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The dynamics of ICT skills in EU Member States

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The Dynamics of ICT skills in EU Member States

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INTRODUCTION AND BACKGROUND

Digitalisation has been ongoing for at least the past 30-40 years. However, the process of digitalisation has increased at a much faster pace over the past 10 years, fuelled by improvements in broadband and mobile network speeds, as well as the proliferation of mobile devices. These developments have disrupted and changed several industries, and fostered entirely new service models, such as platform economy activities (Barnes et al., 2015; De Groen, 2017).

Vazques et al. (2019) noted the emergence of several new occupations and earning models during the past decade, including social media manager, Airbnb host, influencer, search engine optimisation (SEO) specialist, and app developer. While the occupation of app developer is closely related to the traditional occupation of computer programmer and requires highly specialised digital skills, the occupation of social media manager requires a range of broader digital skills not necessarily associated with computer programming. Similarly, from a solely digital perspective, using Airbnb to successfully offer accommodation services requires a certain proficiency in several different digital skills.

These developments, together with advancements in artificial intelligence (AI), have resulted in substantial policy interest in the impact of increasing digitalisation – the so-called digital transformation – at societal level, and on the proficiency of digital skills at the individual level. At societal level, digitalisation is seen as a key driver of future economic growth for European Union (EU) countries and regions. However, the necessary digital skills must be present in the labour force in order to take advantage of the opportunities of digitalisation. A 2018 European Central Bank (ECB) survey of digitalisation in large companies found that 'recruitment and retention of highly skilled ICT staff' and 'development of ICT skills among staff' were key obstacles to the adoption of digital technologies (Elding and Morris, 2018). At policy level, the launch of the European Commission's Skills Agenda in 2016 – updated and enhanced in 2020 (European Commission, 2020b) – with digital skills as one of its focus areas, the Digital Skills and Job Coalition, and the Digital Europe Programme aimed at shaping the digital transformation in Europe indicate the importance attached to digital skills as a driver of creation, benefit and use of digital technologies. A 2019 report from the European Commission's High-Level Expert Group on the Impact of the Digital Transformation on EU Labour Markets reiterated this point (European Commission, 2019a).

The COVID-19 pandemic has brought the issue of digitalisation and digital skills in the workforce into sharper focus. The scale of the pandemic has had an impact on the speed of adaptation of digital solutions, transforming how and where people work, at least temporarily. This highlights two other important implications. Firstly, at the aggregate level, the impact on different industries has been (and may continue to be) diverse. The adverse impact on the labour market thus has the potential to differ between countries or between regions, potentially halting or slowing down the economic and social convergence that is a key aim of the EU. Some regions will experience a limited or positive impact, while others may suffer from a permanently lower level of demand. Secondly, at the level of the individual worker, possessing sufficient digital skills has increased substantially in importance. Evidence from studies conducted prior to the onset of COVID-19 suggests that digital skills already carried individual benefits in the labour market[1]. However, COVID-19 has expanded the part of the workforce where digital skills are an advantage, if not yet a requirement.

More information on digital skills use and changes in that use over time in different regions and among different demographic groups is therefore of interest when mapping recovery and economic performance across the EU. It can also be used to inform the design of policies to mitigate the negative effects and enable digital transformation or assist regions in formulating appropriate policy responses.

Important tools and surveys assessing the proficiency of digital skills at individual level already exist. The Programme for the International Assessment of Adult Competencies (PIAAC) survey assesses digital skills competences among adults in Organisation for Economic Co-operation and Development (OECD) countries (OECD, 2013). Eurostat has an indicator of self-reported proficiency of digital skills based on the Community survey on information and communications technology (ICT) usage in households and by individuals (ICT Survey)[2]. The PIAAC is a comprehensive survey that uses a test-based assessment (reducing errors related to self-reporting), but is, however, conducted only every 10 years and not for all EU countries. The ICT Survey is undertaken annually across all EU countries, but country-specific sample sizes are relatively small, allowing only limited cross-tabulation detail.

This study[3] proposes a *digital skills intensity index* to measure the average number of digital skills used by a worker, based on their International Standard Classification of Occupations (ISCO) occupational classification. Unlike the PIAAC and ICT Survey, skills are assessed based on occupation, rather than measured or self-reported. The digital skills intensity index can be applied in combination with the EU Labour Force Survey (EU-LFS) to obtain digital skills intensities for sub-samples of the EU-LFS using sample weights. For example, digital skills intensities are computed for NUTS2 regions. The occupation-specific digital skills intensity is derived from combining the work done by the European Skills, Competencies, Qualifications and Occupations (ESCO) framework[4] of identifying occupation-specific skills and competences with the work of the Digital Competence Framework (DigComp Framework)[5] that specifies digital skills: the number of essential digital skills used in each

[1] Lane and Conlon (2016) documented higher earnings for ICT skills proficiency, while Falck et al. (2020) found a causal relationship between earnings and ICT skills. Kässi and Lehdonvirta (2019) reported that digital skills certification increases earnings for online freelancers. All three studies rely on the PIAAC dataset, where skills involved in 'using digital technology, communication tools and networks to acquire and evaluate information, communicate with others and perform practical tasks' (OECD, 2013, p.86) are measured by proficiency in solving a set of tasks relying on ICT skills. See also Grundke et al. (2018), which looks at the reward to cognitive and non-cognitive skills in low-intensity versus high digital intensity industries.

[2] Data table tepsr_sp410. See https://ec.europa.eu/eurostat/databrowser/view/tepsr_sp410/default/table?lang=en

[3] The cut-off date for the analysis presented in this study is October 2021.

[4] Developed by the European Commission and Member States: https://ec.europa.eu/esco/portal/occupation

[5] See https://ec.europa.eu/jrc/en/digcomp; Vuorikari et al. (2016).

occupation are derived by comparing the essential skills matched with each occupation in the ESCO framework with the skills identified as digital in the DigComp Framework.

The main advantage of linking a digital skills intensity index with the EU-LFS lies in the regularity and sample size of the survey. The EU-LFS is available annually (or even quarterly) with a large sample size that allows for extensive subgroup analysis. It can, for example, look at regional subsamples (NUTS2 level, or NUTS3 level if available) or analyse skills intensity in the occupations of specific groups of people.

This study found substantial variation in overall digital skills intensity across the 23 countries covered. Sweden and the Netherlands have the highest digital skills intensities, with Romania and Hungary having the lowest. The variation in outcomes is also evident among NUTS2 areas within countries, with particularly large variation in Romania. Men are overrepresented relative to women in average digital skills intensive occupations, with a strong education gradient in occupational digital skills intensity. This is most marked in countries with low overall digital intensity scores. Differences in economic structure measured by NACE categories (1 digit) explain 20-40% of observed differences in overall skills intensities. Measured at EU level, average skills intensity increased by around 5% between 2011 and 2019. All countries except Ireland experienced increases. Countries with low digital skills intensities generally had above average increases, as did countries with high skills intensities. There is no evidence of general convergence across countries on digital skills intensities. For NUTS2 regions, the changes from 2011 to 2019 were more mixed, with several regions showing a decrease in digital skills intensity. There is no sign of regions converging on digital skills intensities from the aggregated number. Looking more closely at differences in digital skills intensities for different economic activities (NACE 1 digit), there is some evidence of slow sector-by-sector convergence.

The next section describes how the digital skills intensity index is constructed, followed by a more detailed discussion of the study results and some conclusions.

METHODOLOGY AND DATA

DATA SOURCES

To construct a digital skills intensity index related to individual employment, the EU-LFS is linked to the ESCO classification system. That linking is done through the ISCO occupation code recorded both in the EU-LFS and as part of the ESCO classification system.

The ESCO classification system contains a description of around 3,000 occupations in EU Member States. These occupations are classified according to their detailed (4-digit) ISCO code. ESCO also describes more than 13,000 different skills and competences. In addition, skills are differentiated according to whether they are occupation-specific, sector-specific or cross-sectoral. Each occupation is linked to several skills, each classified as either essential or optional. Skills can be linked to more than one occupation.

To identify digital skills, the ESCO classification system is harmonised with the DigComp Framework, allowing the identification of digital skills from among the 13,000 different skills.

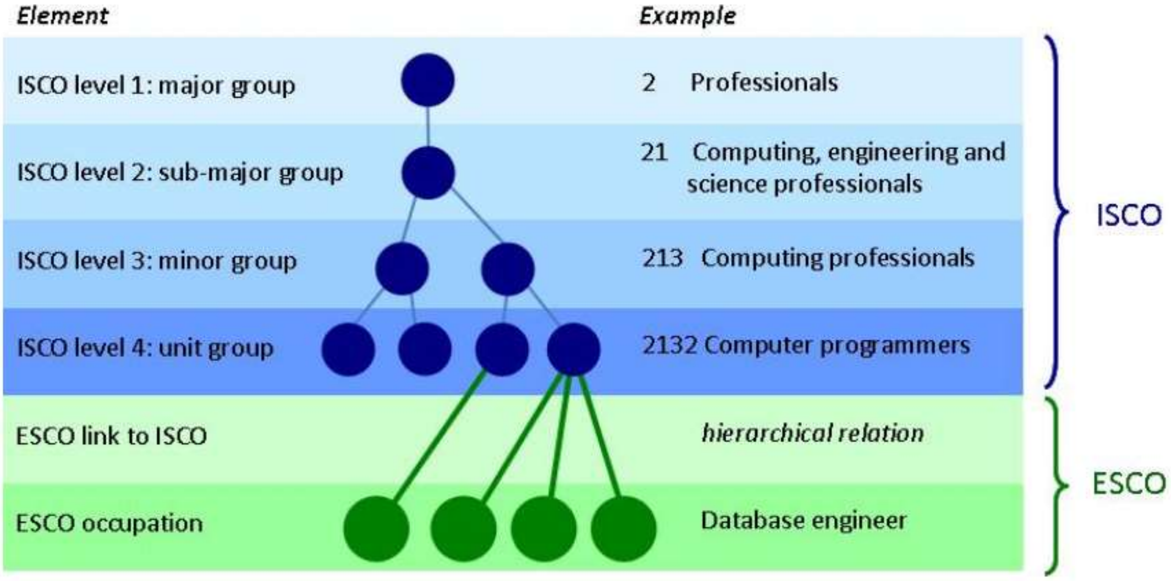
CONSTRUCTION OF THE DIGITAL SKILLS INTENSITY INDEX

Construction of the digital skills intensity index begins with individual data from the EU-LFS. For each respondent, an ISCO code is available for their current (or most recent) job. ISCO codes are available at 3-digit level in the micro data available for researchers from Eurostat[6]. ISCO codes can be linked to the ESCO framework (see Figure 1)[7].

[6] Eurostat has information at 4-digit level ISCO codes for some countries but this is not distributed as part of the use file for researchers (Eurostat, 2020).

[7] Similar mapping process to that of Boven and Hancke (2019) for green jobs.

FIGURE 1: ILLUSTRATIVE MAPPING OF ISCO – ESCO OCCUPATIONS



Source: ESCOpedia[8].

Each ISCO 4-digit code is linked to several occupations in the ESCO framework. The 4-digit ISCO classification contains around 500 categories, with just under 3,000 occupations in the ESCO framework.

Identifying digital skills

The DigComp Framework can be mapped to the ESCO framework so that digital skills can be identified in the list of skills accompanying each ESCO code (see Figure 2).

FIGURE 2. MAPPING DIGCOMP FRAMEWORK TO ESCO FRAMEWORK

DigComp	ESCO transversal ICT skills
Information and data literacy	Digital data-processing
Communication and collaboration	Digital communication
Digital content creation	Content-creation with ICT software
Safety	ICT Safety
Problem solving	Problem-solving with ICT tools and hardware

Source: Vuorikari et al. (2016).

In the ESCO framework, skills are ordered hierarchically, from general to more specific (narrower) skills. The DigComp Framework identifies 21 general digital skills under the heading of 'digital competencies' (see level 2 in Table 1 below). Under each of the general digital skills are several

[8] https://ec.europa.eu/esco/portal/escopedia/ISCO

more specific skills, each of which may have a further level of skills beneath them (not shown in Table 1).

TABLE 1 – BROADER DIGITAL SKILLS CATEGORIES IN THE DIGCOMP FRAMEWORK

ESCO Base category	Broad DigComp Framework categories (ESCO level 1)	DigComp Framework Category	Skills in the DigComp Framework (ESCO level 2)
Digital competencies	Digital data processing	1.1	Browse, search and filter digital data
		1.2	Evaluate data, information and digital content
		1.3	Manage data, information and digital content
	Digital communication and collaboration	2.1	Interact through digital technologies
		2.2	Share through digital technologies / use digital tools for collaboration and productivity
		2.3	Engage in citizenship through digital technologies
		2.4	Collaborate through digital technologies
		2.5	Use online conventions of netiquette
		2.6	Manage digital identity
	Digital content creation	3.1	Develop digital content
		3.2	Integrate and re-elaborate digital content
		3.3	Copyright and licences related to digital content
		3.4	Computer programming
	ICT Safety	4.1	Protect ICT devices
		4.2	Protect personal data and privacy
		4.3	Protect health and well-being while using digital technologies
		4.4	Protect the environment from the impact of digital technologies
	Problem-solving with digital tools	5.1	Solve technical problems
		5.2	Identify needs and technological responses
		5.3	Creatively use digital technologies
		5.4	Identify digital competence gaps

Source: Author's elaboration, based on EU-LFS (2019), ESCO framework and DigComp Framework.

The broader skills identified in the DigComp Framework are not linked to many occupations as a *necessary* skill, as skills related to each occupation are mostly described in more detail. For example, the occupation 'web developer' does not have 'computer programming' (skill 3.4 in Table 1) as an essential skill and competence, but, rather, has the more specific 'web programming', which is one skill level lower. To operationalise the identification of digital skills, therefore, it is necessary to include narrower skills under the 21 broader skills groups identified in the DigComp Framework. As a starting point, skills one level below the 21 broader skills groups (level 3) are marked as digital skills, with narrower skills below this level also categorised as digital (e.g. the skill to 'develop online community plan', which is two levels below the category 'collaborate through digital technologies'). However, other skills at this level are less recognisable as clearly digital. This is the case with the skill 'create innovative desserts', located two levels below the (level 2) category of 'creatively use digital technologies' (see Table 1). In order to consider the skills at level 4 that can be included as digital, skills were chosen where one or more of the words 'software', 'data', 'digital', 'computer', 'ICT', 'online', and 'web' occur in its description. This process yielded 232 digital skills out of the approx. 13,500 in the ESCO framework.

Digital skills intensity

To get to the digital skills intensity index, the sum of identified digital skills in essential skills within each occupation (around 3,000) in the ESCO framework (all mapped to ISCO 4-digit level) was calculated. This defines a digital skill intensity usage or exposure to digital skills within each occupation. Assuming that the same number of people are employed in each occupation under a 3-digit ISCO code, the average skill exposure over occupations gave an average skills intensity for each ISCO 3-digit code. For each ISCO 3-digit level, the skills intensity is the average number of digital skills used in each of the occupations making up the ISCO 3-digit occupation group.

Going back to the EU-LFS survey, the average digital skills intensity can now be attached to each employed person via the recorded ISCO code. For the individual record in the EU-LFS, the attached index can be interpreted as the number of digital skills the individual uses at work in the *average* occupation under that ISCO code.

A digital skills intensity index can thus be defined for common aggregates, using standard EU-LFS weights to levels consistent with EU-LFS categorisations (NACE, NUTS areas, gender, etc.), interpreted as outlined above.

Table 2 presents an indication of the digital skills intensity in selected occupations. It shows the top five digital skills intensive 3-digit ISCO broad occupation codes, and five of the least digital skills intensive (none have any digital skills exposure).

TABLE 2 – DIGITAL SKILLS INTENSITY FOR SELECTED OCCUPATIONS, 3-DIGIT ISCO LEVEL

Occupation at 3-digit ISCO level	Average digital skills intensity within occupation
Database and network professionals	2.6
Software and applications developers and analysts	2.1
Authors, journalists, and linguists	1.3
ICT operations and user support technicians	1.1
Librarians, archivists and curators	1
Market gardeners and crop growers	0.19
Administration professionals	0.19
Heavy truck and bus drivers	0.18
Regulatory government associate professionals	0.17
Personal care workers in health services	0.17
Locomotive engine drivers and related workers	0.0
Other personal services workers	0.0
Refuse workers	0.0
Mining and construction labourers	0.0
Domestic, hotel and office cleaners and helpers	0.0

Source: Author's calculation based on EU-LFS (2019), ESCO framework and DigComp Framework.
Notes: For each occupation (ISCO level 3) the digital skills intensity indicates the number of digital skills that are essential, on average, for occupations covered by each ISCO level 3 code (e.g. occupations under the heading 'Database and network professionals' have 2.6 essential digital skills, on average).

CAVEATS AND LIMITATIONS OF THE STUDY

Country coverage

Three-digit ISCO codes are not available for all 27 EU Member States (EU-27). Eurostat transmits 2-digit ISCO codes for Poland, Bulgaria and Slovenia, and 1-digit ISCO codes for Malta. There is no practical problem in aggregating to 1-digit and 2-digit ISCO codes for all countries, but the assumption that all occupations within each ISCO code are of equal size in terms of number of workers becomes harder to maintain. Where aggregation is across ISCO codes with different levels of detail, comparing countries becomes difficult and the four countries mentioned above are thus excluded from the analysis. For the other 23 countries, 95-99% of all occupations in the ESCO framework can be matched to an ISCO code from EU-LFS (see Table 3). All ISCO codes in the EU-LFS are matched with occupations, using the full EU-LFS sample (individuals currently working).

TABLE 3 – ISCO CODES MATCHED FROM THE ESCO FRAMEWORK AND NUMBER OF OBSERVATIONS FROM THE EU-LFS (2019)

Country	Number of observations from EU-LFS	Share of observations in EU-LFS matched with occupations (%)
Sweden	68,500	100%
Netherlands	43,848	97%
Denmark	51,503	99%
Austria	88,189	100%
Finland	11,235	100%
Luxembourg	5,053	96%
Germany	268,101	99%
Belgium	20,489	99%
Estonia	14,789	99%
Portugal	65,788	97%
Greece	75,413	98%
Lithuania	29,581	100%
Czechia	17,554	99%
France	31,830	99%
Spain	38,134	97%
Ireland	64,604	97%
Slovak Republic	37,237	98%
Latvia	4,015	99%
Italy	201,964	99%
Croatia	12,690	99%
Cyprus	18,200	98%
Hungary	85,212	100%
Romania	99,132	95%

Source: Author's calculation, based on EU-LFS (2019), ESCO framework and DigComp Framework.
Notes: Countries are listed from on order of their digital skills intensity (highest to lowest) (See Figure 3 below).

Averaging across occupations

With the absence of 4-digit ISCO codes in the EU-LFS (available within the ESCO framework) around 3,000 occupations are matched to fewer than 150 3-digit ISCO codes, compared to approximately 500 4-digit ISCO codes. With aggregated information on total employment in each ISCO 4-digit group, it would be possible to improve the proposed digital skills intensity index by weighing the different digital skills intensity contributions by the number of employed persons in each 4-digit ISCO group.

Changes over time

The process of digitalisation is ongoing and fast-moving in many occupations, and in many cases is changing the nature of these occupations or introducing new categories of occupation. This is recognised in the regular updates to the ESCO framework to reflect occupations and skills usage, as well as the several updates to the DigComp Framework. It does, however, present a challenge when comparing digital skills intensities over time. Version 1.0 of the ESCO framework only appeared in 2017, making it impossible to apply older versions of the framework together with past EU-LFS data. In the results section, comparisons are made over 2011 to 2019 (using the latest version of the ESCO framework for both years). The results should be read with these limitations in mind.

RESULTS

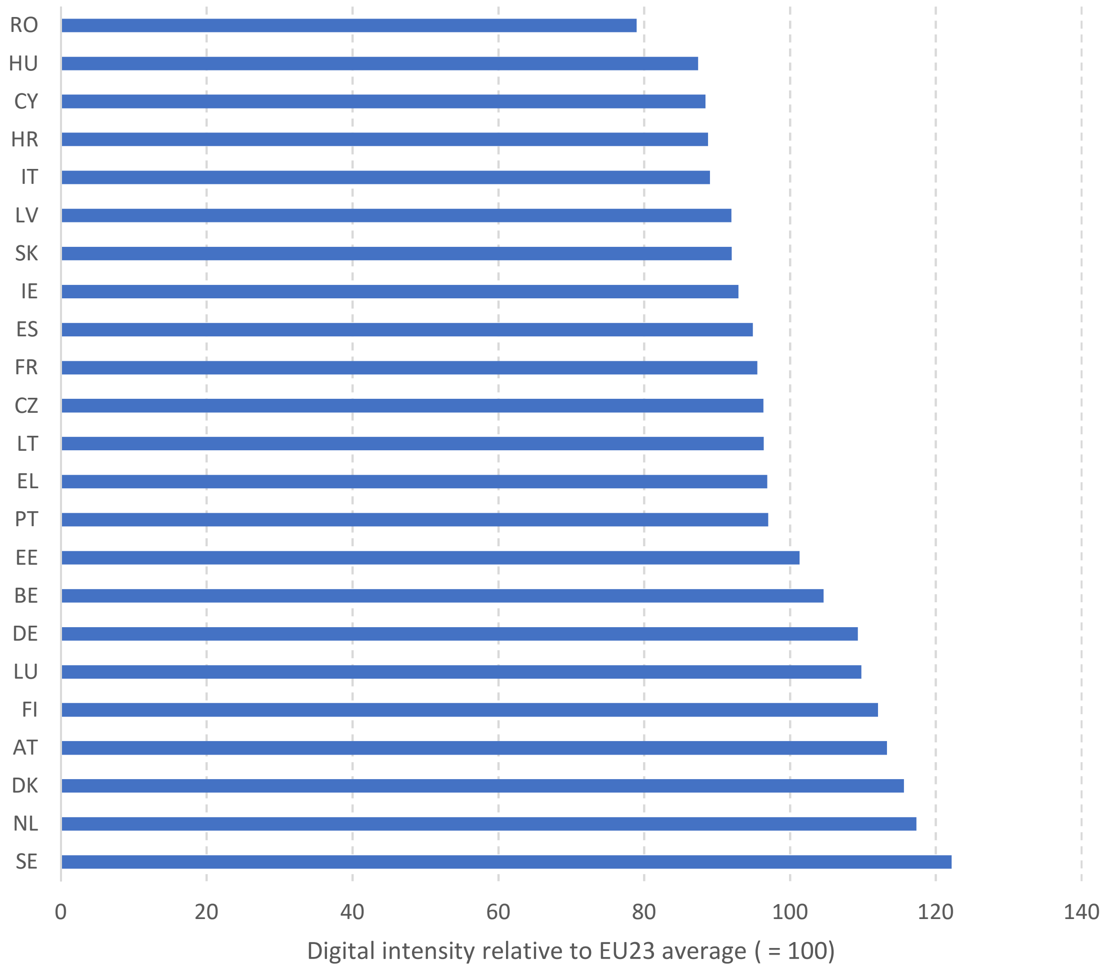
This section discusses the study results. The first two sub-sections detail the difference in digital skills intensity across EU Member States and NUTS2 region, and the extent to which differences in digital skills intensity can be explained by differences in economic structure. It then looks at differences in digital skills intensities in the context of age, gender and educational attainment. This is followed by a discussion of changes in digital skills intensities over time within countries and NUTS2 regions. The final subsection examines digital skills intensity and labour market dynamics.

DIGITAL SKILLS INTENSITY IN MEMBER STATES (2019)

Average digital skills intensity in labour markets varies between the 23 EU Member States included here (Figure 3)[9]. Sweden has the highest digital skills intensity, at around 20% above average. Finland, Austria, Denmark, the Netherlands, Belgium, and Germany also have substantially higher digital intensities than the EU average. Romania has the least digital skills intensive labour market, at less than 80% of the EU average. Of the larger Member States, France, and Spain are both at around 95% of the EU average, while Italy is just below 90%.

[9] Note that data is not available for Bulgaria, Malta, Poland, and Slovenia. See section 2.3 'Caveats and limitation to this approach'.

FIGURE 3. COUNTRY LEVEL DIGITAL SKILLS INTENSITY (2019 AVERAGE = 100)



Source: Author's elaboration, based on EU-LFS (2019), ESCO framework and DigComp Framework.

The ranking of digital skills intensity among EU countries can be compared with related rankings from the European Commission's Digital Scoreboard[10]. For individual digital skills, the Scoreboard has indicators for 'at least basic level of skills' and 'above basic level of skills'. For both indicators, the top six countries are the same for the two indicators (among the countries covered by the digital skills intensity index), and mirror those of the digital skill intensity index. At the bottom end of the scale, Romania, Latvia and Hungary also have among the lowest scores on the two Digital Scoreboard indicators (European Commission, 2020a).

Another relevant indicator from the Digital Scoreboard is the measure of 'enterprises with high levels of digital intensity'. The countries in the top six are again the same, except for Germany, which scores below average on the Digital Scoreboard measure. The lowest ranked countries are also the same.
The national-level outcome of the digital skills intensity index seems broadly consistent with the measures from the Digital Scoreboard.

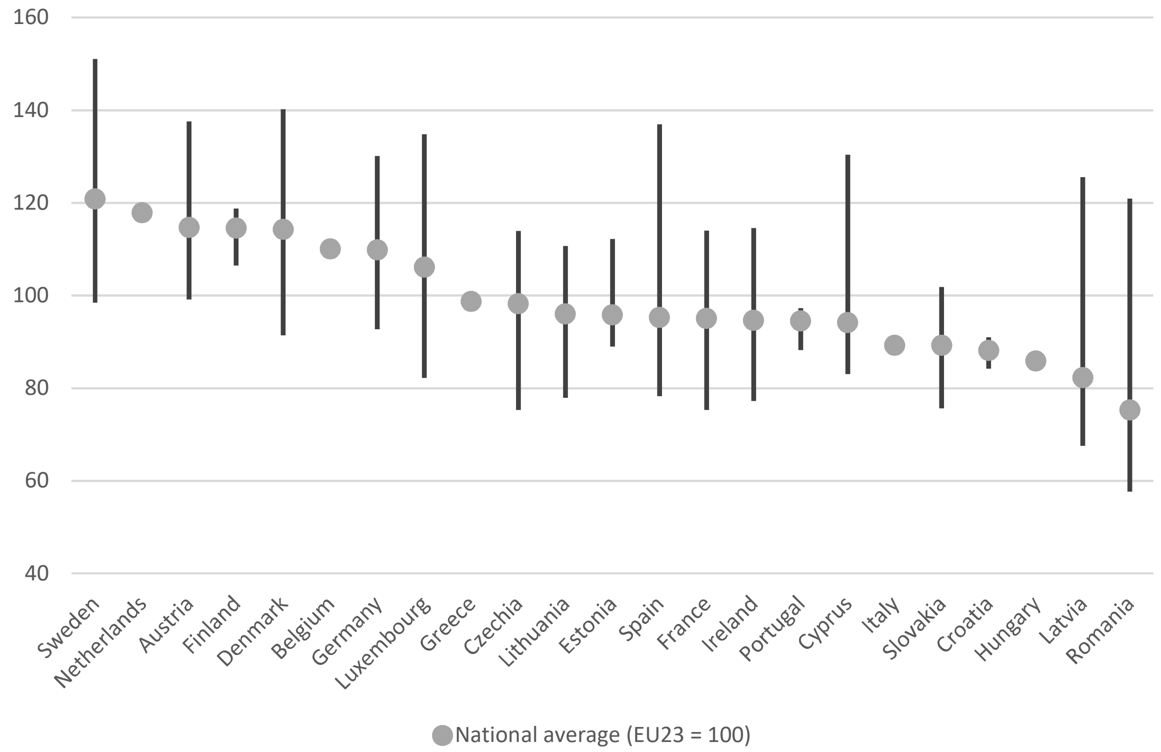
[10] Data from the Digital Scoreboard available at: https://digital-agenda-data.eu/

DIFFERENCES IN ICT SKILLS INTENSITY WITHIN MEMBER STATES (NUTS2 REGIONAL LEVEL)

A key advantage of basing the digital skills intensity index on the EU-LFS survey is that the index can be calculated for subsamples delineated by other relevant variables. Figure 4 shows regional NUTS2 variation in the digital skills intensity index within countries, highlighting the significant variation within countries with more than one NUTS2 region, both among countries with the highest and lowest national averages. Within each country, there are regions with digital skill intensities above and below the average for these 23 Member States. Finland is the exception, with all NUTS2 regions above the average. Regional classifiers are missing for the Netherlands, while for Germany and Austria, only a NUTS1 regional classifier is available in the EU-LFS.

Areas with the highest digital skills intensities are often around capital cities. This is the case in Sweden, Finland, Denmark and Germany (NUTS1), all of which have a high average national digital skills intensity, but is also evident in Romania, Hungary and the Slovak Republic. One exception is Belgium, where the area around Brussels has an average skills intensity.

FIGURE 4: VARIABILITY IN DIGITAL SKILLS INTENSITY, NUTS2 REGIONS, 2019

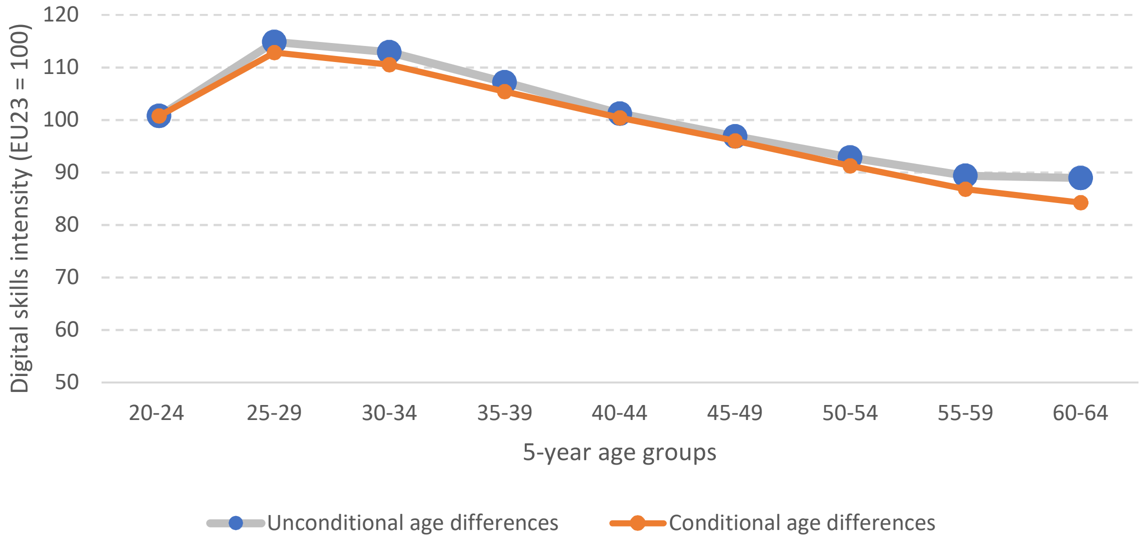


Source: Author's elaboration, based on EU-LFS (2019), ESCO framework and DigComp Framework.
Notes: The figure shows minimum and maximum digital skills intensities in the labour market at NUTS2 regional level, and the national average for the 23 Member States covered by the study. NUTS2 level information is missing for the Netherlands. Cyprus, Estonia, Luxembourg and Latvia only have one NUTS2 area. For Germany and Austria, regional digital skills intensity refers to NUTS1 level (no information available on NUTS2).

AGE, GENDER AND EDUCATIONAL DIFFERENCES IN DIGITAL SKILLS INTENSITY

Age differences in digital skills possession and competence are widely reported (Vasilescu et al., 2020; OECD, 2013; OECD, 2001). Disaggregating the digital skills intensity index by age group reveals a pattern of declining digitals skills intensity with age (Figure 5). A (small) part of this difference can be explained by different levels of educational attainment. However, age differences generally persist after controlling for gender, education (ISCED 0-2, ISCED 3-4, ISCED 5+) and NUTS2 region of residence, although they are reduced somewhat in size.

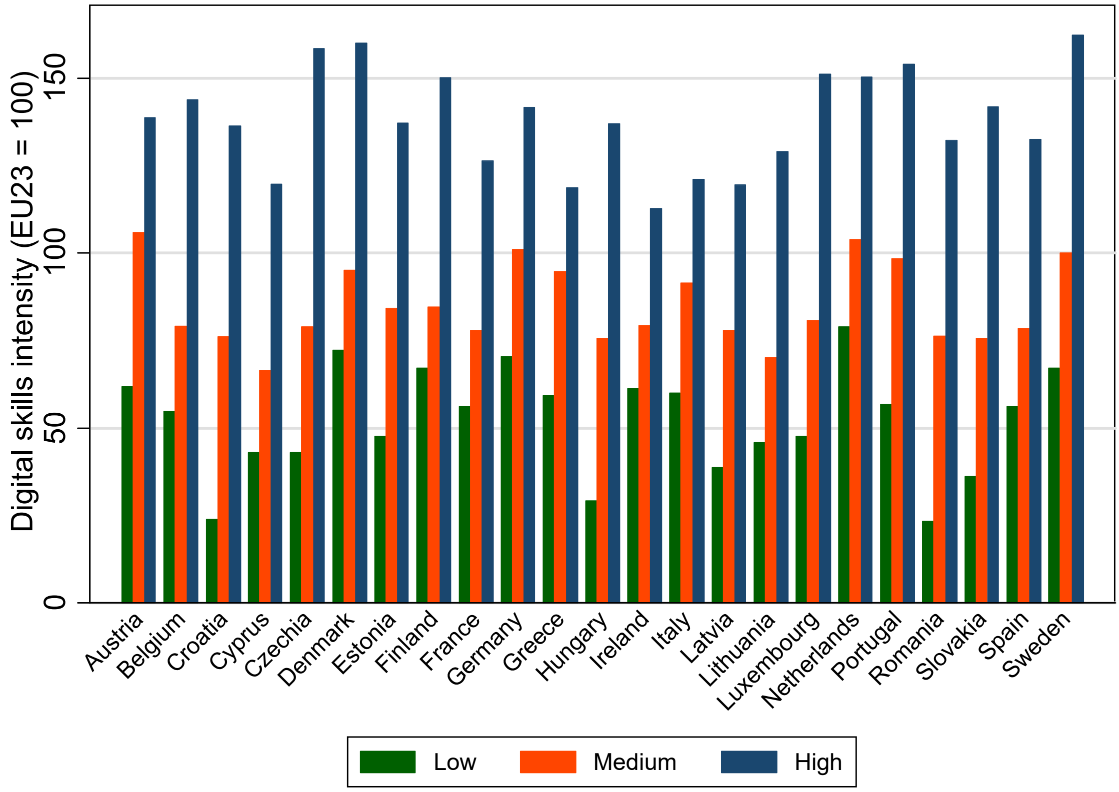
FIGURE 5: AGE GRADIENT IN DIGITAL SKILLS INTENSITY, 23 MEMBER STATES, 2019



Source: Author's elaboration, based on EU-LFS (2019), ESCO framework and DigComp Framework.
Notes: The figure shows unconditional digital skills intensity for five-year age groups, and conditional intensity for five-year age groups, where controls include education, NUTS2 region of residence (Germany and Austria, NUTS1) and gender.

Looking only at differences across educational attainment, there is a strong digital skills gradient (Figure 6). In most countries, people with low educational attainment (ISCED 0-2) tend to work in occupations with around 50% digital skills intensity relative to the average. In some countries – Romania, Slovak Republic, Croatia and Hungary, all countries with low scores overall – the digital skills intensity in low-skilled employment is very low. The same four countries have very steep educational gradients, as medium and highly trained individuals have comparatively higher digital skills intensities in their occupations. In all countries, people with high educational attainment have occupations with digital skills intensities somewhat above the average.

FIGURE 6: DIGITAL SKILLS INTENSITY, BY EDUCATIONAL ATTAINMENT, 2019



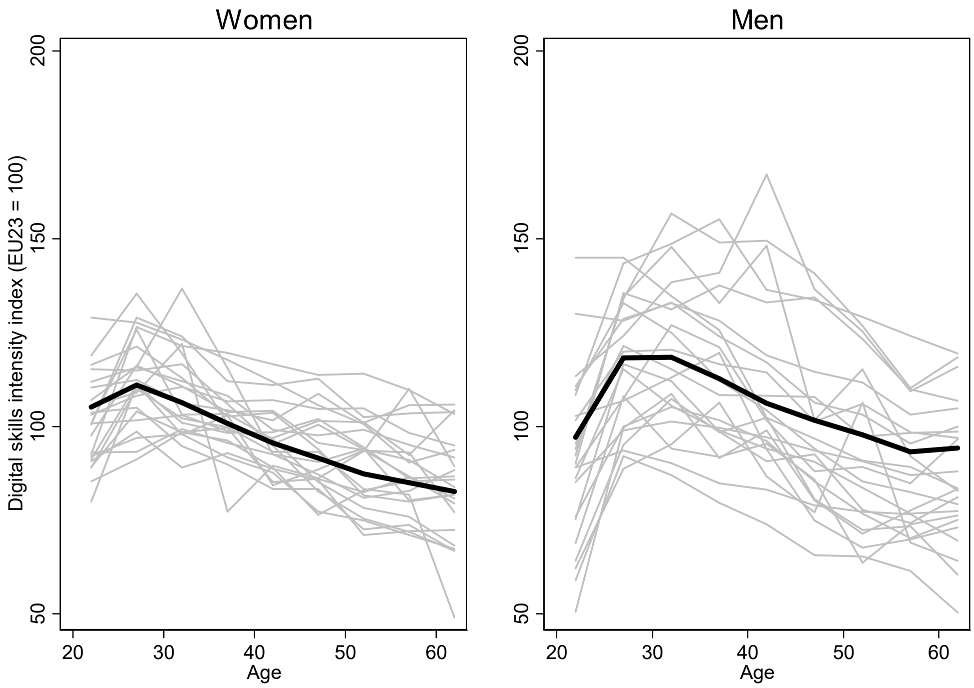
Source: Author's elaboration, based on EU-LFS (2019), ESCO framework and DigComp Framework.

Men are employed in more digital skills-intensive occupations, on average (Figure 7). However, the difference is barely 2 percentage points (p.p.) above the average. This is in line with findings from the PIAAC survey, where men scored slightly higher than women in digital skills proficiency (OECD, 2013), and results from the ICT Survey (Eurostat, 2019)[11]. The latter is based on a composite indicator designed to measure the proportion of people with 'basic or above basic digital skills'. The survey showed that 60% of men had 'basic or above basic digital skills' in 2019, compared to 56% of women. Although these results are consistent, an important distinction is that the PIAAC and Eurostat measures digital skills proficiency, while the digital skills intensity index aims to measure the digital skills demanded by respondents' occupations.

Figure 7 presents the (positive) difference between women and men, along with the age pattern of the digital skills intensity index. The grey lines represent the age patterns for each of the 23 Member States for women and men, respectively. Annex A provides details for each country.

[11] Data table tepsr_sp410. See https://ec.europa.eu/eurostat/databrowser/view/tepsr_sp410/default/table?lang=en

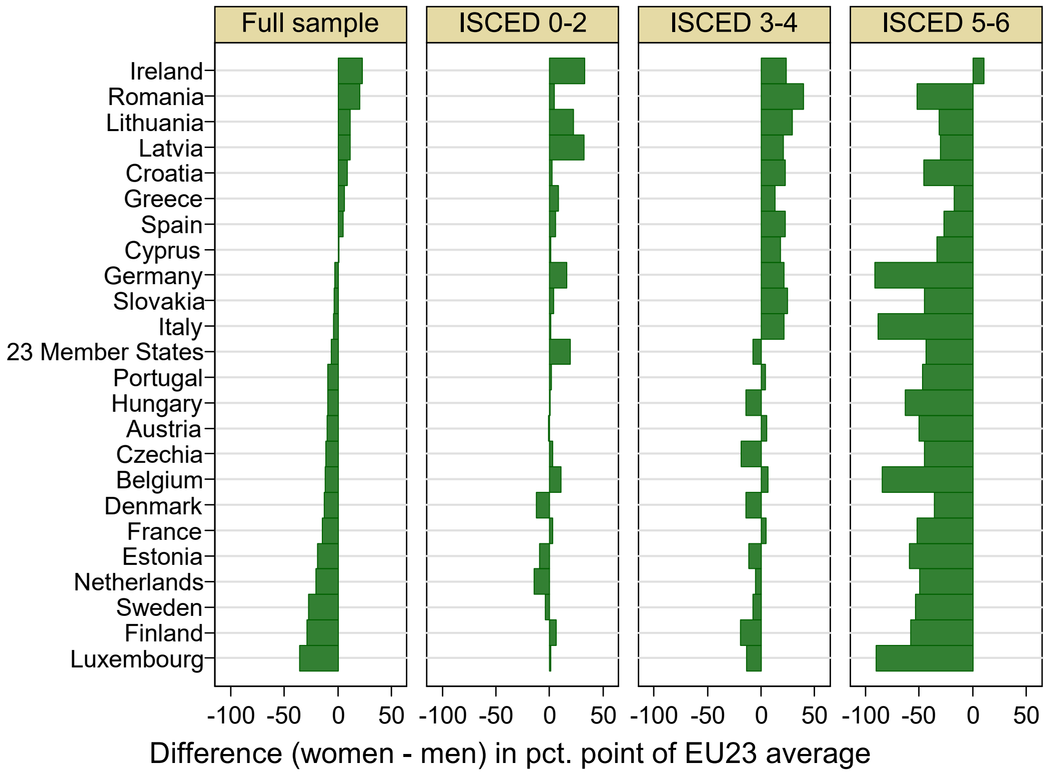
FIGURE 7: AGE GRADIENT IN DIGITAL SKILLS INTENSITY, BY GENDER, 2019



Source: Author's elaboration, based on EU-LFS (2019), ESCO framework and DigComp Framework.
Notes: Figure shows digital skills intensities for women and men, by age. The grey lines represent digital intensities by age for each Member State (by gender) (see Annex A for graphs for each Member State). The black lines are the average (weighted). Age is measured in five-year intervals, starting with the age group 20-24 and ending with 60-64.

Countries differ in the extent to which men are overrepresented relative to women in digital skills-intensive occupations, with women overrepresented in some cases (Figure 8). The positive gap between women and men is largest in Ireland and Romania, with men's overrepresentation most pronounced in Luxembourg and Finland. For both countries with women and men overrepresented in digital skills-intensive occupations, the difference can be substantial. In Ireland, women use, on average, more than 20% of digital skills than men. In Luxembourg, the difference is around 40% in the other direction. Despite these differences, there is a consistent pattern of differences in skills intensities when the sample is disaggregated by educational attainment. The three right-hand panels in Figure 8 show gender differences in skills intensities for low (ISCED 0-2), medium (ISCED 3-4) and high (ISCED 5+) levels of educational attainment. Women are underrepresented in skills-intensive occupations in all countries (except Ireland) among individuals with high educational attainment. On average, women with medium educational attainment tend to work in more digital skills-intensive occupations than men, but with important country differences. Among individuals with low educational attainment, there are only small differences between women and men.

FIGURE 8: GENDER DIFFERENCES IN AVERAGE DIGITAL SKILLS INTENSITY, 2019



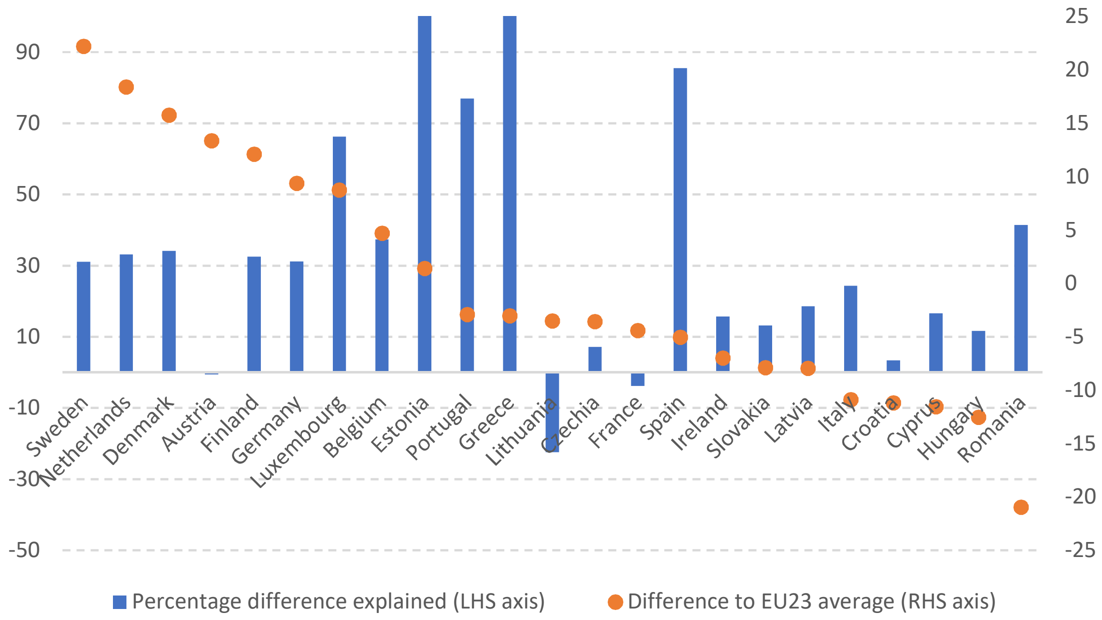
Source: Author's elaboration, based on EU-LFS (2019), ESCO framework and DigComp Framework.
Notes: Figure shows differences in digital skills intensities between women and men, by educational attainment (women – men). A positive entry implies that women are overrepresented relative to men in digital skills intensive occupations.

ECONOMIC STRUCTURE AND DIGITAL SKILLS INTENSITY

The structure of economic activities differs between EU countries. Cross-country differences in economic activities across NACE groups may explain some of the observed differences in country-level digital skills intensity. For example, countries differ in their exposure to the tourism sector (including accommodation and restaurants) as a percentage of Gross Domestic Product (GDP). This sector has low digital content, according to the digital skills intensity measure – around 20% of the average over all NACE groups. Different industry mixes, combined with differences in digital content across NACE groups, imply that differences in skills intensity scores would arise at the aggregate level, even if all countries had the same digital skills content in the same occupations.

It is possible – under some assumptions – to break down the overall difference and attribute part to differences in industry structure and part to differences in the occupational mix and associated digital skills within NACE industry groups (Oaxaca, 1973; Blinder, 1973). Figure 9 illustrates for each country the share of the deviation from the average over the 23 countries which can be attributed to differences industry structures (blue bar). The orange dot shows the distance in the digital skills intensity index to the average (right hand side axis).

FIGURE 9: DIFFERENCES IN ECONOMIC STRUCTURE AND DIGITALS SKILLS INTENSITY, 2019



Source: Author's elaboration, based on EU-LFS (2019), ESCO framework and DigComp Framework.
Notes: Figure shows the difference in digital skills intensity from the average for each of the 23 Member States, together with the share of the difference attributable to differences in industry structure, measured by NACE categories. Break down done by simple Oaxaca-decomposition technique (Jann, 2008).

An interesting way to examine the differences is to consider what Sweden's digital skills intensity would have been if it had the average industry composition but Swedish digital skills intensities within industries. In that case, the difference of 21 p.p. would have been reduced to around 14 p.p. For most countries, 20-40% of the observed differences can be attributed to industry structure. In the case of Romania, that figure is just under 50%. This implies that Romania's (negative) gap versus the EU average would have been halved if it had the average industry composition. Luxembourg, Estonia, Greece, Portugal and Spain have a larger share of their difference explained by industry composition, as their difference from the average is close to zero.

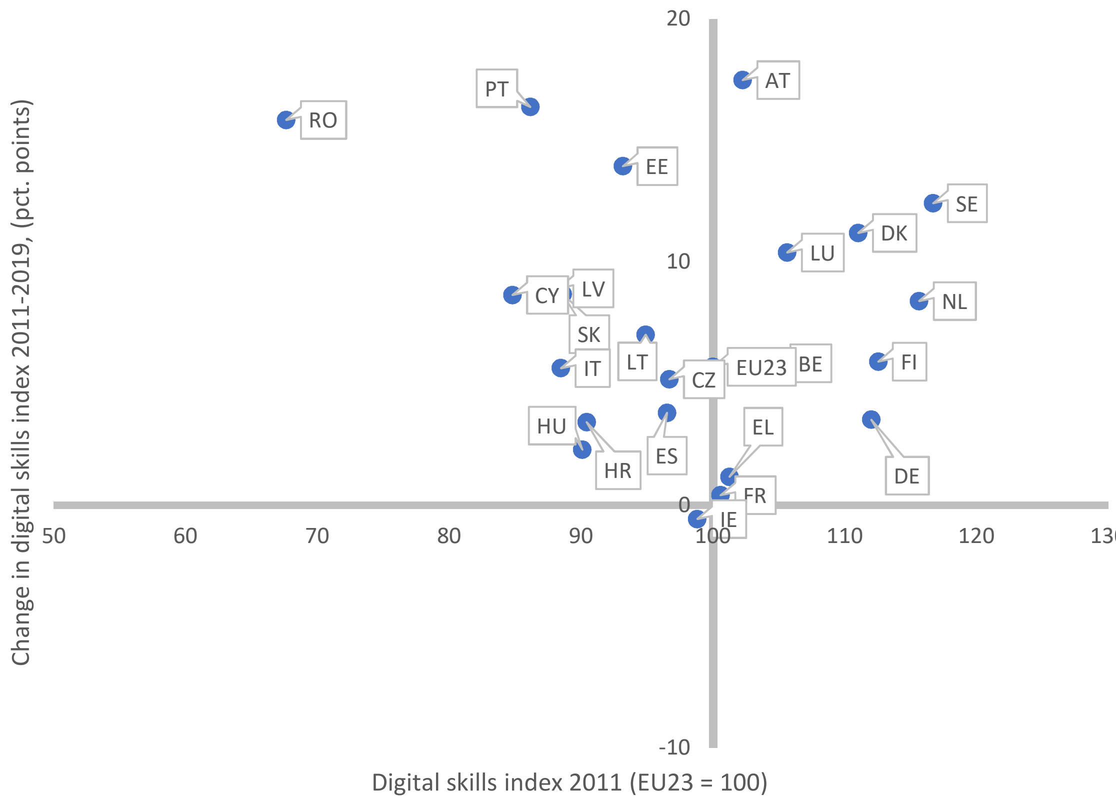
CHANGES IN THE DIGITAL SKILLS INTENSITY INDEX, 2011-2019

This subsection looks at the changes over time in digital skills intensity for countries and regions. The period in question starts in 2011, as the earliest year with a NACE categorisation consistent with 2019. Caution is needed in interpreting absolute changes in the index (see Methodology section). The index is based on skills used in 2019 for each occupation. It is possible that some occupations are using digital skills in 2019 but were not using them in 2011, meaning that the absolute change is likely an underestimate of the 'true' change in digital skills intensity.

To facilitate comparison, the intensities (including in 2019) are normalised with the study average in 2011. Figure 10 shows the dynamics of digital skills intensity changes across the Member States. Countries to the right of the vertical line (crossing at 100) had above-average digital skills intensities in 2011. The vertical line is the change between 2011 and 2019 in digital skills intensity, measured in p.p. of the 2011 average. Countries above the horizontal line have increased their digital skills intensities. Only Ireland had small decreases in digital skill intensity of occupations. The average is also indicated and increased by around 5% between 2011-2019.

Countries with high digital intensity in 2011 – Sweden, Denmark, Finland and the Netherlands – had above average increases in digital intensity. Austria has become substantially more digital skills intensive. Increases were moderate for those countries in the middle of the distribution in 2011, in particular Spain and France, although Estonia is an exception. Countries initially at the bottom of the distribution have tended towards high growth in digital skills intensity, such as Romania, Portugal and Cyprus.

FIGURE 10: CHANGE IN DIGITAL SKILLS INTENSITY INDEX IN EU MEMBER STATES, 2011-2019

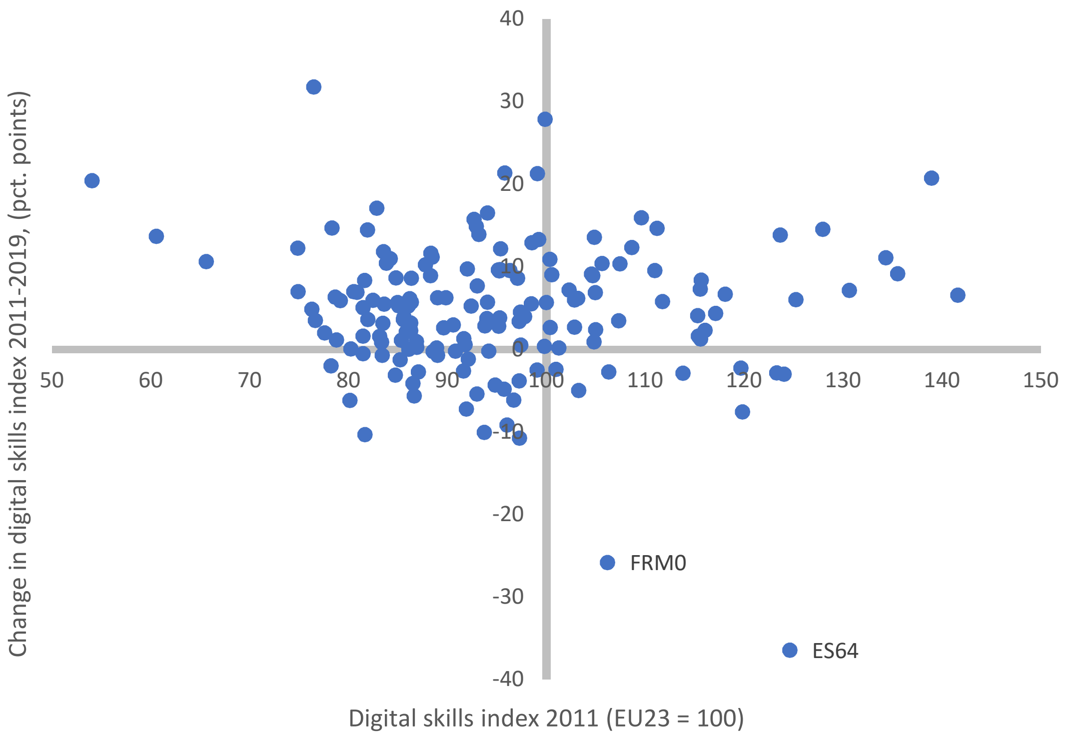


Source: Author's elaboration, based on EU-LFS (2019), ESCO framework and DigComp Framework.
Notes: Figure shows the changes in digital skills intensities at country level, measured in percentage of average in 2011, and 2011 level of digital skills intensity, normalised by average value for 2011.

Figure 10 allows an initial assessment of the extent to which there are signs of convergence in digital skills intensities across countries. A clear downward sloping trend would suggest that countries with a lower starting point tended to have higher increases in their average digital skills intensity. However, the development appears more U-shaped, with a comparison of the coefficient of variation within each year for the two years revealing little movement.

Figure 11 presents an analogous figure at the level of NUTS2 regions (NUTS1 for Germany and Austria). Most regions are closely clustered around the middle of the chart, with outliers at both ends, similar to Figure 4.

FIGURE 11: CHANGE IN DIGITAL SKILLS INTENSITY INDEX ACROSS NUTS2 REGIONS, 2011-2019



Source: Author's elaboration, based on EU-LFS (2019), ESCO framework and DigComp Framework.
Notes: Figure shows changes in digital skills intensities at the level of NUTS2, measured in percentage of EU average in 2011, and 2011 level of digital skills intensity, normalised by average value for 2011.

There is no indication of convergence among regions. The trendline (not shown) is almost perfectly horizontal. The three regions with the lowest digital skills intensities in 2011 (leftmost points) have seen just above-average increase, however the same is true for three of the four most digital skills-intensive regions (rightmost points).

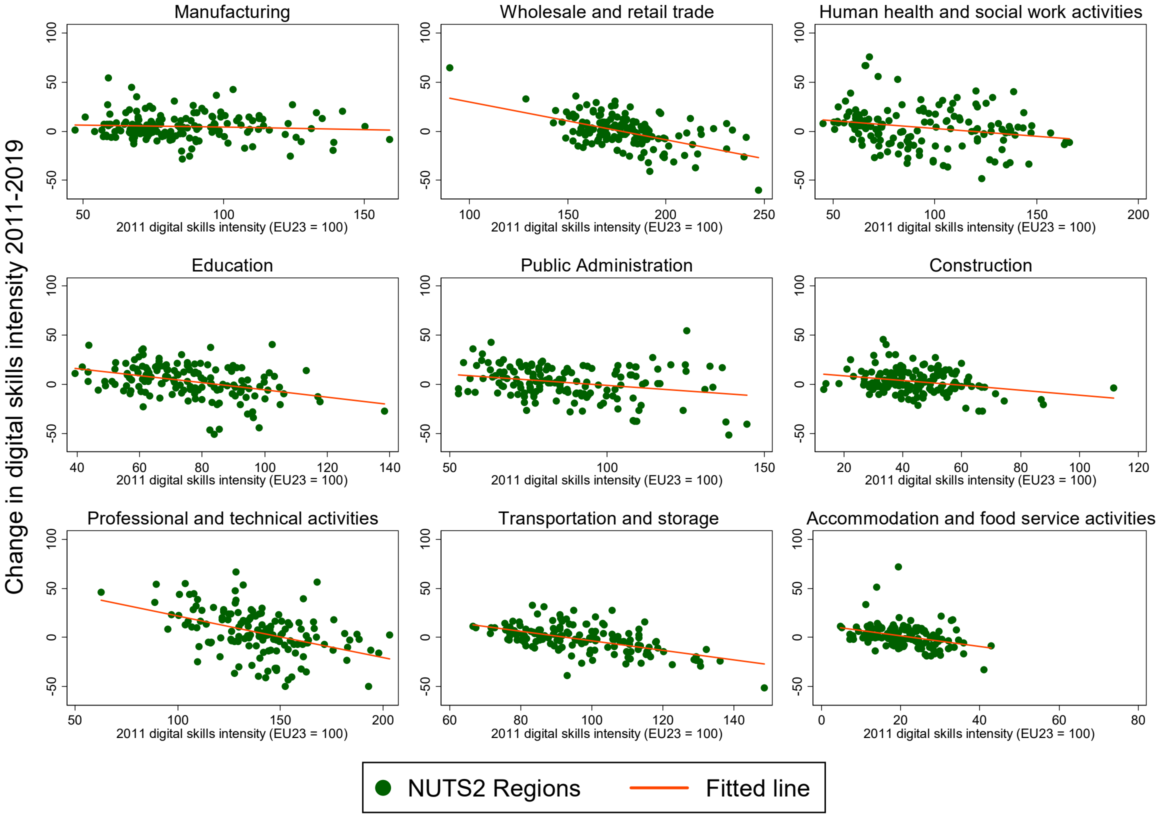
Accounting for differences in size of economic activities

The digital skills intensity in a country or region can be interpreted as the weighted sum of digital skills intensities across economic activities (defined by NACE categories), where the weights consist of the employment share in each economic activity (see Figure 9). A change in digital intensity over time can be attributed to changes in employment shares across economic activities, a change in employment shares of occupations within economic activities, or a combination of the two. These changes can occur independently of the overall change in the workforce, e.g. changes in employment shares can come from increased or decreased employment in some activities, or from the movement of workers from one economic activity to another.

Comparisons of aggregate digital skills intensities (across economic activities) over time mix changes in employment shares of different economic activities and shifts in occupational structure by digital skills intensity within the individual economic activities. By looking at skills intensities within each NACE 1-digit category, the effect of differences across regions in employment changes can be removed.

Figure 12 plots the 2011 digital skills intensity (normalised to the average) against changes in digital skills intensity from 2011 to 2019, at regional NUTS2 level for the nine largest 1-digit NACE groups. These nine sectors account for around 75% of employment.

FIGURE 12: CHANGE IN DIGITAL SKILLS INTENSITY INDEX ACROSS NUTS2 REGIONS, BY ECONOMIC ACTIVITY, 2011-2019



Source: Author's elaboration, based on EU-LFS (2019), ESCO framework and DigComp Framework.
Notes: Figure shows the changes in digital skills intensities at the level of NUTS2, measured in percentage of EU average in 2011, and 2011 level of digital skills intensity, normalised by average value for 2011 for each NACE 1-digit economic activity.

The overall impression from nine sector-specific plots is that of minor but consistent convergence of digital skills intensities within economic sectors. This is a slightly different picture than that given by the raw (unconditional) digital intensity scores (Figure 11). However, given the period (eight years), the variation in digital skills intensities and the slopes of the fitted lines, the speed of convergence (where visible) is very slow. At country level, the evidence is more mixed across economic activities (see Annex, Figure A2).

DIGITAL SKILLS INTENSITY AND EMPLOYMENT DYNAMICS

Companies and employers can increase their digital skills intensity (measured by the skills used by their employees) by reorganising their workforce and shifting more personnel into digital skills-intensive occupations and tasks, or by replacing employees in occupations with low digital skills intensity for employees in occupations with high digital skills intensity (e.g. through layoffs or voluntary leavers). An economy can operate in a similar way when individuals enter unemployment or exit the labour force. Movements in and out of employment – whether through unemployment or retirement - and spatial mobility can have important impacts on the digital skills intensity index.

The EU-LFS user files available for researchers are cross-sectional, which restricts the dynamics that can be studied. Some limited information is available on the status of individuals one year ago (e.g. NUTS2 area of residence and economic activity in previous job if no longer employed). However, there is insufficient information to determine employees with short (less than one year) tenure came from unemployment, other employment, or directly from education. For those out of employment, their occupation in their latest employment and other characteristics are observed, permitting an assessment of the digital skills intensity level of recent retirees.

Individuals made redundant or entering unemployment from a limited duration contract within the last year[12] had around 25% lower digital skills intensity in their previous occupation compared to the average. The result changes only slightly when controlling for country of residence, gender and age.

Retirees or early retirees who had been retired for less than a year in the 2019 EU-LFS sample had average digital skill intensity levels of around 87 (where 100 was the average among employees in 2019), a few p.p. below that observed for 60-64-year olds in employment in 2019 (see Figure 5). Controlling for gender and country does not materially affect the estimate.

Spatial dynamics

The EU-LFS sample allows the identification of individuals who have moved to another NUTS2 region within a country in the past year. As people might not work in the same NUTS2 region in which they live, it is not possible to definitively identify the sample of individuals who have relocated to another NUTS2 area for a new job[13]. However, combining information on within-country movement from one NUTS2 area to another with a variable for length of tenure can identify the sample of people who have moved and changed jobs within the past year. These movers generally work in more digital skills-intensive occupations, around 20% above the average. However, the sample size becomes rather small (around 1,500 observations) due to missing information (e.g. countries not reporting NUTS2 region), thus the results may not be very robust. Movers, on average, move towards more digital skills-intensive NUTS2 areas. The difference between the region they are moving from and the region they are moving to is very small and unlikely to be a robust result, given the sample size.

Movers coming from abroad are also identifiable in the EU-LFS dataset. This is a larger sample, with around 60,000 observations. There are few differences between movers from within the EU, movers outside the EU, and non-movers, with people in employment from outside the EU having around 2% lower digital skills intensity compared to non-movers in the EU.

[12] Last year of employment is observed, as well as reason for being unemployed, together with the ISCO 3-digit code of previous occupation.

[13] Information on NUTS2 area of work is only for current workplace and not for workplace one year ago, which could match NUTS2 region of residence one year ago.

CONCLUSION

Digitalisation – or digital transformation – is continuously progressing, with digital technologies and investments in green technologies set to be a promising path for growth in EU countries. In light of the rapid pace of change, monitoring and steering policy initiatives need tools to measure certain aspects of digital skill usage in the labour market.

This study proposes a digital skills intensity index to measure the use of digital skills by workers. The main advantage of the proposed index is that it can be linked to the EU-LFS, which is the only regular large-scale harmonised survey in the EU allowing for a close look at detailed sub-samples. The digital skills intensity index builds on the ESCO framework and DigComp Framework to provide an average digital skills intensity measure that is compatible with ISCO classification. It measures skills used (on average) on the job. This is different from the results and analyses based on the PIAAC and ICT Survey, both of which measure *proficiency* in digital/ICT skills usage at individual level. An interesting extension to the current work would be to compare (via ISCO codes) the digital skills intensity index with an indicator derived from the PIAAC or ICT Survey.

The digital skills intensity index was calculated for a range of outcomes and subgroups. At country level, there is substantial variation in overall digital skills intensity across the 23 EU Member States covered. Sweden and the Netherlands have the highest digital skills intensities, while Romania and Hungary have the lowest. The is broadly similar to the findings of other surveys measuring digital skills at country level. The variation in outcomes is also visible among NUTS2 areas within countries, with particularly large variation in Romania. Men are overrepresented relative to women in average digital skills-intensive occupations, but the difference is small. There is a strong educational gradient in occupational digital skills intensity, with the difference most marked in countries with low overall digital intensity scores. Differences in economic structure (measured by NACE 1-digit categories) explain 20-40% of the observed variation in overall skills intensities.

Turning to changes over time, average skills intensity increased by around 5% between 2011 and 2019. All countries, except Ireland, experienced increases. Countries with the lowest digital skills intensities generally had above-average increases, as did countries with the highest skills intensities. There is no evidence of general convergence across countries. For NUTS2 regions, the changes from 2011 to 2019 were more mixed, with several regions showing a decrease in digital skills intensity. There is no sign of regions converging towards the aggregated NUTS2 digital skills intensity. Looking more closely at differences in digital skills intensities for different economic activities (NACE 1 digit), there is some evidence of slow sector-by-sector convergence.

There are several caveats to the current approach. One problem is the absence of ISCO 4-digit information, which prohibits more granular analysis. It is important to verify whether the current approach gives approximately the same results when based on ISCO 4-digit information. The index implemented in EU-LFS can only say something about the current use of skills and - to a very limited extent - something about recent unemployed and retired individuals. This limits its usefulness for substantial analysis of dynamics. More detailed information on economic activity (NACE 2-digit) would allow for a better comparison of sectors across countries or regions. The fact that the ESCO framework used here is only in place since 2017 limits what can be achieved in terms of comparisons over time. The description of occupations is set to be regularly updated, however, and will eventually be able to measure changes in digital skills intensity at the level of occupations.

Some of these caveats are partly remediable in the EU-LFS, if researchers' access is expanded or perhaps with access from Eurostat premises. There are also national surveys where more detailed analysis could be compared with that emerging from the EU-LFS.

REFERENCES

Barnes, S. A., Green, A. and de Hoyos, M. (2015). 'Crowdsourcing and work: individual factors and circumstances influencing employability'. *New Technology, Work and Employment*, *30*(1), 16-31.

Becker, S. O., Egger, P. H. and Von Ehrlich, M. (2010). 'Going NUTS: The effect of EU Structural Funds on regional performance'. *Journal of Public Economics*, 94(9-10), 578-590.

Blinder, A. S. (1973). 'Wage discrimination: reduced form and structural estimates.' *Journal of Human Resources*, 8(4), 436-455. doi:10.2307/144855.

Boven, A. and Hancke, B. (2019). *The social dimensions of "greening the economy": developing a taxonomy of labour market effects related to the shift toward environmentally sustainable economic activities*. European Commission, Social Situation Monitor.

Cappelen, A., Castellacci, F., Fagerberg, J. and Verspagen, B. (2003). 'The impact of EU regional support on growth and convergence in the European Union'. *Journal of Common Market Studies*, 41(4), 621-644.

De Groen, W. P., Kilhoffer, Z., Lenaerts, K. and Salez, N. (2017). 'The impact of the platform economy on job creation'. *Intereconomics*, *52*(6), 345-351.

Elding, C. and Morris, R. (2018). 'Digitalisation and its impact on the economy: insights from a survey of large companies'. *Economic Bulletin Boxes*, *7*.

Eurofound (2020). *Upward convergence in the EU: definition, measurement and trends.* Luxembourg: Publications Office of the European Union.

European Commission (2016). *A new skills agenda for Europe: Working together to strengthen human capital, employability, and competitiveness*. COM(2016) 381 final.

European Commission (2019a). *Report of the High-Level Expert Group on Impact of the Digital Transformation on EU Labour Markets*. Brussels 2019. Available at: https://digital-strategy.ec.europa.eu/en/news/final-report-high-level-expert-group-impact-digital-transformation-eu-labour-markets

European Commission (2019b). ESCO handbook - European Skills, Competences, Qualifications and Occupations.

European Commission (2020a). Digital Economy and Society Index (DESI) 2020. European Commission. Available at: https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=67077

European Commission (2020b). European Skills Agenda for sustainable competitiveness, social fairness and resilience. COM(2020) 274 final. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0274&from=EN

Eurostat (2020). EU Labour Force Survey Database User Guide. Luxembourg.

Falck, O., Heimisch-Roecker, A. and Wiederhold, S. (2020). 'Returns to ICT skills'. *Research Policy*, 104064.

Gonzalez Vazquez, I., Milasi, S., Carretero Gomez, S., Napierala, J., Robledo Bottcher, N., Jonkers, K., Goenaga, X. (Eds.), Arregui Pabollet, E., Bacigalupo, M., Biagi, F., Cabrera Giraldez, M., Caena, F., Castano Munoz, J., Centeno Mediavilla, C., Edwards, J., Fernandez Macias, E., Gomez Gutierrez, E., Gomez Herrera, E., Inamorato Dos Santos, A., Kampylis, P., Klenert, D., López Cobo, M., Marschinski, R., Pesole, A., Punie, Y., Tolan, S., Torrejon Perez, S., Urzi Brancati, C. and Vuorikari, R. *The changing nature of work and skills in the digital age*. Luxembourg: Publications Office of the European Union. ISBN 978-92-76-09206-3. doi:10.2760/679150. JRC 117505.

Grundke, R., Marcolin, L. and Squicciarini, M. (2018). 'Which skills for the digital era? Returns to skills analysis'. *OECD Science, Technology, and Industry Working Papers,* 2018/09. https://doi.org/10.1787/18151965

Jann, B. (2008). 'A Stata implementation of the Blinder-Oaxaca decomposition'. *Stata Journal*, 8(4), 453-479.

Kässi, O. and Lehdonvirta, V. (2019). 'Do digital skill certificates help new workers enter the market? Evidence from an online labour platform.' *CESifo Working Paper,* No. 7810.

Lane, M. and Conlon, G. (2016). 'The impact of literacy, numeracy and computer skills on earnings and employment outcomes'. *OECD Education Working Papers,* No. 129.

Morandini, M. C., Thum-Thysen, A. and Vandeplas, A. (2020). Facing the digital transformation: are digital skills enough? No. 054. Directorate General Economic and Financial Affairs (DG ECFIN), European Commission.

Oaxaca, R. (1973). 'Male-female wage differentials in urban labour markets'. *International Economic Review,* 14(3), 693–709.

OECD (2001). 'Understanding the digital divide.' *OECD Digital Economy Papers*, No. 49. Paris: OECD Publishing. 10.1787/236405667766.

OECD (2013). *OECD Skills Outlook 2013. First Results from the Survey of Adult Skills*. Paris: Organisation for Economic Co-operation and Development.

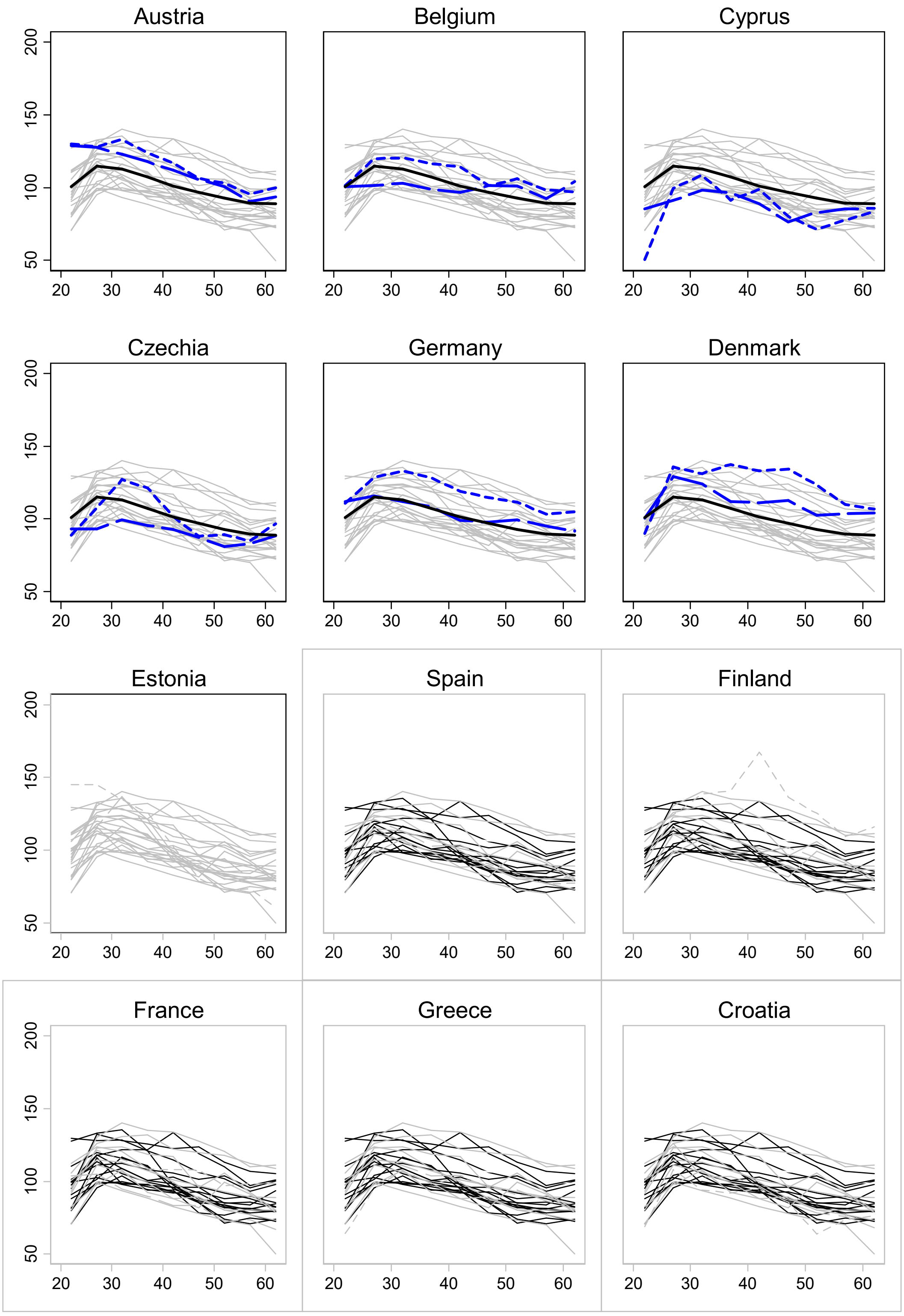
Vasilescu, M. D., Serban, A. C., Dimian, G. C., Aceleanu, M. I. and Picatoste, X. (2020). 'Digital divide, skills, and perceptions on digitalisation in the European Union - towards a smart labour market'. *PloS one*, 15(4). e0232032.

Vuorikari, R., Punie, Y., Carretero Gomez S. and Van den Brande, G. (2016). *DigComp 2.0: the digital competence framework for citizens. update phase 1 - the conceptual reference model*. Luxembourg@ Publication Office of the European Union. EUR 27948 EN. doi:10.2791/11517.

ANNEX

FIGURE A1A. DIGITAL SKILLS INTENSITY IN 23 MEMBER STATES, BY AGE AND GENDER, 2019

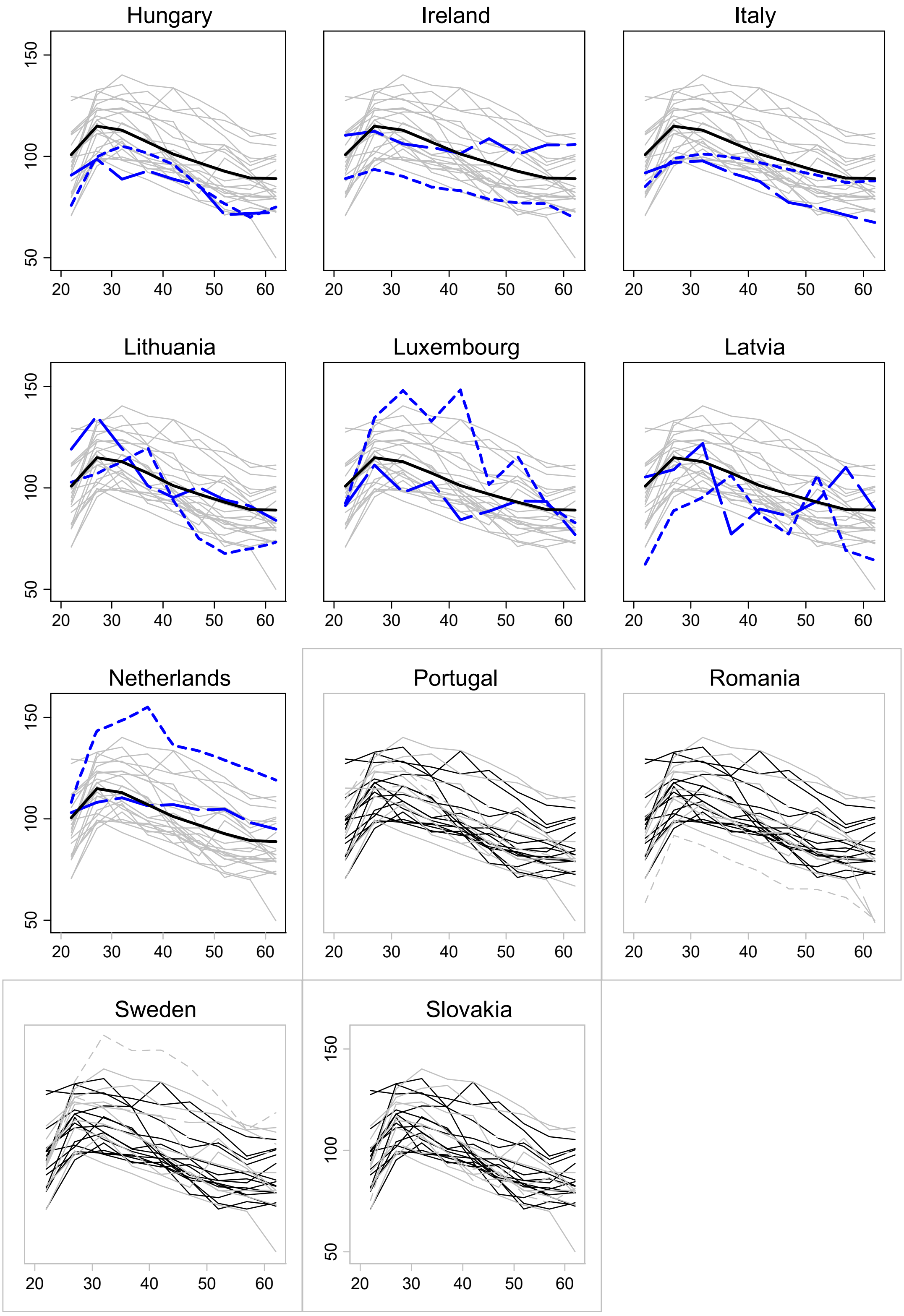
(AVERAGE = 100)



Notes: the solid black line shows the average per age group. The blue lines show digital skills intensity for women (long-dashed line) and men (dashed line) per country. The grey lines are average values, per age group, for all countries.

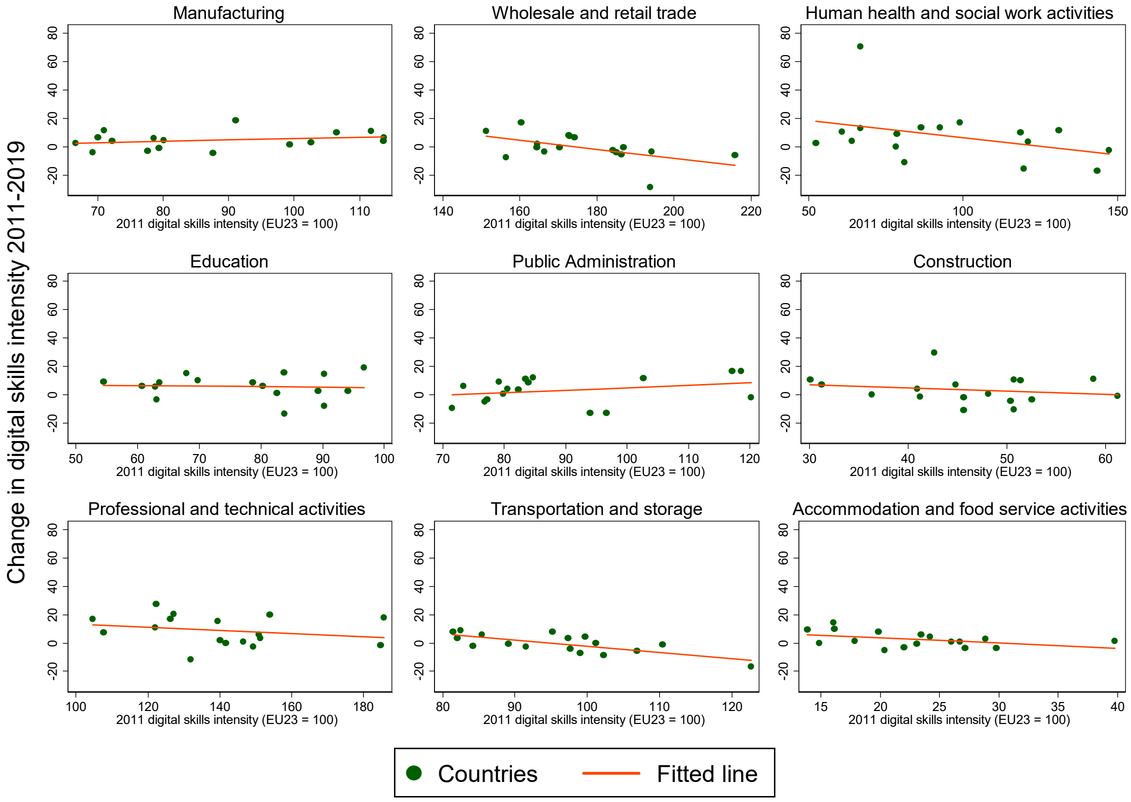
FIGURE A1B. DIGITAL SKILLS INTENSITY FOR 23 MEMBER STATES, BY AGE AND GENDER, 2019

(AVERAGE = 100)



Notes: The solid black line shows the average per age group. The blue lines show digital skills intensity for women (long-dashed line) and men (dashed line) per country. The grey lines are average values, per age group, for all countries.

FIGURE A2: CHANGE IN THE DIGITAL SKILLS INDEX ACROSS MEMBER STATES, BY ECONOMIC ACTIVITY, 2011-2019



Source: Author's elaboration, based on EU-LFS (2019), ESCO framework and DigComp Framework.

Notes: Figure shows the changes in digital skills intensity at country level, measured in percentage of EU average in 2011, and 2011 level of digital skills intensity, normalised by average value for 2011 for each NACE 1-digit economic activity.