Standard Classification of Education
ISCO	International Classification of Occupations
JRC	Joint Research Centre
NEET	Not in Education, Employment or Training
OECD	Organisation for Economic Co-operation and Development
PCA	Principal Component Analysis
PISA	Programme for International Student Assessment
VET	Vocational education and training

1 Introduction and overview

This technical report accompanies the release of the 2024 European Skills Index (ESI, henceforth also called the Index or 2024 ESI) developed by the European Centre for the Development of Vocational Training (CEDEFOP). The aim of this report is to describe the methodology behind the ESI and to give an overview of the results of the current release.

The ESI is intended to measure the performance of skills formation and matching systems in the EU Member States, Iceland, Norway, Switzerland and the United Kingdom (hereinafter to be referred as EU-27+4) to enable a comparative assessment across countries. The concept of a skills system is a multifaceted and a complex one, and there is no single all-encompassing measure of the system's performance. Therefore, the ESI uses a framework of carefully-selected indicators which are aggregated into a *composite indicator* in order to capture this multidimensional concept in a single concise metric.

The 2024 ESI updates the work undertaken for the three previous ESI reports in 2022 ESI, (Cedefop, 2022), 2020 ESI (Cedefop, 2020), and 2018 ESI (Cedefop, 2019). The new Index builds on the methodology described in the 2022 ESI Technical Report (Cedefop, 2022). With every release of the Index, the JRC has audited the Index to validate its statistical soundness (Smallenbroek & Ravanos, 2024), (Caperna & Becker, 2022) and (Norlén & Saisana, 2018). The last JRC statistical audit showed that no methodological changes were required for the current Index, so the present release follows the same methodology used in the 2022 release. However, in this iteration the technical implementation has been improved using a programmatic approach, enabling the Index to be automatically back-casted for eight years. This has resulted in a deeper analysis of time trends.

The rest of this report is structured as follows. We begin in Section 2 by briefly describing the theoretical framework: the framework has been well documented in the previous ESI technical reports but is repeated here for completeness. Section 2 explains apart from the conceptual framework, also how the concept of a skills system was mapped. The indicators in the framework are introduced and discussed in Section 3. In Section 4 we describe the methodology for aggregating the data into an index. Finally, Section 5 gives an account of the Index results, that will be further discussed in an accompanying report. Annexes at the end of this report include detailed indicator tables, results tables, and some code extracts used for constructing the index.

2 Theoretical framework

2.1 Concept mapping of a skills system

One of the first steps in building any composite indicator is to better understand the target concept[1]. In this case, the multidimensional concept is a "Skills System", which needs to be decomposed into simpler dimensions that can be readily captured with indicators. This decomposition is called a "conceptual framework" because it maps the main dimensions (and possibly sub-dimensions) of the concept.

2.2 Defining a skills system

A country's skills system delivers enhanced skills to its population through compulsory education, and post-compulsory education and training. The skills system includes a variety of formal and informal training and education, secondary, further (continuing) and higher education, and both academic and vocational education and training (VET). It also includes lifelong learning, including on-the-job training and the acquisition of competences added through years working in a job. It also includes the activation of skills of different groups into the labour force to increase the skills base of the economy. The skills system's role is to ensure, as far as is feasible, that skills demand is met by skills supply in a way that optimises the use of the skills available in the labour force.

A country's skills system can be seen to fulfil several different roles, including:

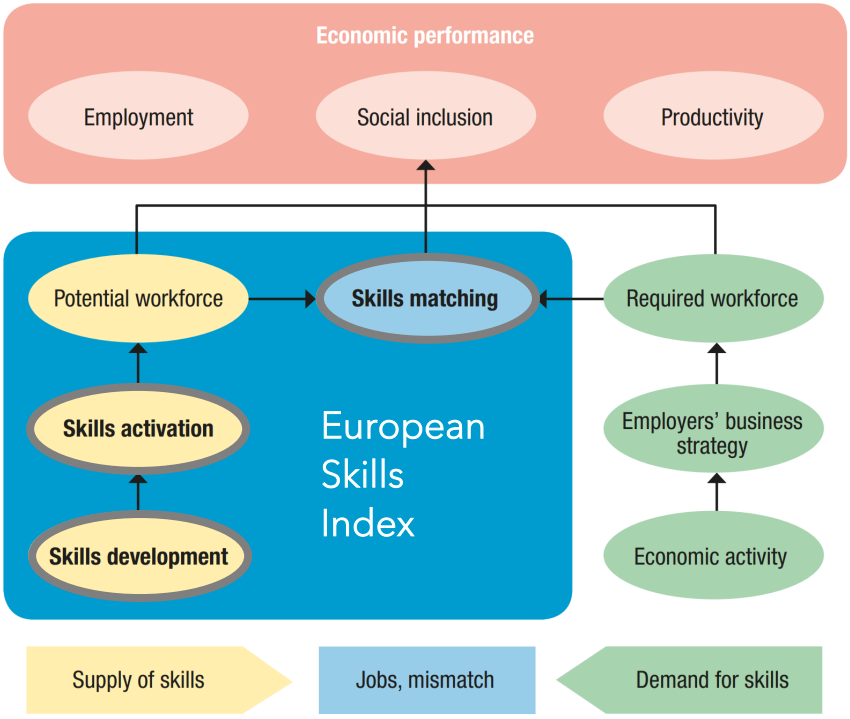
a) delivering the skills the country needs and/ or is anticipated to need in the future (including re-skilling and up-skilling);
b) activating the skills in the labour market, by providing enough job opportunities to different groups in the population;
c) matching, as far as possible, individuals' aspirations, interests, and abilities to the needs of the labour market.

The capacity of a skills system to realise these ends has traditionally been measured with respect to individuals' propensities to avoid unemployment, obtain relatively high-wage work, and secure progression in the labour market. Accordingly, indicators have concentrated on measures of employment status and wages. The role that a skills system has in matching interests, aspirations, and abilities to labour market demand points to a wider range of outcomes that focus, more or less, on non-pecuniary measures relating to the quality of employment and working life. These have driven the design of the ESI.

2.3 The ESI theoretical framework

In Figure 1, the theoretical framework to characterise a country's skills system is presented. The framework developed for ESI is based on a human capital approach in which both the individual and society derive economic benefits from investing in skills. The framework identifies the various dimensions of skills that can be acquired by an individual through both formal and informal learning. The starting point is that these skills drive economic performance through employment, social inclusion and productivity. Within the framework, social inclusion stands as a desired outcome because success in improving employment and productivity outcomes will depend on the latter being shared across the population as a whole. In other words, outcomes are socially as well as economically optimal.

[1] The conceptual framework of the ESI has remained unchanged since the last release (in 2022). The description in this section is the same as the 2022 technical report but is repeated here for the sake of completeness.



Source: European Skills Index (2019), Cedefop.

Figure 1. Theoretical framework for the skills system

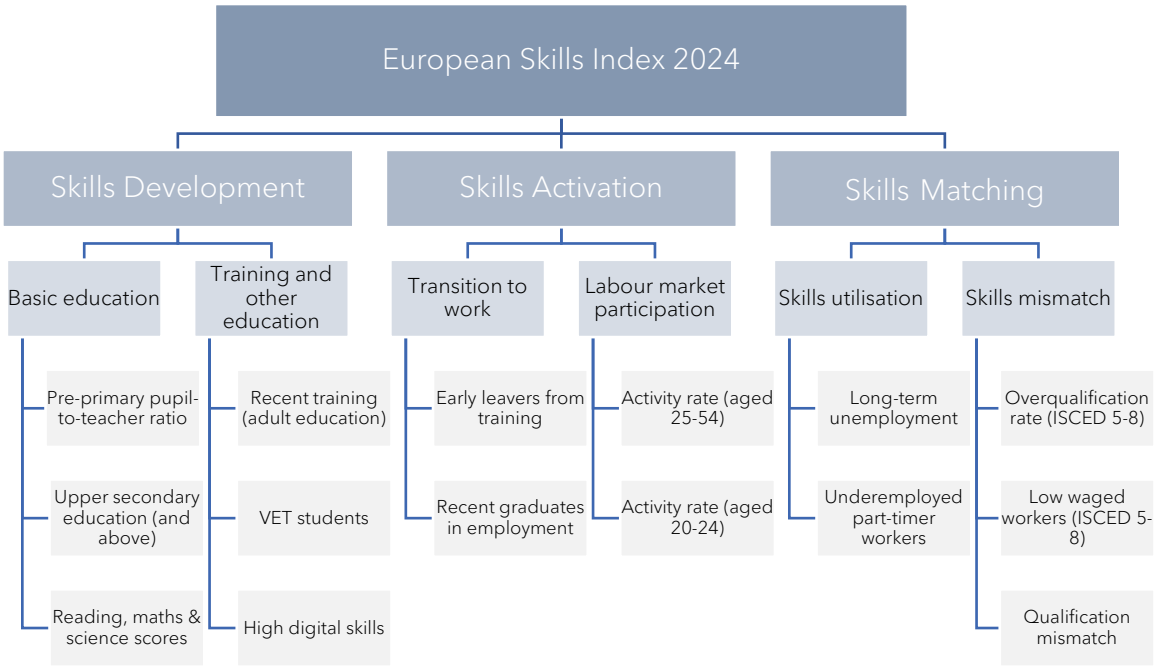
Note: components of the skills system that are included in the ESI are highlighted with a grey outline.

The role of the skills system is to bring together and match a suitably skilled potential workforce (supply) with the needs of employers (the required workforce, demand). The required workforce and the skills needed are determined by the nature and scale of economic activity and by employers' business strategies. The potential workforce is determined by skills development (education and training, and lifelong learning) and by the activation (or participation) of workers in the labour market. It is through the interplay between skills supply and demand that the degree of successful matching of skills is observed.

3 Indicator framework

In Figure 1, the area highlighted in the blue box indicates the aspects of the skills system that are included in the ESI. The ESI has three pillars to assess how well the skills formation and matching systems of the countries are performing in relation to the degree to which they are developing, activating and matching skills reserves within their economies. The ESI focuses on these supply and matching aspects of the skills system. Within the ESI, the demand for skills is captured most clearly in the matching of skills, and in the extent to which it influences decisions to invest in training and to activate skills.

Each pillar is broken down further into sub-pillars, to further organise the indicators into related groups. In total, the ESI has three pillars, six sub-pillars, and 15 indicators: see Figure 2. Sub-pillar, pillar and index scores are calculated as weighted averages of the normalised indicator scores (see Section 4 for details). In this chapter the pillars are described, and the rationale and definition of each indicator are defined. More information about the indicators is given in Annex 1, including the data sources.



Source: European Skills Index (2024), Cedefop.

Figure 2. European Skills Index structure

3.1 Skills Development Pillar

The *Skills Development* pillar represents the training and education activities of a country and the outputs of that system in terms of the skills developed and attained. This pillar has two sub-pillars; *Basic Education*; and *Training and Other Education*.

3.1.1 Basic Education sub-pillar

3.1.1.1 Pre-primary pupil-to-teacher ratio

The indicator measures the ratio of pupils to teachers and academic staff at the pre-primary education level, from three years to the start of primary education (ISCED11[2] level 0). It can be seen as a proxy for the quality of teaching at pre-primary education level, where a lower value is interpreted as a better outcome.

3.1.1.2 Upper secondary education (and above)

The indicator measures the share of population aged 15-64 years old with at least upper secondary education (ISCED11 level 3-8). It is a proxy for the education attainment level of the country, where a higher value is seen as a better outcome.

3.1.1.3 Reading, maths & science scores (PISA scores)

The indicator measures the average reading, maths and science scores among 15-year-old students in the PISA programme. PISA is the OECD's Programme for International Student Assessment. PISA measures 15-year-olds' ability to use their reading, mathematics and science knowledge and skills to meet real-life challenges. A higher value for *reading, maths & science scores* is interpreted as a better outcome. The latest PISA 2022 results were released in December 2023.

3.1.2 Training and Other Education sub-pillar

3.1.2.1 Recent training

The indicator derives from Labour Force Survey[3] (EU-LFS) and refers to the question regarding the share of population aged 25-64 years who stated that they received formal or non-formal education or training in the four weeks preceding the survey. Continued learning after initial education is necessary for raising productivity levels of the working-age population and tackling skill mismatches and bottlenecks on the labour market. A higher value for this indicator is interpreted as a better outcome.

3.1.2.2 Vocational education and training (VET) students

The indicator measures the share of the population at ISCED11 level 3 attending vocational education and training (VET). VET ensures skills development in a wide range of occupational fields, through school-based and work-based learning. It plays a vital role in ensuring lower school dropout rates and facilitates the school-to-work transition. A higher value for *VET students* is interpreted as a better outcome.

3.1.2.3 High digital skills

This indicator is one of key performance indicators in the context of the Digital Decade[4], which sets out Europe's ambition on digital, laying out a vision for the digital transformation and concrete targets for 2030 in the four points: skills, infrastructures, digital transformation of businesses and public services. It measures the share of individuals who performed more than one activity in all digital skills domain (information, communication, problem-solving, software). The indicator monitors the implementation of the European Skills Agenda[5], which provides that the share of adults aged 16-74 having at least basic digital skills should reach 70% by 2025. The indicator is useful to describe general digital literacy and skills in using the internet over time. A higher value for *high digital skills* is interpreted as a better outcome.

[2] International Standard Classification of Education (ISCED) | UNESCO UIS
[3] EU labour force survey - Microdata - Eurostat (europa.eu)
[4] Europe's digital decade: 2030 targets | European Commission (europa.eu)
[5] European Skills Agenda - Employment, Social Affairs & Inclusion - European Commission (europa.eu)

3.2 Skills Activation pillar

The *Skills Activation* pillar includes indicators of the transition from education to employment, together with labour market activity rates for different groups of the population. The potential workforce of a country is determined not only by the development of skills in the population, but also by the activation (or participation) of skills in the labour market. This pillar has two sub-pillars; *Transition to Work*; and *Labour Market Participation*. All the indicators in this pillar derive from the EU-LFS.

3.2.1 Transition to Work sub-pillar

3.2.1.1 Early leavers from training

The indicator measures the share of the population, aged 18-24 having attained ISCED11 level 0, 1, 2 or 3c short and not receiving any formal or non-formal education or training in the four weeks preceding the survey. Early leavers experience reduced lifetime earnings and longer and more frequent unemployment periods. Early leaving also brings large public and social costs, so a lower value for this indicator is interpreted as a better outcome.

3.2.1.2 Recent graduates in employment

The indicator assesses the share of employed people aged 20-34 having successfully completed upper secondary or tertiary education one to three years before the reference year of the survey and who are no longer in education or training. A higher value for this indicator is interpreted as a better outcome.

3.2.2 Labour Market Participation sub-pillar

3.2.2.1 Activity rate (aged 25-54)

3.2.2.2 Activity rate (aged 20-24)

The two indicators measure employed and active persons as a share of the total population of the same age cohort in the two intervals 25 to 54 years old and 20 to 24 years old. Higher values of these *activity rates* are interpreted as better outcomes.

3.3 Skills Matching pillar

The *Skills Matching* pillar represents the degree of successful utilisation of skills, the coverage to which skills are effectively matched in the labour market. This can be observed in the form of jobs and mismatches which include unemployment, skills shortages, and skills surpluses or underutilisation of skills in the labour market. This pillar has two sub-pillars; *Skills Utilisation*; and *Skills Mismatch*.

3.3.1 Skills Utilisation sub-pillar

The two indicators in this sub-pillar derive from the EU-LFS.

3.3.1.1 Long-term unemployment

The indicator measures the percentage of people who have been unemployed for 12 months or more of the total number of active persons in the labour market. A lower value for *long-term unemployment* is interpreted as a better outcome.

3.3.1.2 Underemployed part-time workers

The indicator is measuring people aged 15-74 years old working part-time because they are unable to find full-time work as a share of the active population. Since they are effectively involuntary part-time workers and it is an ineffective use of skills, the labour is underutilised among persons already employed and willing to work more hours. A lower value for *underemployed part-time workers* is thus interpreted as a better outcome.

3.3.2 Skills Mismatch sub-pillar

3.3.2.1 Overqualification rate (ISCED 5-8)

The indicator measures the share of employed people aged 25-34 with high education, ISCED11 level 5 to 8[6], that occupy jobs that are not corresponding to the International Classification of Occupations[7] (ISCO) 1, 2 or 3. It evaluates the ineffective use of skills, i.e. highly educated employees working in lower skilled jobs. The indicator was calculated using microdata from the EU-LFS. A lower value for *over-qualification rate* is interpreted as a better outcome.

3.3.2.2 Low waged workers (ISCED 5-8)

A low wage is defined as "those employees (excluding apprentices) earning two-thirds or less of the national median gross hourly earnings in that particular country". The indicator assesses the proportion of low wage earners out of all employees of ISCED11 level 5-8 qualification level. The indicator gives an indication of the ineffective use of skills, high-educated employees in low wage employment and so a lower value is interpreted as a better outcome. The indicator was calculated using microdata from the survey EU statistics on income and living conditions[8] (EU-SILC).

3.3.2.3 Qualification mismatch

The indicator comes from a special request from the OECD from the Skills for Jobs database[9] and measures the education attainment level for each occupation in each industry and assessing whether each employee's education attainment level matches it. It measures incidences of both underqualification and overqualification, which provides an indication of ineffective use of skills, or the need for upskilling. A lower value for *qualification mismatch* is interpreted as a better outcome.

3.4 Country coverage

The Index covers 31 countries: the EU Member States; as well as Iceland, Norway, Switzerland and the United Kingdom, as illustrated in Table 1.

[6] In the previous ESI Technical reports the ISCED1997 classification for high education was used where high educations had the levels 5-6 which in current classification corresponds to levels 5-8 in ISCED2011.
[7] International Standard Classification of Occupations (ISCO) - ILOSTAT
[8] EU statistics on income and living conditions - Microdata - Eurostat (europa.eu)
[9] https://www.oecdskillsforjobsdatabase.org/

Table 1. Country coverage

Countries (country codes ISO 3166-1 alpha-2)			
Austria (AT)	Estonia (EE)	Italy (IT)	Portugal (PT)
Belgium (BE)	Finland (FI)	Latvia (LV)	Romania (RO)
Bulgaria (BG)	France (FR)	Lithuania (LT)	Slovakia (SK)
Croatia (HR)	Germany (DE)	Luxembourg (LU)	Slovenia (SI)
Cyprus (CY)	Greece (EL)	Malta (MT)	Spain (ES)
Czech Republic (CZ)	Hungary (HU)	Netherlands (NL)	Sweden (SE)
Denmark (DK)	Ireland (IE)	Poland (PL)	
Iceland (IS)	Norway (NO)	Switzerland (CH)	United Kingdom (UK)

Source: European Skills Index (2024), Cedefop.

We note that the data coverage between countries is not uniform, and in particular the UK has poor data coverage in recent years. In fact it has no updated data since 2019 (release year 2021) with the exception of the PISA indicator in 2022. For completeness however, it is still included in the index by using imputed data from previous years.

3.5 Time coverage

Data for the 15 ESI indicators were collected in the time interval from 2015 until the latest available year (in November/December 2023). The Index has then been constructed as a time series for eight consecutive years. By ESI methodology the release year of the index is two years ahead of the source data. In other words, the time series in this release spans release years 2017-2024 but this is based on data spanning 2015-2022 respectively.

4 Index construction

This section gives on account of the steps for building the ESI with the rationales behind the methodological choices. The methodology has remained unchanged since the last release in 2022, following no suggestions for significant changes from the recent JRC audit.

The construction of the ESI follows established international guidelines in the JRC and OECD Handbook on Constructing Composite Indicators (OECD/EC JRC, 2008), and the European Commission's Competence Centre for Composite Indicators and Scoreboards[10]. The recommended steps to follow are summarised as follows.

1. Establish what you are trying to measure, who will use the end product, and what kind of questions you expect the framework to be able to answer.
2. Carefully map the main dimensions and sub-dimensions of the concept via a literature review and interviewing experts.
3. Collect indicators to populate your conceptual framework. This may involve collecting your own raw data through surveys or data mining
4. Select the most relevant indicators through a series of indicator criteria.
5. Build the index/scoreboard, and perform statistical analysis; adjust accordingly.
6. Check the results make sense with experts and stakeholders, and that the product agrees with expectations; adjust accordingly.
7. Check robustness through uncertainty and sensitivity analysis.
8. Visualise the data – this can involve static or interactive data visualisations, and is ideally hosted online for maximum visibility. Make data and methodology clearly available.
9. Extract conclusions and narratives from the data by comparing with other quantities, highlighting higher/lower performers, regional/time trends.
10. Communicate the results through reports, infographics, articles, social media and so on, as appropriate to the context.

These steps are not exhaustive and are also not usually followed strictly one after another – often the framework will be iteratively adjusted after expert consultation and based on data availability and other considerations.

In this section we describe the technical construction of the index, which is effectively steps 3 and 5 in the above list. The general steps followed for the ESI are:

I. Impute missing data points using linear interpolation of each time series.
II. Normalise using a "goalposts" or "distance to frontier" approach.
III. Aggregate using a mixture of weighted arithmetic and geometric means.

These steps are explained in a little more detail here, and the implementation is given in Annex 2: R Code to build ESI.

4.1 Technical implementation

The construction of the ESI in 2024 was performed in R, which is an open-source statistical programming language. R was used because it enables a fully reproducible and accurate data pipeline.

[10] https://knowledge4policy.ec.europa.eu/composite-indicators_en

4.1.1 Data collection

As a first step, data was collected for each indicator. Since most indicators come from Eurostat, we were able to directly query the Eurostat database using its application programming interface (API) and import the indicator data directly into R – this creates a direct data pipeline which can be easily updated and eliminates the need for manual downloads and data assembly. For the few indicators where data could not be collected via an API, we saved the raw data as a csv and wrote independent cleaning scripts for each indicator. In all cases, data was collected for as many years into the past as possible. Finally, the indicators were brought together into a single clean data set.

As a final step, the data set was truncated to include only years where a fairly complete set of indicator data was available. This resulted in a panel data set spanning 2015-2022, which as mentioned corresponds to ESI release years of 2017-2024.

4.1.2 Data validation

The next step was to compare the dataset with the dataset from the previous 2022 release of the ESI. This enabled us to confirm that the indicators that were collected were indeed the same as those collected in the previous edition (e.g. by comparing, for each indicator, the historical time series for each country of our data with the previous data). In most cases, the time series were the same but it is also common for Eurostat to retrospectively alter some historical data points, and this was observed in some cases. The outcome of this step was a fully validated data set.

4.1.3 Index calculation

Given the cleaned data set, the calculation of the index itself was performed in R using the COINr package[11], which is an open-source R package for developing and analysing composite indicators, and is used (and was partially developed) by the European Commission's Competence Centre for Composite Indicators and Scoreboards. The advantage of using COINr is that it enables quick and accurate composite indicator operations, and can handle panel data.

To ensure that COINr faithfully reproduces the ESI methodology, we used the 2020 data collected in the previous release (corresponding to the 2022 ESI) to reconstruct the ESI scores, comparing the data tables at each step (the previous release was calculated in Excel). COINr was able to accurately reproduce the results at every step.

The specific operations performed in COINr were therefore:

1. Impute missing data using cold-deck imputation for the most recent year of data, and linear interpolation for previous years where possible.
2. Normalise using a distance-to-frontier approach.
3. Aggregate using a mixture of the weighted arithmetic and weighted geometric means.

These steps are explained in more detail in the next sections. A summary of the COINr code used to make these calculations is available in Annex 2.

4.2 Missing data Imputation

Imputation is the process of estimating missing data points. This is usually done by replacing missing data points with e.g. the indicator mean, or the mean of a certain group, or by a more complex method such as expectation maximisation or similar.

As written in the previous section, data for the 15 ESI indicators was collected in the time interval from 2015 until latest available year which was 2022 (as of the period of data collection in November/December

[11] https://bluefoxr.github.io/COINr/

2023). By ESI methodology the release year of the index is two years ahead of the source data. For the latest version of ESI, 2024 ESI, uses therefore data from 2022.

Since the data set contained missing data points, cold deck imputation is used, i.e. replacing missing values with values from a previous year. For back-casting the Index, in addition to cold-deck imputation, linear interpolation is used to fill in missing data for which data are available in preceding and subsequent years in the same indicator. In some particular cases, imputation was not possible because some countries have no data for certain indicators. To note that:

- The latest observations for most indicators derive from 2022. The exceptions are indicators: *pre-primary pupil-to-teacher ratio*, *VET students*, *overqualification rate* (from 2021) and *high digital skills*, *qualification mismatch* (from 2019)
- UK has only up to date indicator (2022) for the *reading, maths & science* indicator (PISA scores). All the other indicators for UK are cold deck imputed from 2019 (for 12 indicators) and 2018 (*low waged workers*). The figures for the UK thus need to be considered with caution and should not be strictly compared with the other countries for recent years.
- Data are missing for the entire time series for six countries. *Pre-primary pupil-to-teacher ratio* is missing for Switzerland, Estonia and Ireland. *Long-term unemployment* is missing for UK. *Qualification mismatch* is missing for Croatia and Malta. This corresponds to 1.3% of missing data in the imputed data set. In the index calculation this is conceptually equivalent to imputing the missing value with the weighted mean of the values observed for that unit on the other indicators included in the same lower dimension (mean-row).
- The latest PISA results (PISA 2022) for Luxembourg were not released in December 2023 when data collection was performed. For Luxembourg the *reading, maths & science* indicator uses the PISA scores from an earlier edition (PISA 2018). The indicator is therefore cold deck imputed.

Table 2. Summary statistics of the indicators included in the 2024 ESI with imputed values. Distributions with outliers according to skew/kurtosis thresholds are highlighted in bold.

Pillar	Sub-pillar	Indicator	Acronym	Nr of missing after imputation	% of missing	Main year of data (exeptions)	Mean	Min	Max	Skew	Kurtosis
Skills Development	Basic education	Pre-primary pupil-to-teacher ratio	PTRatio	CH,EE,IE	9.7%	2021 (UK 2019)	13.2	4.5	39.7	***3.1***	***12.7***
		Upper secondary education	SecEd	0	0%	2022 (UK 2019)	78.7	60.4	88.7	-1.2	1.1
		Reading, maths & science scores	PISA	0	0%	2022 (LU 2018)	474.4	403.4	515.6	-1.4	1.7
	Training and other education	Recent training	RecTrain	0	0%	2022 (UK 2019)	14.7	1.7	36.2	0.7	0.0
		VET students	VET	0	0%	2021 (UK 2019)	48.1	17.6	70.0	-0.1	-1.0
		High digital skills	DigiSkill	0	0%	2019	34.7	10.3	61.6	0.1	-0.2
Skills Activation	Transition to work	Early leavers from training	LeaveTrain	0	0%	2022 (UK 2019)	4.2	1.4	9.8	1.0	1.0
		Recent graduates in employment	EmpGrads	0	0%	2022 (UK 2019)	83.4	65.2	93.4	-1.0	1.2
	Labour market participatio	Activity rate (aged 25-54)	Emp25_54	0	0%	2022 (UK 2019)	88.2	78.6	92.9	-1.4	3.3
		Activity rate (aged 20-24)	Emp20_24	0	0%	2022 (UK 2019)	63.0	40.8	85.4	-0.1	-1.4
Skills Matching	Skills utilisation	Long-term unemployment	LTUnemp	UK	3.2%	2022	2.0	0.5	7.7	***2.1***	***5.4***
		Underemployed part-timers	UnderEmpPT	0	0%	2022 (UK 2019)	2.5	0.3	5.1	0.1	-1.3
	Skills mismatch	Overqualification rate (tertiary education ISCED 5-8)	Overqual	0	0%	2021 (UK 2019)	21.7	4.4	40.2	0.6	1.1
		Low waged workers (ISCED 5-8)	LowWage	0	0%	2022 (UK 2018)	9.1	2.1	18.8	0.4	-0.4
		Qualification mismatch	QMismatch	HR,MT	6.5%	2019	32.9	16.7	43.6	-0.5	-0.7

Source: European Skills Index (2024), Cedefop.

4.3 Outliers

In composite indicators, it is fairly common practice to treat outliers. Outliers are data points that stand apart from the distribution of the remaining points. Sometimes this may be due to an error in measurement or calculation, but often it is simply the reality – for example, Luxembourg is often seen as an outlier in terms of GDP/capita, being a small wealthy country.

The problem with outliers is that they dominate the scale of the indicator and cause important differences between other countries to be largely obscured. This can be rectified, if desired, by a treatment method called *Winsorisation*, or transformations such as the logarithm and Box Cox.

Following a fairly standard procedure (recommended by the JRC), outliers were detected using a skew/kurtosis rule: if the absolute skew exceeded 2, and the kurtosis exceeded 3.5, the indicator distribution is considered to have outlying points.

Two indicators with outliers in the data set are highlighted in Table 2. Although the indicators (*pre-primary pupil-to-teacher ratio*, *long-term unemployment*) show high values of skewness and kurtosis, the ESI methodology accounts for this using a special normalisation methodology, which uses a distance-to-frontier approach which automatically caps outliers. As a result, outlier treatment via Winsorisation or similar is not necessary. This is explained further in the following section.

4.4 Normalisation

Normalisation is the operation of bringing indicators onto a common scale. This is done so that indicators with very different units and scales can be aggregated and bring relatively equal contributions.

The normalisation used for the ESI is a "distance-to-frontier" approach, sometimes also called a "goalposts" approach, which calculates the normalised distance between a worst and best-case scenario, for each indicator. More precisely, this is:

$$\tilde{x}_i = \min\left(0, \max\left(1, \frac{x_i - x_{i,W}}{x_{i,B} - x_{i,W}}\right)\right) \times 100$$

where $\tilde{x}_i$ and x_i are respectively the normalised and un-normalised values of the ith indicator, $x_{i,W}$ is its worst case value, and $x_{i,B}$ is its best case value. Each indicator is normalised by its distance between the worst and best case value, and any values below the worst case are assigned zero, and any above the best case are assigned 1. All values are then multiplied by 100. This capping of values outside the range is effectively a type of Winsorisation, and is why an explicit Winsorisation step is not needed, if best/worst case values are chosen appropriately. The bounds for the worst and best case values are kept invariant from 2022 ESI and are shown in Table 3. The rationale for chosen bounds were discussed in detail in the previous technical report of ESI (Cedefop, 2022). No change in the bounds was applied to 2024 ESI since no methodological changes were made.

Table 3. Worst case and best case bounds

Pillar	Sub-pillar	Indicator	Acronym	Indcator Direction	Worst case	Best case
Skills Development	Basic education	Pre-primary pupil-to-teacher ratio	PTRatio	-1	22	5
		Upper secondary education	SecEd	1	55	90
		Reading, maths & science scores	PISA	1	440	525
	Training and other education	Recent training	RecTrain	1	1	32
		VET students	VET	1	17	75
		High digital skills	DigiSkill	1	9	62
Skills Activation	Transition to work	Early leavers from training	LeaveTrain	-1	9	1
		Recent graduates in employment	EmpGrads	1	65	95
	Labour market participatio	Activity rate (aged 25-54)	Emp25_54	1	80	95
		Activity rate (aged 20-24)	Emp20_24	1	40	80
Skills Matching	Skills utilisation	Long-term unemployment	LTUnemp	-1	5	0.5
		Underemployed part-timers	UnderEmpPT	-1	7	0.5
	Skills mismatch	Overqualification rate (tertiary education ISCED 5-8)	Overqual	-1	35	10
		Low waged workers (ISCED 5-8)	LowWage	-1	19	1
		Qualification mismatch	QMismatch	-1	44	16

Source: European Skills Index (2024), Cedefop.

For indicators with a negative direction (e.g. *pupil-to-teacher ratio*) the above formula is analogous but measures the progress in the opposite direction. Therefore the normalisation results in a data set that is comparable and aligned in terms of indicator directions.

4.5 Weighting and aggregation

In order to get a composite measure, i.e. the index, the normalised indicators are hierarchically aggregated, following the conceptual framework and by taking weighted means of each aggregation group, starting at the indicator level and working upwards:

- Sub-pillar scores are calculated as the weighted arithmetic mean of the indicator scores that belong to each sub-pillar.
- Pillar scores are derived from calculating the weighted arithmetic mean of the sub-pillar scores that belong to each pillar.
- The ESI is computed as the *weighted geometric mean* of the three pillar scores.

Notice that two different weighted means are used: the arithmetic for sub-pillar and pillar scores, and the geometric for the aggregation of pillars to the ESI. The arithmetic mean is calculated as follows:

$$y = \frac{1}{\sum_{i=1}^{d} w_i} \sum_{i=1}^{d} x_i \, w_i$$

Where x_i is an indicator, w_i is its corresponding weight, d is the number of indicators in the aggregation group and y is the resulting composite score (e.g. the sub-pillar or pillar score). The geometric mean, on the other hand, is as follows:

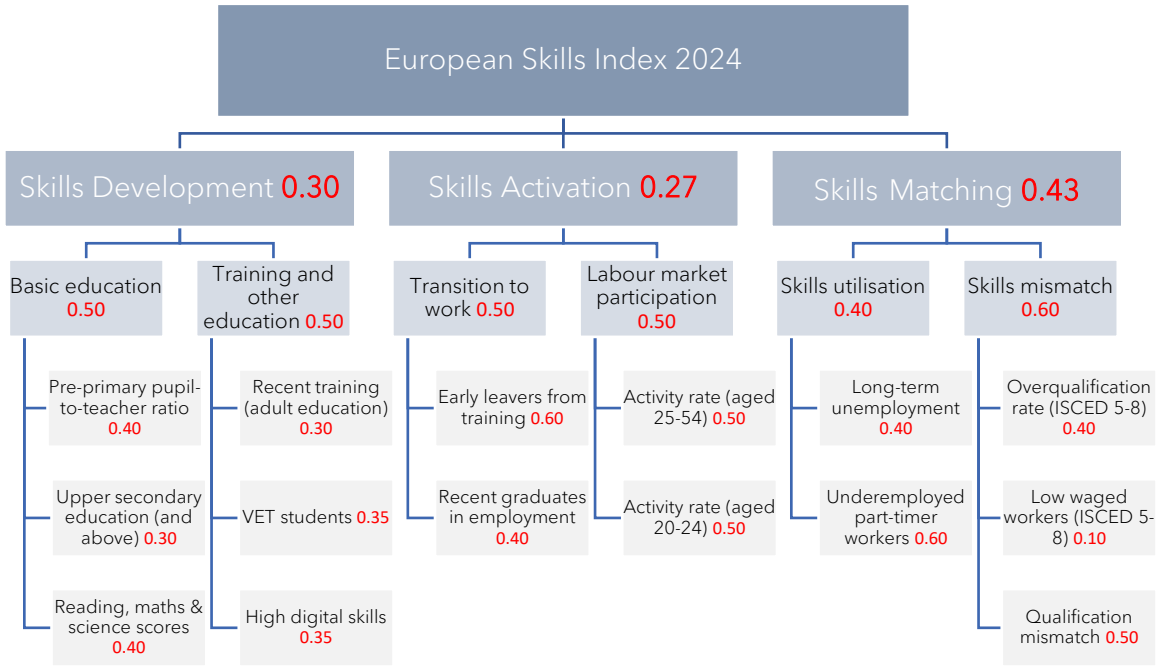
$$y = \left(\prod_{i=1}^{d} x_i^{w_i} \right)^{1/\sum_{i=1}^{d} w_i}$$

Both means give a central measure of their component values, but the arithmetic mean is more compensatory in the sense that higher values of one indicator can fully compensate for lower values of another, whereas the geometric mean only partially compensates in these cases. The rationale is that at the pillar level, skills systems require all three pillars to function effectively, and a high score in one pillar should not fully compensate for a low score in another.

In the first version of the ESI (2018 ESI) weights were chosen with the aim to ensure that the highest number of indicators would contribute in a meaningful way to variation in the Index score. This was done by first assigning equal weights to the indicators and then they were adjusted by using the PCA factor loadings calculated at sub-pillar level. The weights at sub-pillar and pillar level are done in the same way. The weights were slightly updated in 2022 ESI since both the bounds were changed and two indicators replaced. No change in the weighting scheme was applied to 2024 ESI since no methodological changes were made. The weights used for the indicators, sub-pillars and pillars are illustrated in Figure 3.

The result of the weighting and aggregation step is the final data set of ESI, pillar and sub-pillar scores, for all years in the data set (2015-2022), corresponding to release years 2017-2024. This data set is available for download on the ESI website[12].

[12] https://www.cedefop.europa.eu/en/projects/european-skills-index-esi



Source: European Skills Index (2024), Cedefop.

Figure 3. Pillar, sub-pillar and indicator weights (in red)

4.6 Statistical coherence of ESI

This section presents a summary of the statistical audit of the 2024 ESI. The audit was performed by the European Commission's Competence Centre on Composite Indicators and Scoreboards at the JRC in December 2023 and was conducted by invitation of Cedefop. With every release of the Index, the JRC has audited the Index to validate its statistical soundness (Smallenbroek & Ravanos, 2024), (Caperna & Becker, 2022) and (Norlén & Saisana, 2018). The JRC assessment of the 2024 ESI focuses on two main issues: the statistical coherence of the hierarchical structure of indicators, and the impact of key modelling assumptions on the ESI ranking.

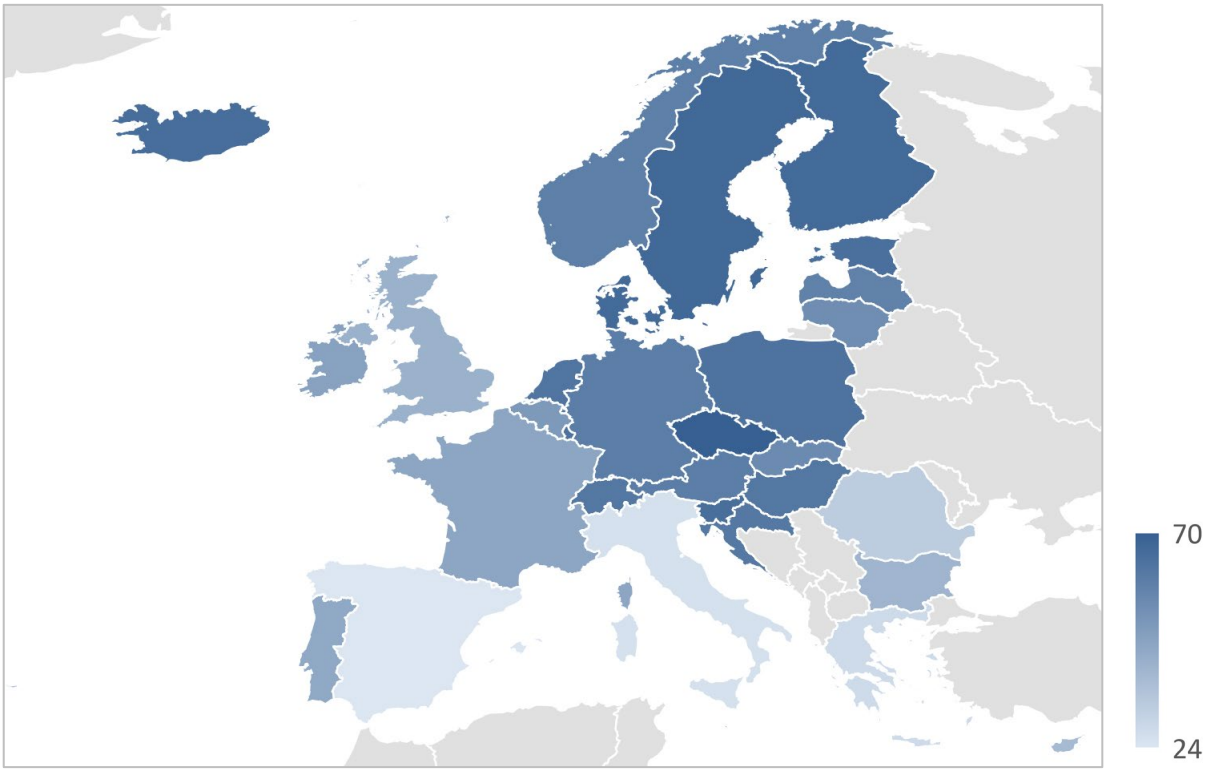
The audit shows that the ESI has excellent data coverage, with minimal missing values. Outliers, found in a small percentage of indicators, are successfully treated through distance-to-frontier normalisation. The ESI is deemed statistically balanced within its pillars, with positive correlations between indicators and their sub-pillars. Weights are employed to balance elements in the composite indicator, enhancing statistical coherence.

However, two indicators (*pre-primary pupil-to-teacher ratio* and *VET students*) show weak or negative correlations within their sub-pillars, potentially impacting aggregation results. The JRC-COIN recommends ongoing monitoring and potential modification of these indicators in future editions. The uncertainty analysis show that the ESI is a robust summary measure for many countries. Simulated intervals are narrow for most countries, suggesting meaningful inferences can be drawn. For eight countries, confidence interval widths of at least five positions lead to significant rank variations with changes in weights, imputation, and aggregation method. The sensitivity analysis confirms the impact of small changes on rankings but attributes this to the similarity in scores among some countries. The audit concludes that the ESI is reliable with good statistical coherence. Significant efforts by the developer's team to achieve a balanced and transparent result are acknowledged. While minor issues are identified, there are no structural problems, and special care is advised in interpreting rankings for certain countries.

5 Results

5.1 2024 ESI results

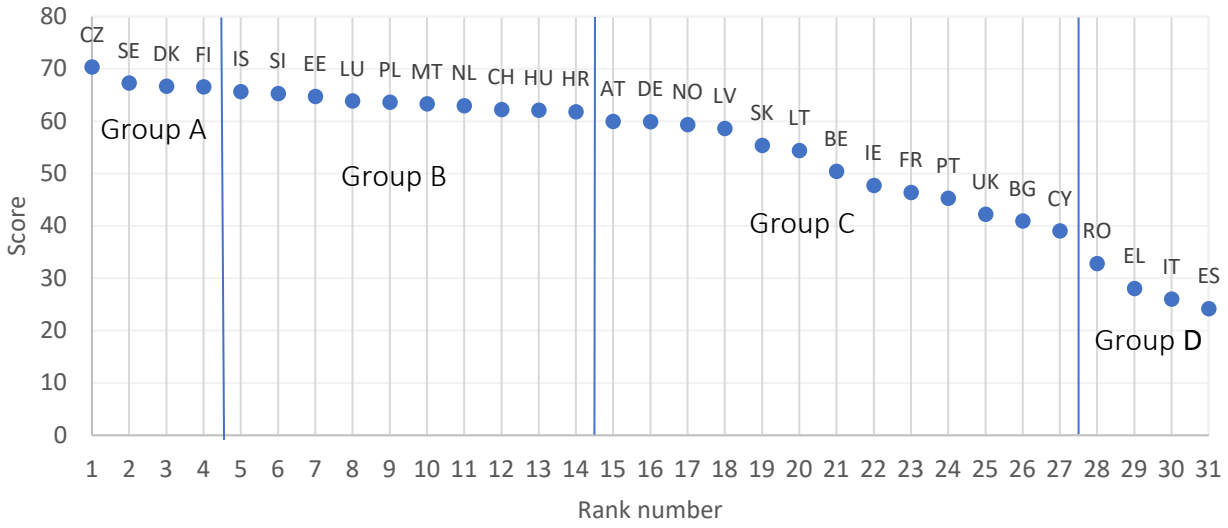
Figure 4 shows the spatial distribution of the 2024 ESI scores. The highest scoring country is once again Czechia, followed by the Nordic countries; Sweden, Denmark, Finland and Iceland. There is a general south-to-north gradient in the scores from lower to higher scores. The southern EU countries; Spain, Italy and Greece have the lowest scores. The range of scores is in the interval from 24 (Spain) to 70 (Czechia). The score of Czechia may be interpreted as the country has reached 70% of the ideal performance (based on the frontiers identified in Section 4.4), so there is still 30% in the index score that can be improved.



Source: European Skills Index (2024), Cedefop.

Figure 4. 2024 ESI scores

Figure 5 shows the index scores and rankings. Groupings of the countries can be found in several ways. One is by first taking the cut offs of the 90th and 10th percentiles to retrieve the best forming countries (Group A) and least performing countries (Group D). Group A contains Czechia, Sweden, Denmark and Finland. Group D contains the following four countries; Romania, Greece, Italy and Spain. Then there is a natural divider between 14th ranked (Croatia) and 15th ranked (Austria) country. In the last group (Group C) the slope in scores is steeper than in previous group (Group B).



Source: European Skills Index (2024), Cedefop.

Figure 5. 2024 ESI scores and rankings

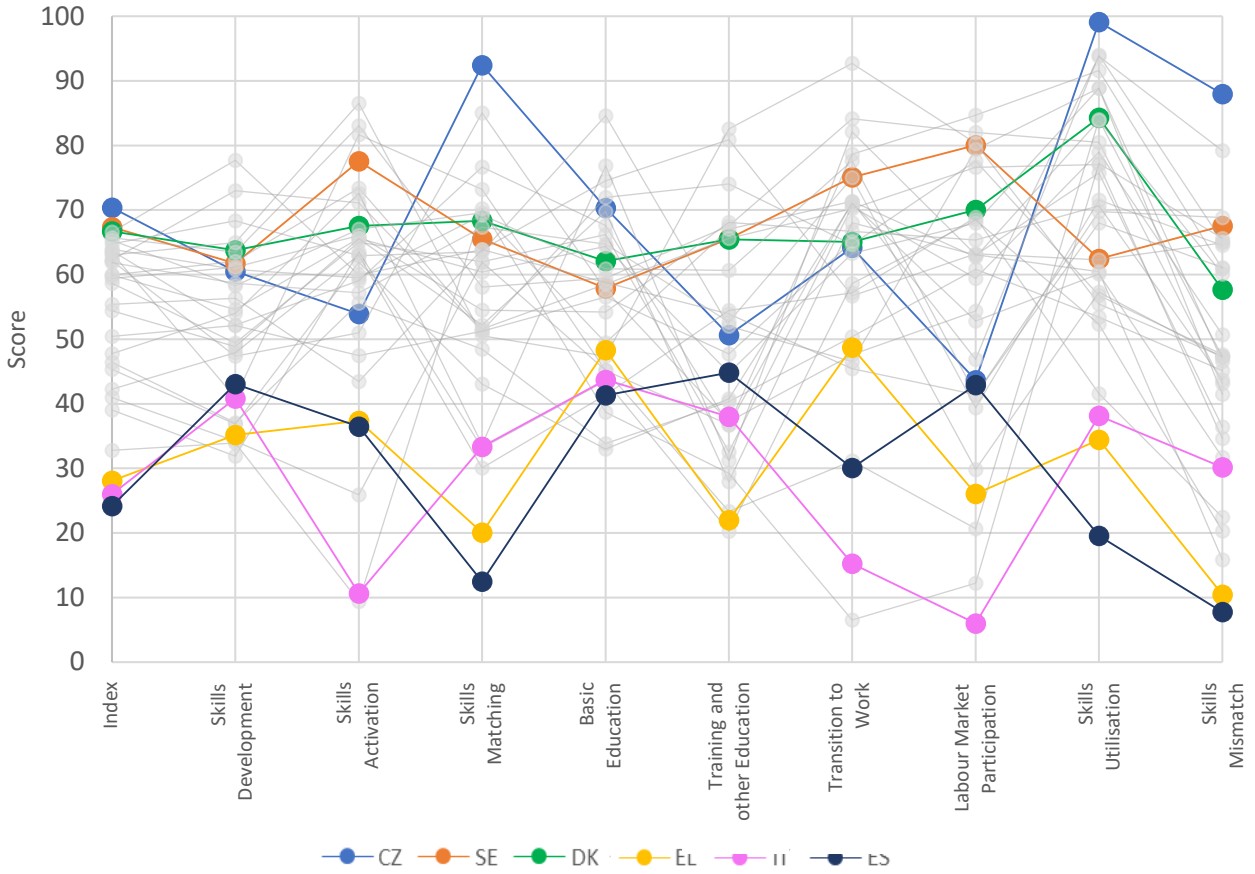
We note however, that groupings of countries by their scores are subjective and could be grouped in a different way.

5.2 Results by the 3 Pillars and by the 6 Sub-pillars

Figure 6 illustrates the distribution of the scores from the index, three pillars and six sub-pillars. One dot represents a country score. The three best and three worst performing counties in the Index are highlighted with various colours while the rest of the countries are illustrated as grey dots. Delving into the three skills pillars, we see that the distribution of scores for the *Activation* and *Matching* pillars are wider than the *Development* pillar.

Czechia´s high score in the *Skills Matching* pillar is clearly seen in the underlying *Skills Utilisation* and *Skills Mismatch* sub-pillar scores. Generally, the low scoring countries at index level are scoring low in the pillar and sub-pillar levels as well.

In the *Basic Education* sub-pillar, none of the scores falls below 30, reflecting the relatively good performance in most countries in providing basic skills. The sub-pillar *Skills Mismatch* has the lowest average score, closely followed together by the *Training and other Education* sub-pillar, highlighting difficulties to provide effective training beyond basic education in many countries. The *Skills Utilisation* sub-pillar shows the highest average score among sub-pillars, with scores ranging from 20 to 99.



Source: European Skills Index (2024), Cedefop.

Figure 6. Distribution of 2024 ESI, Pillars and Sub-Pillars scores

Note: each dot represents a country. The three highest (CZ, SE and DK) and three lowest (EI, IT and ES) scoring ESI countries are highlighted (in diverse colours). The other 25 countries are illustrated as grey dots. First column represents the Index scores, next three columns the Pillar scores (*Development*, *Activation* and *Matching*) and the following six columns represent the Sub-Pillar scores (*Basic Education*, *Training and other Education*, *Transition to Work, Labour Market Participation* , *Skills Utilisation* and *Skills Mismatch*).

Table 4 gives the scores and ranks of the index and pillars in more detail. This shows again that the high score of Czechia is mainly driven by its high score in the *Skills Matching* pillar, and this in turn is driven by high values in many of the indicators in this pillar, including top ranks in *underemployed part-time workers* and *qualification mismatch* and *low-wage workers* (in these cases the lowest values observed).

Conversely we observe that some of the bottom-ranking countries have especially low scores in *Skills Activation*, including Italy and Romania. This is due in both cases to low activity rates, high numbers of early leavers from training and low numbers of recent graduates in employment. Romania on the other hand, has a high score in Skills Matching (rank 5th), owing to high ranks (meaning low scores) in *low waged workers* (ranked 2nd) and *qualification mismatch* (ranked 7th). Annex 3: Sub-pillar and indicator scores and ranks contains tables with scores and ranks of the sub-pillars and indicators.

Table 4. Index and Pillar scores (blue) and ranks (green)

Country	ESI Rank	ESI	Skills Development	Skills Activation	Skills Matching	Skills Dev. Rank	Skills Act. Rank	Skills Mat. Rank
Czechia	1	70	60	54	92	11	23	1
Sweden	2	67	62	78	66	8	4	10
Denmark	3	67	64	68	68	5	8	8
Finland	4	67	78	60	64	1	18	11
Iceland	5	66	63	83	58	6	2	17
Slovenia	6	65	58	67	70	13	9	6
Estonia	7	65	68	63	64	3	16	13
Luxembourg	8	64	61	60	69	10	19	7
Poland	9	64	52	59	77	17	20	3
Malta	10	63	41	82	73	24	3	4
Netherlands	11	63	65	87	51	4	1	23
Switzerland	12	62	73	71	51	2	7	21
Hungary	13	62	47	51	85	22	24	2
Croatia	14	62	59	57	67	12	21	9
Austria	15	60	62	73	52	7	5	20
Germany	16	60	55	66	60	15	11	16
Norway	17	59	61	66	54	9	10	18
Latvia	18	59	49	65	62	19	13	14
Slovakia	19	55	56	43	64	14	26	12
Lithuania	20	54	49	66	52	20	12	19
Belgium	21	50	52	47	51	18	25	22
Ireland	22	48	54	73	34	16	6	26
France	23	46	37	56	48	26	22	24
Portugal	24	45	37	62	43	27	17	25
United Kingdom	25	42	48	63	30	21	15	29
Bulgaria	26	41	34	26	62	29	29	15
Cyprus	27	39	32	64	33	31	14	28
Romania	28	33	34	9	70	30	31	5
Greece	29	28	35	37	20	28	27	30
Italy	30	26	41	11	33	25	30	27
Spain	31	24	43	36	12	23	28	31

Source: European Skills Index (2024), Cedefop.

5.3 Time series of the index scores

Tables 5-6 show the changes in the ESI scores and the ESI rankings over the period 2015-2022 (2017 ESI-2024 ESI) [13]. Czechia has maintained the first position throughout the eight-years period. Sweden has had the second place in six out of the eight years. For the first time Denmark has reached the third place in ranking, moved up five places from the 8th place in 2019 ESI.

Hungary has increased with six places in ranking, from 19th position in 2017 ESI to 13th position 2024 ESI. Ireland has increased with five positions (from 27th to 22nd place) and four countries (Poland, Malta, the Netherlands and Croatia) have increased with four positions in the eight-years period. On the other hand, Norway has dropped ten places in ranking, from the 7th place in 2017 ESI to the 17th place in this release of the index, 2024 ESI. Luxembourg and Germany have dropped 5 places in ranking during this time period. The bottom of the ranking is occupied by Greece, Italy and Spain throughout the whole period.

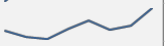
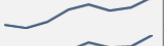
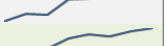
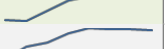
It is important to point out however, that all countries have shown a net score improvement over the eight observed years, which means that the underlying indicators have shown improvements on average. However, in some cases these gains have been marginal: Luxembourg has only increased its score by 0.42, and Norway by 0.03, which are in both cases effectively negligible and explain the falls in ranks for these countries, since other countries have improved more in the same time period.

The relative increases in index scores are the largest for lower ranked countries as illustrated in Figure 7. Cyprus increased in index score from 19 to 39 in the eight-years period (a relative increase of 101%, red line in Figure 7), Ireland increased in score from 25 to 48 (88% increase, light blue line in Figure 7) and Spain increased in score from 14 to 24 (78% increase, dark blue line in Figure 7).

Overall, it is important to consider progress from two angles: the absolute progress in terms of the index scores, and the relative progress in terms of the ranks. Whereas absolute progress is essential and shows demonstrable improvements, if a country is being left behind by its peers this may comprise an important message to policy makers.

[13] By ESI methodology the release year of the index is two years ahead of the source data. Which means that the index with 2022 data is called the 2024 ESI.

Table 5. ESI scores from 2017 to 2024

ESI Rank	Country	2017 ESI	2018 ESI	2019 ESI	2020 ESI	2021 ESI	2022 ESI	2023 ESI	2024 ESI	Trendline
1	Czechia	66	69	71	72	73	69	70	70	
2	Sweden	64	66	67	69	67	64	66	67	
3	Denmark	62	61	61	63	64	63	63	67	
4	Finland	61	60	63	67	68	67	66	67	
5	Iceland	61	62	60	60	64	60	62	66	
6	Slovenia	55	53	63	67	64	62	64	65	
7	Estonia	55	57	63	64	64	62	63	65	
8	Luxembourg	63	62	63	65	65	61	61	64	
9	Poland	52	56	58	61	62	62	61	64	
10	Malta	51	55	58	58	59	60	61	63	
11	Netherlands	51	55	58	61	62	62	62	63	
12	Switzerland	57	58	57	58	60	60	60	62	
13	Hungary	49	51	55	56	56	57	61	62	
14	Croatia	49	51	50	54	60	61	59	62	
15	Austria	52	51	53	56	58	56	57	60	
16	Germany	55	54	56	57	59	58	58	60	
17	Norway	59	59	61	61	62	61	59	59	
18	Latvia	50	51	53	51	50	54	54	59	
19	Slovakia	50	52	51	51	52	52	52	55	
20	Lithuania	48	51	52	55	55	53	54	54	
21	Belgium	44	46	46	49	50	49	49	50	
22	Ireland	25	33	37	39	42	42	45	48	
23	France	38	40	39	44	44	44	44	46	
24	Portugal	33	33	37	41	43	42	44	45	
25	United Kingdom	37	39	40	42	43	42	42	42	
26	Bulgaria	31	27	36	35	39	37	34	41	
27	Cyprus	19	21	22	32	35	35	37	39	
28	Romania	28	27	35	37	40	40	32	33	
29	Greece	19	18	18	20	22	24	26	28	
30	Italy	17	18	17	17	19	15	19	26	
31	Spain	14	15	18	19	20	19	21	24	

0-25% score increase | 26-50% score increase | 51-75% score increase | more than 75% score increase

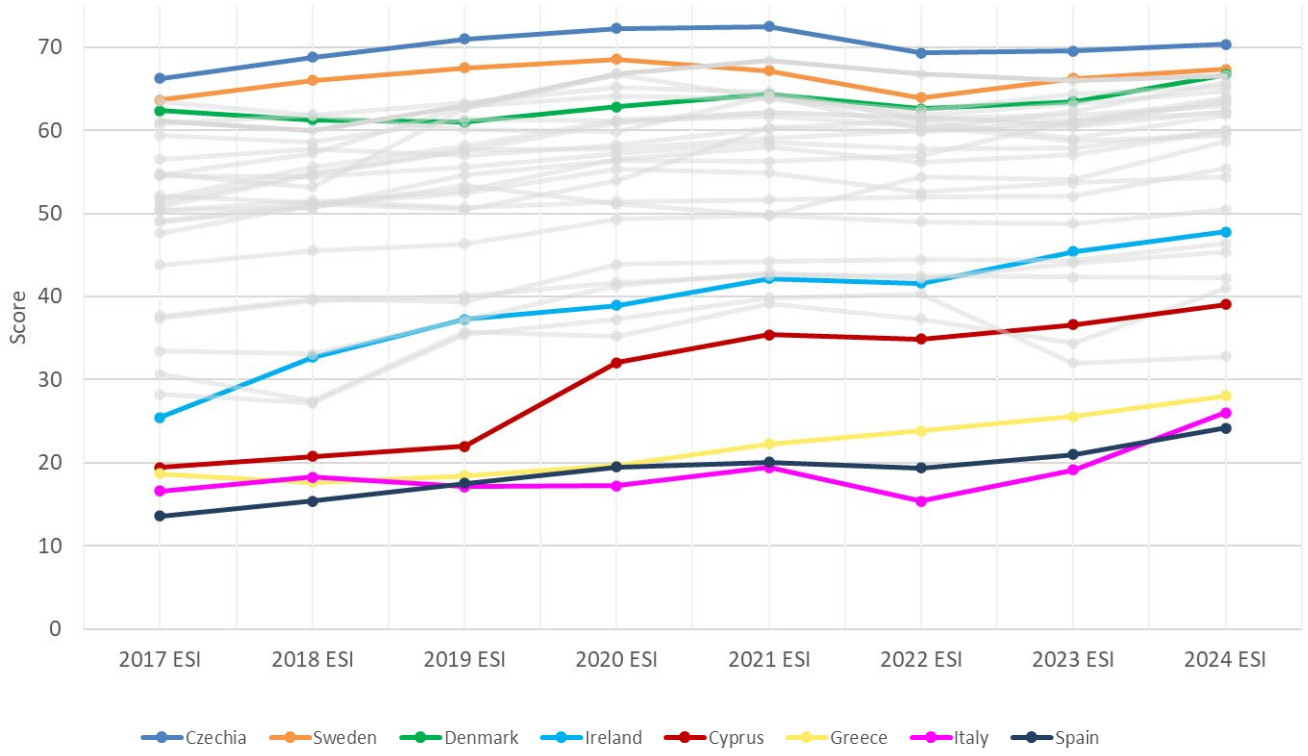
Source: European Skills Index (2024), Cedefop.

Table 6. ESI ranks from 2017 to 2024

ESI Rank	Country	2017 ESI Rank	2018 ESI Rank	2019 ESI Rank	2020 ESI Rank	2021 ESI Rank	2022 ESI Rank	2023 ESI Rank	2024 ESI Rank	Rank Diff Max Min	Rank Diff 2024-2017
1	Czechia	1	1	1	1	1	1	1	1	0	0
2	Sweden	2	2	2	2	3	3	2	2	1	0
3	Denmark	4	5	8	7	5	4	5	3	5	+1
4	Finland	5	6	4	3	2	2	3	4	4	+1
5	Iceland	6	4	9	11	6	12	7	5	8	+1
6	Slovenia	9	14	6	4	7	5	4	6	10	+3
7	Estonia	10	9	5	6	8	6	6	7	5	+3
8	Luxembourg	3	3	3	5	4	9	10	8	7	-5
9	Poland	13	10	10	8	9	7	12	9	6	+4
10	Malta	14	11	11	13	14	13	11	10	4	+4
11	Netherlands	15	12	12	10	10	8	8	11	7	+4
12	Switzerland	8	8	13	12	12	14	13	12	6	-4
13	Hungary	19	20	15	16	17	16	9	13	11	+6
14	Croatia	18	17	20	18	13	10	14	14	10	+4
15	Austria	12	16	17	15	16	17	17	15	5	-3
16	Germany	11	13	14	14	15	15	16	16	5	-5
17	Norway	7	7	7	9	11	11	15	17	10	-10
18	Latvia	17	19	16	20	21	18	18	18	5	-1
19	Slovakia	16	15	19	19	19	20	20	19	5	-3
20	Lithuania	20	18	18	17	18	19	19	20	3	0
21	Belgium	21	21	21	21	20	21	21	21	1	0
22	Ireland	27	25	24	25	25	25	22	22	5	+5
23	France	22	22	23	22	22	22	23	23	1	-1
24	Portugal	24	24	25	24	23	24	24	24	2	0
25	United Kingdom	23	23	22	23	24	23	25	25	3	-2
26	Bulgaria	25	26	26	27	27	27	27	26	2	-1
27	Cyprus	28	28	28	28	28	28	26	27	2	+1
28	Romania	26	27	27	26	26	26	28	28	2	-2
29	Greece	29	30	29	29	29	29	29	29	1	0
30	Italy	30	29	31	31	31	31	31	30	2	0
31	Spain	31	31	30	30	30	30	30	31	1	0

Source: European Skills Index (2024), Cedefop.

Note: the second last column (Rank diff Max Min) shows the maximum difference in rank positions during the whole time interval. Grey highlighted cells show countries with at least 4 positions in rank change. An example, Slovakia was ranked 15th in 2018 ESI and 20th in 2022 ESI and 2023 ESI, therefore the rank difference is 5 positions. The last column (Rank diff 2024-2017) shows the difference in ranks from 2017 ESI and 2024 ESI. Light green cells show countries with an increase in rank positions of four or more places while pale pink cells show countries with a decrease in rank positions with 4 or more places. For example, Hungary was ranked 19th in 2017 ESI and gained 6 positions to 13th place in 2024 ESI. Norway on the other hand was ranked 7th in 2017 ESI but dropped 10 places to 17th place in 2024 ESI.



Source: European Skills Index (2024), Cedefop.

Figure 7. Time series of the index scores

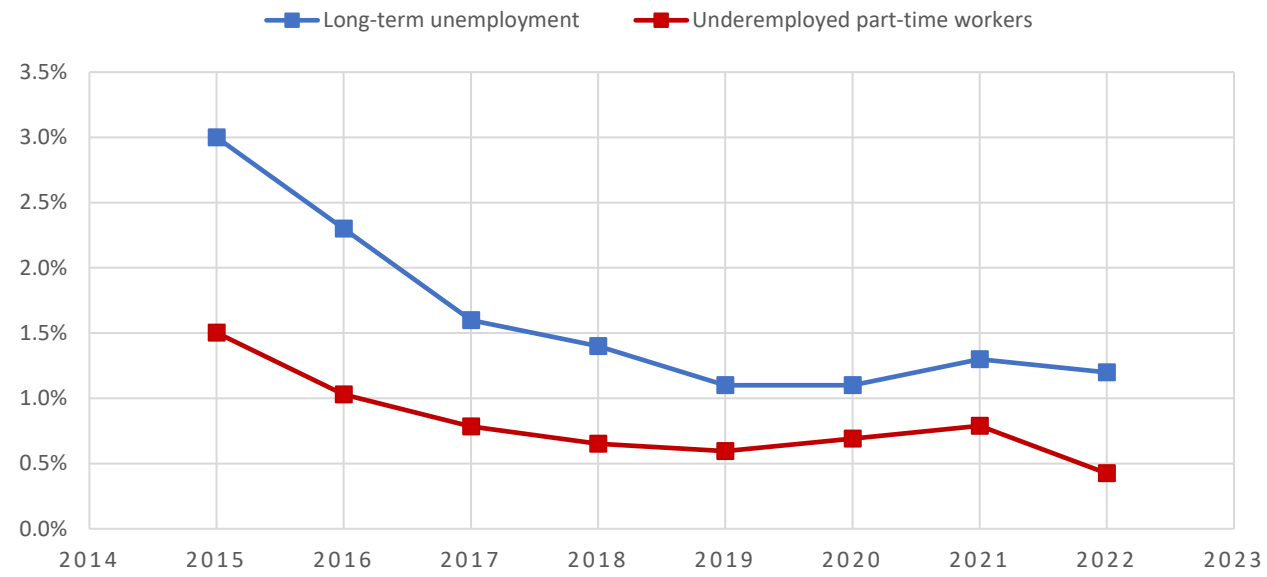
5.4 Country highlights

In this section we briefly highlight several countries that have shown interesting patterns over the observed time series.

5.4.1 Hungary

Hungary is an example of a country that has improved significantly relative to its peers over the last eight years. It shows the highest rank increase over 2017-2024, having increased 6 places from 19th place in 2017 to 13th place in 2024. In that time its overall score has increased from 49 to 62.1, which also corresponds to one of the highest absolute score improvements observed.

In 2024, the highest-ranking indicators of Hungary, in comparison with other countries, were *qualification mismatch* (21.3%, rank 3rd) and *underemployed part-time workers* (0.425%, rank 3rd). On the other hand, its weakest indicators are *early leavers from training* (6.9%, rank 27th) and *recent training* (7.9%, rank 26th).



Source: European Skills Index (2024), Cedefop.

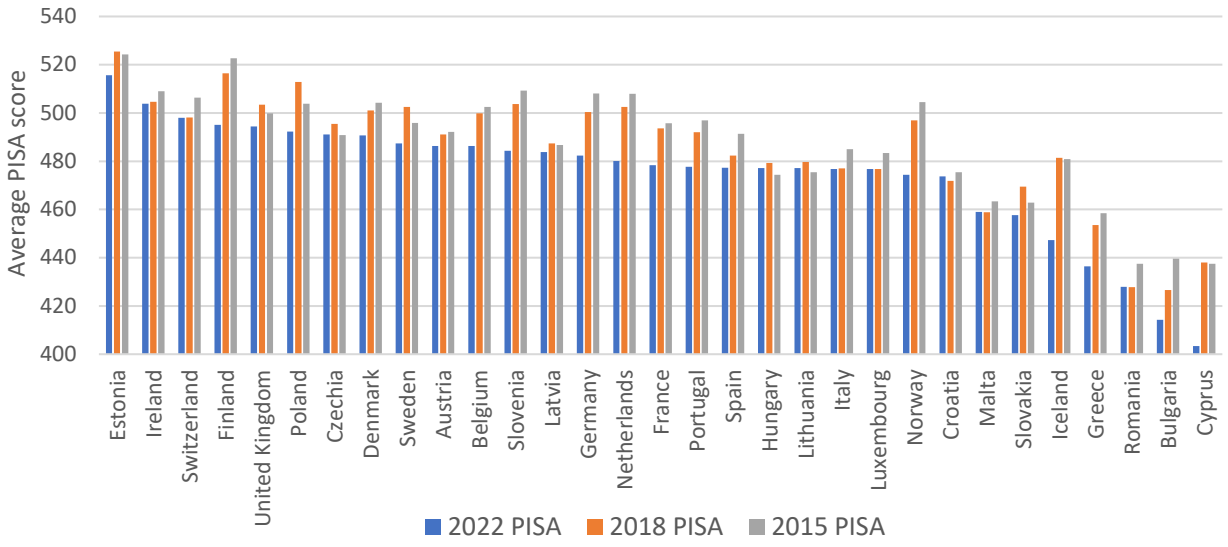
Figure 8. *Long-term unemployment* and *underemployed part-time workers* indicators in Hungary over 2015-2022

The improvement of Hungary is due, among other things, to falls *in long-term unemployment* (3% in 2015 to 1.2% in 2022 – see Figure 8), and *VET students* (23.2% in 2015 to 49.7% in 2022), with a corresponding increase in activity rate. On the other hand, it has seen decreases in scores for *low-wage workers (ISCED 5-8)* (2.5% in 2015 to 4.7% in 2022), and *pre-primary pupil-to-teacher ratio* (12.5 in 2015 to 12.7 in 2022).

5.4.2 Ireland

Ireland is another example of a country that has improved substantially in index scores in the eight-year interval studied. It is the country with the second largest relative increase in index scores, from 25.4 in 2017 to 47.8 in 2024, which corresponds to an 88% increase. The index score increase is illustrated in Figure 7 and corresponds to rank increase in five positions from 27th place in 2017 to 22nd place in 2024. Ireland is ranked 16th in *Skills Development* (score: 54), 6th in *Skills Activation* (score: 72.6) and 26th in *Skills Matching* (score: 33.7).

Many countries saw student learning outcomes decline in the last PISA evaluation, released in December 2023. Ireland had a smaller decline in scores between the PISA waves compared to many other countries and was ranked 2nd (score of 504 – see Figure 9) in the last PISA evaluation, corresponding to the *reading, maths & science scores* indicator. This was one of highest-ranking indicators of Ireland together with *early leavers from training* (2%, rank 3rd). On the other hand, its weakest indicators are *low-wage workers* (ISCED 5-8) (18.8%, rank 31st) and *VET students* (23.9%, rank 30th).

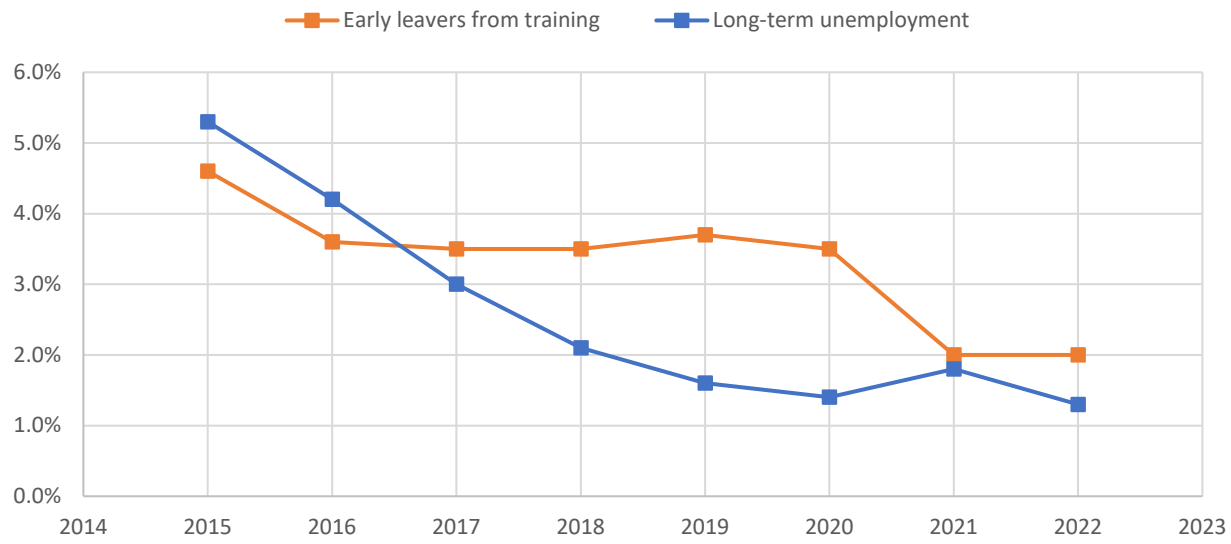


Source: European Skills Index (2024), Cedefop.

Figure 9. *Reading, maths & science scores* indicator in the last three PISA evaluations

Note: the countries are ordered by the highest average scores in the last PISA evaluation (2022 PISA). The 2022 PISA values of Luxembourg is imputed from the previous PISA evaluation (2018 PISA).

Ireland´s good progress in index scores is partly due to the decrease in *long-term unemployment* (5.3% in 2015 to 1.3% in 2022) and decrease in *early leavers from training* (4.6% in 2015 to 2% in 2022), as illustrated in Figure 10.



Source: European Skills Index (2024), Cedefop.

Figure 10. *Early leavers from training* and *long-term unemployment* indicators in Ireland over 2015-2022

The indicators that have shown the greatest declines are VET students (35.7% in 2015 to 23.9% in 2022), and Low-wage workers (ISCED 5-8) (15.2% in 2015 to 18.8% in 2022).

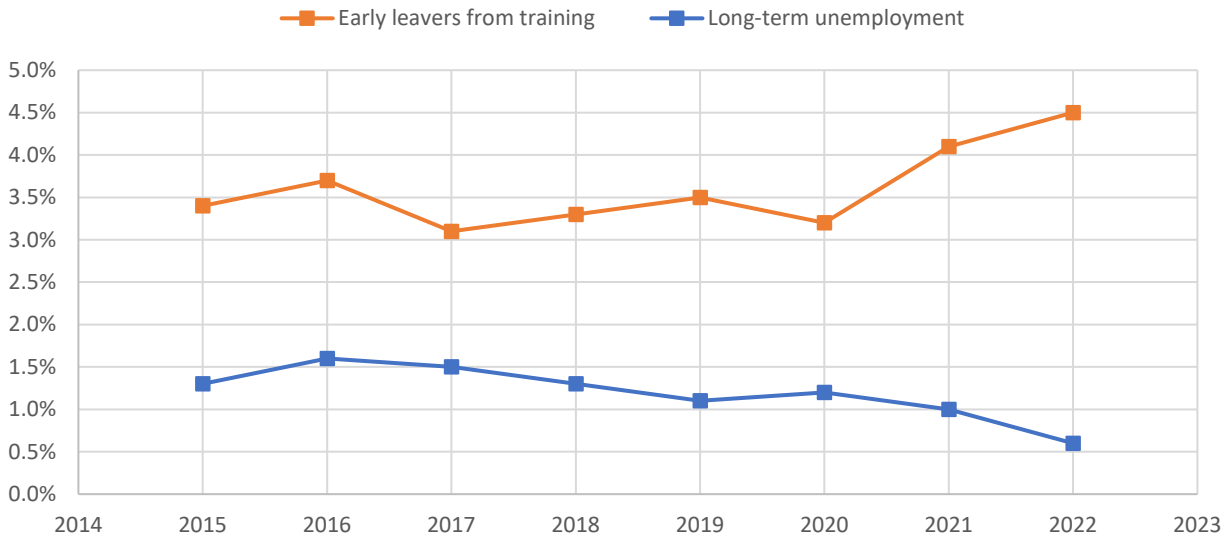
5.4.3 Norway

Norway is the country with the smallest net score increase during the eight observed years. It has only increased its score by 0.03, from 59.1 to 59.4 in the latest version of ESI. On average the scores increased by 25% for the 31 countries. This marginal net increase in scores explains Norway's fall of ten rank positions, from 7th position in 2017 ESI to 17th place in 2024 ESI. At the pillar level, in 2024, it ranks 9th in *Skills Development* (score: 61.1), 10th in *Skills Activation* (score: 66) and 18th in *Skills Matching* (score: 54.5).

The highest-ranking indicators of Norway, in comparison with other countries, are *high digital skills* (51.1%, rank 2nd) and *long-term unemployment* (0.6%, rank 3rd). On the other hand, its weakest indicators are *upper secondary attainment* (and above) (75%, rank 25th) and *activity rate (aged 25-54)* (86.6%, rank 24th).

Many of the indicators have only marginally improved in scores during the considered eight years and the indicators that have improved the most are *pre-primary pupil-to-teacher ratio* (16 in 2017 to 11.4 in 2024), and *long-term unemployment* (1.3% in 2017 to 0.6% in 2024 – as illustrated in Figure 11). But instead of decreasing, the *early leavers from training* has increased in Norway (3.4% in 2017 to 4.5% in 2024). Figure 11 shows this contrasting behaviour of *early leavers from training* going in the "wrong direction" compared to *long-term unemployment* going in the "correct direction".

Norway has experienced the biggest drop in *reading, maths & science scores in the PISA* evaluations among the 31 countries, a drop with more than 30 points, from 504.5 in 2017 to 474.4 in 2024, as shown in Figure 9.



Source: European Skills Index (2024), Cedefop.

Figure 11. *Early leavers from training* and *long-term unemployment* indicators in Norway over 2015-2022

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Annex 1: Indicator metadata

Table 7. Information about the ESI indicators

Indicator (Unit of measurement)	Description	Relevance of indicator (direction of effect)	Source of data (dataset code)	Country coverage	Time coverage
Skills Development					
Pre-primary pupil-to-teacher ratio (students per teacher)	Ratio of pupils and students to teachers and academic staff at the pre-primary education level (ISCED11 level 0, 3 years to the start of primary education.)	Proxy for the quality of teaching at pre-primary education level. (-) A lower value for Pre-primary pupil-to-teacher ratio is interpreted as a better outcome.	Eurostat Collected by the UNESCO, OECD, Eurostat joint data collection (Eurostat code educ_uoe_perp04)	EU 27 plus Iceland, Liechtenstein, Norway, United Kingdom, Bosnia and Herzegovina, Montenegro, North Macedonia, Serbia, Turkey,	2013-2021
Upper secondary education (and above) (%)	Share of population aged 15-64 with at least upper secondary education (ISCED11 level 3-8)	Proxy for the education attainment level of the country (+)A higher value for Upper secondary education (and above) is interpreted as a better outcome.	Eurostat - Labour Force Survey (Eurostat code edat_lfse_03)	EU 27 plus Iceland, Norway, Switzerland, United Kingdom, Montenegro, North Macedonia, Serbia, Turkey	1992 - 2022
Reading, maths & science scores (PISA score)	Average PISA scores (15-year olds) for the reading, maths & science modules.	Proper levels of basic competences are key outcomes of initial education because they build the foundation for long-term economic growth of societies and social inclusion of individuals. Average across three separate indicators. (+) A higher value for Reading, maths & science scores is interpreted as a better outcome.	OECD PISA programme	OECD plus other partner countries for a total of 80 countries in the 2022 edition (released 05/12/23).	8 rounds, every three years, starting in 2000, last one being in 2022
Recent training (%)	Share of population aged 25-64 who stated that they received formal or non-formal education or training in the four weeks preceding the survey.	Continued learning after initial education is crucial for raising productivity levels of the working-age population and tackling skill mismatches and bottlenecks on the labour market. Matches EC E&T Monitor Target 6. (+) A higher value for Recent training is interpreted as a better outcome.	Eurostat - Labour Force Survey, (Eurostat code trng_lfse_01)	EU 27 plus Iceland, Norway, Switzerland, United Kingdom, Montenegro, North Macedonia, Serbia, Turkey	1992 - 2022

VET students (%)	Share of the population at ISCED11 level 3 attending vocational training	Evidence shows that within the group of graduates from upper secondary education, graduates from vocational education and training (VET) programmes have better employment prospects, particularly in countries where work-based learning is a strong component of VET programmes. EC E&T Monitor Target 13. (+) A higher value for VET students is interpreted as a better outcome.	Eurostat Collected by the UNESCO, OECD, Eurostat joint data collection (Eurostat code educ_uoe_enra13)	EU 27 plus Iceland, Norway, Switzerland, United Kingdom, Montenegro, North Macedonia, Serbia, Turkey, with a further breakdown at NUTS 2 level	2013 - 2021
High digital skills (%)	Share of individuals who performed more than one activity in all skills domain (information, communication, problem-solving, software)	Digital competences are required for employability and active participation in society. (+) A higher value for High digital skills is interpreted as a better outcome.	Eurostat Community survey on ICT usage in households and by individual (Eurostat code isoc_sk_dskl_i (until 2019)	EU 27 plus Iceland, Norway, Switzerland, United Kingdom, Bosnia and Herzegovina, Montenegro, North Macedonia, Albania, Serbia, Turkey	2015, 2016, 2017, 2019,
Skills Activation					
Early leavers from training (%)	Early leavers from education and training (work status 'not in employment') as a share of the population, aged 18-24 having attained ISCED11 level 0, 1, 2 or 3c short and not receiving any formal or non-formal education or training in the four weeks preceding the survey.	Early leavers experience reduced lifetime earnings and longer and more frequent unemployment spells; early leaving also brings large public and social costs. (-) (-) A lower value for Early leavers from training is interpreted as a better outcome.	Eurostat - Labour Force Survey (Eurostat code edat_lfse_14)	EU 27 plus Iceland, Norway, Switzerland, United Kingdom, Montenegro, North Macedonia, Serbia, Turkey	1992-2022
Recent graduates in employment (%)	Share of employed people aged 20-34 having successfully completed upper secondary or tertiary education 1 to 3 years before the reference year of the survey and who are no longer in education or training.	Although education and training cannot compensate for the economic downturn, the quality and relevance of education can be strengthened to better meet the needs of the modern labour market. Matches EC E&T Monitor Target 5 A higher value for Recent graduates in employment is interpreted as a better outcome.	Eurostat - Labour Force Survey (Eurostat code edat_lfse_24)	EU 27 plus Iceland, Norway, Switzerland, United Kingdom, Montenegro, North Macedonia, Serbia, Turkey	2000-2022
Activity rate (aged 25-54) (%)	Employed/active persons as a share of same age total population	The supply of skills can be increased through higher activation. (+) A higher value for Activity rate (aged 25-54) is interpreted as a better outcome.	Eurostat - Labour Force Survey (Eurostat code lfsa_argaed)	EU 27 plus Iceland, Norway, Switzerland, United Kingdom, Montenegro, North Macedonia, Serbia, Turkey	1983-2022
Activity rate (aged 20-24) (%)	Employed/active persons as a share of same age total population	Integrating under-represented groups into the labour force can increase the skills base in an economy. (+) A higher value for Activity rate (aged 20-24) is interpreted as a better outcome.	Eurostat - Labour Force Survey (Eurostat code lfsa_argaed)	EU 27 plus Iceland, Norway, Switzerland, United Kingdom, Montenegro, North Macedonia, Serbia, Turkey	1983-2022
Skills Matching					

Long-term unemployment (%)	Share of unemployed persons since 12 months or more in the total number of active persons in the labour market	Gives some indication of structural mismatch and of the effectiveness of a skills system in responding to skill obsolescence. (-) A lower value for Long-term unemployment is interpreted as a better outcome.	Eurostat - Labour Force Survey (Eurostat code une_ltu_a)	EU 27 plus Iceland, Norway, Switzerland, Montenegro, North Macedonia, Serbia, Turkey (No UK)	2003-2022
Underemployed part-timers (%)	Underemployed part-time workers aged 15-74 as share of active population. Persons working on an involuntary part-time basis are those who declare that they work part-time because they are unable to find full-time work	Ineffective use of skills - labour is underutilised among persons already employed and willing to work more hours. (-) A lower value for Underemployed part-timers is interpreted as a better outcome.	Eurostat - Labour Force Survey (Eurostat code lfsa_sup_age and lfsa_agan)	EU 27 plus Iceland, Norway, Switzerland, United Kingdom, Montenegro, North Macedonia, Serbia, Turkey	2006-2022 (lfsa_aga), 1995-2022 (lfsa_aga),
Overqualification rate (tertiary education ISCED 5-8) (%)	Share of employed people aged 25-34 with ISCED11 level 5-8 that occupy jobs NOT corresponding to ISCO 1, 2 or 3	Gives an indication of ineffective use of skills – highly-educated employees working in lower skilled jobs (-) A lower value for Over-qualification rate is interpreted as a better outcome.	Elaboration from Labour Force Survey microdata	EU 27 plus Iceland, Norway, Switzerland, United Kingdom	2015-2021
Low waged workers (ISCED 5-8) (%)	This is defined as the proportion of low wage earners out of all employees of ISCED11 level 5-8 qualification level, where low wage is defined as "those employees (excluding apprentices) earning two-thirds or less of the national median gross hourly earnings in that particular country"	Gives an indication of the ineffective use of skills - high-educated employees in low wage employment (-) A lower value for Low-waged workers (ISCED 5-8) is interpreted as a better outcome.	Elaboration of EU-SILC microdata	EU-27 plus Iceland, Norway, Switzerland, United Kingdom	2015-2022
Qualification mismatch (%)	The measure is calculated by taking the modal education attainment level for each occupation in each industry and assessing whether each employee's education attainment level matches it	Measures incidences of both underqualification and overqualification, which provides an indication of ineffective use of skills, or the need for upskilling. (-) A lower value for Qualification mismatch is interpreted as a better outcome.	Special request from OECD from the Skills for Jobs database, https://www.oecdskillsforjobsdatabase.org/	EU-27 plus Iceland, Norway, Switzerland, United Kingdom	2015-2019

Annex 3: Sub-pillar and indicator scores and ranks

Table 8. Sub-Pillar scores

Country	ESI Rank	Basic Education	Training and other Education	Transition to Work	Labour Market Participation	Skills Utilisation	Skills Mismatch
Czechia	1	70	51	64	44	99	88
Sweden	2	58	66	75	80	62	68
Denmark	3	62	65	65	70	84	58
Finland	4	75	81	57	63	62	65
Iceland	5	59	68	84	82	80	43
Slovenia	6	49	67	71	63	84	60
Estonia	7	85	52	47	79	89	47
Luxembourg	8	61	61	78	41	70	69
Poland	9	68	37	71	47	94	65
Malta	10	45	37	79	85	92	61
Netherlands	11	47	83	93	80	55	47
Switzerland	12	72	74	65	78	57	48
Hungary	13	58	37	48	54	94	79
Croatia	14	65	53	75	39	72	65
Austria	15	59	66	70	77	77	35
Germany	16	64	45	63	68	89	41
Norway	17	54	68	67	65	71	44
Latvia	18	66	33	71	59	79	51
Slovakia	19	59	54	45	41	68	61
Lithuania	20	70	28	68	63	76	36
Belgium	21	57	48	65	30	57	47
Ireland	22	77	31	82	63	60	16
France	23	34	40	50	61	53	45
Portugal	24	33	41	71	53	60	32
United Kingdom	25	41	54	57	69	42	22
Bulgaria	26	45	23	31	21	84	47
Cyprus	27	44	20	59	68	52	20
Romania	28	39	29	7	12	77	66
Greece	29	48	22	49	26	34	10
Italy	30	44	38	15	6	38	30
Spain	31	41	45	30	43	20	8

Table 9. Sub-Pillar ranks

Country	ESI Rank	Basic Education Rank	Training and other Education Rank	Transition to Work Rank	Labour Market Participation Rank	Skills Utilisation Rank	Skills Mismatch Rank
Czechia	1	5	15	18	22	1	1
Sweden	2	16	8	6	4	19	4
Denmark	3	11	9	16	8	7	12
Finland	4	3	2	22	13	20	7
Iceland	5	13	5	2	2	10	21
Slovenia	6	20	6	8	16	9	11
Estonia	7	1	14	26	5	5	18
Luxembourg	8	12	10	5	25	17	3
Poland	9	7	24	9	21	2	6
Malta	10	24	23	4	1	4	10
Netherlands	11	22	1	1	3	25	15
Switzerland	12	4	3	17	6	24	14
Hungary	13	17	22	25	19	3	2
Croatia	14	9	13	7	26	15	8
Austria	15	15	7	12	7	13	24
Germany	16	10	18	19	11	6	22
Norway	17	19	4	14	12	16	20
Latvia	18	8	25	11	18	11	13
Slovakia	19	14	12	27	24	18	9
Lithuania	20	6	28	13	15	14	23
Belgium	21	18	16	15	27	23	17
Ireland	22	2	26	3	14	21	29
France	23	30	20	23	17	26	19
Portugal	24	31	19	10	20	22	25
United Kingdom	25	27	11	21	9	28	27
Bulgaria	26	23	29	28	29	8	16
Cyprus	27	26	31	20	10	27	28
Romania	28	29	27	31	30	12	5
Greece	29	21	30	24	28	30	30
Italy	30	25	21	30	31	29	26
Spain	31	28	17	29	23	31	31

Table 10. ESI Indicator values

Country	ESI Rank	PTRatio	SecEd	PISA	RecTrain	VET	DigiSkill	LeaveTrain	EmpGrads	Emp20_24	Emp25_54	LTUnemp	UnderEmpPT	Overqual	LowWage	QMismatch
Czechia	1	11.7	87.7	491.1	9.4	69.1	25.8	3.5	82.2	50.4	89.2	0.6	0.3	16.4	2.1	16.7
Sweden	2	13.8	80.5	487.4	36.2	35.4	46.0	3.1	88.1	73.1	91.6	1.9	3.2	14.9	9.7	27.1
Denmark	3	10.2	74.2	490.6	27.9	39.1	48.5	3.9	85.1	75.2	87.8	0.5	2.2	16.4	8.9	31.5
Finland	4	8.4	81.9	495.1	25.2	67.3	50.1	4.8	83.9	69.0	88.1	1.5	3.6	17.2	3.9	28.3
Iceland	5	4.5	74.7	447.3	27.1	29.5	61.6	2.6	92.1	81.4	89.6	0.5	2.6	17.9	7.9	38.7
Slovenia	6	19.0	86.2	484.3	22.3	69.8	31.1	2.9	84.2	55.8	92.9	1.6	1.2	23.3	9.3	23.8
Estonia	7		83.1	515.6	21.1	40.3	37.0	5.0	77.4	74.7	90.8	1.3	0.9	12.2	16.8	39.0
Luxembourg	8	9.2	75.8	476.7	18.1	60.8	35.8	3.7	93.4	46.7	89.9	1.3	3.0	4.4	12.8	29.8
Poland	9	12.8	87.1	492.3	7.6	53.8	21.3	3.0	84.7	56.7	87.8	0.9	0.8	23.7	4.1	22.3
Malta	10	10.0	66.9	459.0	12.8	27.0	38.3	3.1	90.8	79.5	90.6	1.0	0.9	20.2	6.9	
Netherlands	11	15.9	77.0	480.1	26.4	68.7	49.6	1.6	92.9	85.4	89.1	0.7	5.1	15.5	8.5	38.2
Switzerland	12		81.5	498.0	22.0	61.9	49.3	3.7	83.7	75.4	90.0	1.5	4.2	17.9	10.2	35.4
Hungary	13	12.7	81.3	477.2	7.9	49.7	25.4	6.9	88.9	53.9	91.1	1.2	0.4	15.9	4.7	21.3
Croatia	14	10.1	83.9	473.8	4.4	70.0	35.3	1.4	78.5	55.5	86.0	2.4	1.8	19.5	5.7	
Austria	15	13.7	81.4	486.3	15.8	68.9	39.2	3.8	88.4	75.7	89.6	1.2	2.3	26.5	10.6	34.9
Germany	16	9.0	77.0	482.4	8.1	47.2	38.8	5.4	92.2	73.6	87.8	1.0	1.2	17.6	7.5	39.9
Norway	17	11.4	75.0	474.4	21.1	51.5	51.1	4.5	89.7	74.7	86.6	0.6	3.6	21.0	9.0	35.2
Latvia	18	11.4	85.1	483.9	9.7	40.1	24.5	3.2	85.3	67.0	87.7	2.0	1.3	15.2	10.2	36.1
Slovakia	19	11.4	87.2	457.7	12.8	67.6	27.1	6.3	83.9	47.0	89.8	4.1	0.5	27.6	4.4	21.0
Lithuania	20	10.2	88.7	477.2	8.5	25.8	32.3	3.2	83.4	63.5	90.1	2.3	1.4	24.0	14.8	34.8
Belgium	21	13.4	78.3	486.3	10.3	53.6	34.2	3.5	82.9	47.6	86.1	2.3	3.4	21.1	7.6	33.6
Ireland	22		82.5	503.8	11.8	23.9	34.1	2.0	87.2	74.2	86.1	1.3	4.0	28.0	18.8	41.5
France	23	22.3	78.7	478.3	13.3	40.1	30.9	4.7	78.6	66.8	88.2	2.0	4.1	22.7	7.5	33.3
Portugal	24	15.6	60.4	477.6	13.8	38.8	32.1	2.5	81.7	52.4	91.2	2.7	2.7	19.7	7.3	43.6
United Kingdom	25	39.7	80.9	494.4	14.8	41.5	48.9	5.0	85.4	75.9	87.2		4.3	26.1	15.6	40.5
Bulgaria	26	11.9	80.0	414.2	1.7	52.0	11.3	7.3	78.8	40.8	85.9	2.3	0.4	28.8	11.5	25.5
Cyprus	27	13.0	81.1	403.4	10.5	17.6	25.2	4.1	81.4	69.7	89.4	2.3	3.9	37.0	13.9	34.2
Romania	28	14.4	79.3	427.9	5.4	56.9	10.3	9.8	69.9	44.2	82.1	2.2	1.3	19.6	2.6	26.1
Greece	29	9.6	77.3	436.5	3.5	33.8	23.3	2.7	66.1	46.7	85.3	7.7	3.3	40.2	4.7	42.6
Italy	30	11.2	61.2	476.8	9.6	51.9	22.0	7.0	65.2	44.8	78.6	4.6	3.3	25.0	10.8	38.6
Spain	31	12.7	62.3	477.3	15.3	38.7	36.1	7.5	79.1	54.6	87.4	5.0	4.9	37.8	14.6	41.0

Table 11. ESI Indicator scores

Country	ESI Rank	PTRatio	SecEd	PISA	RecTrain	VET	DigiSkill	LeaveTrain	EmpGrads	Emp20_24	Emp25_54	LTUnemp	UnderEmpPT	Overqual	LowWage	QMismatch
Czechia	1	61	93	60	27	90	32	69	57	26	61	98	100	75	94	97
Sweden	2	48	73	56	100	32	70	74	77	83	77	69	58	80	51	61
Denmark	3	69	55	60	87	38	75	64	67	88	52	100	74	74	56	45
Finland	4	80	77	65	78	87	77	53	63	73	54	78	52	71	84	56
Iceland	5	100	56	9	84	22	99	80	90	100	64	100	67	68	62	19
Slovenia	6	18	89	52	69	91	42	76	64	40	86	76	89	47	54	72
Estonia	7		80	89	65	40	53	50	41	87	72	82	93	91	12	18
Luxembourg	8	75	59	43	55	76	50	66	95	17	66	82	62	100	34	51
Poland	9	54	92	62	21	63	23	75	66	42	52	91	96	45	83	78
Malta	10	71	34	22	38	17	55	74	86	99	71	89	93	59	67	
Netherlands	11	36	63	47	82	89	77	93	93	100	61	96	29	78	58	21
Switzerland	12		76	68	68	77	76	66	62	89	67	78	43	68	49	31
Hungary	13	55	75	44	22	56	31	26	80	35	74	84	100	77	79	81
Croatia	14	70	83	40	11	91	50	95	45	39	40	58	81	62	74	
Austria	15	49	75	54	48	89	57	65	78	89	64	84	72	34	47	33
Germany	16	76	63	50	23	52	56	45	91	84	52	89	89	70	64	15
Norway	17	62	57	40	65	59	79	56	82	87	44	98	53	56	56	31
Latvia	18	62	86	52	28	40	29	73	68	68	51	67	87	79	49	28
Slovakia	19	62	92	21	38	87	34	34	63	18	65	20	100	30	81	82
Lithuania	20	69	96	44	24	15	44	73	61	59	67	60	86	44	24	33
Belgium	21	51	67	54	30	63	48	69	60	19	41	60	55	56	64	37
Ireland	22		79	75	35	12	47	88	74	86	41	82	46	28	1	9
France	23	0	68	45	40	40	41	54	45	67	55	67	45	49	64	38
Portugal	24	38	15	44	41	38	44	81	56	31	75	51	66	61	65	1
United Kingdom	25	0	74	64	45	42	75	50	68	90	48		42	36	19	13
Bulgaria	26	59	71	0	2	60	4	21	46	2	39	60	100	25	42	66
Cyprus	27	53	75	0	31	1	31	61	55	74	63	60	47	0	28	35
Romania	28	45	69	0	14	69	3	0	16	11	14	62	87	61	91	64
Greece	29	73	64	0	8	29	27	79	4	17	35	0	57	0	79	5
Italy	30	64	18	43	28	60	25	25	1	12	0	9	58	40	46	19
Spain	31	55	21	44	46	37	51	19	47	37	49	0	33	0	24	11

Table 12. ESI indicator ranks

Country	ESI Rank	PTRatio Rank	SecEd Rank	PISA Rank	RecTrain Rank	VET Rank	DigiSkill Rank	LeaveTrain Rar	EmpGrads Rank	Emp20_24 Rank	Emp25_54 Rank	LTUnemp Rank	UnderEmpPT Rank	Overqual Rank	LowWage Rank	QMismatch Rank
Czechia	1	14	2	7	23	3	23	13	21	24	14	3	1	7	1	1
Sweden	2	22	16	9	1	25	8	9	9	12	2	17	19	3	19	8
Denmark	3	8	27	8	2	22	7	18	13	7	18	1	14	8	16	11
Finland	4	2	10	4	5	7	3	22	16	14	17	14	24	9	3	9
Iceland	5	1	26	27	3	27	1	5	4	1	11	1	16	11	14	22
Slovenia	6	26	5	12	6	2	20	7	15	19	1	16	8	20	18	5
Estonia	7		8	1	8	19	12	23	28	8	5	11	7	2	30	23
Luxembourg	8	4	24	22	10	9	14	15	1	27	9	11	18	1	25	10
Poland	9	18	4	6	27	11	29	8	14	18	18	6	5	21	4	4
Malta	10	6	28	25	16	28	11	9	5	3	6	7	6	16	9	
Netherlands	11	25	22	15	4	5	4	2	2	1	15	5	31	5	15	20
Switzerland	12		11	3	7	8	5	15	18	6	8	14	28	12	21	18
Hungary	13	16	13	19	26	16	24	27	7	22	4	9	1	6	7	3
Croatia	14	7	7	24	29	1	15	1	27	20	27	25	13	13	8	
Austria	15	21	12	10	11	4	9	17	8	5	11	9	15	25	22	16
Germany	16	3	22	14	25	17	10	25	3	11	18	7	9	10	11	24
Norway	17	11	25	23	8	15	2	20	6	8	24	3	23	17	17	17
Latvia	18	11	6	13	21	20	26	11	12	15	21	18	11	4	20	19
Slovakia	19	11	3	26	16	6	22	26	16	26	10	27	1	26	5	2
Lithuania	20	8	1	20	24	29	18	11	19	17	7	21	12	22	28	15
Belgium	21	20	20	11	20	12	16	13	20	25	25	21	22	18	13	13
Ireland	22		9	2	18	30	17	3	10	10	25	11	26	27	31	27
France	23	27	19	16	15	20	21	21	26	16	16	18	27	19	12	12
Portugal	24	24	31	17	14	23	19	4	22	23	3	26	17	15	10	29
United Kingdom	25	27	15	5	13	18	6	23	11	4	23		29	24	29	25
Bulgaria	26	15	17	28	31	13	30	29	25	31	28	21	1	28	24	6
Cyprus	27	19	14	28	19	31	25	19	23	13	13	21	25	29	26	14
Romania	28	23	18	28	28	10	31	31	29	30	30	20	10	14	2	7
Greece	29	5	21	28	30	26	27	6	30	27	29	29	21	29	6	28
Italy	30	10	30	21	22	14	28	28	31	29	31	28	20	23	23	21
Spain	31	16	29	18	12	24	13	30	24	21	22	29	30	29	27	26