Study on poverty and income inequality in the context of the digital transformation

Final Report – Part A: Ensuring a socially fair digital transformation

Written by Prognos AG, The Centre for Microsimulation and Policy Analysis & The Centre for European Policy Studies
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Final Report – Part A: Ensuring a socially fair digital transformation

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Table of Contents

Note

The European Commission awarded Prognos AG, The Centre for Microsimulation and Policy Analysis (CeMPA) and The Centre for European Policy Studies (CEPS) a contract, funded by the EaSI programme, to conduct a "**Study on poverty and income inequality in the context of the digital transformation**". The published version of the final report of this study is composed of two documents ("Part A" and "Part B"). Part A of this study analyzes – through 27 country fiches – the extent to which each EU Member State is prepared for ensuring a socially fair digital transformation in the coming years, based on both its current situation and future prospects. In this analysis, key areas of focus include the labour market, digital skills of the population, social protection as well as cross-cutting dimensions, such as the digitalization level of businesses and the quality of digital infrastructures. Part B of the study reviews – through 30 case studies – some of the main actual and potential uses of digital technologies (including AI) by a country's public sector for improving the design and the delivery of social benefits and active labour market policies, as well as for complementing the monitoring of poverty and income inequality (the case studies analysed are mainly in Member States but also in a few third countries).

The **following report presents Part A of the study** and is structured as follows: an introduction briefly describes the background and scope of this part of the study and describes the approach and methodology (including data sources) adopted in developing the country fiches. This is followed by a review of the 27 Member States, in the form of dedicated fiches that discuss the preparedness in ensuring a socially fair digital transformation. To contextualize this study, Annex II provides a succinct yet comprehensive literature review that reviews the ways in which digital transformation can impact labour market outcomes, including poverty and income inequality.

Abstract

[EN] This study is made of two parts: part A and part B.

Part A of the study analyses – through 27 country fiches – the extent to which each EU Member State is prepared for ensuring a socially fair digital transformation in the coming years, based on both its current situation and future prospects. In this analysis, key areas of focus include the labour market, digital skills of the population, social protection as well as cross-cutting dimensions, such as the digitalization level of businesses and the quality of digital infrastructures.

Part B of the study reviews – through 30 case studies – some of the main actual and potential uses of digital technologies (including AI) by a country's public sector for improving the design and the delivery of social benefits and active labour market policies, as well as for complementing the monitoring of poverty and income inequality (the case studies analysed are mainly in Member States but also in a few third countries).

[FR] Cette étude se compose de deux parties : la partie A et la partie B.

La partie A de l'étude analyse, au travers de 27 fiches concernant chacune un Etat membre de l'UE, l'état de préparation de ces derniers, au regard de leur situation actuelle et de leurs perspectives futures, pour faire en sorte que la transition numérique soit socialement juste. Les dimensions-clefs, sur lesquelles s'appuie cette analyse, incluent le marché du travail, les compétences numériques de la population, la protection sociale et les politiques sociales, ainsi que des dimensions transversales telles que les niveaux de numérisation des entreprises et du secteur public ou encore la qualité des infrastructures numériques au sein de chaque Etat membre.

La partie B de l'étude analyse, au travers de 30 études de cas, les utilisations réelles et potentielles que le secteur public d'un pays peut faire des technologies numériques, y compris de l'IA, pour améliorer la conception et le versement des prestations sociales, pour améliorer la conception des politiques du marché du travail, ainsi que pour améliorer le suivi de la pauvreté et des inégalités de revenus (les cas analysés se trouvent principalement au sein des Etats membres mais aussi dans quelques pays tiers).

Key results of the study (one-pager)

Part A: Assessment of Member States' preparedness to ensure a socially fair digital transformation

Part A of the study aims to **assess and provide an overview of each Member State's preparedness for ensuring that the digital transformation** is **socially fair in the next decade**. The evaluation is based on four dimensions: labour market, digital skills, social protection and social policies, and cross-cutting dimensions including digitalization in businesses and in the public sector, as well as digital infrastructure quality. The outcome of this analysis is presented as country fiches.

The analysis shows country variation in the extent to which more digitised activity sectors are projected to experience growth in their employment shares in the coming decade, pointing to potential discrepancies across Member States in their ability to benefit from digitalisation. The analysis also shows that the occupations that are most vulnerable to automation also differ across Member States. It also appears that the (average) level of digital skill of the population varies strongly across Member States and that digital divides between different socio-economic groups exist within all Member States (though with significant differences across Member States in the scale of these divides). Finally, social protection systems play a key role in mitigating the potential adverse effects of the digital transformation on poverty and inequality, but their coverage and adequacy vary across Member States.

To contextualize this study, a literature review is provided in Annex II, which explores the channels through which the digital transformation impacts or may impact labour market dynamics and hence poverty and income inequality.

Part B: Uses of digital technologies by the public sector to improve the delivery and the design of social benefits and of active labour market policies, as well as for complementing the monitoring of poverty and income inequality

Part B of the study **identifies and describes – through 30 case studies – some of the main actual or potential uses of digital technologies (incl. AI) by the public sector for** improving the delivery and the design of social benefits and active labour market policies, as well as for finding complementary ways to monitor poverty and income inequality (the case studies analysed are mainly in Member States but also in a few third countries). After an extensive review of these case studies, the analysis concludes with presenting a typology of the main digital technologies used in the analysed case studies, including automation, analytics, public services digital infrastructures, blockchain and cryptography, and new data sources, offering insights into current practices and future possibilities. Moreover, proactive approaches for the delivery of social benefits are discussed, which, facilitated by digital platforms, can auto-deliver these benefits to eligible individuals, removing bureaucratic hurdles. Automated systems are also explored, which can process applications and manage routine tasks more efficiently, freeing up resources and providing a smoother, faster service for beneficiaries.

Synthèse des principaux résultats de l'étude (en une page)

Partie A: Évaluation de l’état de préparation des États membres pour garantir que la transformation numérique soit socialement juste

La partie A de l'étude vise à analyser l’état de préparation de chaque État membre quant à ce qui est de garantir que la transformation numérique soit socialement juste dans la prochaine décennie. Cette analyse repose sur quatre dimensions : le marché du travail, les compétences numériques, la protection sociale et les politiques sociales, ainsi que sur des dimensions transversales incluant la numérisation dans les entreprises, le secteur public et la qualité de l'infrastructure numérique. Les résultats de cette analyse sont présentés sous la forme de fiches (une par Etat membre).

L'analyse montre des écarts entre les pays quant au niveau de croissance que les secteurs d’activité les plus numérisés devraient connaître, au cours de la prochaine décennie, dans la part qu’ils représentent dans l’emploi total d’un pays. Ces écarts suggèrent qu’il pourrait y avoir des différences entre les États membres quant à leur capacité à bénéficier de la transition numérique. L’analyse montre également que les professions les plus vulnérables à l'automatisation varient également d'un État membre à l'autre. Il apparaît aussi que le niveau (moyen) de compétences numériques de la population varie fortement d'un État membre à l'autre et que des différences quant à ce niveau existent entre différents groupes socio-économiques au sein de chacun des États membres (bien que l’ampleur de ces différences varie d’un Etat membre à l’autre). Enfin, le système de protection sociale joue un rôle-clef pour atténuer les possibles impacts négatifs de la transition numérique sur la pauvreté et les inégalités de revenus, mais son niveau de protection et sa couverture de la population varient d'un État membre à l'autre.

En complément de l’analyse principale présentée dans cette étude, l'annexe II présente une revue de la littérature qui décrit les canaux selon lesquels la transformation numérique influe ou pourrait influer sur la dynamique du marché du travail et, par conséquent, sur la pauvreté et les inégalités des revenus.

Partie B: Utilisation des technologies numériques par le secteur public pour améliorer la conception et le versement des prestations sociales, la conception des politiques du marché du travail, ainsi que pour améliorer le suivi de la pauvreté et des inégalités de revenus

La partie B de l'étude analyse, au travers de 30 études de cas, certaines des principales utilisations actuelles ou potentielles des technologies numériques (dont l’IA) par le secteur public pour améliorer la conception et le versement des prestations sociales, la conception des politiques du marché du travail, ainsi que pour améliorer le suivi de la pauvreté et des inégalités de revenus (les cas analysés se trouvent principalement au sein des Etats membres mais aussi dans quelques pays tiers). Cette analyse se conclut par la présentation d’une typologie des principales technologies numériques utilisées dans les 30 cas étudiés, dont l'automatisation, les blockchains et la cryptographie, ainsi que l’utilisation de nouvelles sources de données. Cette typologie offre un aperçu des pratiques actuelles et des possibilités futures quant à l’utilisation des technologies numériques dans le secteur public. Par exemple, une approche proactive pour le versement des prestations sociales est analysée, laquelle permet un versement automatique de ces prestations aux individus éligibles et d’éliminer divers obstacles bureaucratiques ayant trait à ces versements. L’automatisation des systèmes informatiques traitant les demandes de prestations sociales est également analysée, laquelle permet un traitement et une gestion plus efficaces de ces demandes et des tâches administatives y étant liées, ce qui bénéficie aussi bien aux allocataires de ces prestations sociales qu’aux administrations publiques étant responsables de leur versement.

Executive summary

Part A: Assessment of Member States' preparedness to ensure a socially fair digital transformation

The **aim** of this part of the study is to **provide an overview of the degree to which Member States are prepared to ensure a socially fair digital transformation in the coming decade**. To contextualize this assessment, a literature review is provided in Annex II, which explores the channels through which the digital transformation impacts or may impact labour market dynamics and hence poverty and income inequality. In addition to the mapping of channels through which the digital transformation may impact poverty and income inequality, it also provides a brief description of the impact of the digital transformation on purchasing power and how these effects may differ along the income distribution.

To assess the degree of Member State preparedness in ensuring a socially fair digital transformation, **an analysis is pursued that reviews both the current situation and the future prospects for each Member State** across a multitude of dimensions. The analysis is based on **four selected dimensions**: **the labour market in the context of the digital transformation**, **digital skills in the population**, **social protection and social policies**, and finally, cross-cutting dimensions including **the level of digitalization in businesses**, **in the public sector**, and **the quality of the digital infrastructure**.

For the **labour market**, a total of nine indicators are considered. These include six indicators for the current situation and three indicators that can be used to grasp developments in the next decade. Promoting a socially fair digital transformation involves placing emphasis on employment and its growth and the evolution of labour demand in specific sectors and occupations that will be influenced by the digital transformation and the associated risk of automation. Thus, a comprehensive read of the selected indicators can provide insight into whether the current economic structure is suitable to reap the benefits of the digital transformation and how labour demand may develop in specific Member States.

For what concerns the **level of digital skills**, a total of three indicators are considered. These include two indicators for the current situation and one indicator for the forward-looking aspect of the analysis. The analysis is enriched by a description of national policy strategies relevant to the dimension of digital skills, such as measures included in National Recovery and Resilience Plans (NRRPs) or in other policy plans or strategies. The level of digital skills emerges as a crucial aspect that warrants close attention, as it plays a pivotal role in determining the Member States' strengths and vulnerabilities associated with achieving a socially fair digital transformation.

For **social protection and social policies**, we consider several quantitative indicators to assess the extent to which social protection systems in EU Member

States currently mitigate poverty (and income inequality) and whether planned initiatives are likely to improve the coverage and adequacy of social protection in the coming decade. The degree to which social protection schemes can absorb the impact of the digital transformation will be crucial in ensuring that this transition is socially fair.

For what concerns the cross-cutting dimensions of **the level of digitalization in businesses**, **in the public sector**, and **the quality of the digital infrastructure**, we consider a total of eight quantitative indicators, supplemented by qualitative information emerging from National Recovery and Resilience Plans and other relevant policy documents.

The **output** of this part of the study is 27 country fiches, where each Member State is assessed according to the above-mentioned dimensions. For the labour market dimension, we find that there is a positive and statistically significant correlation, at EU27 level and in nine of the EU Member States, between, on the one hand, the projected annual growth (2022-2035) in the employment share (in the total employment of a country) that an activity sector represents and, on the other hand, the percentage of ICT specialists employed in this activity sector (note: this percentage can be considered as a proxy of the degree of digital transformation of an activity sector). While no causal relation can be inferred from this statistically significant correlation, this could suggest that **in these Member States, more digitised sectors are likely to experience higher growth in their employment shares in the coming decade**. These Member States may therefore be better prepared to reap labour market benefits from the digital transformation, which could have consequences for social fairness. On the other hand, for the other Member States analysed, no such positive and significant correlation is found. The analysis also shows that, at EU level, trade workers are the most vulnerable type of occupation to automation, but that **across Member States, different types of occupations emerge as the most vulnerable**. This implies that the extent to which different labour market groups are vulnerable to the digital transformation may differ across Member States, which has important implications for policy-making.

A high overall level of digital skills in the population is a prerequisite for a socially fair digital transformation, but **this overall level of digital skills varies significantly across Member States**. Moreover, in all Member States, there are digital skill premiums for socio-economically advantaged groups, including the highly educated and workers in non-manual occupations. However, the extent of these digital divides differs across countries. Next to digital skills, countries with more comprehensive social protection systems may be better positioned to absorb the potential negative impact of the digital transformation on inequality and poverty. Yet, **there are significant discrepancies in the coverage and adequacy of social protection systems across Member States.** The extent to which the employment status and access to social protection of platform workers, one of the groups of workers significantly affected by digitalisation, has been addressed through policy action also varies strongly across countries.

Looking forward, conducting **further policy action to ensure a socially fair digital transformation** - including by further investing in digital skills and addressing socio-economic discrepancies in digital skills, as well as strengthening social protection systems - appears therefore as a strong policy priority. A number of Member States are implementing policy measures in these areas, including through the National Recovery and Resilience Plans.

Part B: Uses of digital technologies by the public sector to improve the delivery and the design of social benefits and of active labour market policies, as well as for complementing the monitoring of poverty and income inequality

The **main objective** of this part of the study is to identify and describe – through 30 case studies – some of the main actual or potential uses of digital technologies (including AI) by a country's public sector for: (i) improving the **delivery of social benefits or of active labour market policies** (**ALMPs**), (ii) improving the **design of social benefits or of ALMPs**, and (iii) improving or complementing the **monitoring of poverty and income inequality**.

Specifically, we identify and describe eight existing and six potential cases of the use of digital technologies by the public sector to improve the delivery of social benefits or of ALMPs; two existing and five potential uses to improve the design of social benefits or of ALMPs; and six existing and three potential uses to complement the monitoring of poverty and of income inequality (the case studies analysed are mainly in Member States but also in a few third countries). In addition, three case studies amongst the 30 case studies analyzed, which were considered of particular interest, are described in greater detail.

After researching and reviewing the case studies, we also develop a **typology of digital technologies** that are currently being used or explored for application in the public sector, which seek to improve the delivery and design of social policies and of ALMPs or to complement the monitoring of poverty and income inequality. This typology can be used to highlight opportunities and hindrances to the wide-scale deployment of innovative digital technologies in the public sector. Specifically, we distinguish between five clusters (i.e., types) of technologies as detailed below.

The first cluster of technologies concerns **automation**. Automation refers to technologies that are explicitly aimed at emulating and substituting the actions currently performed by social workers or employees of the public administration. We can further distinguish between **front-office automation technologies** (e.g. chatbots or virtual assistants) and **back-office automation technologies** (e.g. robotic process automation and automated decision making).

The second cluster of technologies concerns **analytics**. The relevant case studies highlight three key developments in this context. First, advanced data analytics is becoming increasingly accessible to public sector employees. Second, the powers of data analytics are increasingly being used for the optimisation of processes, namely for an evidence-based allocation of resources and policy making. Third, public institutions' interest in data analytics is shifting to its predictive capabilities, as testified by a growing attention to Machine Learning.

The third cluster of technologies concerns **digital public services**. The extent to which a service for citizens (or information concerning that service) is provided via an online portal is one of the key dimensions along which the development level of eGovernment is usually measured. One of the biggest developments in the area of digital public services concerns the set up, by public administrations, of virtual hubs and platforms for seamless mediation with citizens (e.g. one-stop shops).

The fourth cluster concerns **blockchain and cryptography**. The use of blockchain technology in the public sector has often been characterized as the digital infrastructure that could potentially revolutionize digital governance. It is claimed that Distributed Ledger Technologies (DLT) could lead to many benefits, including process efficiency, increased security of record-keeping, and improved interactions between the public sector and citizens. However, despite a few case studies in our selection that describe these technologies, promising prospects have yet to be proven and implementation of these systems has been slowed down by their low technological maturity and by incompatible regulatory regimes.

The fifth cluster focuses on the use of **new sources of data** arising from digitization technologies. National Statistical Offices traditionally relied on active data collection practices through surveys (or on the use of traditional administrative data sources). However, the digital transformation has introduced **passive data sources** that offer potential for socio-economic research. These sources, such as credit card transactions or mobile phone logs, provide information collected automatically without active user participation. Utilizing these passive data sources can overcome the limitations of traditional methods. They offer high-frequency availability and cost advantages compared to expensive traditional surveys.

Key Terms

Active Labour Market Policies (ALMPs): Active Labour Market Policies (ALMPs) encompass a wide range of proactive interventions and initiatives designed to empower individuals, particularly those facing employment barriers or disadvantaged groups, in their pursuit of sustainable and quality employment. ALMPs embrace diverse strategies, including skill development programs, vocational training, job placement services, career guidance, entrepreneurship support, and active job search assistance.

Artificial Intelligence (AI): An AI system is defined as a: "software that is developed with [specific] techniques and approaches (e.g. machine learning, logic and knowledge-based systems or statistical approaches) and can, for a given set of human-defined objectives, generate outputs such as content, predictions, recommendations, or decisions influencing the environments they interact with" (source: EC proposal for an EU AI act).

Automated Decision Making (ADM): Automated Decision Making refers to the process of using algorithms and computational models to make decisions or take actions without direct human intervention. It involves the utilization of data and, potentially, Artificial Intelligence techniques to analyse information, identify patterns, and generate outcomes or recommendations.

Automation: Automation refers to the use of technology, such as machines, robots, or software, to perform tasks or processes that were previously carried out by humans. It involves the implementation of systems that can operate and control various functions with minimal or no human intervention, thereby increasing efficiency, productivity, and accuracy in a wide range of industries and sectors.

Big data: Big Data refers to extremely large and complex datasets that are difficult to manage and analyze using traditional data processing methods. It encompasses the collection, storage, and analysis of vast amounts of structured and unstructured data, often characterized by high volume, velocity, and variety. Big Data enables organizations to extract valuable insights, identify patterns, and make data-driven decisions for various purposes, such as improving operations, enhancing customer experiences, and driving innovation.

Capital share of national income: The capital share of national income refers to the portion or percentage of a country's total income that accrues to capital owners, such as shareholders, investors, or owners of physical or financial assets. It represents the portion of national income generated through the ownership and deployment of capital, including profits, dividends, interest, and rents, relative to other factors of production, such as labour.

Consumer surplus: Consumer surplus refers to the economic benefit or value that consumers derive from a product or service, exceeding the price they paid to acquire it. It represents the difference between what consumers are willing to pay for a good or service and the actual price they pay in the market.

Demand-side effects (of the digital transformation): These effects relate to changes in the demand for labour resulting from the digital transformation. They include shifts in the types of skills and expertise that are in demand due to the integration of digital technologies in various industries.

Digital divide: The gap between individuals, households, businesses and geographic areas at different socio-economic levels with regard both to their opportunities to access ICT and to their use of the Internet for a wide variety of activities.

"Digital-first" principle: In the public sector, the "digital-first" principle refers to a strategic approach where digital technologies and channels are prioritized as the primary means of delivering government services, engaging with citizens, and conducting administrative functions. It involves utilizing digital platforms, tools, and data to enhance accessibility, efficiency, and transparency in public service delivery, empowering citizens with convenient and seamless digital interactions, and leveraging technology to optimize government operations and decision-making processes.

Digital governance: Digital governance refers to the framework, policies, and processes established to guide and manage the use of digital technologies within an organization or government. It involves defining rules, regulations, and standards for digital initiatives, ensuring data privacy and security, fostering digital inclusion, and promoting ethical and responsible use of technology.

Digital literacy: Digital literacy refers to the ability to understand, evaluate, and use digital technologies and information effectively. It encompasses the skills and knowledge needed to navigate digital platforms, assess the credibility of online sources, communicate, and collaborate online, and protect personal data and privacy. Digital literacy empowers individuals to participate confidently and responsibly in the digital world, enabling them to access opportunities, make informed decisions, and adapt to the ever-evolving digital landscape.

Digital platforms: Digital platforms refer to online systems or applications that facilitate the exchange, interaction, and collaboration between users or businesses. These platforms typically provide a digital infrastructure that enables various activities such as buying and selling goods or services, sharing content, connecting with others, or accessing specific functionalities. Examples of digital platforms include e-commerce websites, social media networks, sharing economy platforms, and online marketplaces.

Digital services: In the public sector, "digital services" refer to the online or technology-enabled solutions and offerings provided by government entities to citizens, businesses, or other stakeholders. These services aim to enhance accessibility, convenience, and efficiency by leveraging digital channels, platforms, and tools.

Digital skills: Digital skills refer to the competencies and abilities individuals possess to effectively use and navigate digital technologies. These skills include basic digital literacy, proficiency in utilizing digital tools and platforms, information literacy for evaluating and critically engaging with digital content, and the ability to adapt to evolving digital environments.

Digital skills divide: The digital skills divide, refers to disparities in the level of digital skills and literacy among individuals or communities. This divide reflects differences in people's ability to effectively use digital technologies and navigate the digital landscape.

Digital skills gap: The digital skills gap refers to the disparity or mismatch between the demand for digital skills in the workforce and the availability or proficiency of individuals possessing those skills. It represents the difference between the skills required by employers to effectively utilize digital technologies and the current capabilities of the workforce. The digital skills gap poses challenges in meeting the needs of a rapidly advancing digital economy and highlights the importance of efforts to bridge this gap through education, training, and upskilling initiatives.

Digital technology: Digital technology refers to the application of electronic systems, devices, and processes that utilize digital information and communication methods to perform tasks, store and transmit data, and enable various functionalities in a wide range of domains.

Digital transformation (or digital transition): Digital transformation refers to the comprehensive and strategic integration of digital technologies, processes, and capabilities across various aspects of an organization or society, leading to fundamental changes in how they operate, deliver value, and interact. It involves leveraging digital advancements to drive innovation, enhance efficiency, and adapt to the evolving demands of the digital age.

Digitalization: Digitalization refers to the process of converting analog information, processes, or systems into digital formats, enabling the use of digital technologies and data for storage, processing, analysis, and communication.

Disposable income: Household disposable income is households' income from market sources (e.g. earnings) and cash benefits, after the deduction of direct taxes and regular inter-household cash transfers (e.g. alimony and child support). It can be considered as the income available to the household for spending and saving (source: Eurostat).

Earnings: Earnings refer to the total amount of money an individual or entity receives as income from employment or business activities, typically before taxes and deductions are applied (note that in the study we distinguish between gross and net earnings).

E-government: E-government, or electronic government, refers to the utilization of digital technologies and online platforms by government entities to deliver public services, interact with citizens, and conduct administrative processes. It involves the use of information and communication technologies (ICT) to enhance efficiency, accessibility, transparency, and citizen engagement in government operations, enabling online access to government information, digital service delivery, and electronic interactions between citizens and public agencies.

Employment creation: Employment creation refers to the process of generating new job opportunities within an economy, leading to an increase in the number of people employed and contributing to the workforce.

Employment destruction: Employment destruction refers to the process of eliminating or reducing job positions within an economy, resulting in a decrease in the number of people employed and potentially leading to unemployment.

Gini coefficient: The Gini coefficient is a statistical measure used to quantify and represent income or wealth inequality within a population, where a value of zero indicates perfect equality and a value of one represents maximum inequality.

Gross output: Gross output refers to the total value of goods and services produced by an industry or economy before accounting for intermediate inputs, providing a measure of the overall economic activity or production volume.

ICT infrastructure: ICT infrastructure refers to the physical and virtual components, including hardware, software, networks, and data centers, that support the storage, processing, and transmission of information and enable the functioning of information and communication technologies within an organization, region, or country.

Income distribution: Income distribution refers to the way in which the total income generated within a society or economy is divided among individuals or households.

Income inequality: Income inequality refers to the unequal distribution of income among individuals or households within a society, highlighting disparities in earnings, wages or wealth, and the resulting gaps between the affluent and the less affluent members of the population.

Information and Communication Technology (ICT): Information and communication technologies (ICT) refer to the broad range of technological tools, systems, and platforms used to collect, process, store, transmit, and share information, enabling communication, collaboration, and the retrieval and utilization of data in various domains and sectors.

Job displacement: Job displacement refers to the situation where workers lose their employment (opportunities) due to factors such as automation, technological advancements, or changes in economic conditions, leading to a reduction or elimination of specific job roles or occupations.

Job polarization: Job polarization refers to the phenomenon in the labour market where employment opportunities shift towards both high-skilled, high-wage occupations and low-skilled, low-wage occupations, while the middle-skill, middle-wage jobs experience relative decline or stagnation.

Labour market outcomes: Labour market outcomes refer to the various indicators and measures that assess the conditions and results of employment within an economy, including employment rates, unemployment rates, wages, job quality, and other factors that impact individuals' experiences in the labour market.

Labour productivity: Labour productivity refers to the measure of output or economic value generated per unit of labor input, indicating the efficiency and effectiveness with which workers contribute to the production of goods or services.

Labour share of national income: The labour share of national income refers to the portion or percentage of total income generated within an economy that is received by workers in the form of wages, salaries, and other forms of compensation for their labour contributions, as opposed to the share going to capital owners.

Machine learning: Machine learning is a branch of artificial intelligence that involves the development of algorithms and models that enable computers to learn from data and make predictions or decisions without being explicitly programmed, relying on patterns and statistical techniques to improve performance over time.

Macro-analysis: Macro-level analysis in economic research refers to the examination and study of aggregate or overall economic phenomena, such as national or regional economies, by analysing broad indicators, trends, and relationships among various macroeconomic variables.

Micro-analysis: Micro-level analysis in economic research refers to the examination and study of individual economic units, such as individuals, households, firms, or specific markets, with a focus on understanding the behavior, decision-making processes, and interactions of these entities at a more granular level. It involves analysing data and variables at the individual level to gain insights into specific economic phenomena and their impacts.

Occupational composition: Occupational composition refers to the distribution or structure of different types of occupations within a workforce or population, providing insight into the relative representation of various job categories or roles and their contributions to the overall employment landscape.

Occupational upgrading/downgrading: Occupational upgrading/downgrading refers to changes in the skill level or requirements of jobs within a workforce, where upgrading indicates a shift towards higher-skilled occupations, often accompanied by improved wages and job quality, while downgrading signifies a movement towards lower-skilled occupations, potentially resulting in reduced wages and job quality.

“Only-once” principle: The "Only-once" principle in the context of public services refers to the principle of minimizing the burden on citizens by requiring them to provide their information or data to government entities only once, and subsequently, sharing that information across different government agencies to reduce duplication and streamline administrative processes.

Poverty: in this study, poverty most often refers to monetary poverty, defined for an individual as having an equivalised disposable income below the national poverty threshold (which corresponds to 60% of the national median equivalised disposable income).

Purchasing power: Purchasing power refers to the ability of an individual, household, or entity to acquire goods and services based on their available income or wealth, taking into account the prevailing prices or cost of living.

Robotics: Robotics is the interdisciplinary field encompassing the design, construction, programming, and use of robots, which are mechanical or virtual agents capable of performing tasks autonomously or with human assistance, often mimicking or augmenting human actions and intelligence.

Routine-biased technological change: Routine-Biased Technological Change refers to a pattern of technological advancements that disproportionately affect routine or repetitive tasks, often replacing or reducing the demand for middle-skilled jobs while increasing the demand for both low-skilled and high-skilled jobs.

Sectoral composition: Sectoral composition of an economy refers to the distribution and relative importance of different economic sectors, such as agriculture, manufacturing, services, and others, in terms of their contributions to overall output, employment, and economic activity.

Skill mismatch: Skill mismatch refers to a situation where there is a mismatch or misalignment between the skills and qualifications possessed by individuals in the labour market and the skills and qualifications required by employers, resulting in underutilization or insufficient utilization of skills and potential labour market inefficiencies.

Skill upgrading: Skill upgrading refers to the process of acquiring or developing higher-level skills, knowledge, or competencies by individuals, often through education, training, or work experience, enabling them to perform more complex tasks or take on higher-skilled job roles.

Skill-biased technological change: Skill Biased Technological Change refers to a phenomenon in which technological advancements and automation disproportionately favour workers with higher levels of skills and education, leading to increased demand and higher wages for skilled workers while reducing demand and potentially lowering wages for low-skilled workers.

Skills demand: Skills demand refers to the specific skills, knowledge, and qualifications that are sought after by employers and industries to meet their workforce requirements and fulfill job roles effectively and efficiently.

Skills supply: Skills supply refers to the availability and proficiency of individuals with specific skills, knowledge, and qualifications in the labour market, indicating the pool of potential workers capable of meeting the skills demand of employers and industries.

Social benefits: Social benefits refer to financial assistance provided by the government or social welfare programs to individuals or households to help meet their basic needs, alleviate poverty (and income inequality), promote social inclusion, and enhance social well-being.

Social services: Social services refer to a range of government or community-provided services aimed at addressing social needs, supporting the well-being and quality of life of individuals and communities, and promoting social welfare, such as healthcare, education, housing assistance, welfare programs, and other forms of support.

Social protection: Social protection systems provide support to people who cannot earn their income or face additional needs, for instance, because of unemployment, parental responsibilities, sickness, disability or old age. This support can take the form of cash benefits, such as pensions or unemployment benefits, or benefits in kind, such as care services. In the EU, most social protection benefits are provided by public authorities. In some cases, employers or social partners jointly also provide benefits, such as occupational pensions. (source: DG EMPL).

Supply-side effects (of the digital transformation): These effects pertain to changes in the supply or availability of labour as a result of the digital transformation. They involve how workers adapt to and meet the changing demands of the digital economy. Supply-side effects include upskilling and reskilling efforts by individuals to acquire the digital skills and competencies required in the evolving job market. This may involve formal education, vocational training programs, or self-directed learning to enhance digital literacy and proficiency.

Technological unemployment: Technological unemployment refers to the phenomenon where advances in technology and automation lead to a reduction in the demand for human labour, resulting in unemployment or displacement of workers due to the substitution of their roles by machines or software.

Twin transition: The Twin transition, as understood in the context of EU policy, refers to the simultaneous and interrelated processes of transitioning towards a greener and more sustainable economy (the ecological transition) while also embracing digitalization and harnessing the potential of digital technologies (the digital transition). It involves aligning economic development with environmental objectives and leveraging digital innovation to drive growth, competitiveness, and societal well-being in a sustainable manner.

Value added: Value added refers to the additional economic value created by a business or industry through its production process, calculated by subtracting the cost of inputs from the revenue generated, and serves as a measure of the contribution made to the final value of a product or service.

Wage compensation: Wage compensation refers to the monetary remuneration provided to employees in exchange for their labour, skills, and services, typically in the form of regular payments or salaries.

Wage differentials: Wage differentials refer to the variations or disparities in wages and salaries across different individuals, occupations, industries, or regions, reflecting differences in skills, education, experience, job characteristics, market conditions, or other factors.

Wage distribution: Wage distribution refers to the pattern or dispersion of wages across a population or workforce, depicting the range of wages earned by individuals and providing insight into the level of inequality or equity in the distribution of earnings.

Wage dynamics: Wage dynamics refer to the patterns, changes, and movements in wages over time, including factors such as wage growth, fluctuations, adjustments, and trends, which can be influenced by various economic, labour market, and policy factors.

Wage inequality: Wage inequality refers to the disparity or unequal distribution of wages among individuals or groups within a population, indicating differences in earnings based on factors such as skills, education, occupation, gender, or other socioeconomic characteristics.

A socially fair digital transformation: a review of preparedness across the European Union

The core aim of this part of the study is to provide an overview of the degree to which each Member State (MS) is prepared to ensure a socially fair digital transformation in the coming decade. For each Member State, we pursue an analysis that encompasses both the current situation and the situation going forward. This analysis is, for each MS, based on 3 pillars that cover, each, one or several dimensions: pillar 1 concerns the labour market dimension, pillar 2 concerns policy-related dimensions (support of digital skills formation, social protection and social policies), and, finally, pillar 3 concerns other cross-cutting dimensions that are relevant for a socially fair digital transformation. The outcome of this analysis is a list of country fiches, each one structured around 3 sections that cover the 3 aforementioned pillars.

First, each fiche presents, in its first section, an analysis of the potential labour market impact of the digital transformation. This analysis is based on an assessment of the sectoral and occupational structures of each Member State's labour market, and on their vulnerability to the digital transformation. Considering, in both cases, the relationship with the projected employment growth in the coming decade offers insights into the degree of preparedness of each Member State. Note that employment and employment growth are among the main channels to ensure a socially fair digital transition. Indeed, the digital transition and the risk of automation will influence the evolution of labour demand and, thus, the level of employment in specific sectors and occupations.

Second, each fiche outlines, in its second section, the favourable or unfavourable outlooks of a Member State regarding two key policy dimensions for a socially fair digital transformation, namely a) digital skills as well as b) social protection and social policies. The level of digital skills is a significant aspect to consider when reviewing the strengths and vulnerabilities of a Member State for ensuring a socially fair digital transformation. The degree to which the potential of the digital future will be realized, especially in a socially fair manner, will principally depend on the digital capabilities of the workforce. Furthermore, the extent to which the negative consequences of the digital transformation can be alleviated will depend on effective social protection measures. In this regard, the adequacy and coverage of social protection schemes and the degree to which the "digital shock" can be absorbed, at least in the short term, will be essential.

Finally, the fiche analyses, in its third section, some further relevant dimensions for ensuring a socially fair digital transformation, notably the level of digitalisation in firms, digital infrastructures and digital public services. Those aspects are essential to benefit from the potential opportunities created by the digital transformation.

Table 1 below lists the (set of) indicators/indexes used to evaluate each of the dimensions used in the analysis of MS, along with the name of the variable, the year(s) covered, and the source. In addition to the quantitative indicators, some qualitative insights will be reported. These have been collected through analyses of national policy plans, including national digital strategies and other relevant policy plans.

The following subsection will elaborate on each indicator and its link with the digital transformation. Indicators are described according to the order in Table 1, group-by-group, considering first the current view and then the forward-looking view. By current view, we refer to the year of last available data, in most cases 2022, whereas by forward-looking view we refer to the coming five to thirteen years, depending on data availability. It is worth stressing that it was not possible to use, for a given dimension, the same indicators for the 'current' view and for the 'forward-looking' view due, *inter alia*, to the heterogeneity of the sources used. Nevertheless, this does not undermine the storyline that links the selected variables. Methodologically, as far as the parts including the use of indicators are concerned, we refer to descriptive statistics and correlation analyis. This latter does not imply any causal relationship. However, we must stress that it is not possible to establish a causal and exclusive relationship between the various variables considered and the various proxies of digital transformation. Accordingly, we only refer to correlations between selected variables.

Table 1 – Dimensions and indicators/indexes included in the current and forward-looking assessment of Member States' positive and negative outlooks regarding the effect of the digital transformation.

Dimension	Current indicators/indexes	Forward-looking indicators/indexes
1. The labour market and the digital transformation	**1.1 Employment by sector NACE Rev.2**	
	• Employment share by sector (2022) *Source*: Own computations on Eurostat (lfsa_egan) **Ranked by:** • Percentage of enterprises that employ ICT specialists (2022) *Source*: Eurostat (isoc_ske_itspen2) • Digital Capital Intensity index (average 2014-2017) *Source*: Own computations on EUKLEMS & INTANProd database	• Future annual growth rate of sector's employment share (2022-2035) *Source*: Own computation on 'Cedefop Skill forecast 2023' data **Ranked by:** • Percentage of enterprises that employ ICT specialists (2022) *Source*: Eurostat (isoc_ske_itspen2) • Digital Capital Intensity index (average 2014-2017) *Source*: Own computations on EUKLEMS & INTANProd database

<table>
<tr><td rowspan="2"></td><td colspan="2">1.2 Employment by occupation ISCO-08 1 and 2 digits</td></tr>
<tr><td>• Employment share by occupation (2022)
Source: Authors' computations on Eurostat (lfsa_egais)

Ranked by:
• Automation risk for occupations at the EU level (ISCO-08 1 digit) 2022
Source: Cedefop

• Employment share of ICT professionals (ISCO-08 code 25) (2022)
Source: Eurostat (lfsa_egai2d)</td><td>• Future annual growth rate of employment share by occupation (2022-2035)
Source: Own computation on Cedefop ‘Skill forecast 2023’ data

Ranked by:
• Automation risk for occupations at the EU level (ISCO-08 1 digit) 2022
Source: Cedefop

• Future annual growth rate of employment share of ICT professionals (ISCO-08 code 25 (2022-2035)
Source: Cedefop</td></tr>
<tr><td rowspan="4">2 Key policy dimensions for a socially fair digital transformation</td><td colspan="2">2.1 Digital skills</td></tr>
<tr><td>• Estimated digital skills and digital skill divides across population groups (2019)
Source: CEPS estimation on Eurostat microdata
• DESI index on: Human Capital (2021)
Source: European Commission</td><td>• National Recovery and Resilience Plans (NRRP)’ planned investments and reforms in:
- human capital (2021-2026)
• Qualitative information from National Digital Strategies, DESI country reports, RRF thematic analyses and other policy documents</td></tr>
<tr><td colspan="2">2.2 Social protection and social policies</td></tr>
<tr><td>• Population at risk of poverty (2021)
Source: Eurostat [TPS00184]
• Impact of social transfers (excluding pensions) on poverty reduction (2021)
Source: Eurostat
• Benefit recipiency rate for the population at risk of poverty before social transfers (+16 yo)
Source: JRC
• Platform work cluster
Source: Public Policy Management Institute (2021)</td><td>• NRRP planned investments and reforms in social expenditure, including:
i. Employment and skills
ii. Education and childcare
iii. Health and long-term care
iv. Social policies
• Qualitative information from national implementation plans for the Recommendation on access to social protection and RRF thematic analyses</td></tr>
</table>

3. Other dimensions relevant to the digital transformation	**3.1 Digitalisation of businesses**	
	• Total robot density and robot density in manufacturing (2010, 2019) *Source*: International Federation of Robotics (IFR) • Digital capital intensity (2008, 2018) *Source*: Own computations on EUKLEMS & INTANProd database • DESI Index on: integration of digital technologies (2021) *Source*: European Commission	• NRRP planned investments and reforms in: digitalisation of businesses (2021-2026) • Qualitative information from DESI country reports, RRF thematic analyses and other national policy documents
	3.2 Digital infrastructure and public services	
	• DESI Index on: - connectivity (2021) - digital public services (2021) *Source*: European Commission	• NRRP planned investments and reforms in digital infrastructure policies in: - connectivity (2021-2026) - digital public services (2021-2026) • Qualitative information DESI country reports, RRF thematic analyses and other national policy documents.

1. The labour market

For the employment dimension, we will consider a total of nine indicators, three for the current view, three for the forward looking view, and three used for ranking purposes. Below, we list the indicators, elaborating on the way some groups of indicators are to be read together, and how to interpret them. On the one hand, we will consider the sectoral composition of the economy. On the other hand, we will look at the occupational composition of the economy.

1.1. Sectoral composition

By looking at the sectoral composition of the economy, we can infer whether the outlook – in terms of employment share growth – is favourable or unfavourable in the sectors that are more or less influenced by digital transformation. The sectoral composition of the economy is analysed by considering 21 activity sectors (NACE rev. 2 classes) and by showing the **employment share** of each of these sectors (which is computed using Eurostat data for the year 2022). When showing the employment share data, the activity sectors are ranked according to their "level of digital transformation". In this ranking, this level of digital transformation is proxied by two variables: the **'percentage of enterprises that employ ICT specialists'** and the **'digital capital intensity'**.

The former variable, by Eurostat (code: isoc_ske_itspen2), offers a decomposition by NACE Rev. 2 activity[1] at 1-digit level, which includes only enterprises with more than ten workers and refers to the year 2022 (see Table 2 here below for the availability of sectors).

The latter variable is an index of digital transformation – built in the context of this study[2] – that looks at the ratio between the stock of capital that firms have in software and databases and their overall stock of capital excluding non-residential buildings[3]. Note that this variable is subject to a few limitations, namely it cannot be computed for eleven Member States[4] plus the EU27 which present only aggregated data. Furthermore, for the remaining Member States that present disaggregated data by sector, there is heterogeneity in data availability (see Table 3 here below for the availability of sectors). Finally, due to time inconsistencies in the availability of the necessary data, we take the average 2014-2017 to ensure the homogeneity of this variable.

The aforementioned analysis based on the employment share data provides descriptive evidence on the current situation of the labour market in each Member State. This is to be complemented with a forward-looking assessment, which is done by considering the future annual growth rate of employment share by sector for the period 2022-2035, as estimated based on Cedefop (European Center for the Development of Vocational Training) 'Skill forecast 2023' data[5]. This indicator provides an estimate of how much the demand for jobs is expected to grow or shrink in each of the 20 NACE[6] sectors' shares in each year, on average, from 2022 to 2035.

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[1] The NACE rev.2, at 1 digit level available for this indicator are 9 over 21: C - Manufacturing; E - Water supply, sewerage, waste management and remediation activities; F - Construction; G - Wholesale and retail trade; repair of motor vehicles and motorcycles; H – Transport and storage; I – accommodation and food service activities; J – Information and communication; M – professional, scientific and technical activities; N – administrative and service activities. Source Eurostat (code: isoc_ske_itspen2). The year 2022 has been selected because, at the moment this document was redacted, was the most recent, as well as, the one with fewer missing values in the NACE Rev.2 1-digit codes.

[2] Please refer to the Annex for details on its construction.

[3] For this, we use data from the new integrated EUKLEMS & INTANProd database, run by the Luiss Lab of European Economics at Luiss University in Rome, Italy. EUKLEMS includes information on gross output, gross value added, employment, number of hours worked, compensation of employees, as well as investment in capital stocks across both tangible and intangible assets for all the EU 27 Member States. EUKLEMS & INTANProd updates this widely-used EUKLEMS productivity database and extends it with new estimates of intangible investment coherent with INTAN-Invest (www.intaninvest.net). The dataset covers all EU countries for the period 1995-2019, and provides both measures of investment (flows) and stock of capital. We opt for looking at the capital stock, as this is less volatile and provides a better description of the extent of the ongoing digitalization process. More specifically, our indicator of digital capital intensity is defined as:

$$DigitalCapitalIntensity_{it} = \frac{K\_Soft\_Db_{it}}{({K_{Intang}}_{it} + {K_{TangNRes}}_{it})}$$

where K_Soft_Db is the series on net capital stock in computer software and databases, K_{Intang} is total intangibles, and $K_{TangNRes}$ is total tangible assets excluding non-residential buildings, i refers to the industry and t to time.

[4] As it can be seen in Table 3, these Member States are Bulgaria, Ireland, Croatia, Cyprus, Hungary, Malta, Netherlands, Poland, Portugal, Romania, Sweden.

[5] Available upon request from Cedefop.

[6] The sectors excluded are: L, S, T, U.

Table 2 – Availability of Eurostat 'percentage of enterprises that employ ICT specialists' data by sector and by Member State.

MS/NACE Rev.2	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
BE	N	N	Y	N	N	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	N	N	N	N	N
BG	N	N	Y	N	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	N	N	N	N	N
CZ	N	N	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	N	N	N	N	N
DK	N	N	Y	N	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	N	N	N	N	N
DE	N	N	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	N	N	N	N	N
EE	N	N	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	N	N	N	N	N
IE	N	N	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	N	N	N	N	N
EL	N	N	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	N	N	N	N	N
ES	N	N	Y	Y	N	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	N	N	N	N	N
FR	N	N	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	N	N	N	N	N
HR	N	N	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	N	N	N	N	N
IT	N	N	Y	Y	N	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	N	N	N	N	N
CY	N	N	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	N	N	N	N	N
LV	N	N	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	N	N	N	N	N
LT	N	N	Y	Y	N	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	N	N	N	N	N
LU	N	N	Y	Y	N	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	N	N	N	N	N
HU	N	N	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	N	N	N	N	N
MT	N	N	Y	N	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	N	N	N	N	N
NL	N	N	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	N	N	N	N	N
AT	N	N	Y	N	N	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	N	N	N	N	N
PL	N	N	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	N	N	N	N	N
PT	N	N	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	N	N	N	N	N
RO	N	N	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	N	N	N	N	N
SI	N	N	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	N	N	N	N	N
SK	N	N	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	N	N	N	N	N
FI	N	N	Y	Y	N	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	N	N	N	N	N
SE	N	N	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	N	N	N	N	N
EU 27	N	N	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	N	N	N	N	N

Note: according to the NACE Rev.2 activities classification the following applies A - Agriculture, forestry and fishing, B - Mining and quarrying, C – Manufacturing, D - Electricity, gas, steam and air conditioning supply, E - Water supply, sewerage, waste management and remediation activities, F – Construction, G - Wholesale and retail trade, H - Transportation and storage, I - Accomodation and food service activities, J - Information and communication, K - Financial and insurance activities, M - Professional, scientific and technical activities, N - Administrative and support service activities, O - Public administration and defence, compulsory social security, P – Education, Q - Human health and social work activities, R - Arts, entertainment and recreation, S - Other services activities, T - Activities of households as employers (undifferentiated goods), U - Activities of extraterritorial organisations and bodies.

Table 3 – Availability of EUKLEMS & INTANProd data by sector and by Member State for constructing the Digital Capital Intensity index.

MS/NACE Rev.2	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
BE	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
BG	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
CZ	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
DK	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
DE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	N	N
EE	Y	Y	N	Y	Y	Y	N	N	Y	N	Y	Y	Y	Y	Y	Y	N	Y	Y	N	N
IE	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
EL	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
ES	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
FR	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
HR	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
IT	Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
CY	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
LV	Y	N	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N

LT	Y	Y	N	Y	Y	Y	N	N	N	N	Y	Y	Y	Y	Y	N	Y	Y	Y	N	N
LU	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N	Y	Y	Y	Y	Y	N	N
HU	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
MT	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
NL	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
AT	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N	N
PL	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
PT	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
RO	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
SI	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	N	N
SK	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
FI	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
SE	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
EU27	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N

Note: according to the NACE Rev.2 activities classification the following applies A - Agriculture, forestry and fishing, B - Mining and quarrying, C – Manufacturing, D - Electricity, gas, steam and air conditioning supply, E - Water supply, sewerage, waste management and remediation activities, F – Construction, G - Wholesale and retail trade, H - Transportation and storage, I - Accomodation and food service activities, J - Information and communication, K - Financial and insurance activities, M - Professional, scientific and technical activities, N - Administrative and support service activities, O - Public administration and defence, compulsory social security, P – Education, Q - Human health and social work activities, R - Arts, entertainment and recreation, S - Other services activities, T - Activities of households as employers (undifferentiated goods), U - Activities of extraterritorial organisations and bodies.

We suggest the following reading and interpretation of the described indicators. First, as mentioned above, we rank – from the highest to the lowest - the activity sectors in a given country according to their level of digital transformation (using two proxies for the level of digital transformation as mentioned above). Using this ranking, we show the share of employment (current view) and the annual rate of growth (forward-looking view) of these ranked activity sectors. This enables to see whether the current employment structure and the future evolution in the employment share of a country is or will be mainly driven (or not) by activity sectors where digital transformation is high. Moreover, when it comes to the forward-looking view, in order to offer a summary measure of the strength and direction of the relationship between the proxies of digital transformation and the annual rate of growth of the employment share by sectors, we compute their correlation coefficient, also testing the statistical significance of the relation. It is worth stressing that, even when obtaining a strong and statistically significant correlation coefficient, this cannot be interpreted as a causal relationship between whichever couple of variables. Finally, the exercise will be repeated with the alternative proxy of the digital transformation, the digital capital intensity, for a limited number of countries.

1.2 Occupational composition

We can mirror the aforementioned exercise with respect to the occupational composition of the economy. Specifically, **by looking at the occupational composition of the economy**, we can estimate whether there is employment growth in the occupations that are more or less influenced by digital transformation. Here, the occupational composition of the economy is represented by the **employment share by occupation** in the year 2022[7], computed from Eurostat data as the number of employed individuals in an occupation over the total employed individuals. Note that this measure is available for 9 ISCO-08[8]

[7] 2020 is used for a matter of consistency with the year for which the risk of automation has been calculated.
[8] International Standard classification of occupations.

occupations at 1-digit level[9] and 40 ISCO-08 occupations at 2-digits level. The digital transformation is proxied by the automation risk as estimated by Cedefop[10]. According to the Cedefop definition, the most exposed occupations are those with a significant share of tasks that can be automated and those with a small reliance on communication, collaboration, critical thinking and customer-serving skills. The indicator is calculated based on the methodology elaborated in Pouliakas (2018)[11] at the EU27 level. The year to which the risk of automation is referred is 2022. Under the strong assumption that the automation risk calculated for the whole European Union is constant across Member States, we applied it to the share of employment by occupation per each Member State. The size of the effect of the risk of automation in a Member State is thus the result of a composition effect, as it depends on the percentage of workers employed in certain occupations in this Member State.

These variables provide descriptive evidence on the current situation of the labour market in each Member State. This is to be complemented with a forward-looking assessment, which we offer by considering the future annual growth rate of employment share by occupation for the period 2022-2035, as estimated by Cedefop. This indicator is available for 9 ISCO-08 1-digit occupations and provides an estimate of the expected annual percentage change in employment demand for each country: that is, how much the demand for jobs is expected to grow or shrink each year from 2022 to 2035.

We suggest the following reading and interpretation of the described indicators. Under the assumption that the automation risk (for a given

[9] The 1-digit classification includes the categories Managers, Professionals, Associate Professionals, Clerks, Services and Sales workers, Farm and related workers, Trades workers, Operators and assemblers and Elementary Occupations. Examples of Managers (Legislators, senior officials and managers ISCO 1 in the Eurostat nomenclature) are Chief executives, senior officials and legislators (ISCO 11), Administrative and commercial managers (ISCO 12), Production and specialised services managers (ISCO 13) Hospitality, retail and other services managers (ISCO 14); examples of Professionals (ISCO 2) are Science and engineering professionals (ISCO 21), Health professionals (ISCO 22), Teaching professionals (ISCO 23), Business and administration professionals (ISCO 24), Information and communications technology professionals (ISCO 25), Legal, social and cultural professionals (ISCO 26); examples of Associate professionals (Technicians and associate professionals ISCO 3 in the ESTAT nomenclature) are Science and engineering associate professionals (ISCO 31), Health associate professionals (ISCO 32), Business and administration associate professionals (ISCO 33), Legal, social, cultural and related associate professionals (ISCO 34), Information and communications technicians (ISCO 35); examples of Clerks (clerical support workers in the Eurostat nomenclature) are General and keyboard clerks (ISCO 41), Customer services clerks (ISCO 42), Numerical and material recording clerks (ISCO 43), Other clerical support workers (ISCO 44); examples of Service and sales workers (ISCO 5) are Personal service workers (ISCO 51), Sales workers (ISCO 52), Personal care workers (ISCO 53), Protective services workers (ISCO 54); examples of Farm and related workers (Skilled agricultural, forestry and fishery workers - ISCO 6, in the Eurostat nomenclature) are Market-oriented skilled agricultural workers (ISCO 61), Market-oriented skilled forestry, fishery and hunting workers (ISCO 62), Subsistence farmers, fishers, hunters and gatherers (ISCO 63); Examples of Trades workers (Craft and related trades workers - ISCO 7 in the Eurostat nomenclature) are Building and related trades workers, excluding electricians (ISCO 71), Metal, machinery and related trades workers (ISCO 72), Handicraft and printing workers (ISCO 73), Electrical and electronic trades workers (ISCO 74), Food processing, wood working, garment and other craft and related trades workers (ISCO 75); examples of Operators and assemblers (Plant and machine operators and assemblers – ISCO 8 in the Eurostat nomenclature) are Stationary plant and machine operators (ISCO 81), Assemblers (ISCO 82), Drivers and mobile plant operators (ISCO 83); examples of Elementary workers (ISCO 9) are Cleaners and helpers (ISCO 91), Agricultural, forestry and fishery labourers (ISCO 92), Labourers in mining, construction, manufacturing and transport (ISCO 93), Food preparation assistants (ISCO 94), Street and related sales and service workers (ISCO 95), Refuse workers and other elementary workers (ISCO 96).

[10] Cedefop risk forecast database retrieved at: https://www.cedefop.europa.eu/en/tools/skills-intelligence/automation-risk-occupations#1

[11] Pouliakas, K. (2018) "The risk of automation in EU labour markets: a skill-requirements approach", in Economy, Employment and Skills: European and global perspectives in an age of uncertainty, Fondazione Giacomo Brodolini Quaderni Series, also IZA DP 11829.

occupation) is constant across Member States, we apply it to the share of employment for this occupation in each Member State, which allows us to decompose the employment share of this occupation in two components: the employment sub-share made of workers 'at risk of automation' and the employment sub-share made of workers 'not at risk of automation'. We then use the employment sub-share made of workers at risk of automation to rank – from the highest to the lowest share - the occupations. Using this ranking, we show graphically (in the same chart for a given country) the two employment sub-shares[12] (which are the indicators used for the current view) as well as the annual rate of growth (which is the indicator used for the forward-looking view) of the ranked occupations.

As a final contribution to this section, we offer a **focus on the ICT professional occupation**. Here we still rely on the share of employment by occupation, but zoom in on the ISCO-08 code 25 (Eurostat lfa_egai2d), which corresponds to ICT professionals. We relate this latter measure with the relative risk of automation (Cedefop) to provide some descriptive evidence on the status of this occupation now and going forward.

2. Key policy dimensions for a socially fair digital transformation

Next, we consider two policy dimensions of key importance to the digital transformation.

2.1 Digital skills

The **level of digital skills** is one of the most significant aspects to consider when reviewing countries' potential strengths and vulnerabilities in ensuring a socially fair digital transformation. The degree to which the potential of the digital future will be realized, especially in a socially fair manner, will depend on the digital capabilities of the workforce. To assess the level of digital skills, we will refer, overall, to **three indicators**, including two indicators assessing current levels of digital skills in the population and one taking a forward-looking view on digital human capital expenditure. For this latter aspect, some qualitative information deriving from Member States' digital strategies, national RRPs and other policy initiatives has also been considered.

First, we consider **the overall digital skill level in the population** as well as the **divides in digital skill across population groups** to examine the extent to which certain population groups are currently particularly likely to face a lack of digital skills in EU Member States, meaning they may be at higher risk of inferior labour market outcomes. To this end, we employ an index of digital skill levels in the EU calculated for this study. Briefly, the index of digital skills is calculated using a range of variables deriving from the **EU Survey on ICT usage in households and by individuals**, an annual survey conducted by Eurostat since 2002. This survey aims to collect and disseminate harmonized and comparable information on the use of ICT in households and by individuals[13].

[12] I.e. the employment sub-shares made of workers at risk of automation and the employment sub-share made of workers not at risk of automation.

[13] For more information, see https://ec.europa.eu/eurostat/web/microdata/community-statistics-on-information-society

To construct this index of individuals' level of digital skills, we draw inspiration from the official Eurostat indicator on "individuals' level of digital skills"[14]. The composite indicator constructed by Eurostat is defined as the percentage of individuals aged 16-74 performing selected activities in four specific areas: information, communication, problem-solving, and software skills. Therefore, the indicators can be considered as a proxy of the digital competencies and skills of individuals. We create a continuous measure of individuals' digital skills based on the 22 digital skill items[15] contained within the Eurostat digital skill index. We first convert all measures of digital skill into binary dummy variables, the full set of which is available for the years 2015-2019. To construct a continuous measure of digital skills, we use an item response theory (IRT) model. IRT is a methodology for aggregating a number of items, such as our binary variables capturing various aspects of digital skill, in order to capture an underlying trait, in this case, true digital skills (OECD, 2016)[16]. Briefly, based on individuals' responses for each variable (or item) capturing a specific digital skill, the model used in this study estimates this item's difficulty (i.e. what should be the level of underlying true digital skills overall in the population for 50% of individuals to be able to perform this item) and discrimination (a slope parameter indicating how steeply the likelihood of an individual performing this item changes as true digital skills increase) (DeMars, 2010)[17]. This implies that the IRT models enable us to attribute an estimated differentiated level of difficulty to each of the 22 digital skills items from the ICT survey, rather than simply assuming they have the same level of difficulty and averaging an individual's performance on each of them (e.g. the digital skill level associated with sending or receiving emails is expected to be much lower than that associated with writing code). In a second step, the parameter estimates from the IRT model can then be used to predict a level of true digital skill for each individual within the dataset. Finally, the measure of true digital skill was rescaled to have at mean of 2 and standard deviation of 1 within the pooled sample of EU Member States.

For the purpose of the country fiche exercise, we calculate – based on the aforementioned methodology - the estimated level of digital skill in each member state and the EU27 for the most recent year available, 2019. Moreover, we also examine divides in digital skills between different socio-economic groups, which are an important measure of inequality. To examine divides in digital skills, we calculate measures of digital skill across subgroups and, subsequently, gaps in digital skill between them. Specifically, we examine **gaps in digital skills between individuals with tertiary and non-tertiary education, as well as in manual and non-manual occupations**. Higher gaps can be interpreted as

[14] https://ec.europa.eu/eurostat/cache/metadata/en/tepsr_sp410_esmsip2.htm

[15] The digital skills items included are the following: Information skills – copying or moving files or folders; saving files on Internet storage space; obtaining information from public authorities/services' websites; finding information about foods or services; seeking health-related information. Communication skills – sending/receiving emails; participating in social networks; telephoning/video calls over the internet; uploading self-created content for any website to be shared. Problem solving skills – transferring files between computers or other devices; installing software and applications (apps); changing settings of any software, including operational system or security programs; online purchases (in the last 12 months); selling online; using online learning resources; Internet banking. Software skills – using word processing software; using spreadsheet software; using software to edit photos, videos or audio files; creating a presentation of document integrating text, pictures, tables or charts; using advanced functions of spreadsheet to organize and analyze data; writing a code in a programming language.

[16] OECD (2016). The Survey of Adult Skills: Reader's Companion, Second Edition. Paris: OECD Publishing.

[17] DeMars, C. (2010). Item Response Theory. Oxford: Oxford University Press.

indicative of greater inequality in digital skill across population groups, which may render the digital transformation less socially fair.

As a second quantitative indicator, we use the **human capital dimension of the EU Digital Economy and Society (DESI) index[18] 2022 (reference year 2021)**. The DESI is a tool developed by the European Commission to measure and monitor the advancement of digitalisation in European Union Member States, focusing on four dimensions: human capital, connectivity, digital public services, integration of digital technology. The human capital indicator is composed of several measures related to the digital skills level of individuals. First, it integrates measures of individuals' digital skills based on the previously mentioned Eurostat composite indicator of digital skills. Second, it includes information on the number of employed ICT specialists and female ICT specialists in a country, as well as enterprises providing ICT training and ICT graduates, deriving from the EU Labour Force Survey and the survey on ICT usage in households and by individuals. Taken together, the DESI human capital indicator thus allows us to assess to what extent Member States are prepared for the digital transformation as regards the **stock of human capital related to digital skills**. It complements the study's own estimate of digital skill described above by incorporating a wider range of variables relating to digital human capital.

Turning toward the third quantitative indicator related to the area of digital skills, **we focus on the forward-looking perspective by including data on digital expenditure within national Recovery and Resilience Plans (RRPs)**. Digital expenditure within national RRPs can be categorized as belonging to one of six dimensions: connectivity; digital-related investments in R&D; human capital; e-government, digital public services and local digital ecosystem; digitalisation of businesses; investments in digital capacities and deployment of advanced technologies[19]. A correspondence between these expenditure areas and the DESI can be established, as explained in Annex VII of the Regulation (EU) 2021/241[20]. Information on planned digital expenditure gives us an indication on the emphasis of national governments on specific aspects of the digital transformation in the post-pandemic recovery. In this section, the focus is on spending on human capital.

In addition to this data, we also **complement our analysis with a description of national policy action and plans related to digital skills**. To this end, we examine national digital strategies released by countries (where applicable), as well as information on other relevant policy plans and initiatives, drawing on information provided within the Digital Skills & Jobs Platform[21], the DESI Country Reports[22] and other national policy papers or information. Moreover, we provide information on relevant measures contained within national RRPs drawing on the RRF thematic analyses[23] and each country's RRP. This synthesis is not meant to

[18] For further information, see: https://digital-strategy.ec.europa.eu/en/policies/desi-human-capital
[19] For further information, see: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/digital.html
[20] Regulation (EU) 2021/241 of the European Parliament and of the Council of 12 February 2021 establishing the Recovery and Resilience Facility
[21] https://digital-skills-jobs.europa.eu/en/actions/national-initiatives/national-strategies
[22] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[23] https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/thematic_analysis.html

provide an exhaustive overview of policy action in each country, but rather to highlight significant developments and remaining challenges.

2.2 Social protection and social policy

In addition to digital skills, social protection also plays a key role in influencing the extent to which the digital transformation is socially fair. Countries with more encompassing social protection systems may be better positioned to protect citizens and workers from the potential adverse impact of digitalisation on the labour market.

We collect several quantitative indicators to assess – more or less directly - the extent to which social protection systems in EU Member States currently effectively mitigate against poverty. This includes:

i) the **rate of the population at risk of poverty** (Eurostat, 2023)[24]. This indicator measures the share of people with an equivalised disposable income (after social transfers) below the at-risk-of-poverty threshold, which is set at 60% of the national median equivalised disposable income after social transfers[25]. The most recent year available for all Member States at the time of writing is 2021.

ii) the **benefit recipiency rate for the population at risk of poverty before social transfers** (JRC, 2022)[26]. This indicator aims to monitor the coverage of social protection and refers - within the working age population - to the share of individuals at risk of poverty before social transfers that are taking up benefits[27]. The most recent year available for the indicator is 2019.

iii) the **impact of social transfers on poverty reduction** (Eurostat, 2023)[28]. This indicator reveals the impact of social transfers on poverty and is calculated excluding pensions. The most recent year available for all Member States at the time of writing is 2021.

In addition, we specifically look at the **social protection of people working through platforms**. The extent to which people working through platforms are covered by social protection measures may differ depending on national regulation, as they are generally classified as self-employed and, therefore not automatically covered. For our assessment of the social protection of people working through platforms, we draw on the 2021 study to support the impact

[24] Eurostat (2023). TPS00184: At-risk-of-poverty rate after social transfers by sex. Available at: https://ec.europa.eu/eurostat/databrowser/product/page/TPS00184

[25] For more information, see https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:At-risk-of-poverty_rate

[26] JRC (2022) "Monitoring the effective coverage and adequacy of social protection in the EU. Development and update of the monitoring framework of the Council Recommendation on access to social protection". The paper aims to develop quantitative indicators to assess the effective implementation of the Recommendation on access to social protection for all workers and the self-employed, focusing on concrete ways to assess the effective coverage and adequacy of social protection systems across the EU.

[27] By benefit is meant the sum of unemployment benefits (PY090G/PY090N), sickness benefits (PY120G/PY120N), disability benefits (PY130G/PY130N) and education-related allowances (PY140G/PY140N) that are at individual level plus the household-level benefits. The old age and survivor's benefits in this case are excluded.

[28] Eurostat (2023). TESPM050: Impact of social transfers (excluding pensions) on poverty reduction by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/TESPM050/bookmark/table?lang=en&bookmarkId=b001ae62-ce34-4b49-9741-28a3ef99477f

assessment of an EU initiative to improve the working conditions of people working through platforms[29]. This study included a mapping of national policy responses to platform work and a cluster analysis of the extent of regulation of platform work, resulting in a categorization of Member States into four clusters: active regulation of platform work; limited discussion of the employment status of people working through platforms; activity on employment status but not on working conditions; and few or no initiatives on platform work. Through this clustering of countries, an indication of the extent to which platform work is regulated in each Member State, and therefore how likely platform workers are to be covered by social protection, can be given.

Finally, **we also consider policy action on social protection and social policy more broadly from a forward-looking perspective**. In particular, in response to the 2019 Council Recommendation on access to social protection for workers and the self-employed, each Member State has presented a national implementation plan (NIP) setting out measures to implement the Recommendation[30]. These plans were also synthesized in a January 2023 report of the European Commission to the Council, including an assessment of which workers would be covered through the measures included in the NIPs (including platform workers) and whether existing gaps in formal and effective coverage of social protection[31] are likely to be closed[32]. By integrating information on these national policy plans, our analysis allows to assess whether future social protection measures, if implemented, may increase coverage and adequacy of social protection within Member States. In addition, we also take into account social protection measures included within national RRPs, drawing on the RRP thematic analyses and national sources, where relevant. Finally, the country fiches presented in this part of the study also include data on broader social expenditure included within each RRP[33]. This data shows to what extent social expenditure within each RRP focuses on the following four categories: employment and skills, education and childcare, health and long-term care, and social policies. While no explicit link to a socially fair digital transformation should be drawn based on this descriptive account, the social expenditure data showcases future policy priorities within the social sphere identified by Member States in the NRRPs.

3. Other dimensions relevant to the digital transformation

Finally, we consider further supporting dimensions that may be relevant for looking at the extent to which a Member State is prepared for having a socially fair digital transformation, with these dimensions focusing more on the technical potential of a Member State for benefitting from the digital transformation, and

[29] PPMI (2021). Study to support the impact assessment on improving working conditions in platform work. Available at: https://ec.europa.eu/social/main.jsp?catId=738&furtherPubs=yes&langId=en&pubId=8428

[30] The plans can be found here: https://ec.europa.eu/social/European Commission (2023). Access to social protection. Available at: https://ec.europa.eu/social/main.jsp?catId=1312&langId=en=en

[31] Workers and self-employed people are 'formally covered by a specific social protection branch if the existing legislation or collective agreement states that they are entitled to participate in a social protection scheme in that specific branch. Formal coverage can be provided via mandatory or voluntary schemes' (Council Recommendation, recital 15). In contrast, 'workers and self-employed persons can be identified as effectively covered in a specific social protection branch if they have the opportunity to accrue adequate benefits and the ability, in of the event that the corresponding risk materialises, to access a given level of benefits. A person may be granted formal access without de facto being able to build and take up entitlements to benefits' (Council Recommendation, recital 16).

[32] https://ec.europa.eu/social/main.jsp?langId=en&catId=89&furtherNews=yes&newsId=10502

[33] https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/country_overview.html?lang=en

wide-ranging access to digital infrastructure and services, which have (indirect) links with inequality and poverty. These are (i) digitalisation of businesses and (ii) digital infrastructure and digitalisation of public services.

On digitalisation of businesses, the first indicator we include is the **DESI index on the integration of digital technologies**. This is calculated as the weighted average of three sub-dimensions: i) degree of digital transformation, ii) digital technologies for businesses and iii) e-Commerce. These sub-dimensions integrate data on the uptake of digital technologies by companies, taken from the Eurostat survey on ICT usage and e-commerce in enterprises and the Survey of businesses on the use of digital technologies by Ipsos and iCite[34]. We also include **other data on the uptake of digital technologies in companies**. First, we include data on the extent of robot adoption in European companies. The main data source of reference for this measure is the International Federation of Robotics (IFR) *Industrial and Service Robots* dataset. The IFR collects data on installations of robotic equipment from robot manufacturers and cross-checks the results with statistics from national institutes of robotics to ensure high levels of reliability. We use this data to construct a measure of robot density in the economy, that is, the number of robots per thousand employees in the economy. In the country fiche, we include measures of robot density in both the total economy and in manufacturing (both for 2019), the sector where robots are most present, as well as growth therein in the ten most recent years available (2010-2019). The index is missing for Cyprus, Greece, Luxembourg and Slovenia. Finally, we also include a measure of digital capital intensity, i.e. the stock of capital firms have in software and databases relative to the overall capital stock as described in section 1.1. We focus on levels of digital capital intensity in 2018, the most recent year available, as well as changes between 2008 and 2018. AT country level, the index is available for all countries but Cyprus, Hungary, Ireland and Romania.

With regard to digital infrastructure and digitalisation of public services, we focus on the two remaining elements of the DESI Index. The **connectivity component of the DESI** combines a number of indicators on the coverage and price of broadband, taken from the Eurostat survey on ICT usage by households and individuals and data provided in studies for the European Commission. The **digital public services indicator** combines several measures on the uptake of digital public services, countries' open data policies and administrative steps involved in various processes, taken from the Eurostat Survey on ICT usage in households and by individuals, the eGovernment Benchmark and the European data Portal.

In addition to these quantitative indicators, we also incorporate information on current and future policy developments. To this end, first, we analyse the share of planned digital expenditure allocated to the three dimensions of interest – digitalisation of businesses, connectivity and digital public services – within national RRPs. Moreover, similar to the section on digital skills, we include qualitative information on key policy initiatives based on information obtained from DESI country reports, national RRPs and other key policy documents.

Based on the dimensions discussed above, in what follows, we present the 27 country fiches.

[34] For more detail on the DESI methodology and data used, see https://digital-strategy.ec.europa.eu/en/policies/desi

1. BELGIUM: elements of a socially fair digital transformation

Key Points

Labour market: The Health and social care sector, which has the largest employment share in the economy, has the ninth highest degree of digital transformation (as measured by digital capital intensity)[35]. The Health and social care sector's employment share in the economy is projected to grow further in the decade to come (but slightly less than EU trends). ICT services, Professional services and Manufacturing are the three sectors with the highest degree of digital capital intensity currently, and their employment shares, except for Manufacturing, are projected to grow in the decade to come (though slightly less than EU trends when it comes to ICT services). Workers in Professional occupations are most at risk of their occupation being automated.

Digital skills: Digital skill levels in Belgium are in line with the EU averages, but there are some specific areas of concern, such as the number of ICT graduates. Similarly, digital skill gaps between different educational and occupational groups align with those observed at the EU level.

Social protection: Overall, Belgium has a comprehensive social protection system and one of the lowest rates of the population at risk of poverty in the EU. Belgium has also been active in regulating the employment status of platform workers.

BE 1. The labour market and the digital transformation

BE 1.1 Sectoral composition (current and forward-looking perspectives)

In Belgium ("BE"), in 2022, the sectors with the largest employment shares in the economy were: Health and social care (14.4% vs 11.0% at the EU27 level), Wholesale and retail trade (12.3% vs 13.6% at the EU27 level), and Manufacturing (11.4% vs 16.0% at the EU27 level). For the period 2022-2035, Cedefop data projects[36] the annual growth rate of a sector's employment share. For Belgium's Health and social care sector, the annual growth rate is 0.3% (0.6% for the EU27), for the Wholesale and retail trade sector it is -0.4% (0.0% for the EU27), and for the Manufacturing sector it is -0.3% (-0.2% for the EU27).

[35] The ranking based on digital capital intensity is used in the key points only when the sector with the largest employment share is not rankable according to the percentage of enterprises that employ ICT specialists.
[36] Own elaboration on Cedefop 'Skill forecast 2023' data.

Table 1 presents each sector's employment share in 2022, the projected annual growth rates (2022-2035) of its employment share, and its resulting employment share in the economy by 2035. Along with these elements relating to employment, Table 1 also presents the degree of "digital transformation" of each sector. Table 1 thus enables a comparison between the degree of digital transformation of a sector and its employment share or its employment share's prospects. The aforementioned degree of digital transformation is proxied in Table 1, for each sector, using two indicators: i) the percentage of enterprises in the sector that employ ICT specialists and ii) the digital capital intensity[37] of the sector. Table 1 presents the ranking of each sector according to these two proxy indicators (with rank n°1 corresponding to the most digitised sector). According to the first indicator, the three sectors with the highest degree of digital transformation in Belgium, in order, are: ICT services (employment share: 4.4% in BE vs 3.7% in the EU27), Professional services (6.4% vs 5.7%). and Manufacturing (11.4% vs 16.0%). According to the second indicator (digital capital intensity), the three sectors with the highest degree of digital transformation, in order, are: ICT services (employment share: 4.4% in BE vs 3.7% in the EU27), Finance and insurance (3.1% vs 2.8%), and Professional services (6.4% vs 5.7%). In Belgium, these sectors' employment shares have a projected annual growth rate for 2022-2035 of 0.5% for ICT services (vs 0.8% for the EU27), 0.6% for Professional services (as for the EU27), -0.3% for Manufacturing (vs -0.2% for the EU27), and -0.1% for Finance and insurance (vs 0.2% for the EU27).

As can be seen from Table 1, it is worth noting that two of the top four sectors in terms of the degree of digital transformation – ICT services and Professional services – are also among the top four sectors in terms of the annual growth rate of employment share in the decade to come in Belgium[38]. Furthermore, in terms of employment share (in 2022), the second and the third sectors[39] – Wholesale and retail trade and Manufacturing - rank fourth and third on one of the two proxy indicators of digital transformation (% of enterprises that employ ICT specialists).

Table 1 – BE. Sector's share of employment, annual growth rate, and ranking of "digital transformation" (the sectors are ranked according to the ranking in the last column of the table)

Sectors	Sector's employment share in 2022 (%)		Projected annual growth rate of the sector's employment share (2022 - 2035, %)		Projected sector's employment share in 2035 (%)		Proxy 1 for digital transformation (ranking)	Proxy 2 for digital transformation (ranking)
	BE	**EU**	**BE**	**EU**	**BE**	**EU**	**% enterprises that employ ICT specialists**	**Digital capital intensity**
J - ICT services	4.4	3.7	0.5	0.8	4.7	4.2	1	1
K - Finance & insurance	3.1	2.8	-0.1	0.2	3.0	2.8	n.a.	2

[37]'Digital capital intensity' is an index – built in the context of this study – that looks at the ratio between the stock of capital the firms have in software and databases and the overall stock of capital excluding non-residential buildings. Its construction is based on the integrated EUKLEMS & INTANProd database, run by the Luiss Lab of European Economics at Luiss University in Rome, Italy. For more in-depth information on the source, and the availability of the indicator for Member States/sectors, please refer to the Annex.

[38]This is true for both the rankings based on the proxy indicators for the digital transformation ('percentage of enterprises with ICT specialists' and 'digital capital intensity'.

[39] The first sector in terms of employment share (in 2022) - Health and social care - was not rankable on one of the two proxies of the digital transformation (% of enterprises that employ ICT specialists). It ranks ninth with the second proxy indicator for the digital transformation (digital capital intensity).

M - Professional services	6.4	5.7	0.6	0.6	6.9	6.3	2	3
N - Administrative services	5.9	4.1	0.5	0.0	6.3	4.1	6	4
C - Manufacturing	11.4	16.0	-0.3	-0.2	11.0	15.6	3	5
R - Arts & recreation and other services	1.6	1.7	0.3	0.3	1.6	1.7	n.a.	6
O - Public sector & defence	8.7	7.1	-0.4	-0.1	8.2	7.0	n.a.	7
P - Education	9.7	7.4	-0.4	0.3	9.2	7.7	n.a.	8
Q - Health & social care	14.4	11.0	0.3	0.6	14.9	11.9	n.a.	9
F - Construction	6.2	6.8	0.2	-0.3	6.4	6.5	7	10
B - Mining & quarrying	0.1	0.3	0.1	-1.7	0.1	0.2	n.a.	11
E- Water and waste treatment	0.8	0.8	0.1	-0.1	0.8	0.8	n.a.	12
D - Energy supply services	0.6	0.7	1.6	0.1	0.8	0.8	n.a.	13
I - Accommodation & food	3.7	4.5	0.2	0.6	3.8	4.9	8	14
G - Wholesale & retail trade	12.3	13.6	-0.4	0.0	11.7	13.6	4	n.a.
H - Transport & storage	5.6	5.3	-0.4	-0.1	5.2	5.3	5	n.a.
A - Agriculture, forestry & fishing	0.8	3.5	-1.6	-3.1	0.6	2.3	n.a.	n.a.
L - Real Estate	0.8	0.9	-1.2	0.9	0.7	1.0	n.a.	n.a.
S - Other service activities	2.1	2.6	0.3	0.0	2.1	2.6	n.a.	n.a.
T - Activities of households as employers	0.1	0.9	0.2	-0.3	0.1	0.9	n.a.	n.a.
U - Activities of extraterritorial organisations	1.4	0.1	n.a.	n.a.	1.4	0.1	n.a.	n.a.

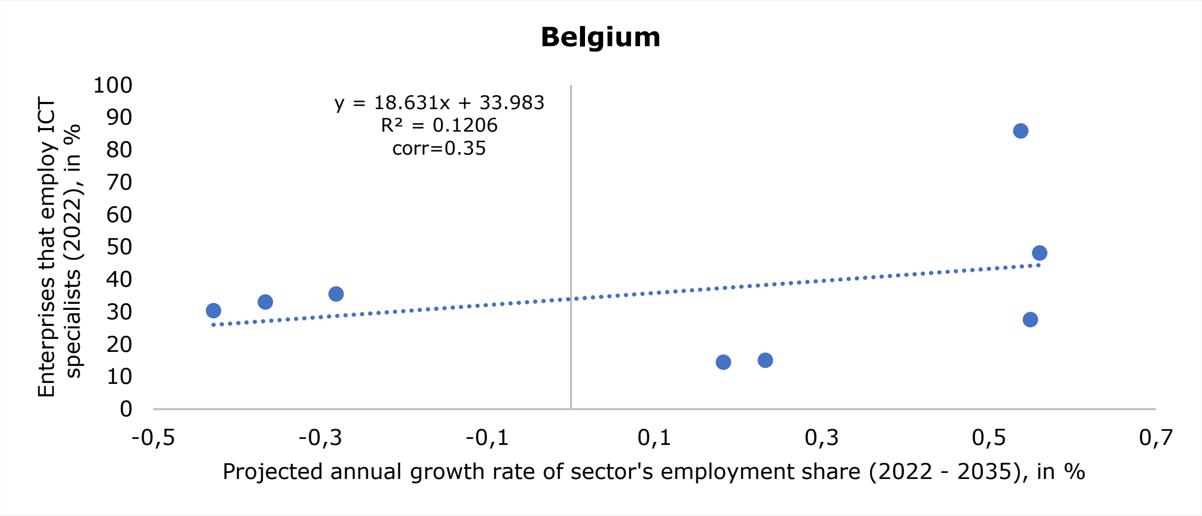
Source: for the employment-related indicators own elaboration on Eurostat data (share of employment, 2022 calculated based on lfsa_egan) and on Cedefop 'Skill forecast data 2023' (annual growth rate of sector's employment share, 2022-2035), for the digital transformation-related indicators: own elaboration on Eurostat data (share of enterprises that employ ICT specialists) and on EUKLEMS data (digital capital intensity).
Note: In the first column of the table, the letter preceding the sectors is the code of the NACE Rev.2 classification. In the last two columns of the table, the two proxy indicators used for digital transformation are: i) the share of enterprises that employ ICT specialists (Eurostat and ii) the digital capital intensity (EUKLEMS & INTANprod data, average 2014-2017) with rank n°1 corresponding to the most digitally intense sector.

Figures 1a and 1b below complement Table 1, further enabling a comparison between the projected annual growth rates of the sectors' employment shares in the economy and their degree of digital transformation[40].

In **Figure 1a**, we present a scatterplot to shed light on the relationship between the first proxy of the digital transformation used (percentage of enterprises that employ ICT specialists) and the projected annual growth rate of a sector's employment share between 2022-2035. The correlation is positive, but statistically not significant in Belgium, with a value of 0.35 (it is 0.62 and statistically significant for the EU27). **The statistically insignificant result implies that an association between the percentage of enterprises in a sector that employ ICT specialists, and that sector's projected annual employment share growth rate cannot be inferred at the sectoral level in Belgium.**

[40] With the caveat that the correlation coefficients presented in Figure 1a and Figure 1b cannot be directly compared, as they pertain to a combination of sectors that varies across different Member States.

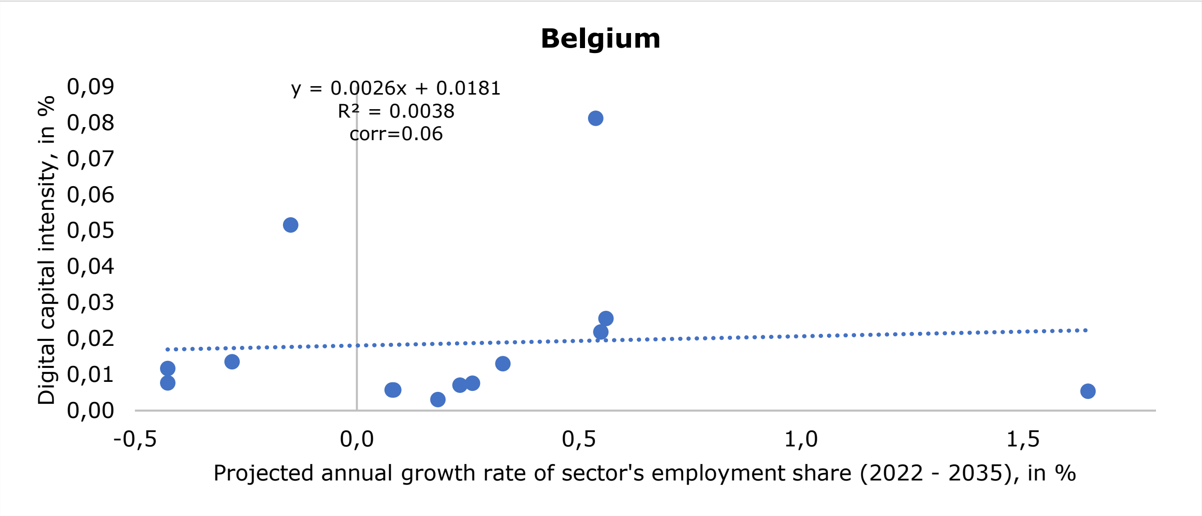
Figure 1a – BE. Relationship between the percentage of enterprises that employ ICT specialists (in 2022) and the projected annual growth rate of sector's employment share (2022-2035).



Source: Own elaboration on Eurostat and Cedefop 'Skill forecast 2023' data.

Figure 1b shows the correlation between the second digital transformation proxy ('digital capital intensity') and the projected annual growth rate of a sector's employment share between 2022-2035. The correlation coefficient is 0.06 and is not statistically significant. In this case, **the statistically insignificant result implies that an association between the digital capital intensity and the projected annual growth rate of a sector's employment share cannot be inferred at the sectoral level in Belgium.**

Figure 1b – BE. Relationship between 'digital capital intensity' and the projected annual growth rate of sector's employment share (2022-2035).

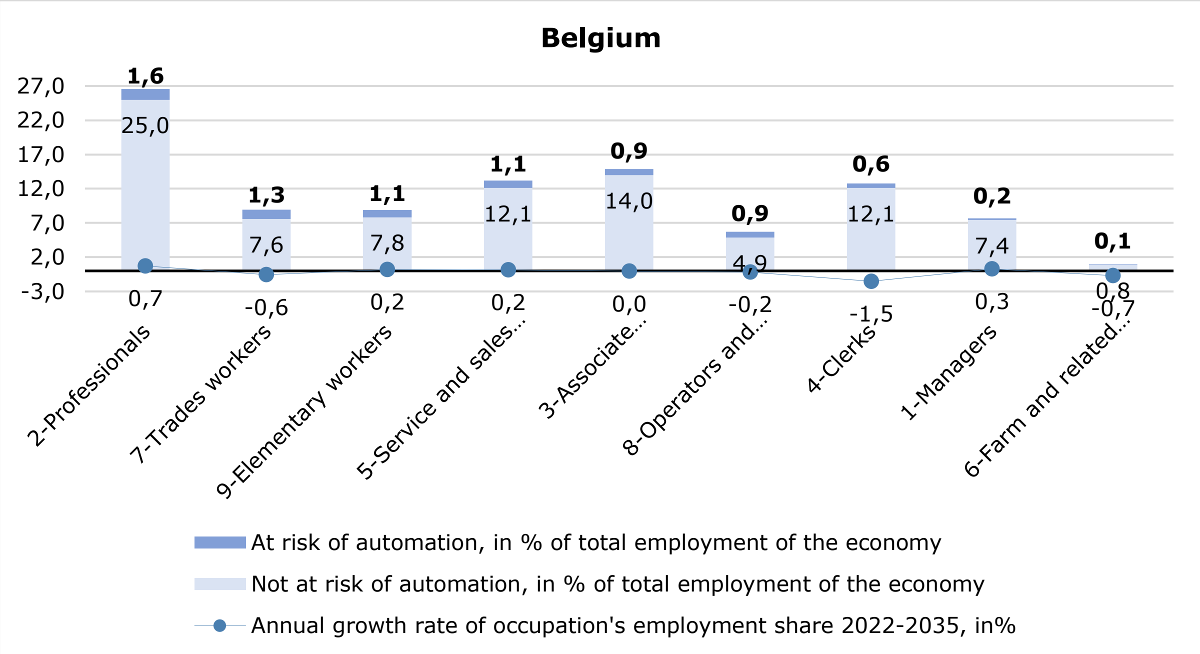


Source: Own elaboration on EUKLEMS & INTANprod, and Cedefop 'Skill forecast 2023' data.

BE 1.2 Occupational composition at ISCO-08 1 digit and risk of automation (current and forward-looking perspectives)

Different types of occupation are subject to differing levels of automation risk. Cedefop developed[41] a "risk of automation" index by occupation at the EU27 level, most recently updated for 2022[42]. We apply this indicator at the Member State level, with the assumption that the risk of automation for a given occupation is relatively constant across Member States[43]. As such, the variation in the susceptibility to automation of a Member State' workforce across all occupations can be attributed to the employment composition effect. Thus, while the automation risk for a given occupation stays constant across Member States, the overall automation risk of a Member State can be considered greater for those Member States with larger employment shares in occupations with a higher automation risk.

Figure 2 – BE. Employment shares of occupations (at ISCO-08 1 digit level) - split into sub shares 'not at risk' and 'at risk' of automation (2022) - and projected annual growth rate



Source: Own elaboration on Cedefop data (risk of automation calculated by Cedefop at EU27 level by ISCO-08 1 digit level for 2022) applied to Eurostat data (share of employment by occupation, lfsa_egais, 2022).
Note: The numbers preceding the occupations are the ISCO-08 codes. Occupations are ranked from the highest to the lowest share of workers that present a risk of automation. The vertical sum of the two components (dark blue and light blue) gives back the total employment share by occupation (in % of total employment in the MS). The ISCO nomenclature used in the text and the figure is the Cedefop one. For examples of specific occupations see: https://esco.ec.europa.eu/en/classification/occupation_main.

[41] Based on the methodology in Pouliakas, K. (2018) "The risk of automation in EU labour markets: a skill-requirements approach", in Economy, Employment and Skills: European and global perspectives in an age of uncertainty, Fondazione Giacomo Brodolini Quaderni Series, also IZA DP 11829.
[42] As retrieved at https://www.cedefop.europa.eu/en/tools/skills-intelligence/automation-risk-occupations#1
[43] While this assumption may be considered strong, Cedefop data are the only ones available that are at the same time, up to date and available for all the occupations at the ISCO-08 level.

As can be seen in **Figure 2**, in Belgium, the occupation with the largest employment sub-share (in % of total employment in the economy) at risk of automation is Professionals, with an employment sub-share of workers 'at risk of automation' representing 1.6% of total employment in the country (vs 1.3% for the EU27). Ranking second regarding the employment sub-share of workers at risk of automation are Trades workers, with an employment sub-share of workers 'at risk' of 1.3% of total employment in Belgium (vs 1.3% for the EU27). Ranking third are Elementary workers, with a share of workers 'at risk' of 1.1% in total employment in Belgium (vs 1.0% for the EU27). **These three occupations are not the most affected across the EU27.**

The 2022 employment share for **ICT professionals (ISCO 25)**[44] is 3.5% in Belgium (vs 2.3% in the EU27). Of that, 0.2% (vs 0.1% in the EU27) is at risk of automation, with the remaining employment sub-share of 3.3% (vs 2.2% at the EU27 level) not expected to be at risk of automation. The projected annual growth rate 2022-2035 of the employment share of ICT professionals is 2.2% in Belgium (vs 1.9% in EU27).

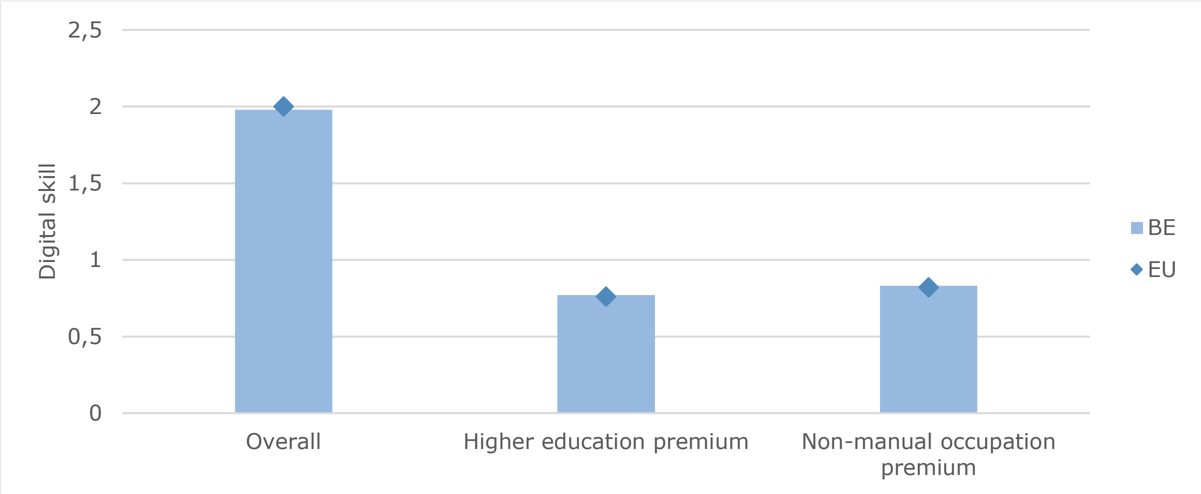
BE 2. Key policy dimensions for a socially fair digital transformation

BE 2.1 Digital skills

The level of digital skills within the population plays a significant role in influencing the extent to which the digital transformation is socially fair. Overall, **the level of digital skills in Belgium is average compared to the rest of the EU**, as shown by both the DESI Index[45] for human capital, where the country ranks 13th in the EU27 (Figure 5 in the section "Other dimensions"), and the study's own estimated index of digital skills[46], where it equally ranks 13th (Figure 3, bar "Overall"). Equally, gaps in digital skills between individuals with different levels of education and in different occupations align with the EU level. Belgium ranks 13th among EU Member States with regard to digital divides between individuals with different levels of education ("higher education premium" in Figure 3) and 18th with regard to divides between individuals in manual and non-manual occupations ("non-manual occupation premium" in Figure 3). However, there are some areas of digital skills where Belgium performs markedly worse than the EU average, such as the number of ICT graduates, an indicator that has seen only limited growth in recent years.

[44] Eurostat code: lfsa_egai2d
[45] European Commission (2022). Digital Economy and Society Index. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi
[46] The construction of the digital skill index is described in detail in the introductory section.

Figure 3 – Estimated Digital Skills in BE and the EU (2019)



Source: Authors' own estimation based on Eurostat ICT survey
Note: Higher education premium refers to the difference in digital skills between individuals with tertiary and lower than tertiary education. Non-manual occupation premium refers to the difference in digital skills between individuals in manual and non-manual occupations.

To improve the level of digital skills within the population, investment in skills development is essential. Several Belgian policy initiatives have been launched to this end. This includes the digital federal strategy #SmartNation[47] and strategies of the Belgian regions. For instance, the Digital Wallonia 2019-2024 Strategy[48] defines digital skills and education as one of the key policy pillars, and sets out several high-priority projects to invest in digital skills, such as the Citizen's Digital Maturity initiative, a programme to develop the basic digital skills of the population. The NRRP for Belgium also includes plans for further investment in human capital as part of the digital pillar (16.5% share of total digital expenditure). The Belgian NRRP also includes a variety of measures targeted at increasing digital skills for the different Belgian regions[49]. For instance, these include initiatives to increase the digital skills of the workforce, to digitise existing training offers and improve the digital inclusion of vulnerable groups, including people lacking basic digital skills.

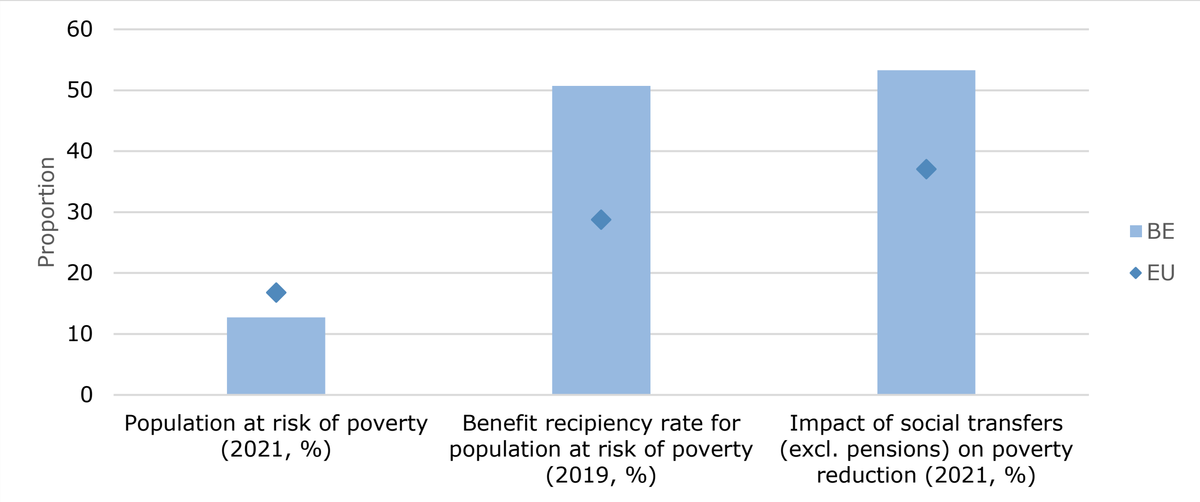
BE 2.2 Social protection and social policy

In addition to policies to foster digital skills across the population, social protection systems can play a key role in protecting individuals from potential adverse labour market effects of the digital transformation. **When it comes to the effectiveness and adequacy of social protection, Belgium is relatively well positioned,** ranking among the countries in the EU with the best performance on relevant indicators (Figure 4). The proportion of the population at risk of poverty after social transfers[50] is 12.7%, one of the lowest rates in the EU. Equally, the

[47] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[48] For more information, see https://www.digitalwallonia.be/en/posts/digital-wallonia-2019-2024/
[49] European Commission (2023); Recovery and Resilience Scoreboard Thematic Analyses. Digital Skills. Available at : https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_digital_skills.pdf
[50] Eurostat (2023). TPS00184: At-risk-of-poverty rate after social transfers by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/tps00184/default/table?lang=en

benefit recipiency rate for the population at risk of poverty before social transfers[51] is high (50.7%), as is the estimated impact of social transfers on poverty reduction[52] (53.3%), with both ranking as the fourth highest in the EU27. **The comprehensive nature of the social protection system could be a future strength in addressing the employment impacts of the digital transformation**.

Figure 4 – Social Protection in BE and the EU



Source: Eurostat (2023) and JRC (2022)

Taking a forward-looking view, in the course of the implementation of the Recommendation on access to social protection, **Belgium has adopted several measures to improve effective coverage and adequacy of social protection**, with further measures planned. According to the European Commission assessment, these measures are expected to address all or most of the existing gaps in access to social protection[53]. The national implementation plan for the Recommendation also includes specific measures for platform workers in order to avoid misclassification of their employment status. In 2022, the Belgian government adopted regulations introducing criteria for a (rebuttable) presumption of employment status for platform workers, as well as accident insurance for all platform workers (including the self-employed)[54]. Furthermore, there is a significant amount of planned social expenditure within the Belgian NRRP (32.0% of total expenditure). The largest share of this expenditure is by far devoted to investment in education and childcare (46.5%), with 31.0% targeted at employment and skills measures and 18.1% at social policies.

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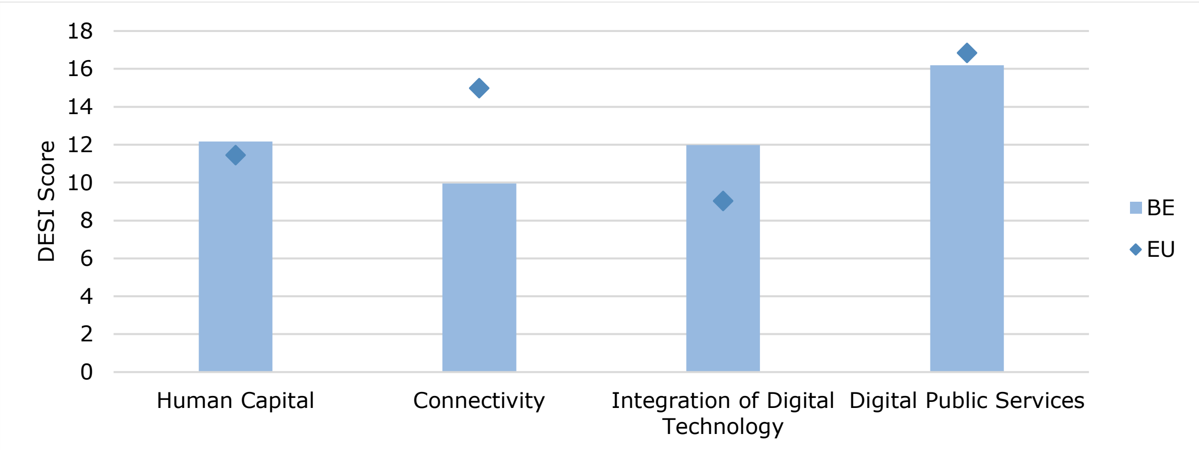
[51] Eurostat indicator as re-elaborated by JRC (2022) "Monitoring the effective coverage and adequacy of social protection in the EU".
[52] Eurostat (2023). TESPM050: Impact of social transfers (excluding pensions) on poverty reduction by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/TESPM050/bookmark/table?lang=en&bookmarkId=b001ae62-ce34-4b49-9741-28a3ef99477f
[53] European Commission (2023). Report from the Commission to the Council on the implementation of the Council Recommendation on access to social protection for workers and the self-employed. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023DC0043&qid=1676473347749
[54] Loi du 3 octobre 2022 portant des dispositions diverses relatives au travail, see https://www.ejustice.just.fgov.be/mopdf/2022/11/10_1.pdf#Page11

BE 3. Other dimensions relevant to the digital transformation

To achieve a socially fair digital transformation, broader contextual factors also need to be in place. In the first place, digitalisation in firms is a prerequisite to be able to take advantage of opportunities created by the digital transformation.

Digitalisation in firms is quite highly developed in Belgium. According to the DESI index (Figure 5), the level of integration of digital technologies in firms is the sixth highest in the EU27. Equally, the amount of robots employed in firms[55], particularly in the manufacturing sector, is higher in Belgium than the EU average[56]. However, the rate at which robot density has increased over the last decade is less than half the EU average in Belgium, though this may be related to the already existing high stock of robots in the country. Conversely, looking at digital capital intensity[57], current levels are somewhat lower than the EU average[58], but the growth rate in digital capital intensity over the past decade has been slightly higher than the EU average. Belgium has introduced measures to support digitalisation of businesses at various governmental levels. Examples include the Brussels-capital innovation strategy and an SME growth subsidy in Flanders[59]. Within the planned digital expenditure in the NRRP, digitalisation of businesses plays a minor role in Belgium, in accordance with the existing relatively high levels of digitalisation of businesses within the country. Out of planned digital expenditure in the NRRP, only 3.3% will be dedicated to the digitalisation of businesses. Some measures towards the digitalisation of businesses are also included in the Digital Wallonia 2019-2024 Strategy and the Flemish Reform Programme 2023.

Figure 5 – DESI Index for BE and the EU (2022)



Source: European Commission (2022)

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[55] As described in the Annex, based on data from the International Federation of Robotics (2010-2019). Data is not available for Cyprus, Greece, Luxembourg and Slovenia.
[56] Average of EU27 MS for whom data was available.
[57] As described in the Annex, based on data from EU-KLEMS (2008-2018). Data is not available for Cyprus, Croatia, Ireland and Romania.
[58] Average of EU27 MS for whom data was available.
[59] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance

However, **digital infrastructure is a shortcoming in Belgium**. According to the DESI index (Figure 5), connectivity levels are the lowest in the EU27. While some policy initiatives sought to improve this, progress has been slow, and there have been issues, for instance, concerning 5G development[60]. Digital public services are more developed but still rank comparatively low, with the DESI index placing Belgium 16th in the EU. Despite the low levels of connectivity, connectivity is only addressed to a very limited extent in the Belgian NRRP. Of total spending devoted to the digital transformation in the NRRP, 4.4% is allocated towards connectivity measures. In contrast, a large share (53.7%) of the planned digital expenditure is allocated to digital public services. The measures related to the digitalisation of public services include initiatives seeking to digitalize social security services and interactions with public administration[61].

[60] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[61] European Commission (2021); Recovery and Resilience Scoreboard Thematic Analyses. Digital public services. Available at :https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/2_Digital.pdf

2. BULGARIA: elements of a socially fair digital transformation

Key Points

Labour market: Bulgaria's largest sector in terms of employment share, Manufacturing, is also its fourth highest for digital transformation (based on the current percentage of enterprises that employ ICT specialists in a sector). The Manufacturing sector's employment share in the economy is projected to grow further in the decade to come (much more than EU trends). ICT services, Professional services, and Water and waste treatment are the three sectors with the highest degree of digital transformation currently. All three sector's employment shares are projected to grow over the next decade, much more than for the EU27. In Bulgaria, Operators and assemblers are most at risk of their occupation being automated.

Digital skills: Bulgaria has one of the lowest overall levels of digital skills in the EU, which is a significant concern when it comes to a socially fair digital transformation. While digital divides within Bulgaria are similar to the divides at an EU level, in the context of very low overall levels of digital skills, this is not very meaningful.

Social protection: Relative to other EU countries, the Bulgarian social protection system is less developed, and Bulgaria has one of the highest 'population at risk of poverty' rates in the EU. Regulatory action on the employment status of platform workers has also been limited.

BG 1. The labour market and the digital transformation

BG 1.1 Sectoral composition (current and forward-looking perspectives)

In Bulgaria ("BG"), in 2022, the sectors with the largest employment shares in the economy were Manufacturing (18.4% vs 16.0% at the EU27 level), Wholesale and retail trade (17.1% vs 13.6% at the EU27 level), and Construction (8.8% vs 6.8% at the EU27 level). Cedefop data projects[62] the annual growth rate of a sector's employment share for 2022-2035, and projects an annual growth rate of 0.9% (-0.2% for the EU27) for Bulgaria's Manufacturing sector, -1.1% (0.0% for the EU27) for the Wholesale and retail trade sector, and 0.3% (-0.3% for the EU27) for the Construction sector.

[62] Own elaboration on Cedefop 'Skill forecast 2023' data.

Table 1 presents each sector's employment share in 2022, the projected annual growth rates (2022-2035) of its employment share, and its resulting employment share in the economy by 2035. Along with these elements relating to employment, Table 1 also presents the degree of "digital transformation" of each sector, thus enabling comparison between the degree of digital transformation of a sector and its employment share or its employment share's prospects. The aforementioned degree of digital transformation is proxied in Table 1, for each sector, using the percentage of enterprises in the sector that employ ICT specialists. Table 1 presents the ranking of each sector according to this indicator (with rank n°1 corresponding to the most digitised sector). According to the first indicator, the three sectors with the highest degree of digital transformation in BG, in order, are: ICT services (employment share: 3.9% in BG vs 3.7% in the EU27), Professional services (3.7% vs 5.7%) and Water and waste treatment (1.0% vs 0.8%). These sectors' employment shares have a projected annual growth rate for 2022-2035 in Bulgaria of 2.3% for ICT services (vs 0.8% for the EU27), 1.7% for Professional services (vs 0.6% for the EU27), and 0.5% for Water and waste treatment (vs -0.1% for the EU27).

As can be seen from Table 1, it is worth noting that only one of the top four sectors in terms of the degree of digital transformation – ICT services – is also among the top four sectors in terms of the annual growth rate of employment share in the decade to come in Bulgaria. Furthermore, in terms of employment share (in 2022) the first and the second sectors – Manufacturing and Wholesale and retail trade - rank fourth and fifth on the only proxy indicator of the digital transformation available (% of enterprises that employ ICT specialists).

Table 1 – BG. Sector's share of employment, annual growth rate, and ranking of "digital transformation" (the sectors are ranked according to the ranking in the last column of the table).

Sectors	Sector's employment share in 2022 (%)		Projected annual growth rate of the sector's employment share (2022 - 2035, %)		Projected sector's employment share in 2035 (%)		Proxy 1 for digital transformation (ranking)	Proxy 2 for digital transformation (ranking)
	BG	**EU**	**BG**	**EU**	**BG**	**EU**	**% enterprises that employ ICT specialists**	**Digital capital intensity**
J - ICT services	3.9	3.7	2.3	0.8	5.4	4.2	1	n.a.
M - Professional services	3.7	5.7	1.7	0.6	4.7	6.3	2	n.a.
E- Water and waste treatment	1.0	0.8	0.5	-0.1	1.1	0.8	3	n.a.
C - Manufacturing	18.4	16.0	0.9	-0.2	20.9	15.6	4	n.a.
G - Wholesale & retail trade	17.1	13.6	-1.1	0.0	14.8	13.6	5	n.a.
N - Administrative services	3.2	4.1	1.5	0.0	4.0	4.1	6	n.a.
I - Accommodation & food	4.7	4.5	2.4	0.6	6.5	4.9	7	n.a.
H - Transport & storage	6.9	5.3	1.0	-0.1	7.9	5.3	8	n.a.
F - Construction	8.8	6.8	0.3	-0.3	9.2	6.5	9	n.a.
A - Agriculture, forestry & fishing	6.4	3.5	-4.1	-3.1	3.6	2.3	n.a.	n.a.
B - Mining & quarrying	0.9	0.3	-0.3	-1.7	0.8	0.2	n.a.	n.a.
D - Energy supply services	1.2	0.7	0.6	0.1	1.3	0.8	n.a.	n.a.
K - Finance & insurance	2.2	2.8	0.6	0.2	2.4	2.8	n.a.	n.a.
L - Real Estate	0.6	0.9	2.3	0.9	0.9	1.0	n.a.	n.a.

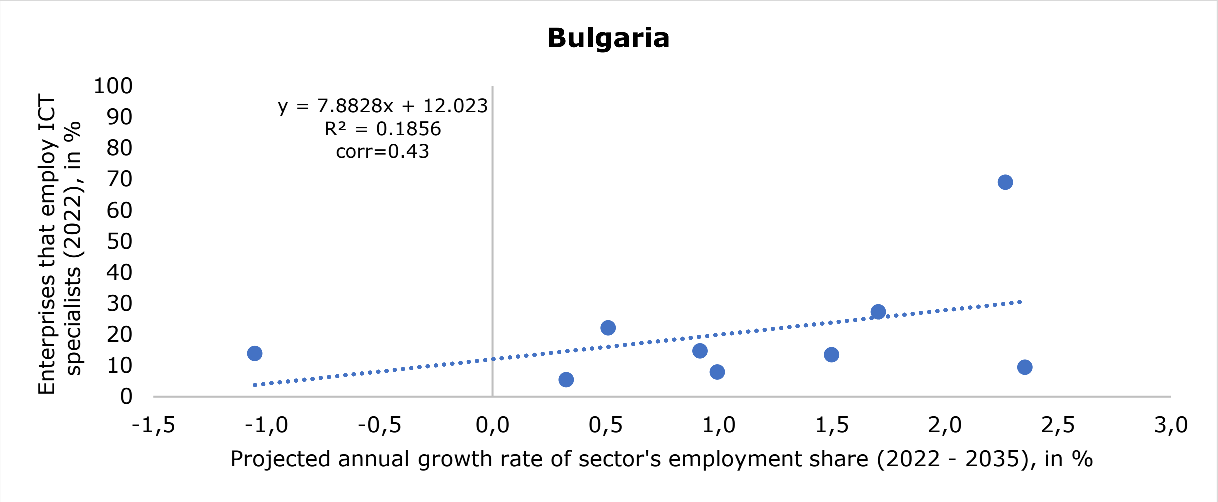
O - Public sector & defence	6.8	7.1	0.7	-0.1	7.6	7.0	n.a.	n.a.
P - Education	5.4	7.4	1.7	0.3	6.8	7.7	n.a.	n.a.
Q - Health & social care	5.3	11.0	1.6	0.6	6.7	11.9	n.a.	n.a.
R - Arts & recreation and other services	1.4	1.7	1.8	0.3	1.8	1.7	n.a.	n.a.
S - Other service activities	1.8	2.6	0.0	0.0	1.8	2.6	n.a.	n.a.
T - Activities of households as employers	0.1	0.9	n.a.	-0.3	n.a.	0.9	n.a.	n.a.
U - Activities of extraterritorial org.	n.a.	0.1	n.a.	n.a.	n.a.	0.1	n.a.	n.a.

Source: For the employment-related indicators own elaboration on Eurostat data (share of employment, 2022 calculated based on lfsa_egan) and on Cedefop 'Skill forecast data 2023' (annual growth rate of sector's employment share, 2022-2035), for the digital transformation-related indicators: own elaboration on Eurostat data (share of enterprises that employ ICT specialists, Eurostat code: lfsa_egais) and on EUKLEMS & INTANProd data (digital capital intensity).
Note: In the first column of the table, the letter preceding the sectors is the code of the NACE Rev.2 classification. In the last two columns of the table, the two proxy indicators used for the digital transformation are: i) the share of enterprises that employ ICT specialists (Eurostat code: lfsa_egais) and ii) the digital capital intensity (EUKLEMS & INTANProd data, average 2014-2017) with rank n°1 corresponding to the most digitally intense sector.

Figure 1 below complements Table 1, further enabling comparison between the projected annual growth rates of the sectors' employment shares in the economy and their degree of digital transformation[63].

In **Figure 1**, we present a scatterplot to shed light on the relationship between the proxy of the digital transformation used (percentage of enterprises that employ ICT specialists) and the projected annual growth rate of a sector's employment share between 2022-2035. The correlation is positive, but statistically not significant in Bulgaria, with a value of 0.43 (it is 0.62 and statistically significant for the EU27). **The lack of correlation implies that in Bulgaria an association, at the sectoral level, between the 'percentage of enterprises that employ ICT specialists' and the projected annual growth rate of a sector's employment share cannot be inferred.**

Figure 1 – BG. Relationship between the percentage of enterprises that employ ICT specialists (in 2022) and the projected annual growth rate of sector's employment share (2022-2035).



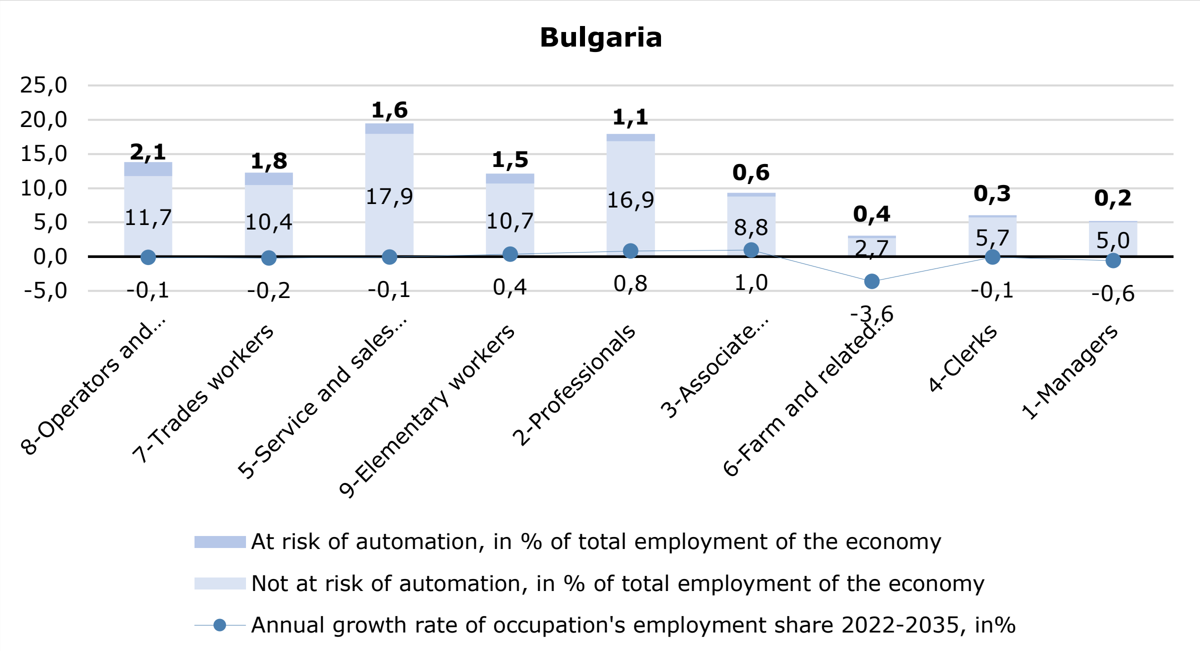
[63] With the caveat that the correlation coefficients presented in Figure 1a and Figure 1b cannot be directly compared, as they pertain to a combination of sectors that varies across different Member States.

Source: Own elaboration on Eurostat and Cedefop 'Skill forecast 2023' data.

BG 1.2 Occupational composition at ISCO-08 1 digit and risk of automation (current and forward-looking perspectives)

Different types of occupation are subject to differing levels of automation risk. Cedefop have developed[64] a "risk of automation" index by occupation at the EU27 level, most recently updated for 2022[65]. We apply this indicator at the Member State level, with the assumption that the risk of automation for a given occupation is relatively constant across Member States[66]. As such, the variation in the susceptibility to automation of a Member State' workforce across all occupations can be attributed to the employment composition effect. Thus, while the automation risk for a given occupation stays constant across Member States, the overall automation risk of a Member State can be considered greater for those Member States with larger employment shares in occupations with a higher automation risk.

Figure 2 – BG. Employment shares of occupations (at ISCO-08 1 digit level) - split into sub shares 'not at risk' and 'at risk' of automation (2022) - and projected annual growth rate



Source: Own elaboration on Cedefop data (risk of automation calculated by Cedefop at EU27 level by ISCO-08 1 digit level for 2022) applied to Eurostat data (share of employment by occupation, lfsa_egais, 2022).
Note: The numbers preceding the occupations are the ISCO-08 codes. Occupations are ranked from the highest to the lowest share of workers that present a risk of automation. The vertical sum of the two components (darker blue and lighter blue) gives back the total employment share by occupation (in % of total employment in the Member State). The ISCO nomenclature used in the text and the figure is the Cedefop one. For examples of specific occupations see: https://esco.ec.europa.eu/en/classification/occupation_main.

[64] Based on the methodology in Pouliakas, K. (2018) "The risk of automation in EU labour markets: a skill-requirements approach", in Economy, Employment and Skills: European and global perspectives in an age of uncertainty, Fondazione Giacomo Brodolini Quaderni Series, also IZA DP 11829.
[65] As retrieved at https://www.cedefop.europa.eu/en/tools/skills-intelligence/automation-risk-occupations#1
[66] While this assumption may be considered strong, Cedefop data are the only ones available that are at the same time, up to date and available for all the occupations at the ISCO-08 level.

As can be seen in **Figure 2**, in Bulgaria, Operators and assemblers is the occupation with the largest employment sub-share (% of total employment in the economy) at risk of automation, with 2.1% of total employment in the country in those occupations and 'at risk of automation' (vs 1.1% for the EU27). Trades workers, with an employment sub-share of workers 'at risk' of 1.8% of total employment in Bulgaria (vs 1.3% for the EU27), rank second. Finally, ranking third are Service and sales workers, with a share of workers 'at risk' of 1.6% in total employment in Bulgaria (vs 1.3% for the EU27). **Of these three occupations, only Service and sales occupations are the most affected by the risk of automation, both in BG and at EU27 level.**

The 2022 employment share for **ICT professionals (ISCO 25)**[67] is 2.2% in Bulgaria (vs 2.3% in the EU27). Of that, 0.1% (vs 0.1% in the EU27) is 'at risk of automation', with the remaining employment sub-share of 2% (vs 2.2% at EU27 level) not expected to be at risk of automation. The projected annual growth rate 2022-2035 of the employment share of ICT professionals is 3.0% in Bulgaria (vs 1.9% in EU27).

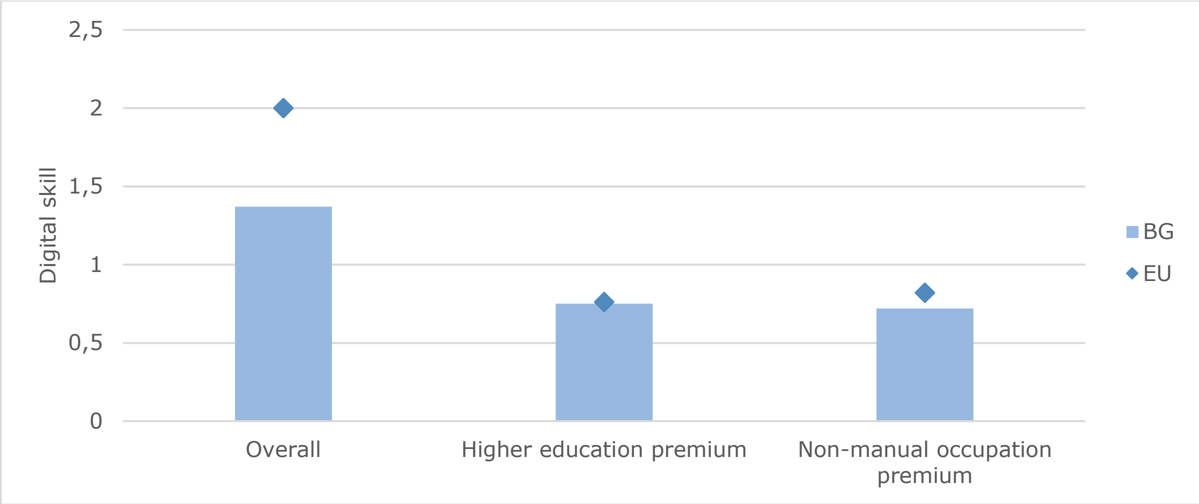
BG 2. Key policy dimensions for a socially fair digital transformation

BG 2.1 Digital skills

Digital skills are an important prerequisite for a successful and socially fair digital transformation. **Overall, Bulgaria exhibits a very low level of digital skills, especially compared to the rest of the EU**. This is evident when considering the DESI index[68] for human capital (see Figure 5) in which BG ranks 26th in the EU27, as well as the study's own estimate of digital skills[69], where it ranks last (Figure 3, bar "Overall"). More positively, digital divides between individuals with different levels of education ("higher education premium" in Figure 3) and between manual versus non-manual occupations ("non-manual occupation premium" in Figure 3) align with the EU27 level, with Bulgaria ranking 12th and 11th in the EU, respectively. **However, given the low overall level of digital skills, this relative equality in digital skills is not particularly meaningful, and skills investment remains a significant policy concern.**

[67] Eurostat code: lfsa_egai2d.
[68] European Commission (2022). Digital Economy and Society Index. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi
[69] The construction of the digital skill index is described in detail in the introductory section.

Figure 3 – Estimated Digital Skills in BG and the EU (2019)



Source: Authors' own estimation based on Eurostat ICT survey
Note: Higher education premium refers to the difference in digital skills between individuals with tertiary and lower than tertiary education. Non-manual occupation premium refers to the difference in digital skills between individuals in manual and non-manual occupations.

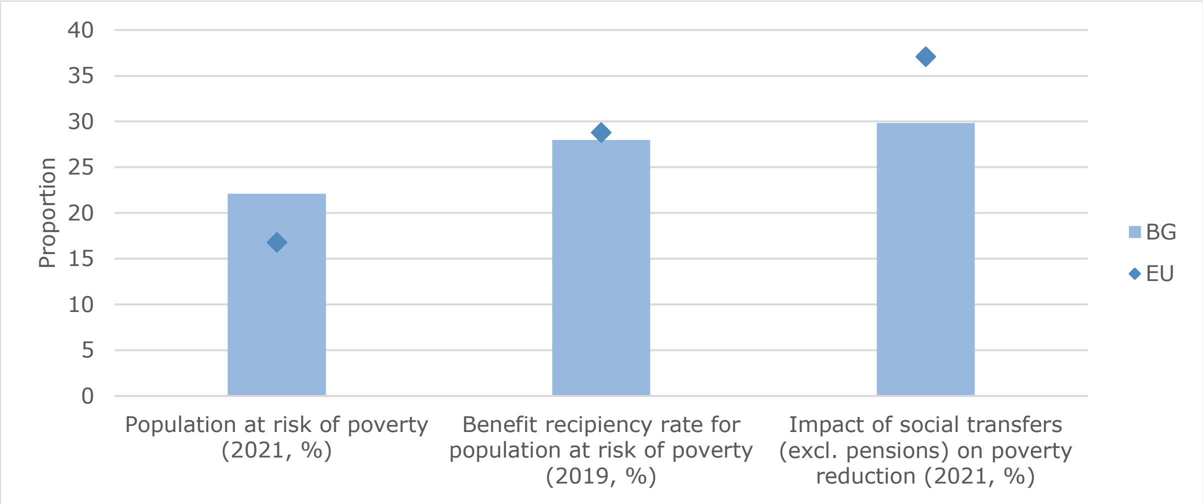
To increase the level of digital skills in the population, several policy initiatives have been put forward in Bulgaria. In 2019, Bulgaria adopted the 'Digital Bulgaria 2025 National Programme'[70], which lists three main objectives related to digital skills: The modernisation of schools and higher education in the field of ICT; the increase in the number of highly qualified ICT specialists; and the improvement of the digital skills of the workforce. Further to this, digital skills are also referred to in the 'Digital Transformation of Bulgaria for the period 2020-2030' plan[71]. In the Bulgarian NRRP, an above-average share of funding (36.8%) is allocated towards issues relating to the overall digital transformation. The expenditure on human capital constitutes 13.8% of this digital pillar. Relevant measures under the Bulgarian NRRP include the promotion of Science, Technology, Engineering and Mathematics (STEM) and the establishment of STEM centres and labs in schools to foster interest and capabilities in natural and engineering sciences, artificial intelligence, robotics, and natural science, as well as the provision of digital skill training and the establishment of a platform for adult learning. Overall, **extensive, swift, and targeted action remains necessary to improve the level of digital skills in Bulgaria[72]**.

[70] For more information, see https://www.mtc.government.bg/sites/default/files/uploads/it/09-12-2019_programa_-cifrova_bulgariya_2025.pdf
[71]For more information, see https://www.mtc.government.bg/sites/default/files/digital_transformation_of_bulgaria_for_the_period_2020-2030_f.pdf
[72] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance

BG 2.2 Social protection and social policy

Furthermore, social protection may play a key role in the digital transformation process by cushioning the potential adverse employment and wage impact of digitalisation. Key indicators on social protection in Bulgaria are presented in **Figure 4**. Bulgaria has the third highest rate of the population at risk of poverty after social transfers[73] in the EU (22.1%), while the impact of social transfers on poverty reduction[74] is comparatively low (29.8%). The benefit recipiency rate for the population at risk of poverty before social transfers[75] is just below the EU rate (28%). **Overall, the coverage and adequacy of the social protection system in Bulgaria is therefore limited compared to the rest of the EU**. Moreover, there has so far been little effort to regulate the employment status of platform workers[76], one of the groups of workers significantly affected by digitalisation.

Figure 4 – Social Protection in BG and the EU



Source: Eurostat (2023) and JRC (2022)

The Bulgarian implementation plan for the Recommendation on social protection argues that, given the existing wide scope of the Bulgarian social insurance system, the provisions of the Recommendation are already fulfilled in Bulgaria[77]. As such, existing gaps in access to social protection are not expected to be closed by the response to the Recommendation[78]. Measures aimed at platform workers are not included. The Bulgarian NRRP does not contain measures specifically

[73]Eurostat (2023). TPS00184: At-risk-of-poverty rate after social transfers by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/tps00184/default/table?lang=en

[74] Eurostat (2023). TESPM050:Impact of social transfers (excluding pensions) on poverty reduction by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/TESPM050/bookmark/table?lang=en&bookmarkId=b001ae62-ce34-4b49-9741-28a3ef99477f

[75] Eurostat indicator as re-elaborated by JRC (2022) "Monitoring the effective coverage and adequacy of social protection in the EU".

[76] PPMI (2021). Study to support the impact assessment on improving working conditions in platform work. Available at: https://ec.europa.eu/social/main.jsp?catId=738&furtherPubs=yes&langId=en&pubId=8428

[77] European Commission (2023). Access to social protection. Available at: https://ec.europa.eu/social/main.jsp?catId=1312&langId=en=en

[78] European Commission (2023). Report from the Commission to the Council on the implementation of the Council Recommendation on access to social protection for workers and the self-employed. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023DC0043&qid=1676473347749

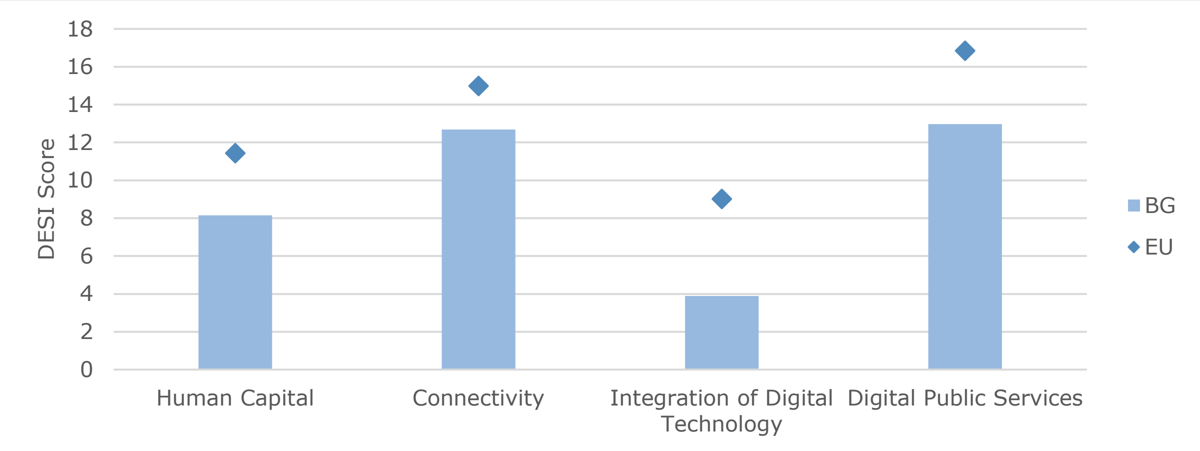
targeted at the social protection system. As regards NRRP expenditure, 23.7% of the total budget is allocated to social expenditure. However, only very low shares are allocated to employment and skills (13%) and, particularly, social policies (1.6%). Significant measures to be mentioned include investment in youth centres meant to enhance the probability of getting a job, especially for those from vulnerable groups. These centres will offer a variety of activities promoting digital equality through access to education and training.

BG 3. Other dimensions relevant to the digital transformation

Contextual factors can also support a socially fair digital transformation, including the level of digitalisation in firms and of digital infrastructure and digital public services. Considering the former, the level of digitalisation in firms in Bulgaria is very low compared to the EU average. According to the DESI index, the level of integration of digital technology in firms is the second lowest in the EU (Figure 5). Other factors also confirm this picture. Robot density[79], both in the overall economy and in manufacturing, is very low in Bulgaria compared to the EU average[80]. However, growth in robot density between 2010 and 2019, while starting out from a very low base, has been slightly higher than the EU average, pointing to some positive developments. As far as digital capital intensity[81] is concerned, the rate of growth between 2008 and 2018 is slightly lower than the EU average, and absolute levels are also significantly lower than in other EU Member States. As such, **digitalisation of businesses in Bulgaria lags significantly behind the rest of the EU**. Within the planned expenditure on the digital transformation that forms part of the NRRP, expenditure on the digitalisation of businesses is less of a priority, with a share of 5.8% of overall digital expenditure. This funding is intended to support SMEs and mid-capitalisation companies in updating their technology and in their transition, inter alia, to digital-oriented business practices. More broadly, further policies targeting the deployment of technologies such as AI and Cloud, particularly in SMEs, should be put in place[82].

[79] As described in the Annex, based on data from the International Federation of Robotics (2010-2019). Data is not available for Cyprus, Greece, Luxembourg and Slovenia.
[80] Average of EU27 MS for whom data was available
[81] As described in the Annex, based on data from EU-KLEMS (2008-2018). Data is not available for Cyprus, Croatia, Ireland and Romania.
[82] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance

Figure 5 – DESI index for BG and the EU (2022)



Source: European Commission (2022)

Concerning digital infrastructure and digital public services, Bulgaria has some shortcomings and is below the EU27 average. Indeed, for the DESI index on connectivity, it ranks 19th, while for the DESI index on digital public services, it ranks 25th. However, substantial investment in connectivity (11.6% of the digital pillar of the NRRP) and, in particular, digital public services (68.5% of the digital pillar of the NRRP) is foreseen as part of the Bulgarian NRRP. The NRRP expenditure on connectivity focuses on the development of extremely high-capacity networks in rural and poorly inhabited areas considered lagging in terms of digital inclusion[83]. It also contains a comprehensive package of reforms and investments to assist the digitalisation of public administration with the goal of unleashing potential in various sectors like justice, health, agriculture, environment, culture, employment, and social protection. Bulgaria has also adopted the Broadband Plan Connected Bulgaria, though the targets set do not yet align with those of the Digital Decade, and further concrete measures are necessary[84].

[83] European Commission (2023); Recovery and Resilience Scoreboard Thematic Analyses. Connectivity. https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_connectivity.pdf
[84] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance

3. CZECHIA: elements of a socially fair digital transformation

Key Points

Labour market: Currently, the sector with the largest employment share in the economy – which is the Manufacturing sector - ranks third amongst the sectors in terms of a sector's degree of digital transformation (based on the current percentage of enterprises that employ ICT specialists in a sector). The Manufacturing sector's employment share in the economy is not projected to grow further in the decade to come (slightly less than EU trends). ICT services, Professional services and Manufacturing are the three sectors with the highest degree of digital transformation currently, and their employment shares, except for Manufacturing, are projected to grow, in the decade to come, slightly more than in the EU27. The type of occupation that is most vulnerable to automation is Trades workers.

Digital skills: The level of digital skills in Czechia is in line with the EU level. Moreover, gaps in digital skill levels between different educational and occupational groups are somewhat less pronounced than at EU level.

Social protection: The overall coverage of social protection systems in Czechia is quite developed relative to the rest of the EU, and the rate of the population at risk of poverty significantly is lower than the EU rate. However, regulation of the status of platform workers has been limited so far.

CZ 1. The labour market and the digital transformation

CZ 1.1 Sectoral composition (current and forward-looking perspectives)

In Czechia ("CZ"), in 2022, the sectors with the largest employment shares in the economy were the Manufacturing (26.4% vs 16.0% at the EU27 level), Wholesale and retail trade (11.3% vs 13.6% at the EU27 level), and Construction (7.9% vs 6.8% at the EU27 level) sectors. For the period 2022-2035, Cedefop data projects[85] the annual growth rate of a sector's employment share. For Czechia's Manufacturing sector, the annual growth rate is -0.5% (-0.2% for the EU27), for the Wholesale and retail trade sector it is -0.4% (0.0% for the EU27), and for the Health and social care sector it is -0.8% (-0.3% for the EU27).

[85] Own elaboration on Cedefop 'Skill forecast 2023' data.

Table 1 presents each sector's employment share in 2022, the projected annual growth rates (2022-2035) of its employment share, and its resulting employment share in the economy by 2035. Along with these elements relating to employment, Table 1 also presents the degree of "digital transformation" of each sector. Table 1 thus enables a comparison between the degree of digital transformation of a sector and its employment share or its employment share's prospects. The aforementioned degree of digital transformation is proxied in Table 1, for each sector, using two indicators: i) the percentage of enterprises in the sector that employ ICT specialists and ii) the digital capital intensity[86] of the sector. Table 1 presents the ranking of each sector according to these two proxy indicators (with rank n°1 corresponding to the most digitised sector). According to the first indicator, the three sectors with the highest degree of digital transformation in Czechia, in order, are ICT services (employment share: 3.8% in CZ vs 3.7% in the EU27), Professional services (4.9% vs 5.7%) and Manufacturing (26.4% vs 16.0%). According to the second indicator (digital capital intensity), the three sectors with the highest degree of digital transformation, in order, are ICT services (sector's employment share: 3.8% in CZ vs 3.7% in the EU27), Finance and insurance (2.4% vs 2.8%) and Professional services (4.9% vs 5.7%). These sectors' employment shares have a projected annual growth rate for 2022-2035 in Czechia of 1.2% for ICT services (vs 0.8% for the EU27), 1.1% for Professional services (vs 0.6% for the EU27), -0.5% for Manufacturing (vs -0.2% for the EU27), and 0.8% for Finance and insurance (vs 0.2% for the EU27).

As can be seen in Table 1, only one of the top four sectors in terms of the degree of digital transformation (for both the first and the second proxy indicators) – ICT services – is also among the top four sectors with the largest predicted annual growth rate of employment share in the next decade. Professional service, that ranks second in the first proxy indicator of degree of digital transformation (% of enterprises that employ ICT specialists) and third according to the second proxy indicators of degree of digital transformation ranks fifh in terms of employment share (in 2022).Furthermore, in terms of employment share (in 2022), the first and the second sectors – Manufacturing and Wholesale and retail trade - rank third and fourth on the first proxy indicators of degree of digital transformation (% of enterprises that employ ICT specialists). Wholesale and retail trade ranks fourth also on the second proxy of the digital transformation (digital capital intensity).

Table 1 – CZ. Sector's share of employment, annual growth rate, and ranking of "digital transformation" (the sectors are ranked according to the ranking in the last column of the table).

Sectors	Sector's employment share in 2022 (%)		Projected annual growth rate of the sector's employment share (2022 - 2035, %)		Projected sector's employment share in 2035 (%)		Proxy 1 for digital transformation (ranking)	Proxy 2 for digital transformation (ranking)
	CZ	**EU**	**CZ**	**EU**	**CZ**	**EU**	**% enterprises that employ ICT specialists**	**Digital capital intensity**
J - ICT services	3.8	3.7	1.2	0.8	4.5	4.2	1	1
K - Finance & insurance	2.4	2.8	0.8	0.2	2.7	2.8	n.a.	2

[86] 'Digital capital intensity' is an index of digital transformation – built in the context of this study – that looks at the ratio between the stock of capital the firms have in software and databases and the overall stock of capital excluding non-residential buildings. Its construction is based on the integrated EUKLEMS & INTANProd database, run by the Luiss Lab of European Economics at Luiss University in Rome, Italy. For more in-depth information on the source, and the availability of the indicator for Member States/sectors, please refer to the Annex.

M - Professional services	4.9	5.7	1.1	0.6	5.7	6.3	2	3
G - Wholesale & retail trade	11.3	13.6	-0.4	0.0	10.7	13.6	4	4
N - Administrative services	2.2	4.1	0.2	0.0	2.2	4.1	7	5
C - Manufacturing	26.4	16.0	-0.5	-0.2	24.6	15.6	3	6
F - Construction	7.9	6.8	-0.8	-0.3	7.1	6.5	9	7
O - Public sector & defence	6.6	7.1	-0.7	-0.1	6.0	7.0	n.a.	8
Q - Health & social care	7.7	11.0	1.1	0.6	8.9	11.9	n.a.	9
R - Arts & recreation and other services	1.6	1.7	1.5	0.3	2.0	1.7	n.a.	10
H - Transport & storage	6.3	5.3	0.1	-0.1	6.3	5.3	8	11
D - Energy supply services	1.0	0.7	1.0	0.1	1.2	0.8	5	12
I - Accommodation & food	3.2	4.5	-0.2	0.6	3.1	4.9	10	13
P - Education	7.1	7.4	0.8	0.3	8.0	7.7	n.a.	14
A - Agriculture, forestry & fishing	2.5	3.5	-0.6	-3.1	2.3	2.3	n.a.	15
E- Water and waste treatment	1.2	0.8	0.3	-0.1	1.2	0.8	6	16
B - Mining & quarrying	0.5	0.3	-2.5	-1.7	0.3	0.2	n.a.	17
L - Real Estate	0.8	0.9	0.1	0.9	0.8	1.0	n.a.	n.a.
S - Other service activities	1.8	2.6	1.1	0.0	2.1	2.6	n.a.	n.a.
T - Activities of households as employers	0.7	0.9	1.7	-0.3	0.9	0.9	n.a.	n.a.
U - Activities of extraterritorial org.	0.0	0.1	n.a.	n.a.	0.0	0.1	n.a.	n.a.

Source: For the employment-related indicators own elaboration on Eurostat data (share of employment, 2022 calculated based on lfsa_egan) and on Cedefop 'Skill forecast data 2023' (annual growth rate of sector's employment share, 2022-2035), for the digital transformation-related indicators: own elaboration on Eurostat data (share of enterprises that employ ICT specialists, Eurostat code: lfsa_egais) and on EUKLEMS & INTANProd data (digital capital intensity).
Note: In the first column of the table, the letter preceding the sectors is the code of the NACE Rev.2 classification. In the last two columns of the table, the two proxy indicators used for the digital transformation are: i) the share of enterprises that employ ICT specialists (Eurostat code: lfsa_egais) and ii) the digital capital intensity (EUKLEMS & INTANProd data, average 2014-2017) with rank n°1 corresponding to the most digitally intense sector.

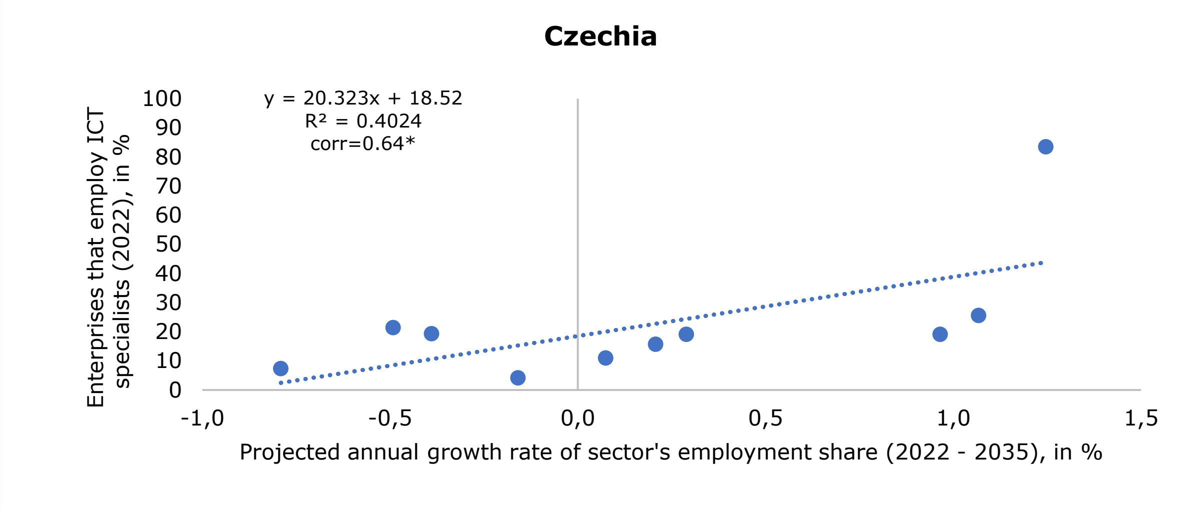
In complement to Table 1, Figures 1a and 1b (below) show to what extent there may be a relationship between the projected annual growth rates of the sectors' employment shares in the economy and the ranking of the sectors in terms of the degree of digital transformation[87].

In **Figure 1a**, we present a scatterplot to shed light on the relationship between the first proxy of the digital transformation used (percentage of enterprises that employ ICT specialists) and the projected annual growth rate of a sector's employment share between 2022-2035. The correlation is positive, and statistically significant in Czechia, with a value of 0.64 (it is 0.62 and statistically significant for the EU27). Among the ten Member States with a significant correlation, Czechia ranks 7th in terms of the highest correlation. The positive correlation could imply **an association between the percentage of enterprises in a sector that employ ICT specialists, and that sector's projected annual employment share growth rate in Czechia**. The

[87] With the caveat that the correlation coefficients presented in Figure 1a and Figure 1b cannot be directly compared, as they pertain to a combination of sectors that varies across different Member States.

relationship is highly positive, and slightly higher than the one at the EU27 level. However, this correlation does not imply a causal link.

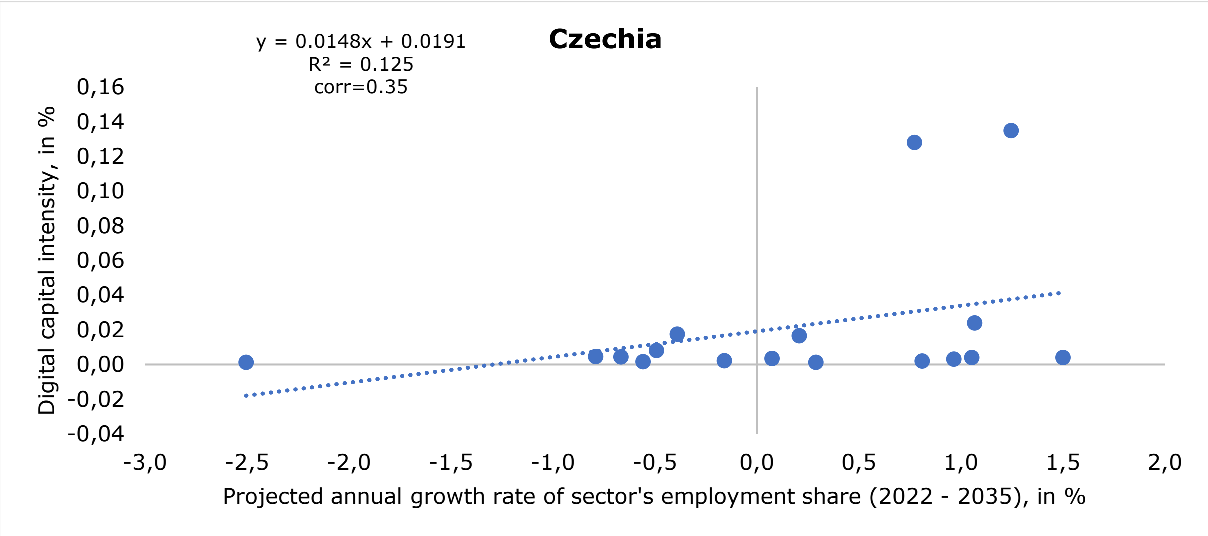
Figure 1a – CZ. Relationship between the percentage of enterprises that employ ICT specialists (in 2022) and the projected annual growth rate of sector's employment share (2022-2035).



Source: Own elaboration on Eurostat and Cedefop 'Skill forecast 2023' data.

Figure 1b shows the correlation between the second digital transformation proxy ('digital capital intensity') and the projected annual growth rate of a sector's employment share between 2022-2035. The correlation coefficient exhibits a value of 0.35 but is not statistically significant. In this case, **the statistically insignificant result implies that an association between the digital capital intensity and the projected annual growth rate of a sector's employment share cannot be inferred at the sectoral level in Czechia.**

Figure 1b – CZ. Relationship between 'digital capital intensity' and the projected annual growth rate of sector's employment share (2022-2035).

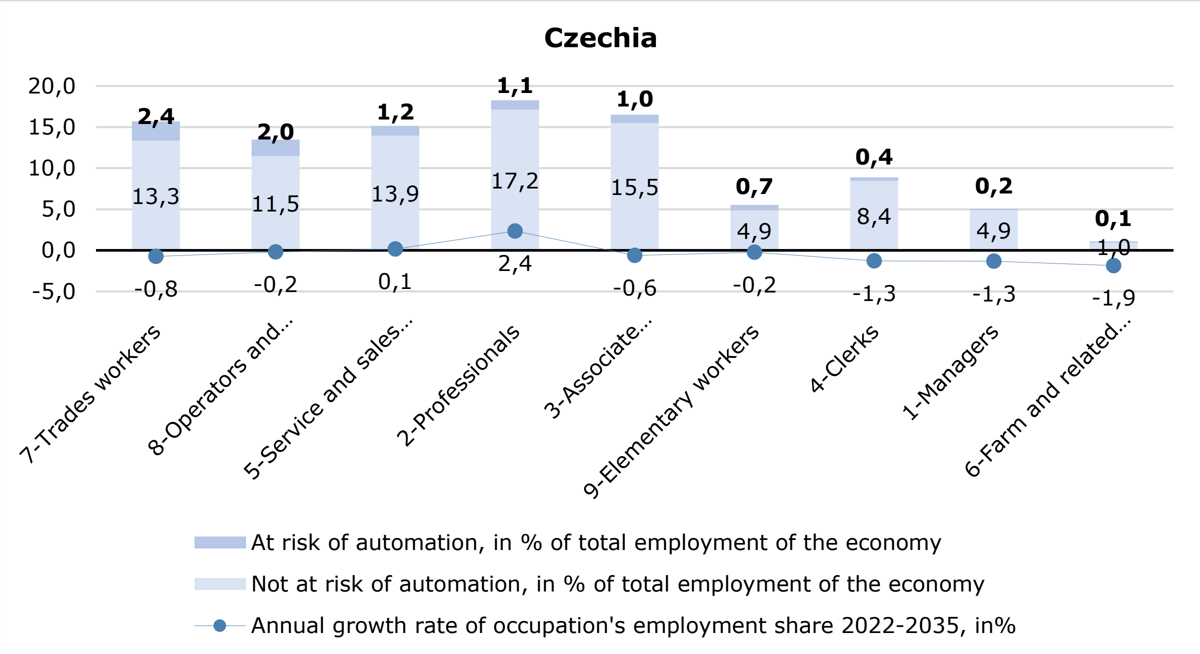


Source: Own elaboration on EUKLEMS & INTANProd, and Cedefop 'Skill forecast 2023' data.

CZ 1.2 Occupational composition at ISCO-08 1 digit and risk of automation (current and forward-looking perspectives)

Different types of occupation are subject to differing levels of automation risk. Cedefop developed[88] a "risk of automation" index by occupation at the EU27 level, most recently updated for 2022[89]. We apply this indicator at the Member State level, with the assumption that the risk of automation for a given occupation is relatively constant across Member States[90]. As such, the variation in the susceptibility to automation of a Member State' workforce across all occupations can be attributed to the employment composition effect. Thus, while the automation risk for a given occupation stays constant across Member States, the overall automation risk of a Member State can be considered greater for those Member States with larger employment shares in occupations with a higher automation risk.

Figure 2 – CZ. Employment shares of occupations (at ISCO-08 1 digit level) - split into sub shares 'not at risk' and 'at risk' of automation (2022) - and projected annual growth rate



Source: Own elaboration on Cedefop data (risk of automation calculated by Cedefop at EU27 level by ISCO-08 1 digit level for 2022) applied to Eurostat data (share of employment by occupation, lfsa_egais, 2022).
Note: The numbers preceding the occupations are the ISCO-08 codes. Occupations are ranked from the highest to the lowest share of workers that present a risk of automation. The vertical sum of the two components (darker blue and lighter blue) gives back the total employment share by occupation (in % of total employment in the Member State). The ISCO nomenclature used in the text and the figure is the Cedefop one. For examples of specific occupations see: https://esco.ec.europa.eu/en/classification/occupation_main.

[88] Based on the methodology in Pouliakas, K. (2018) "The risk of automation in EU labour markets: a skill-requirements approach", in Economy, Employment and Skills: European and global perspectives in an age of uncertainty, Fondazione Giacomo Brodolini Quaderni Series, also IZA DP 11829.
[89]As retrieved at https://www.cedefop.europa.eu/en/tools/skills-intelligence/automation-risk-occupations#1
[90] While this assumption may be considered strong, Cedefop data are the only ones available that are at the same time, up to date and available for all the occupations at the ISCO-08 level.

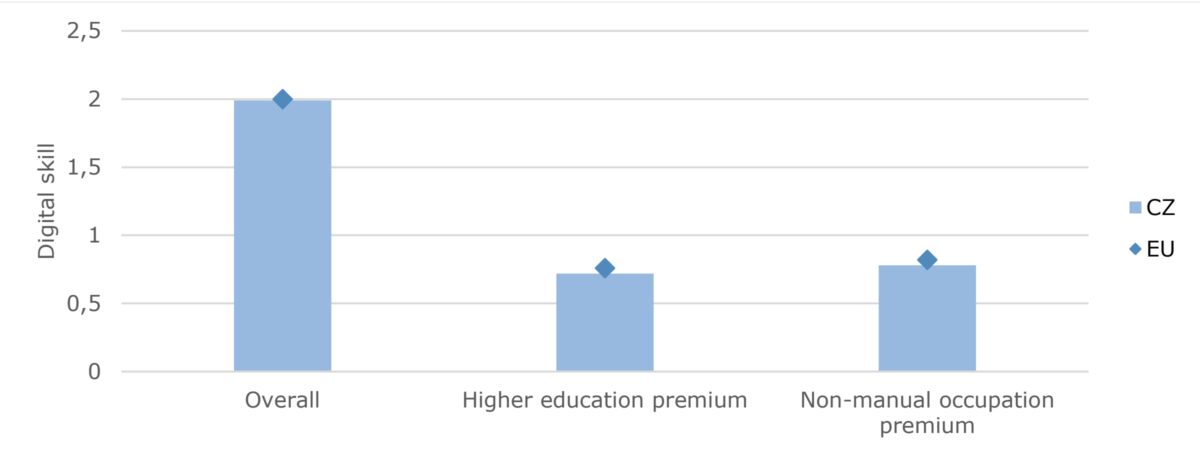
As can be seen in **Figure 2**, in Czechia, the occupation with the largest employment sub-share (in % of total employment in the economy) 'at risk of automation' is the highest is Trades workers, with an employment sub-share of workers 'at risk of automation' representing 2.4% of total employment in the country (vs 1.3% for the EU27). The second largest occupation in terms of the employment sub-share of workers 'at risk of automation' are Operators and assemblers, with an employment sub-share of workers 'at risk of automation' of 2.0% of total employment in Czechia (vs 1.1% for the EU27). Ranking third are Service and sales workers, with a share of workers 'at risk of automation' of 1.2% in total employment in Czechia (vs 1.3% for the EU27). **Among these three occupations, the first and the third ones are also the most affected across the EU27[91].**

For **ICT professionals (ISCO 25)**[92], the 2022 employment share is 2.1% in Czechia (vs 2.3% in the EU27), of which an employment sub-share of 0.1% (vs 0.1% in the EU27) is 'at risk of automation'. The remaining employment sub-share of 2.0% (vs 2.2% at EU27 level) is 'not at risk of automation'. The projected annual growth rate 2022-2035 of the employment share of ICT professionals is a large 5.6% in Czechia (vs 1.9% in EU27).

CZ 2. Key policy dimensions for a socially fair digital transformation

CZ 2.1 Digital skills

Figure 3 – Estimated Digital Skills in CZ and the EU (2019)



Source: Authors' own estimation based on Eurostat ICT survey
Note: Higher education premium refers to the difference in digital skills between individuals with tertiary and lower than tertiary education. Non-manual occupation premium refers to the difference in digital skills between individuals in manual and non-manual occupations.

To successfully manage the labour market impact of the digital transformation, a high level of digital skills across the population is of high importance. **The level of digital skills in Czechia closely matches the EU level,** as highlighted by the DESI 2022 index in human capital (**Figure 5**, in section "Other dimensions"),

[91] The most affected in the EU27 are Trades workers, Professionals, and Service and sales workers.
[92] Eurostat code: lfsa_egai2d.

for which it ranks 15th in the EU[93]. Similarly[94], the estimate of digital skill which has been computed for this study shows, for the overall population, the same value for Czechia and the EU27 (**Figure 3**, bar "Overall"). Moreover, digital divides between individuals with different levels of education ("Higher education premium" in Figure 3) and types of occupation ("Non-manual occupation premium" in Figure 3) are lower than those observed at EU level, with Czechia ranking 10th and 13th in the EU27, respectively (**Figure 3)**. **The fact that inequalities in digital skills across educational groups are, comparatively speaking, not very pronounced[95] constitutes is a potential strength when it comes to mitigating the potential distributional impacts of the digital transformation**.

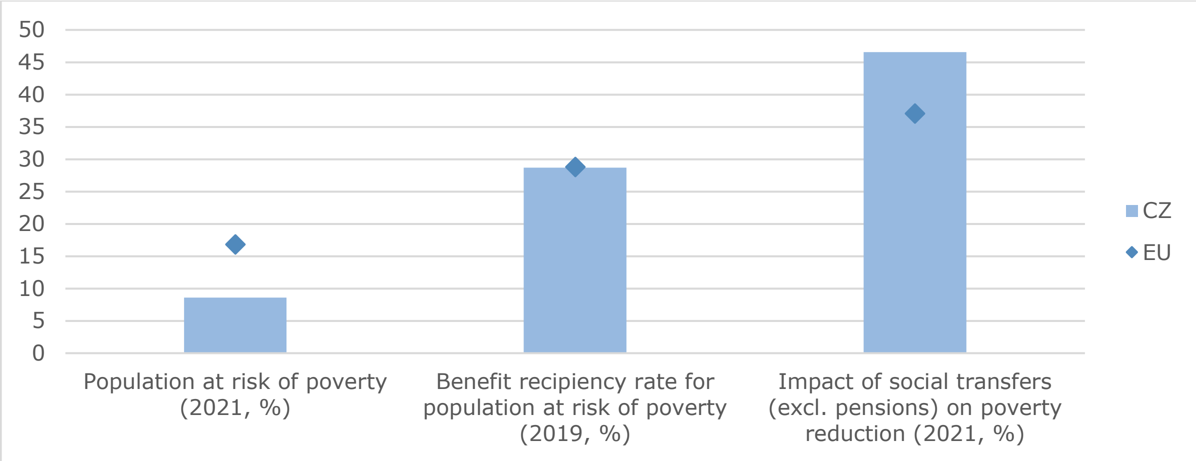
In 2018, Czechia put forward the Digital Czechia Strategy, updated in 2020, which sets out strategies to invest in digital transformation across a range of areas in the economy and society, including the labour market. Moreover, to further invest in skills, particularly digital skills, Czechia has put forward two national Strategies: the Education Policy Strategy 2030 and the Innovation Strategy 2019-2030. Moreover, as part of the Czech NRRP, 26.4% of the total expenditure for the digital pillar is devoted to human capital. The NRRP complements the national strategies by proposing investment in up- and re-skilling programmes, focusing primarily on digital skills, for employees and job seekers[96]. Though Czechia has a relatively high share of ICT graduates and professionals, demand for ICT skills is nevertheless outpacing supply, as the share of enterprises reporting difficulties in recruiting ICT specialists as the lack of ICT specialists is the highest in the EU, which constitutes a significant obstacle to digitalisation in the country[97].

CZ 2.2 Social protection and social policy

Next to digital skills, effective social protection and social policy are key to mitigating the potential distributional impacts of the digital transformation. **Czechia is relatively well positioned in this regard** (Figure 4). The proportion of the population at risk of poverty after social transfers[98] (8.6%) is significantly lower than the EU rate [99] (28.7%). Social transfers have a significant impact on poverty reduction, reducing the rate of the population at risk of poverty by 46.6%[100].

[93] European Commission (2022). Digital Economy and Society Index.
Available at: https://digital-strategy.ec.europa.eu/en/policies/desi
[94] The construction of the digital skill index is described in detail in the introductory section.
[95] Although it should be mentioned that some marginalized groups, like Roma people, are strongly impacted by digital gaps.
[96] European Commission (2022); Recovery and Resilience Scoreboard Thematic Analyses. Digital Skills.
Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_digital_skills.pdf
[97] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[98] Eurostat (2023). TPS00184: At-risk-of-poverty rate after social transfers by sex.
Available at: https://ec.europa.eu/eurostat/databrowser/view/tps00184/default/table?lang=en
[99] Eurostat indicator as re-elaborated by JRC (2022) "Monitoring the effective coverage and adequacy of social protection in the EU".
[100] Eurostat (2023). TESPM050: Impact of social transfers (excluding pensions) on poverty reduction by sex.
Available at:
https://ec.europa.eu/eurostat/databrowser/view/TESPM050/bookmark/table?lang=en&bookmarkId=b001ae62-ce34-4b49-9741-28a3ef99477f

Figure 4 – Social Protection in CZ and the EU



Source: Eurostat (2023) and JRC (2022)

While the Czech national plan for the implementation of the Recommendation for access to social protection of workers and the self-employed does not set out further measures to improve coverage or adequacy of social protection, meaning that remaining gaps in coverage are likely to remain for the moment[101], the plan also underlines that most provisions of the Recommendation are already fulfilled in Czechia[102]. As regards the specific group of platform workers, discussion of the regulation of their employment status – with implications for access to social protection – has been limited in the country so far[103], and no further policy action is foreseen in the national implementation plan. Within the Czech NRRP, broader investment in the social dimension is foreseen, constituting 35.5% of the total budget. Some important measures focus on improving the quality of education and increasing students' digital skills in specific regions, modernising employment services, helping to create high-quality jobs and improving labour force participation among women with young children by increasing the capacity of preschool childcare.

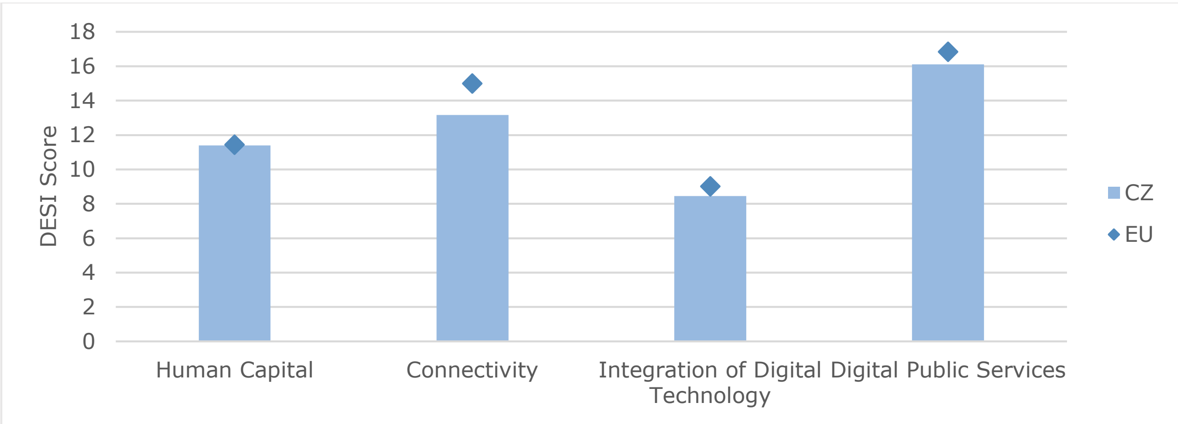
CZ 3. Other dimensions relevant to the digital transformation

Other dimensions are relevant for a successful, socially fair digital transformation. In the first place, digitalisation in firms is a prerequisite to harnessing the potential economic benefits from digitalisation. However, in Czechia, the level of digitalisation in firms is low compared to the EU average. In particular, according to the European Commission's DESI index, the level of integration of digital technology is the 19th lowest in the EU (Figure 5). At the same time, more specific indicators paint a more positive picture. Compared to other countries, robot density (2019)[104] in Czechia is relatively high both in the overall economy and in

[101] European Commission (2023). Report from the Commission to the Council on the implementation of the Council Recommendation on access to social protection for workers and the self-employed. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023DC0043&qid=1676473347749
[102] European Commission (2023). Access to social protection. Available at: https://ec.europa.eu/social/main.jsp?catId=1312&langId=en=en
[103] PPMI (2021). Study to support the impact assessment on improving working conditions in platform work. Available at: https://ec.europa.eu/social/main.jsp?catId=738&furtherPubs=yes&langId=en&pubId=8428
[104] As described in the Annex, based on data from the International Federation of Robotics (2010-2019). Data is not available for Cyprus, Greece, Luxembourg and Slovenia.

manufacturing, though growth in robot density between 2010 and 2019 was lower than the the EU average[105]. Looking at levels of digital capital intensity[106], however, Czechia lags behind the EU average[107]., though growth rates between 2008 and 2018 are relatively high. Hence, these two indicators point to **strengths in some specific dimensions of digitalisation of firms.** Expenditure on the digitalisation of businesses constitutes 27.2% of the digital pillar of the Czech NRRP. These investments include grant support programmes for individual investment projects that are available to both SME and larger businesses, including those carrying out major projects that could qualify as Integrated Projects of Common European Interest (IPCEI). Czechia has also published an innovation strategy, "Country for the Future" and a Strategy for AI, with the NRRP expected to become a key financing tool for the digitalisation of the economy[108].

Figure 5 – DESI Index for CZ and the EU (2022)



Source: European Commission (2022)

Next to the digitalisation of firms, **digital infrastructure and digital public services** constitute an important supporting dimension for a socially fair digital transformation. According to the DESI 2022 index (Figure 5), Czechia ranks 17th both for connectivity and for digital public services. Thus, according to these two aggregated indicators, Czechia **performs slightly below the EU average.** Connectivity represents a share of 13.4% of the digital pillar expenditure in CZ NRRP. The share of expenditure in digital public services in this digital pillar is 19.8%. One of the largest investments in connectivity in the NRRP aims, amongst others, to narrow the digital divide between urban and rural areas[109]. Further investment in connectivity beyond the NRRP is also envisioned, with strategic objectives set out in the National Plan for the Development of Very High Capacity Networks[110].

[105] Average of EU27 MS for whom data was available
[106] As described in the Annex, based on data from EU-KLEMS (2008-2018). Data is not available for Cyprus, Croatia, Ireland and Romania.
[107] Average of EU27 MS for whom data was available
[108] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[109] European Commission (2023); Recovery and Resilience Scoreboard Thematic Analyses. Connectivity. https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_connectivity.pdf
[110] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance

4. DENMARK: elements of a socially fair digital transformation

Key Points

Labour market: Currently, the sector with the largest employment share in the Danish economy – the Health and social care sector - ranks fifteenth in terms of its sectoral degree of digital transformation (based on the current digital capital intensity in a sector)[111]. The Health and social care sector's employment share in the economy is not projected to grow further in the decade to come (whereas it will grow at the EU27 level). ICT services, Professional services, Water and waste treatment are the three sectors with the highest degree of digital transformation currently, and their employment shares are projected to grow, in the decade to come, and more than in the EU27. Danish workers in Professional occupations are those most at risk of their occupation being automated.

Digital skills: On digital skills, Denmark is a leader in the EU. The country has a very high overall level of digital skills in the population, as well as low socio-economic divides in digital skill levels.

Social protection: Denmark has a very comprehensive social protection system, with few gaps in access to social protection and one of the lowest at risk of poverty rates in the EU. Regulation on the employment status of platform workers has also been advanced.

DK 1. The labour market and the digital transformation

DK 1.1 Sectoral composition (current and forward-looking perspectives)

In Denmark ("DK"), in 2022, the sectors with the largest employment shares in the economy were the Health and social care (18.5% vs 11.0% at the EU27 level), Wholesale and retail trade (15.5% vs 13.6% at the EU27 level), and Manufacturing (11.3% vs 16.0% at the EU27 level) sectors. For the period 2022-2035, Cedefop data projects[112] the annual growth rate of a sector's employment share. For Denmark's Health and social care sector, the annual growth rate is -0.3% (0.6% for the EU27), for the Wholesale and retail trade sector it is -0.7% (0.0% for the EU27), and for the Manufacturing sector it is -0.1% (-0.2% for the EU27).

Table 1 presents each sector's employment share in 2022, the projected annual growth rates (2022-2035) of its employment share, and its resulting employment

[111] The ranking based on digital capital intensity is used in the key points only when the sector with the largest employment share is not rankable according to the percentage of enterprises that employ ICT specialists.
[112] Own elaboration on Cedefop 'Skill forecast 2023' data.

share in the economy by 2035. Along with these elements relating to employment, Table 1 also presents the degree of "digital transformation" of each sector. Table 1 thus facilitates a comparison between the digital transformation of a sector and its employment share or its employment shares' prospects. The degree of digital transformation is proxied in Table 1, for each sector, using two indicators: i) the percentage of enterprises in the sector that employ ICT specialists, and ii) the digital capital intensity[113] of the considered sector. Table 1 presents the ranking of each sector according to these two proxy indicators (with rank n°1 corresponding to the most digitised sector). According to the first indicator, the three sectors with the highest degree of digital transformation in Denmark are ICT services (sector's employment share: 4.4% in DK vs 3.7% in the EU27), Professional services (5.6% vs 5.7%) and Water and waste treatment (0.5% vs 0.8%). According to the second indicator (digital capital intensity), the three sectors with the highest degree of digital transformation are: rank n°1) Finance and insurance (sector's employment share: 2.8% in DK, as in the EU27), rank n°2) ICT services (4.4% vs 3.7%) and rank n°3) Professional services (5.6% vs 5.7%). These sectors' employment shares have a projected annual growth rate for 2022-2035 in Denmark of 1.7% for ICT services (vs 0.8% for the EU27), 1.6% for Professional services (vs 0.6% for the EU27), 0.2% for Water and waste treatment (vs -0.1% for the EU27), and 1.3% for Finance and insurance (vs 0.2% for the EU27).

It can be seen from Table 1 that two of the four sectors with the highest degrees of digital transformation – ICT services and Professional services – are also among the four sectors with the highest projected annual growth rate of employment shares over the next decade in Denmark[114]. Furthermore, the sectors with the second and third largest current employment shares[115] – Wholesale and retail trade and Manufacturing - rank fourth and sixth, according to the first proxy indicator for the degree of digital transformation (% of enterprises that employ ICT specialists). Similarly, Wholesale and retail trade and Manufacturing rank fourth and fifth on the second proxy indicator (digital capital intensity).

Table 1 – DK. Sector's share of employment, annual growth rate, and ranking of "degree of digital transformation" (the sectors are ranked according to the ranking in the last column of the table).

Sectors	Sector's employment share in 2022 (%)		Projected annual growth rate of the sector's employment share (2022 - 2035, %)		Projected sector's employment share in 2035 (%)		Proxy 1 for digital transformation (ranking)	Proxy 2 for digital transformation (ranking)
	DK	**EU**	**DK**	**EU**	**DK**	**EU**	**% enterprises that employ ICT specialists**	**Digital capital intensity**
K - Finance & insurance	2.8	2.8	1.3	0.2	3.3	2.8	n.a.	1
J - ICT services	4.4	3.7	1.7	0.8	5.6	4.2	1	2

[113] 'Digital capital intensity' is an index – built in the context of this study – that looks at the ratio between the stock of capital the firms have in software and databases and the overall stock of capital excluding non-residential buildings. Its construction is based on the integrated EUKLEMS & INTANProd database, run by the Luiss Lab of European Economics at Luiss University in Rome, Italy. For more in-depth information on the source, and the availability of the indicator for Member States/sectors, please refer to the Annex.

[114] This is true for both the rankings based on the proxy indicators for digital transformation ('percentage of enterprises with ICT specialists' and 'digital capital intensity').

[115] The first sector in terms of employment share (in 2022) - Health and social care - is not rankable on one of the two proxies of digital transformation (% of enterprises that employ ICT specialists), while it ranks fifteenth with the second proxy indicator for digital transformation (digital capital intensity).

M - Professional services	5.6	5.7	1.6	0.6	6.9	6.3	2	3
G - Wholesale & retail trade	15.5	13.6	-0.7	0.0	14.0	13.6	4	4
C - Manufacturing	11.3	16.0	-0.1	-0.2	11.2	15.6	6	5
F - Construction	6.5	6.8	-0.6	-0.3	5.9	6.5	9	6
O - Public sector & defence	5.4	7.1	0.0	-0.1	5.4	7.0	n.a.	7
I - Accommodation & food	3.7	4.5	-1.8	0.6	2.9	4.9	8	8
R - Arts & recreation and other services	2.4	1.7	0.4	0.3	2.5	1.7	n.a.	9
N - Administrative services	3.8	4.1	0.7	0.0	4.2	4.1	5	10
H - Transport & storage	4.1	5.3	1.0	-0.1	4.7	5.3	7	11
P - Education	8.7	7.4	-0.7	0.3	7.9	7.7	n.a.	12
E- Water and waste treatment	0.5	0.8	0.2	-0.1	0.5	0.8	3	13
A - Agriculture, forestry & fishing	1.9	3.5	-1.0	-3.1	1.6	2.3	n.a.	14
Q - Health & social care	18.5	11.0	-0.3	0.6	17.9	11.9	n.a.	15
D - Energy supply services	0.6	0.7	0.9	0.1	0.7	0.8	n.a.	16
B - Mining & quarrying	0.1	0.3	-2.2	-1.7	0.1	0.2	n.a.	17
L - Real Estate	1.2	0.9	1.8	0.9	1.6	1.0	n.a.	n.a.
S - Other service activities	2.4	2.6	1.7	0.0	3.1	2.6	n.a.	n.a.
T - Activities of households as employers	0.1	0.9	0.4	-0.3	0.1	0.9	n.a.	n.a.
U - Activities of extraterritorial org.	0.1	0.1	n.a.	n.a.	0.1	0.1	n.a.	n.a.

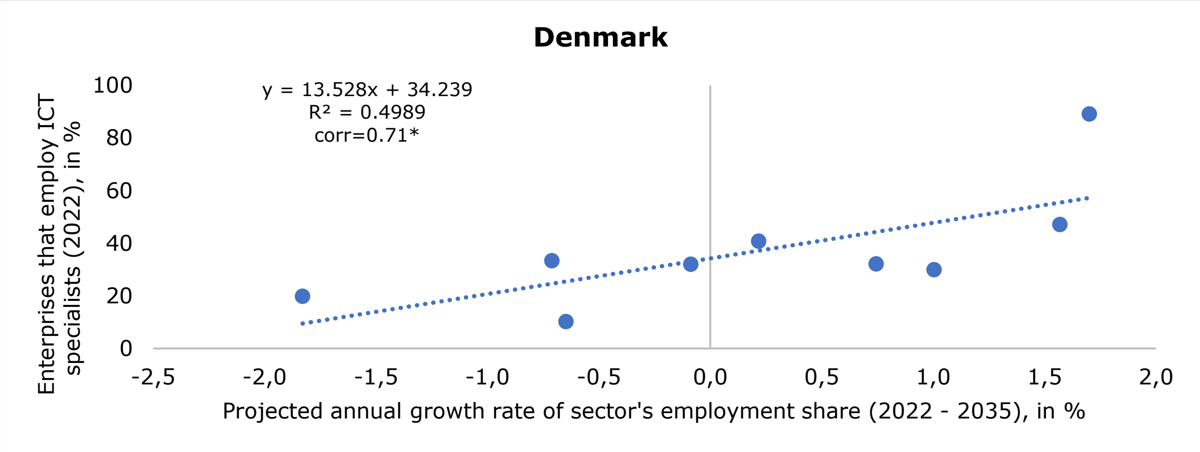
Source: For the employment-related indicators own elaboration on Eurostat data (share of employment, 2022 calculated based on lfsa_egan) and on Cedefop 'Skill forecast data 2023' (annual growth rate of sector's employment share, 2022-2035), for the digital transformation-related indicators: own elaboration on Eurostat data (share of enterprises that employ ICT specialists, Eurostat code: lfsa_egais) and on EUKLEMS & INTANProd data (digital capital intensity).
Note: In the first column of the table, the letter preceding the sectors is the code of the NACE Rev.2 classification. In the last two columns of the table, the two proxy indicators used for digital transformation are: i) the share of enterprises that employ ICT specialists (Eurostat code: lfsa_egais) and ii) the digital capital intensity (EUKLEMS & INTANProd data, average 2014-2017) with rank n°1 corresponding to the most digitally intense sector.

Complementing Table 1, Figures 1a and 1b (below) show to what extent there may be a relationship between the projected annual growth rates of the sectors' employment shares in the economy and the ranking of the sectors in terms of digital transformation[116]. In **Figure 1a**, we present a scatterplot of the first proxy of digital transformation used (percentage of enterprises that employ ICT specialists) and the projected annual growth rate of a sector's employment share between 2022-2035. The correlation is positive, and statistically significant in Denmark, with a value of 0.71 (it is 0.62 and statistically significant for the EU27). Among the ten Member States with a significant correlation, Denmark has the 4th highest correlation. The positive correlation could suggest that the employment shares of those sectors with a **higher percentage of enterprises that employ ICT specialists are more likely to experience higher growth (over 2022-2035) than other sectors.** The relationship is strong and strong than the one at

[116] With the caveat that the correlation coefficients presented in Figure 1a and Figure 1b cannot be directly compared, as they pertain to a combination of sectors that varies across different Member States.

the EU27 level. Nevertheless, this correlation does not necessarily imply causal links.

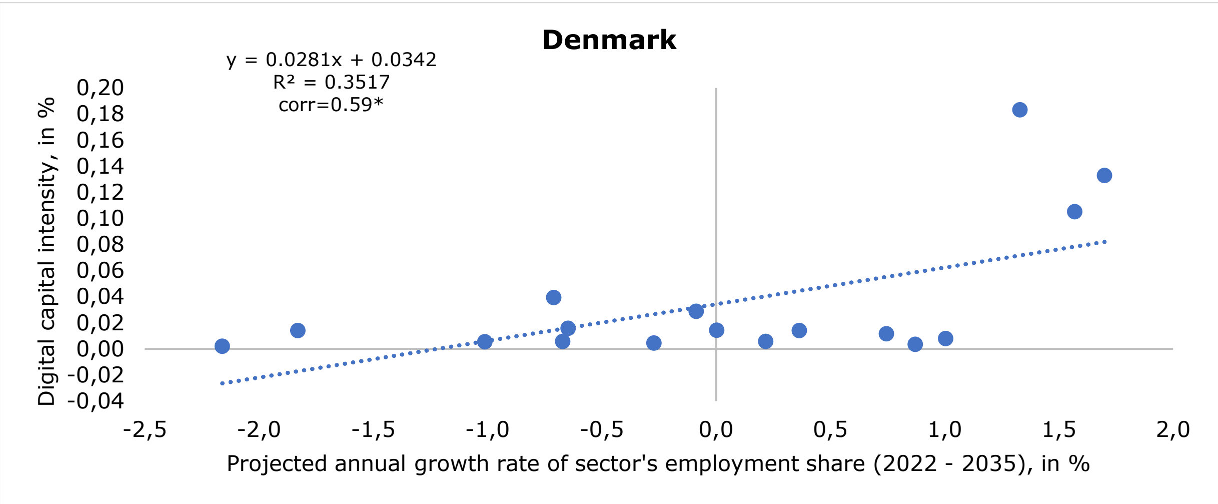
Figure 1a – DK. Relationship between the percentage of enterprises that employ ICT specialists (in 2022) and the projected annual growth rate of sector's employment share (2022-2035).



Source: Own elaboration on Eurostat and Cedefop 'Skill forecast 2023' data.

Figure 1b shows the correlation between the second digital transformation proxy ('digital capital intensity') and the projected annual growth rate of a sector's employment share between 2022-2035. The correlation coefficient exhibits a value of 0.59 and is statistically significant in Denmark. Among the 16 MS for which the 'digital capital intensity' can be computed (7 of which present a positive and significant correlation), Denmark ranks third. In this case, **the positive correlation could suggest that, in Denmark, the employment shares of those sectors with a higher 'digital capital intensity' are more likely to grow (over 2022-2035) than in other sectors. The relationship is strong** and above the average of the seven Member States presenting a positive correlation. As before, this correlation does not necessarily imply causal links.

Figure 1b – DK. Relationship between 'digital capital intensity' and the projected annual growth rate of sector's employment share (2022-2035).

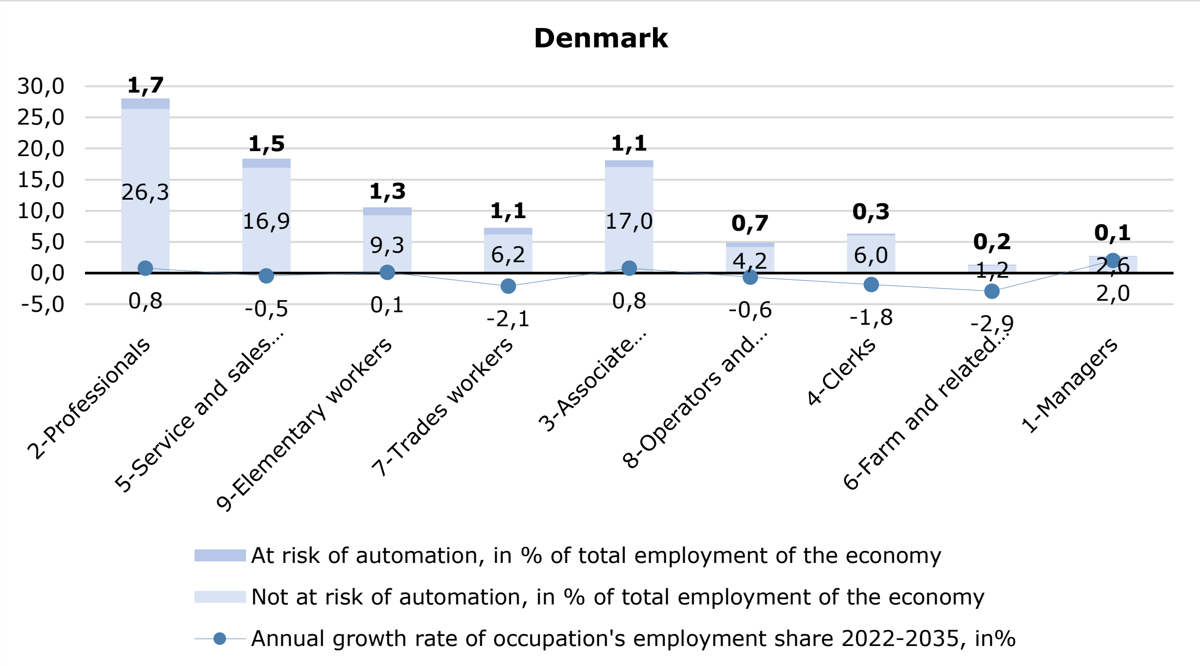


Source: Own elaboration on EUKLEMS & INTANProd, and Cedefop 'Skill forecast 2023' data.

DK 1.2 Occupational composition at ISCO-08 1 digit and risk of automation (current and forward-looking perspectives)

Different types of occupation are subject to differing levels of automation risk. Cedefop developed[117] a "risk of automation" index by occupation at the EU27 level, most recently updated for 2022[118]. We apply this indicator at the Member State level, with the assumption that the risk of automation for a given occupation is relatively constant across Member States[119]. As such, the variation in the susceptibility to automation of a Member State's workforce across all occupations can be attributed to the employment composition effect. Thus, while the automation risk for a given occupation stays constant across Member States, the overall automation risk of a Member State can be considered greater for those Member States with larger employment shares in occupations with a higher automation risk.

Figure 2 – DK. Employment shares of occupations (at ISCO-08 1 digit level) - split into sub shares 'not at risk' and 'at risk' of automation (2022) - and projected annual growth rate



Source: Own elaboration on Cedefop data (risk of automation calculated by Cedefop at EU27 level by ISCO-08 1 digit level for 2022) applied to Eurostat data (share of employment by occupation, lfsa_egais, 2022).
Note: The numbers preceding the occupations are the ISCO-08 codes. Occupations are ranked from the highest to the lowest share of workers that present a risk of automation. The vertical sum of the two components (darker blue and lighter blue) gives back the total employment share by occupation (in % of total employment in the Member State). The ISCO nomenclature used in the text and the figure is the Cedefop one. For examples of specific occupations see: https://esco.ec.europa.eu/en/classification/occupation_main.

[117] Based on the methodology in Pouliakas, K. (2018) "The risk of automation in EU labour markets: a skill-requirements approach", in Economy, Employment and Skills: European and global perspectives in an age of uncertainty, Fondazione Giacomo Brodolini Quaderni Series, also IZA DP 11829.
[118] As retrieved at https://www.Cedefop.europa.eu/en/tools/skills-intelligence/automation-risk-occupations#1
[119] While this assumption may be considered strong, Cedefop data are the only ones available that are at the same time, up to date and available for all the occupations at the ISCO-08 level.

As can be seen in **Figure 2**, in Denmark, the occupation with the largest employment sub-share (in % of total employment in the economy) 'at risk of automation' is Professionals, with the employment sub-share of workers in Professional occupations 'at risk of automation' representing 1.7% of total employment in Denmark (vs 1.3% for the EU27). The second largest employment sub-share of workers 'at risk of automation' is Service and sales workers, representing 1.5% of total employment in Denmark (vs 1.3% for the EU27). Ranking third is Elementary workers, with a share of workers 'at risk' of 1.3% in total employment in Denmark (vs 1.0% for the EU27). **These three occupations are not the most affected across the EU27[120].**

ICT professionals (ISCO 25)[121] made up 3.2% of workers in Denmark in 2022. For them, an employment sub-share of 0.2% (vs 0.1% in the EU27) is 'at risk of automation', and the remaining employment sub-share of 3.0% (vs 2.2% at EU27 level) is 'not at risk of automation'. The projected annual growth rate 2022-2035 of the employment share of ICT professionals is 2.2% in Denmark (vs 1.9% in EU27).

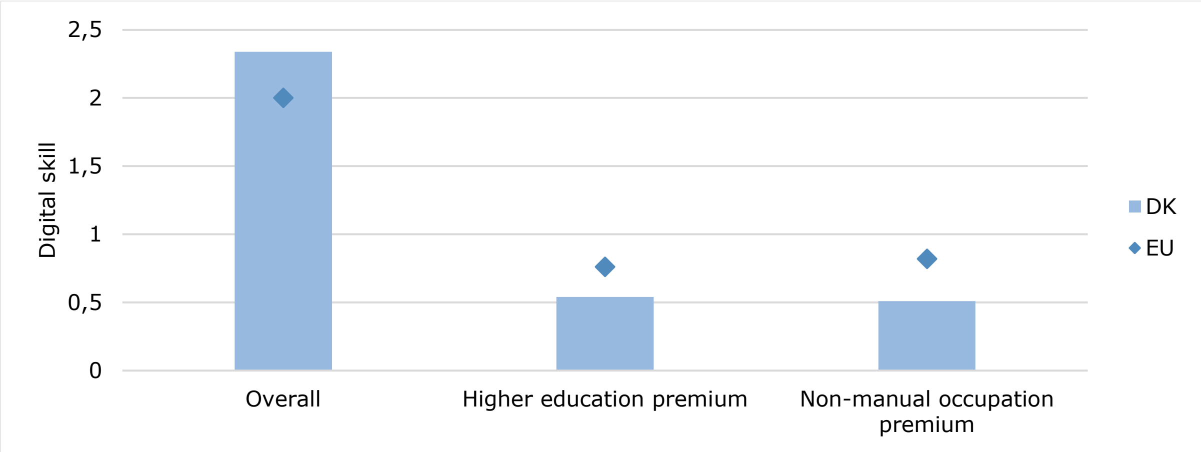
DK 2. Key policy dimensions for a socially fair digital transformation

DK 2.1 Digital skills

A first key policy dimension to consider in the context of a socially fair digital transformation is the level of digital skills in the population. **Denmark is one of the countries with the highest levels of digital skills in the EU**. It ranks third in the EU in the study's estimated index of digital skills[122] (Figure 3, bar "Overall") and fifth in the DESI Index for Human Capital[123] (Figure 5, section "Other Dimensions"). Furthermore, gaps in digital skills between individuals with tertiary versus non-tertiary education ("Higher education premium" in Figure 3), and with manual versus non-manual occupations ("Non-manual occupation premium" in Figure 3), are among the lowest across EU member states. On these indicators, Denmark ranks second and third in the EU, respectively.

[120] The most affected in the EU27 are Trades workers, Professionals, and Service and sales workers.
[121] Eurostat code: lfsa_egai2d.
[122] The construction of the digital skill index is described in detail in the introductory section.
[123] European Commission (2022). Digital Economy and Society Index. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi

Figure 3 – Estimated Digital Skills in DK and the EU (2019)



Source: Authors' own estimation based on Eurostat ICT survey
Note: Higher education premium refers to the difference in digital skills between individuals with tertiary and lower than tertiary education. Non-manual occupation premium refers to the difference in digital skills between individuals in manual and non-manual occupations.

Looking at policy action for digital skill development, the Danish Digital Growth Strategy 2025[124] sets out a policy strategy for further improving digital skill levels in Denmark, with policy actions including, among others, a Technology Pact for skills and the Creation of a Centre for the application of IT in teaching in vocational education. While the digital pillar of the Danish NRRP contains no expenditure on human capital, reflecting the existing high stock of digital skills in the country, the plan included the development of a new Digital Strategy, adopted in 2022[125], with two sub-reforms targeted at digital skills development[126].

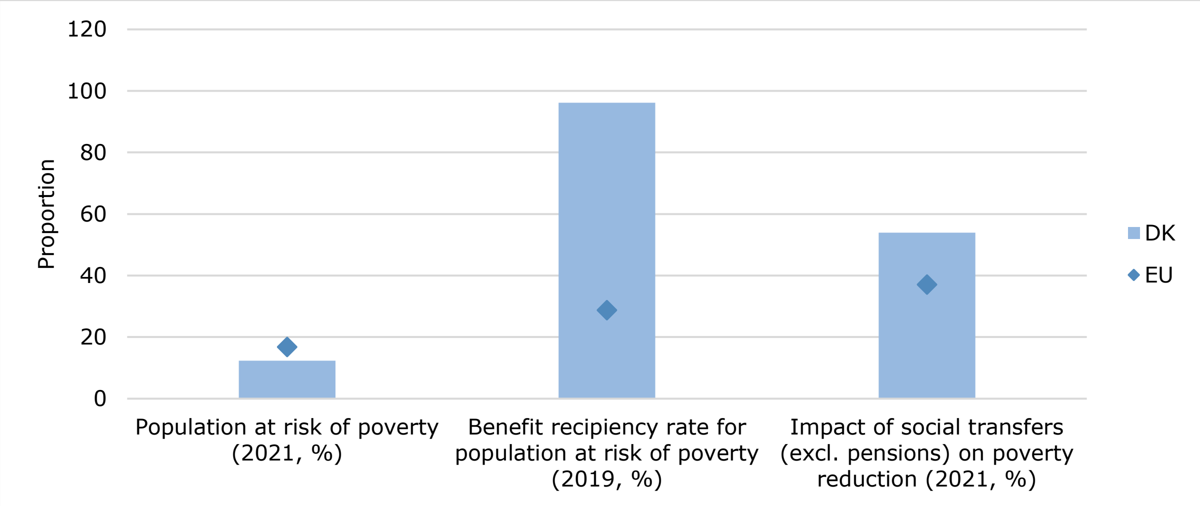
DK 2.2 Social protection and social policy

Next to a high level of digital skills, **Denmark also has a very comprehensive social protection system (Figure 4), which could be a strength when it comes to mitigating the potential labour market impact of the digital transformation and its effects on inequality**. The rate of the population at risk of poverty after social transfers[127] (12.3%) is among the lowest in the EU. Additional indicators point to the high effectiveness of the social protection system in mitigating poverty. The benefit recipiency rate for the population at risk of poverty[128] before social transfers (96.2%) is the highest in the EU by far, while the impact of social transfers on poverty reduction[129] (53.9%) is the third highest

[124] For more information, see https://investindk.com/insights/the-danish-government-presents-digital-growth-strategy
[125] For more information, see https://en.digst.dk/media/27861/national-strategy-for-digitalisation-together-in-the-digital-development.pdf
[126] European Commission (2022); Recovery and Resilience Scoreboard Thematic Analyses. Digital Skills. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_digital_skills.pdf
[127] Eurostat (2023). TPS00184: At-risk-of-poverty rate after social transfers by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/tps00184/default/table?lang=en
[128] Eurostat indicator as re-elaborated by JRC (2022) "Monitoring the effective coverage and adequacy of social protection in the EU".
[129] Eurostat (2023). TESPM050:Impact of social transfers (excluding pensions) on poverty reduction by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/TESPM050/bookmark/table?lang=en&bookmarkId=b001ae62-ce34-4b49-9741-28a3ef99477f

in the EU27. Equally, Denmark has been actively trying to regulate the employment status of platform workers[130], a group significantly influenced by the process of digitalisation in the labour market.

Figure 4 – Social Protection in DK and the EU



Source: Eurostat (2023) and JRC (2022)

While the Danish national implementation plan for the Recommendation on access to social protection[131] contains no further measures to improve formal or effective coverage of social protection, given the existing comprehensive nature of the system, there are only limited gaps to address[132]. Specific measures for platform workers are not included. Similarly, the Danish RRP contains no reforms or investment to improve access to social protection. Within social expenditure in the Danish RRP, the large majority is dedicated to health and long term care (64.2%), with the rest is allocated towards the area of employment and skills.

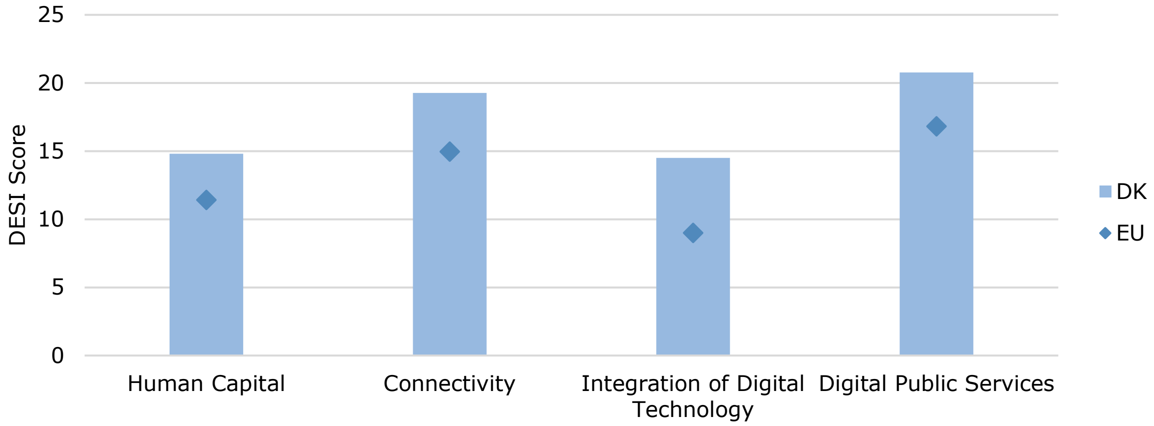
DK 3. Other dimensions relevant to the digital transformation

In addition to digital skills and social protection, broader elements of digitalisation in society constitute significant support factors for a successful and socially fair digital transformation. First, the level of digitalisation in firms is of significant importance. According to the DESI Index, the level of integration of digital technology in Danish firms is the second-largest in the EU. Other indicators also confirm that digitalisation of firms is advanced in Denmark. Robot density[133] – both in the economy overall and in manufacturing – is significantly higher than the EU average[134]. It should be noted that growth in robot density between 2010 and 2019 has not been as strong as in other countries, though this may partly

[130] PPMI (2021). Study to support the impact assessment on improving working conditions in platform work. Available at: https://ec.europa.eu/social/main.jsp?catId=738&furtherPubs=yes&langId=en&pubId=8428
[131] Commission (2023). Access to social protection. Available at: https://ec.europa.eu/social/main.jsp?catId=1312&langId=en=en
[132] European Commission (2023). Report from the Commission to the Council on the implementation of the Council Recommendation on access to social protection for workers and the self-employed. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023DC0043&qid=1676473347749
[133] As described in the Annex, based on data from the International Federation of Robotics (2010-2019). Data is not available for Cyprus, Greece, Luxembourg and Slovenia.
[134] Average of EU27 MS for whom data was available

reflect the existing high stock of robots in the economy. As regards digital capital intensity[135], both absolute levels and growth rates are more advanced than the EU average[136]. Within the Danish RRP, a strong emphasis is placed on digitalisation of businesses, with 63.1% of the digital pillar expenditure targeted towards this field. The new digital strategy adopted as part of the RRF also includes substantive policies aimed at the digitalisation of SMEs[137].

Figure 5 – DESI Index for DK and the EU



Source: European Commission (2022)

A second supporting dimension is digital infrastructure and digital public services. Denmark ranks first in the EU in the DESI for connectivity. In digital public services, in comparison to the other DESI dimensions, Denmark ranks somewhat lower, though at eighth-best in the EU, it still performs very well. Denmark published its most recent broadband strategy in 2021; however, in view of the existing high levels of connectivity, the strategy could have set more ambitious targets to be aligned to 2030 Digital Decade targets[138]. Within the Danish NRRP, while connectivity plays only a marginal role in planned digital expenditure (3.4%), a somewhat larger share is devoted to digitalisation of public services (18.1%). The EU connectivity funding, in combination with national co-funding, will be used to close gaps in high-speed internet access for households and companies in rural and remote areas[139], while the measures on digital public services are focused on digitalizing public administration and healthcare[140].

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[135] As described in the Annex, based on data from EU-KLEMS (2008-2018). Data is not available for Cyprus, Croatia, Ireland and Romania.
[136] Average of EU27 MS for whom data was available
[137] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[138] https://en.digst.dk/media/27861/national-strategy-for-digitalisation-together-in-the-digital-development.pdf
[139] European Commission (2023); Recovery and Resilience Scoreboard Thematic Analyses. Connectivity. https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_connectivity.pdf
[140] European Commission (2021); Recovery and Resilience Scoreboard Thematic Analyses. Digital public services. Available at :https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/2_Digital.pdf

5. GERMANY: elements of a socially fair digital transformation

Key Points

Labour market: In Germany, the Manufacturing sector currently has a larger employment share of the economy than any other sector. In terms of digital transformation, it is only the fourth highest sector (based on the current percentage of enterprises that employ ICT specialists in a sector), and its employment share is not projected to grow further in the next decade (at the same level as the EU trends). ICT services, Energy supply services and Professional services are the three sectors with the highest degree of digital transformation currently, and their employment shares are also not projected to grow, in the next decade, unlike those sectors at EU27 level. Trades workers in Germany are most at risk of automation of their occupation.

Digital skills: With regard to the overall level of digital skills in the population, Germany performs somewhat above the EU rate. Moreover, digital divides between population gaps are less pronounced than at EU level.

Social protection: The German social protection system is well-developed relative to other EU countries, the rate of the population at risk of poverty being slightly lower than the EU rate. Moreover, Germany has been one of the countries most active in regulating platform work.

DE 1. The labour market and the digital transformation

DE 1.1 Sectoral composition (current and forward-looking perspectives)

In Germany ("DE"), in 2022, the sectors with the largest employment shares in the economy were the Manufacturing (19.3% vs 16.0% in the EU27), Health and social care (13.6% vs 11.0% in the EU27), and Wholesale and retail trade (12.6% vs 13.6% in the EU27) sectors. For the period 2022-2035, Cedefop data projects[141] the annual growth rate of a sector's employment share. For Germany's Manufacturing sector, the annual growth rate is -0.2% (same as the EU27), for the Health and social care sector, it is 1.3% (0.6% for the EU27), and for the Wholesale and retail trade sector it is -0.3% (0.0% for the EU27).

Table 1 presents each sector's employment share in 2022, the projected annual growth rates (2022-2035) of its employment share, and its resulting employment

[141] Own elaboration on Cedefop 'Skill forecast 2023' data.

share in the economy by 2035. Along with these elements relating to employment, Table 1 also presents the degree of "digital transformation" of each sector. Table 1 thus enables comparison between the digital transformation of a sector and its employment or employment prospects. The degree of digital transformation is proxied in Table 1, for each sector, using two indicators: i) the percentage of enterprises that employ ICT specialists in the considered sector and ii) the digital capital intensity[142] of the considered sector. Table 1 presents the ranking of each sector according to these two proxy indicators (with rank n°1 corresponding to the most digitised sector). According to the first indicator, the three sectors with the highest degree of digital transformation in Germany are ICT services (sector's employment share: 4.0% in DE vs 3.7% in the EU27), Energy supply services (0.9% vs 0.7%), and Professional services (5.4% vs 5.7%). According to the second indicator (digital capital intensity), the three sectors with the highest degree of digital transformation are ICT services (sector's employment share: 4.0% in DE vs 3.7% in the EU27), Wholesale and retail trade (12.6% vs 13.6%) and Professional services (5.4% vs 5.7%). These sectors' employment shares have a projected annual growth rate for 2022-2035 in Germany of -0.4% for ICT services (vs 0.8% for the EU27), -0.3% for Energy supply services (vs 0.1% for the EU27), -0.3% for Professional services (vs 0.6% for the EU27) and -0.3% for Wholesale and retail trade (vs 0.0% for the EU27).

As in Table 1, none of the sectors with the highest degree of digital transformation are also sectors with the highest annual growth rates of employment share over the next decade. Furthermore, the first and third largest sectors in terms of employment share[143] in 2022 – Manufacturing and Wholesale and retail trade - rank fourth and seventh on one of the two proxy indicators of digital transformation (% of enterprises that employ ICT specialists). Using the other proxy for degree of digital transformation (digital capital intensity), Wholesale and retail trade ranks second.

Table 1 – DE. Sector's share of employment, annual growth rate, and ranking of "digital transformation" (the sectors are ranked according to the ranking in the last column of the table).

Sectors	Sector's employment share in 2022 (%)		Projected annual growth rate of the sector's employment share (2022 - 2035, %)		Projected sector's employment share in 2035 (%)		Proxy 1 for digital transformation (ranking)	Proxy 2 for digital transformation (ranking)
	DE	**EU**	**DE**	**EU**	**DE**	**EU**	**% enterprises that employ ICT specialists**	**Digital capital intensity**
J - ICT services	4.0	3.7	-0.4	0.8	3.7	4.2	1	1
G - Wholesale & retail trade	12.6	13.6	-0.3	0.0	12.2	13.6	7	2
M - Professional services	5.4	5.7	-0.3	0.6	5.2	6.3	3	3
K - Finance & insurance	3.1	2.8	-0.5	0.2	2.9	2.8	n.a.	4
F - Construction	6.2	6.8	-0.7	-0.3	5.6	6.5	9	5

[142] 'Digital capital intensity' is an index – built in the context of this study – that looks at the ratio between the stock of capital the firms have in software and databases and the overall stock of capital excluding non-residential buildings. Its construction is based on the integrated EUKLEMS & INTANProd database, run by the Luiss Lab of European Economics at Luiss University in Rome, Italy. For more in-depth information on the source, and the availability of the indicator for Member States/sectors, please refer to the Annex.
[143] The second sector in terms of employment share (in 2022) - Health and social care - is not rankable on one of the two proxies of digital transformation (% of enterprises that employ ICT specialists), while it ranks eleventh with the second proxy indicator for digital transformation (digital capital intensity).

C - Manufacturing	19.3	16.0	-0.2	-0.2	18.8	15.6	4	6
I - Accommodation & food	3.2	4.5	-0.7	0.6	2.9	4.9	10	7
N - Administrative services	4.6	4.1	0.2	0.0	4.7	4.1	6	8
B - Mining & quarrying	0.2	0.3	-2.0	-1.7	0.1	0.2	n.a.	9
D - Energy supply services	0.9	0.7	-0.3	0.1	0.9	0.8	2	10
Q - Health & social care	13.6	11.0	1.3	0.6	16.3	11.9	n.a.	11
P - Education	6.8	7.4	1.3	0.3	8.1	7.7	n.a.	12
O - Public sector & defence	7.7	7.1	0.3	-0.1	8.0	7.0	n.a.	13
H - Transport & storage	4.8	5.3	-0.1	-0.1	4.8	5.3	8	14
R - Arts & recreation and other services	1.3	1.7	-0.6	0.3	1.2	1.7	n.a.	15
E- Water and waste treatment	0.6	0.8	-1.8	-0.1	0.5	0.8	5	16
A - Agriculture, forestry & fishing	1.2	3.5	-4.0	-3.1	0.7	2.3	n.a.	17
L - Real Estate	0.9	0.9	1.5	0.9	1.1	1.0	n.a.	n.a.
S - Other service activities	3.4	2.6	-0.7	0.0	3.1	2.6	n.a.	n.a.
T - Activities of households as employers	0.3	0.9	-1.2	-0.3	0.3	0.9	n.a.	n.a.
U - Activities of extraterritorial org.	n.a.	0.1	n.a.	n.a.	n.a.	0.1	n.a.	n.a.

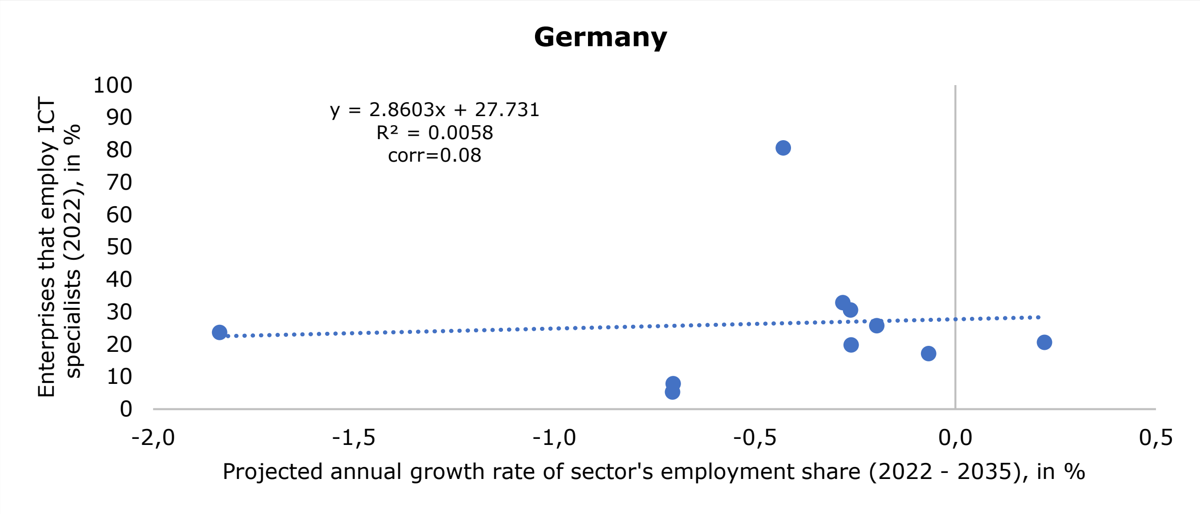
Source: For the employment-related indicators own elaboration on Eurostat data (share of employment, 2022 calculated based on lfsa_egan) and on Cedefop 'Skill forecast data 2023' (annual growth rate of sector's employment share, 2022-2035), for the digital transformation-related indicators: own elaboration on Eurostat data (share of enterprises that employ ICT specialists, Eurostat code: lfsa_egais) and on EUKLEMS & INTANProd data (digital capital intensity).
Note: In the first column of the table, the letter preceding the sectors is the code of the NACE Rev.2 classification. In the last two columns of the table, the two proxy indicators used for the digital transformation are: i) the share of enterprises that employ ICT specialists (Eurostat code: lfsa_egais) and ii) the digital capital intensity (EUKLEMS & INTANProd data, average 2014-2017) with rank n°1 corresponding to the most digitally intense sector.

To build on Table 1, Figures 1a and 1b (below) further enabling comparison between the projected annual growth rates of the sectors' employment shares in the economy and their degree of digital transformation[144].

In **Figure 1a**, we present a scatterplot to shed light on the relationship between the first proxy of digital transformation used (percentage of enterprises that employ ICT specialists) and the projected annual growth rate of a sector's employment share between 2022-2035. The correlation is positive, but small and statistically not significant in Germany, with a value of 0.08 (it is 0.62 and statistically significant for the EU27). **The statistically insignificant result implies that an association between the percentage of enterprises in a sector that employ ICT specialists, and that sector's projected annual employment share growth rate, cannot be inferred at the sectoral level in Germany.**

[144] With the caveat that the correlation coefficients presented in Figure 1a and Figure 1b cannot be directly compared, as they pertain to a combination of sectors that varies across different Member States.

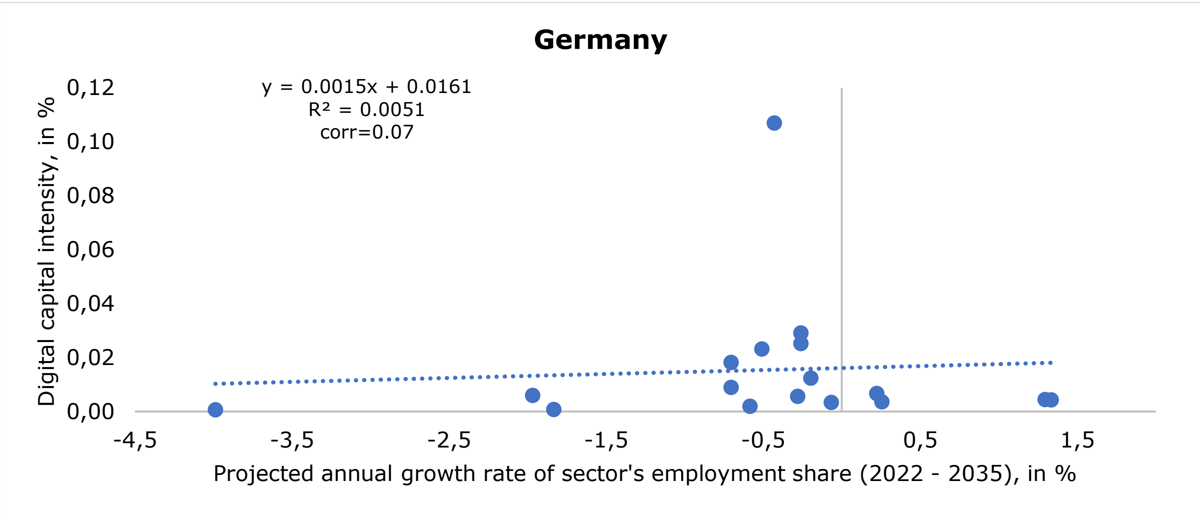
Figure 1a – DE. Relationship between the percentage of enterprises that employ ICT specialists (in 2022) and the projected annual growth rate of sector's employment share (2022-2035).



Source: Own elaboration on Eurostat and Cedefop 'Skill forecast 2023' data.

Figure 1b shows the correlation between the second digital transformation proxy ('digital capital intensity') and the projected annual growth rate of a sector's employment share between 2022-2035. The correlation coefficient exhibits a value of 0.07, and it is not statistically significant in Germany. Also in this case, **the lack of correlation implies that in Germany an association, at the sectoral level, between the 'digital capital intensity' and the projected annual growth rate of a sector's employment share cannot be inferred.**

Figure 1b – DE. Relationship between 'digital capital intensity' and the projected annual growth rate of sector's employment share (2022-2035).

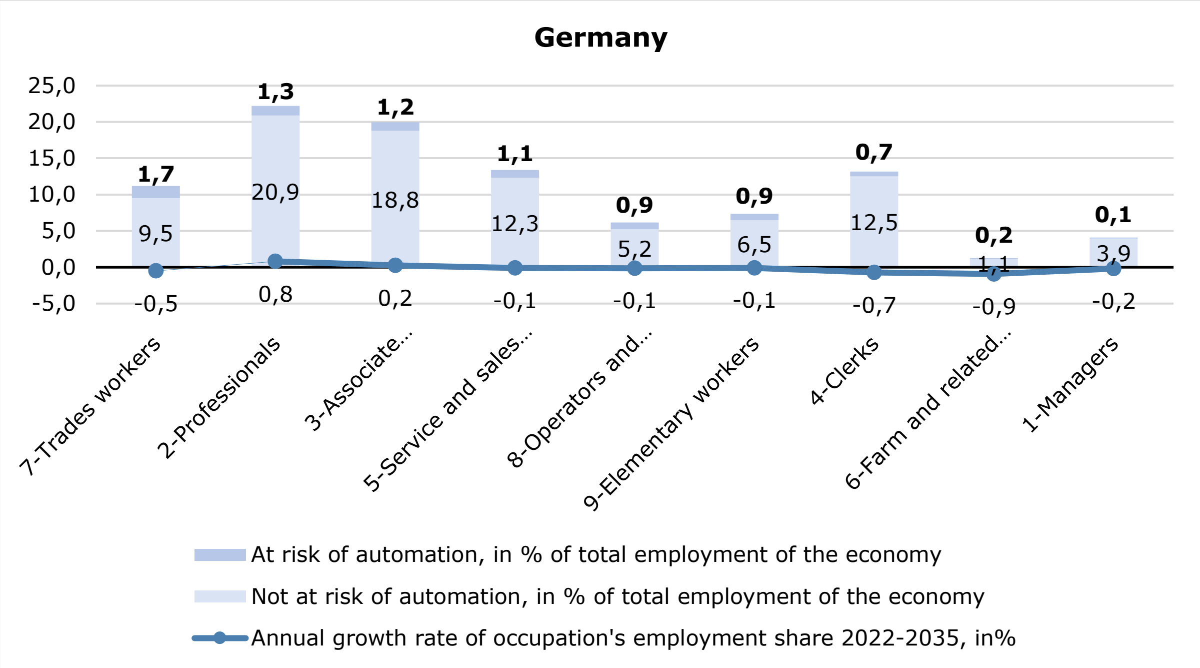


Source: Own elaboration on EUKLEMS & INTANProd, and Cedefop 'Skill forecast 2023' data.

DE 1.2 Occupational composition at ISCO-08 1 digit and risk of automation (current and forward-looking perspectives)

Different occupations are vulnerable to automation risk to differing degrees. Cedefop developed[145] a "risk of automation" index by occupation at the EU27 level, most recently updated for 2022[146]. We apply this indicator at the Member State level, with the assumption that the risk of automation for a given occupation is relatively constant across Member States[147]. As such, the variation in the susceptibility to automation of a Member State's workforce across all occupations can be attributed to the employment composition effect. Thus, while the automation risk for a given occupation stays constant across Member States, the overall automation risk of a Member State can be considered greater for those Member States with larger employment shares in occupations with a higher automation risk.

Figure 2 – DE. Employment shares of occupations (at ISCO-08 1 digit level) - split into sub shares 'not at risk' and 'at risk' of automation (2022) - and projected annual growth rate



Source: Own elaboration on Cedefop data (risk of automation calculated by Cedefop at EU27 level by ISCO-08 1 digit level for 2022) applied to Eurostat data (share of employment by occupation, lfsa_egais, 2022).
Note: The numbers preceding the occupations are the ISCO-08 codes. Occupations are ranked from the highest to the lowest share of workers that present a risk of automation. The vertical sum of the two components (darker blue and lighter blue) gives back the total employment share by occupation (in % of total employment in the Member State). The ISCO nomenclature used in the text and the figure is the Cedefop one. For examples of specific occupations see: https://esco.ec.europa.eu/en/classification/occupation_main.

As can be seen in **Figure 2**, in Germany, the occupation with the largest sub-share (in % of total employment in the economy) 'at risk of automation' is Trades workers, with an employment sub-share of workers 'at risk of automation'

[145] Based on the methodology in Pouliakas, K. (2018) "The risk of automation in EU labour markets: a skill-requirements approach", in Economy, Employment and Skills: European and global perspectives in an age of uncertainty, Fondazione Giacomo Brodolini Quaderni Series, also IZA DP 11829.
[146]As retrieved at https://www.Cedefop.europa.eu/en/tools/skills-intelligence/automation-risk-occupations#1
[147] While this assumption may be considered strong, Cedefop data are the only ones available that are at the same time, up to date and available for all the occupations at the ISCO-08 level.

representing 1.7% of total employment in the country (vs 1.3% for the EU27). Ranking second regarding the employment sub-share of workers 'at risk of automation' are Professionals, with an employment sub-share of workers 'at risk' of 1.3% of total employment in Germany (vs 1.3% for the EU27). The third-ranked occupation is Associate professionals, with a share of workers 'at risk' of 1.2% in total employment in Germany (vs 1.3% for the EU27). **Among these three occupations, the first and the second ones are also the most affected** by the risk of automation **across the EU27**[148]**.**

The 2022 employment share for **ICT professionals (ISCO 25)**[149] is 2.4% in Germany (vs 2.3% in the EU27). Of that, an employment sub-share of 0.1% (vs 0.1% in the EU27) is 'at risk of automation', whereas the remaining employment sub-share of 2.3% (vs 2.2% at EU27 level) is 'not at risk of automation'. The projected annual growth rate 2022-2035 of the employment share of ICT professionals is 1.1% in Germany (vs 1.9% in EU27).

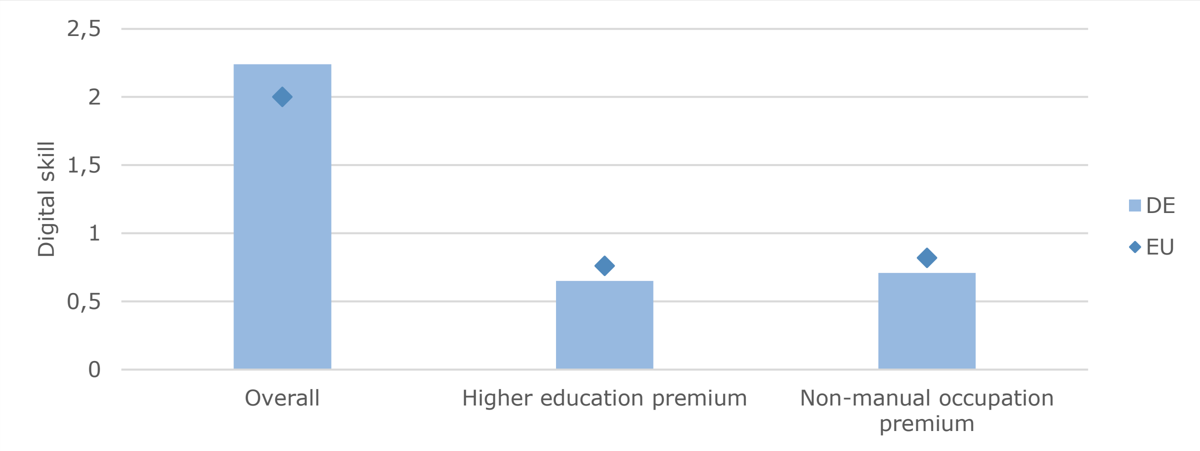
DE 2. Key policy dimensions for a socially fair digital transformation

DE 2.1 Digital skills

A high level of digital skills in the population is an important precondition for managing the labour market impact of the digital transformation. The overall level of digital skills in Germany is relatively high, placing the country fifth in the EU according to the study's estimated index of digital skill[150] (Figure 3, bar "Overall"). Moreover, differences in digital skills between different socio-economic groups – individuals with different levels of education ("Higher education premium" in Figure 3) and in manual versus non-manual occupations ("Non-manual occupation premium" in Figure 3) – are relatively smaller than at EU level. The higher education premium on digital skills is the eighth lowest in the EU, while in terms of the non-manual occupation premium, Germany ranks ninth. In the DESI index[151] for human capital (Figure 5, Section "Other dimensions"), however, which takes into account a broader range of indicators relating to digital skills, Germany positions itself slightly below the EU average, ranking 16th.

[148] The most affected in the EU27 are Trades workers, Professionals, and Service and sales workers.
[149] Eurostat code: lfsa_egai2d
[150] The construction of the digital skill index is described in detail in the introductory section.
[151] European Commission (2022). Digital Economy and Society Index. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi

Figure 3 – Estimated Digital Skills in DE and the EU (2019)



Source: Authors' own estimation based on Eurostat ICT survey
Note: Higher education premium refers to the difference in digital skills between individuals with tertiary and lower than tertiary education. Non-manual occupation premium refers to the difference in digital skills between individuals in manual and non-manual occupations.

Looking at policy action in the field of digital skills, the German Digital Strategy 2025[152] sets out ten policy pillars for digitalisation, including a pillar focused on digital education. This pillar includes a variety of policy actions to implement digital skills training at all stages of education and throughout the life course. Moreover, the national skills strategy sets out ten action fields for fostering vocational education and lifelong learning[153]. Within the German NRRP, a significant amount of planned expenditure is allocated to the digital pillar (54.9%). Of this expenditure, 18% is devoted to human capital investment. The plan includes seven measures linked to digital skills, such as the establishment of a national education platform for online trainings and courses and the establishment of training networks to support companies in training development[154].

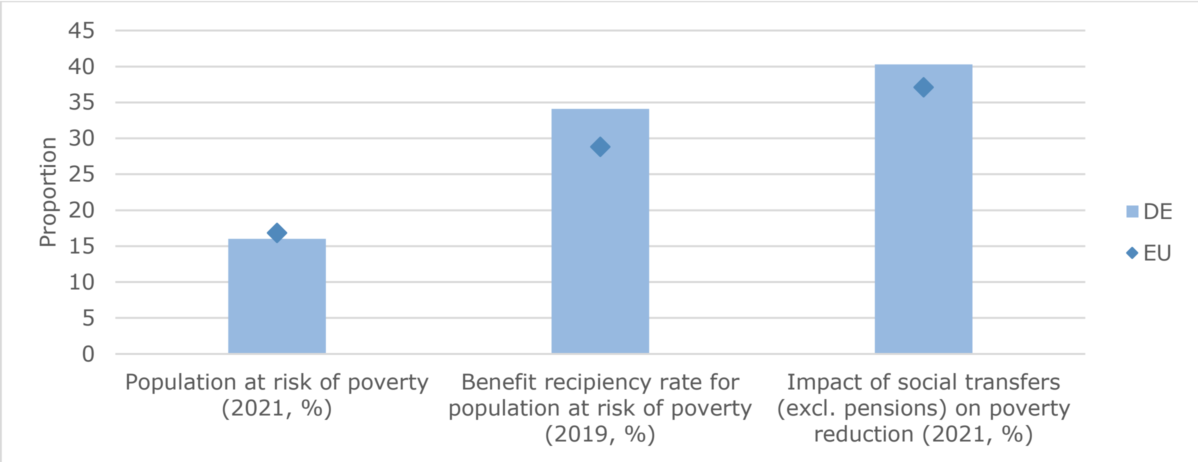
DE 2.2 Social protection and social policy

Alongside the fostering of digital skills, a robust social protection system can play a key role in mitigating the potentially adverse labour market impact of the digital transformation. **In this regard, Germany performs positively compared to other EU countries (Figure 4).** The rate of the population at risk of poverty after social transfers (16.0%)[155] is slightly lower than the EU rate. The benefit recipiency rate for the population at risk of poverty before social transfers

[152] For more information, see https://www.de.digital/DIGITAL/Redaktion/EN/Publikation/digital-strategy-2025.pdf?__blob=publicationFile&v=9
[153] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[154] European Commission (2022); Recovery and Resilience Scoreboard Thematic Analyses. Digital Skills. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_digital_skills.pdf
[155] Eurostat (2023). TPS00184: At-risk-of-poverty rate after social transfers by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/tps00184/default/table?lang=en

(34.1%)[156] and the impact of social transfers on poverty reduction (40.3%)[157] are both higher than at EU level. Moreover, Germany is one of the EU Member States most active in regulating platform work, one of the forms of work driven by the digital transformation[158].

Figure 4 – Social Protection in DE and the EU



Source: Eurostat (2023) and JRC (2022)

The German implementation plan for the Recommendation on access to social protection[159] does not include measures to improve formal or effective coverage of social protection, though there are some planned measures to address transparency and adequacy. As such, existing gaps in access to social protection are unlikely to be fully addressed by the measures proposed[160]. Within the German NRRP, the vast majority of social expenditure (64.5%) is devoted to health and long-term care, with most of the rest allocated towards education and childcare (33.2%) and only small shares for employment and skills and social policies. Measures specifically targeted at social protection are limited within the plan, but several measures to reduce social vulnerabilities more broadly are included[161].

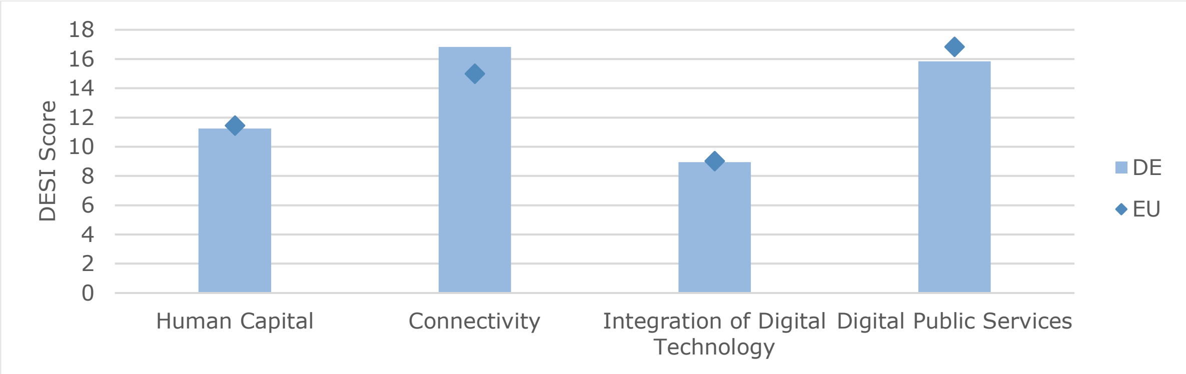
DE 3. Other dimensions relevant to the digital transformation

Beyond the key dimensions of digital skills and social protection, broader support factors matter for a successful and socially fair digital transformation. In the first place, digitalisation in firms should be considered. In Germany, according to the DESI Index (Figure 5), levels of integration of technology in firms are around the

156 Eurostat indicator as re-elaborated by JRC (2022) "Monitoring the effective coverage and adequacy of social protection in the EU".
157 Eurostat (2023). TESPM050:Impact of social transfers (excluding pensions) on poverty reduction by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/TESPM050/bookmark/table?lang=en&bookmarkId=b001ae62-ce34-4b49-9741-28a3ef99477f
158 https://ec.europa.eu/social/main.jsp?catId=738&furtherPubs=yes&langIdIn =en&pubId=8428
159 European Commission (2023). Access to social protection. Available at: https://ec.europa.eu/social/main.jsp?catId=1312&langId=en=en
160 PPMI (2021). Study to support the impact assessment on improving working conditions in platform work. Available at: https://ec.europa.eu/social/main.jsp?catId=738&furtherPubs=yes&langId=en&pubId=8428
161 https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_social_protection.pdf

EU average, ranking 16th in the EU27. Rates of digital capital intensity[162] in Germany are lower than the EU average[163] , though growth in the past decade has been relatively high. When looking at robot density[164] – both across the whole economy and in the manufacturing sector –, Germany exhibits a significantly higher ratio of robots to employees than the EU average[165]. However, growth rates between 2010 and 2019 are much lower than the EU average, though this likely partially reflects the existing high stock of robots in the economy. Overall, continuous investment in digital technology in firms, therefore, seems to be essential. Several initiatives have been introduced by the German government in this regard, including measures targeted at the digitalisation of SMEs and measures focusing on advanced technologies[166]. Within the German NRRP, digitalisation of businesses constitutes 9.3% of overall digital expenditure.

Figure 5 – DESI Index for DE and the EU



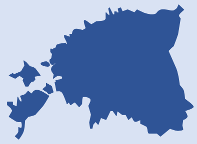
Source: European Commission (2022)

Finally, digital infrastructure and public services is an important aspect to be considered. The DESI Index shows that in terms of digitalisation of public services, Germany lags behind the majority of EU countries, ranking 18th overall. However, connectivity levels are advanced (fourth in the EU27). Connectivity has improved significantly in Germany in recent years, though divides between rural and urban areas remain[167]. In the planned digital expenditure within the German NRRP, connectivity does not figure (as it is financed through national funds only)[168], while expenditure on digital public services constitutes 50.8% of overall digital expenditure. Measures included in this area include implementation of the Online Access Act to digitalise the German administrative landscape, a digital pension overview system and measures to modernise public administration[169].

[162] As described in the Annex, based on data from EU-KLEMS (2008-2018). Data is not available for Cyprus, Croatia, Ireland and Romania.
[163] For the EU MS where data is available
[164] As described in the Annex, based on data from the International Federation of Robotics (2010-2019). Data is not available for Cyprus, Greece, Luxembourg and Slovenia.
[165] For the EU MS where data is available
[166] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[167] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[168] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[169] European Commission (2021); Recovery and Resilience Scoreboard Thematic Analyses. Digital public services. Available at :https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/2_Digital.pdf

6. ESTONIA: elements of a socially fair digital transformation

Key Points



Labour market: Currently, the sector with the largest employment share in the Estonian economy – the Manufacturing sector – is the sector with the seventh highest degree of digital transformation (based on the current percentage of enterprises that employ ICT specialists in a sector). The Manufacturing sector's employment share in the economy is not projected to grow further in the decade to come (in line with EU trends). ICT services, Water and waste treatment and Energy supply services are the three sectors with the highest degree of digital transformation currently, and their employment shares, except for Energy supply services, are projected to grow in the decade to come, much more than in the EU27. Trades workers are most vulnerable to the risk of automation of occupations in Estonia.

Digital skills: Estonia exhibits a high overall level of digital skills in the population, as well as the highest percentage of ICT graduates in the EU. In addition, the gap in digital skills between individuals with different levels of education is the smallest in the EU, though digital divides between individuals in manual and non-manual occupations are more pronounced.

Social protection: Estonia faces challenges in its social protection system and has one of the highest rates of the population at risk of poverty in the EU. There has also been little regulatory action on the employment status of platform workers.

EE 1. The labour market and the digital transformation

EE 1.1 Sectoral composition (current and forward-looking perspectives)

In Estonia ("EE"), in 2022, the sectors with the largest employment shares in the economy were: Manufacturing (18.5% vs 16.0% at the EU27 level), Wholesale and retail trade (13.4% vs 13.6% at the EU27 level), and Education (9.3% vs 7.4% at the EU27 level). For the period 2022-2035, Cedefop data projects[170] the annual growth rate of a sector's employment share. For Estonia's Manufacturing sector, the annual growth rate is -0.2% (-0.2% for the EU27), for the Wholesale and retail trade sector it is -0.6% (0.0% for the EU27), and for the Education sector, it is -0.6% (0.3% for the EU27).

[170] Own elaboration on Cedefop 'Skill forecast 2023' data.

Table 1 presents each sector's employment share in 2022, the projected annual growth rates (2022-2035) of its employment share, and its resulting employment share in the economy by 2035. Along with these elements relating to employment, Table 1 also presents the degree of "digital transformation" of each sector. Table 1 thus enables a comparison between the degree of digital transformation of a sector and its employment share or its employment shares' prospects. The degree of digital transformation is proxied in Table 1, for each sector, by two indicators: i) the percentage of enterprises that employ ICT specialists in the considered sector and ii) the digital capital intensity[171] of the considered sector. Table 1 presents the ranking of each sector according to these two proxy indicators (with rank n°1 corresponding to the most digitised sector). According to the first indicator, the three sectors with the highest degree of digital transformation in Estonia are ICT services (sector's employment share: 5.7% in EE vs 3.7% in the EU27), Water and waste treatment (0.6% vs 0.8%), and Energy supply services (0.8% vs 0.7%). According to the second indicator (digital capital intensity), the three sectors with the highest degree of digital transformation are Finance and insurance (sector's employment share: 2.6% in EE vs 2.8% in the EU27), Public sector and defence (6.3% vs 7.1%), and Professional services (4.2% vs 5.7%). These sectors' employment shares have a projected annual growth rate for 2022-2035 in Estonia of 3.6% for ICT services (vs 0.8% for the EU27), 0.6% for Water and waste treatment (vs -0.1% for the EU27), 0.0% for Energy supply services (vs 0.1% for the EU27), 0.4% for Finance and insurance (vs 0.2% for the EU27) and -1.0% for Public sector and defence (vs -0.1% for the EU27).

As can be seen from Table 1, it is worth noting that two of the four sectors with the highest degree of digital transformation – ICT services and Professional services – are also among the top four sectors in terms of the annual growth rate of employment share in the decade to come in Estonia. Furthermore, in terms of employment share (in 2022), the first and the second sectors - Manufacturing and Wholesale and retail trade - rank seventh and sixth, on one of the two proxy indicators of digital transformation (% of enterprises that employ ICT specialists). Similarly, Wholesale and retail trade sector ranks fifth, on the second proxy indicator for digital transformation (digital capital intensity).

Table 1 – EE. Sector's share of employment, annual growth rate, and ranking of "digital transformation" (the sectors are ranked according to the ranking in the last column of the table).

Sectors	Sector's employment share in 2022 (%)		Projected annual growth rate of the sector's employment share (2022 - 2035, %)		Projected sector's employment share in 2035 (%)		Proxy 1 for digital transformation (ranking)	Proxy 2 for digital transformation (ranking)
	EE	**EU**	**EE**	**EU**	**EE**	**EU**	**% enterprises that employ ICT specialists**	**Digital capital intensity**
K - Finance & insurance	2.6	2.8	0.4	0.2	2.8	2.8	n.a.	1
O - Public sector & defence	6.3	7.1	-1.0	-0.1	5.5	7.0	n.a.	2

[171] 'Digital capital intensity' is an index – built in the context of this study – that looks at the ratio between the stock of capital the firms have in software and databases and the overall stock of capital excluding non-residential buildings. Its construction is based on the integrated EUKLEMS & INTANProd database, run by the Luiss Lab of European Economics at Luiss University in Rome, Italy. For more in-depth information on the source, and the availability of the indicator for Member States/sectors, please refer to the Annex.

M - Professional services	4.2	5.7	1.6	0.6	5.3	6.3	4	3
N - Administrative services	3.0	4.1	1.2	0.0	3.5	4.1	5	4
G - Wholesale & retail trade	13.4	13.6	-0.6	0.0	12.4	13.6	6	5
I - Accommodation & food	3.3	4.5	-0.2	0.6	3.1	4.9	9	6
P - Education	9.3	7.4	-0.6	0.3	8.6	7.7	n.a.	7
D - Energy supply services	0.8	0.7	0.0	0.1	0.8	0.8	3	8
B - Mining & quarrying	0.5	0.3	-1.6	-1.7	0.4	0.2	n.a.	9
E- Water and waste treatment	0.6	0.8	0.6	-0.1	0.7	0.8	2	10
R - Arts & recreation and other services	2.2	1.7	0.0	0.3	2.2	1.7	n.a.	11
F - Construction	8.9	6.8	-0.1	-0.3	8.8	6.5	10	12
A - Agriculture, forestry & fishing	2.6	3.5	-1.1	-3.1	2.3	2.3	n.a.	13
J - ICT services	5.7	3.7	3.6	0.8	9.3	4.2	1	n.a.
C - Manufacturing	18.5	16.0	-0.2	-0.2	17.9	15.6	7	n.a.
H - Transport & storage	7.3	5.3	-0.9	-0.1	6.5	5.3	8	n.a.
L - Real Estate	1.3	0.9	0.5	0.9	1.4	1.0	n.a.	n.a.
Q - Health & social care	6.6	11.0	1.1	0.6	7.7	11.9	n.a.	n.a.
S - Other service activities	3.0	2.6	-2.2	0.0	2.2	2.6	n.a.	n.a.
T - Activities of households as employers	n.a.	0.9	n.a.	-0.3	n.a.	0.9	n.a.	n.a.
U - Activities of extraterritorial org.	n.a.	0.1	n.a.	n.a.	n.a.	0.1	n.a.	n.a.

Source: For the employment-related indicators own elaboration on Eurostat data (share of employment, 2022 calculated based on lfsa_egan) and on Cedefop 'Skill forecast data 2023' (annual growth rate of sector's employment share, 2022-2035), for the digital transformation-related indicators: own elaboration on Eurostat data (share of enterprises that employ ICT specialists, Eurostat code: lfsa_egais) and on EUKLEMS & INTANProd data (digital capital intensity).
Note: In the first column of the table, the letter preceding the sectors is the code of the NACE Rev.2 classification. In the last two columns of the table, the two proxy indicators used for digital transformation are: i) the share of enterprises that employ ICT specialists (Eurostat code: lfsa_egais) and ii) the digital capital intensity (EUKLEMS & INTANProd data, average 2014-2017) with rank n°1 corresponding to the most digitally intense sector.

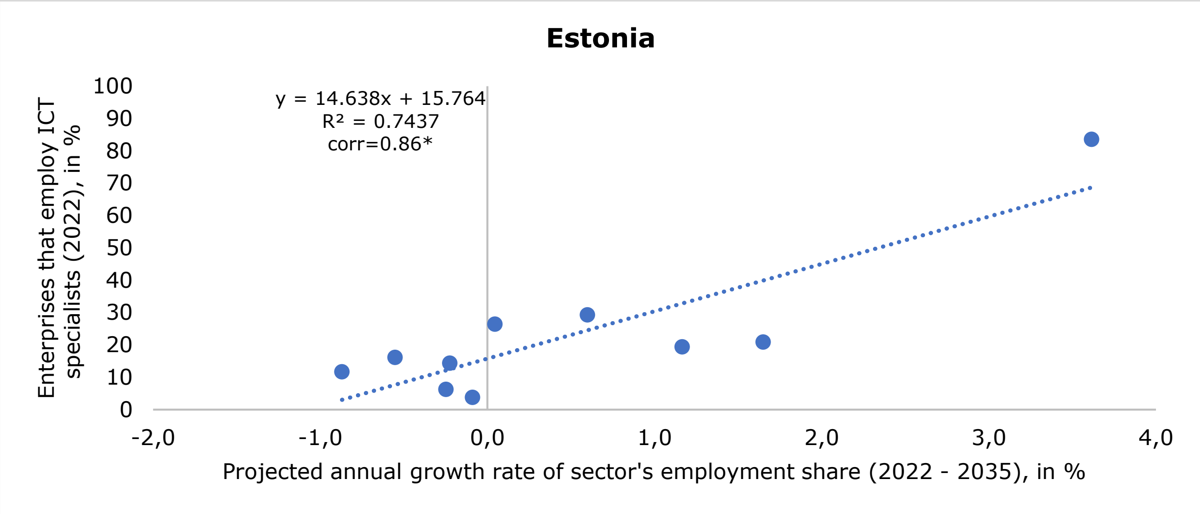
In complement to Table 1, figures 1a and 1b below show to what extent there may be a relationship between the projected annual growth rates of the sectors' employment shares in the economy and the ranking of the sectors in terms of digital transformation[172].

In **Figure 1a**, we present a scatterplot to shed light on the relationship between the first proxy of digital transformation used (percentage of enterprises that employ ICT specialists) and the projected annual growth rate of a sector's employment share between 2022-2035. The correlation is positive, and statistically significant in Estonia, with a value of 0.86 (it is 0.62 and statistically significant for the EU27). Among the ten Member States with a significant correlation, Estonia has the highest correlation. The positive – and statistically significant - correlation could suggest that the employment shares of **those**

[172] With the caveat that the correlation coefficients presented in Figure 1a and Figure 1b cannot be directly compared, as they pertain to a combination of sectors that varies across different Member States.

sectors with a higher 'percentage of enterprises that employ ICT specialists' are more likely to experience a higher growth (over 2022-2035) than in other sectors. The relationship is very strong and higher than the one at the EU27 level. Nevertheless, this correlation does not imply causal links.

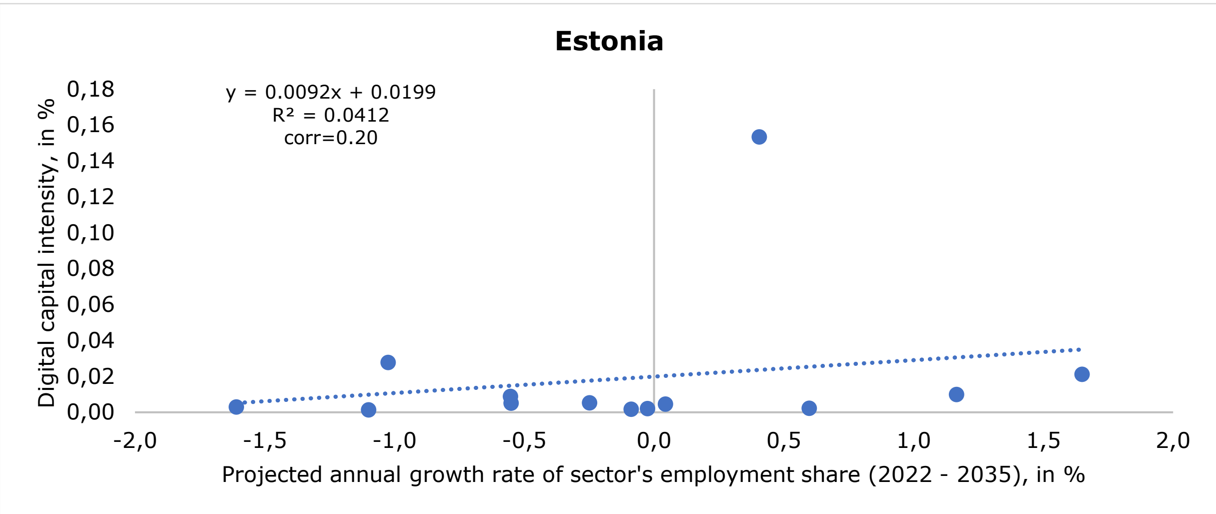
Figure 1a – EE. Relationship between the percentage of enterprises that employ ICT specialists (in 2022) and the projected annual growth rate of sector's employment share (2022-2035).



Source: Own elaboration on Eurostat and Cedefop 'Skill forecast 2023' data.

Figure 1b shows the correlation between the second digital transformation proxy ('digital capital intensity') and the projected annual growth rate of a sector's employment share between 2022-2035. The correlation coefficient exhibits a value of 0.20, and it is not statistically significant in Estonia. In this case, **the lack of correlation implies that in Estonia an association cannot be inferred, at the sectoral level, between the 'digital capital intensity' and the projected annual growth rate of a sector's employment share.**

Figure 1b – EE. Relationship between 'digital capital intensity' and the projected annual growth rate of sector's employment share (2022-2035).

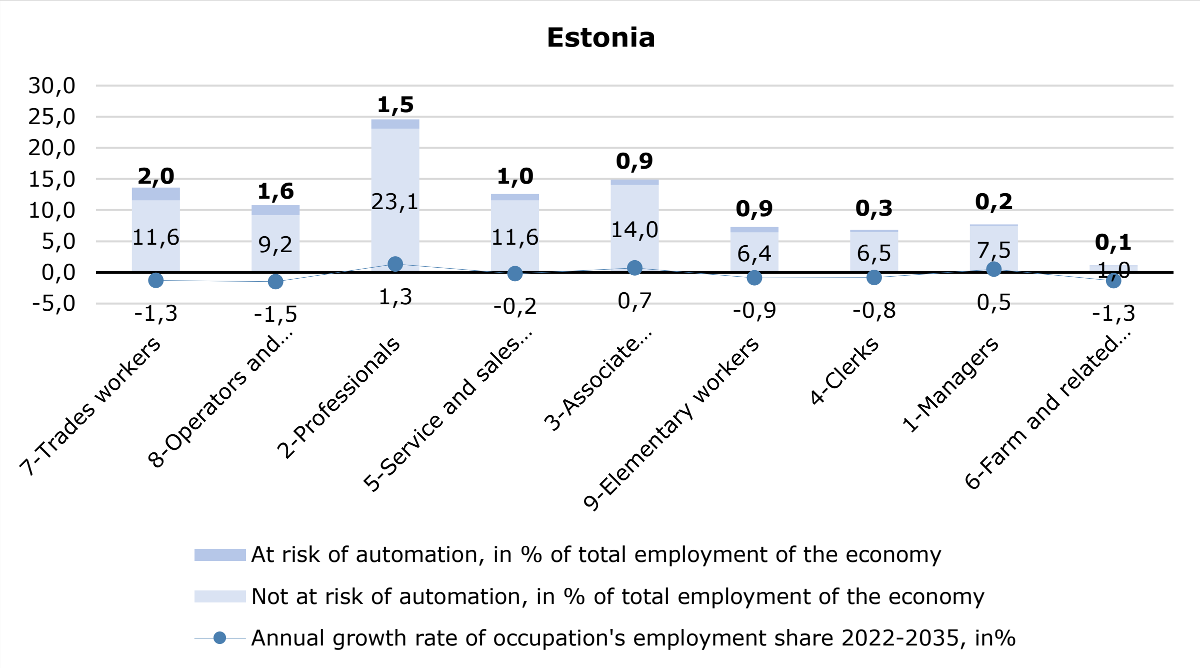


Source: Own elaboration on EUKLEMS & INTANProd, and Cedefop 'Skill forecast 2023' data.

EE 1.2 Occupational composition at ISCO-08 1 digit and risk of automation (current and forward-looking perspectives)

Different types of occupation are subject to differing levels of automation risk. Cedefop developed[173] a "risk of automation" index by occupation at the EU27 level, referred to 2022, in its latest version[174]. We apply this indicator at the Member State level, with the assumption that the risk of automation for a given occupation is constant across Member States[175]. As such, the variation, across Member States, in the overall susceptibility to automation of a Member State's workforce (overall risk across all occupations in that Member State) will be due to the employment composition effect, meaning that while the automation risk for a given occupation stays constant across Member States, the overall automation risk of a Member State will naturally be greater for those Member States having more employment in occupations that have a higher automation risk.

Figure 2 – EE. Employment shares of occupations (at ISCO-08 1 digit level) - split into sub shares 'not at risk' and 'at risk' of automation (2022) - and projected annual growth rate



Source: Own elaboration on Cedefop data (risk of automation calculated by Cedefop at EU27 level by ISCO-08 1 digit level for 2022) applied to Eurostat data (share of employment by occupation, lfsa_egais, 2022).

Note: The numbers preceding the occupations are the ISCO-08 codes. Occupations are ranked from the highest to the lowest share of workers that present a risk of automation. The vertical sum of the two components (darker blue and lighter blue) gives back the total employment share by occupation (in % of total employment in the Member State). The ISCO nomenclature used in the text and the figure is the Cedefop one. For examples of specific occupations see: https://esco.ec.europa.eu/en/classification/occupation_main.

[173] Based on the methodology in Pouliakas, K. (2018) "The risk of automation in EU labour markets: a skill-requirements approach", in Economy, Employment and Skills: European and global perspectives in an age of uncertainty, Fondazione Giacomo Brodolini Quaderni Series, also IZA DP 11829.
[174] As retrieved at https://www.Cedefop.europa.eu/en/tools/skills-intelligence/automation-risk-occupations#1
[175] While this assumption may be considered strong, Cedefop data are the only ones available that are at the same time, up to date and available for all the occupations at the ISCO-08 level.

As can be seen **in Figure 2**, in Estonia, the occupation with the largest employment sub-share (in % of total employment in the economy) 'at risk of automation' is Trades workers, with an employment sub-share of workers 'at risk of automation' representing 2% of total employment in the country (vs 1.3% for the EU27). Ranking second regarding the employment sub-share of workers 'at risk of automation' are Operators and assemblers, with an employment sub-share of workers 'at risk' of 1.6% of total employment in Estonia (vs 1.1% for the EU27). Ranking third are Professionals, with a share of workers 'at risk' of 1.5% in total employment in Estonia (vs 1.3% for the EU27). **Among these three occupations, only the first one is also the most affected across the EU27[176].**

For **ICT professionals (ISCO 25)**[177], the 2022 employment share is 4.4% in Estonia (vs 2.3% in the EU27) and an employment sub-share of 0.3% (vs 0.1% in the EU27) is 'at risk of automation'. The remaining employment sub-share of 4.2% (vs 2.2% at EU27 level) is 'not at risk of automation'. The projected annual growth rate 2022-2035 of the employment share of ICT professionals is 3.3% in Estonia (vs 1.9% in EU27).

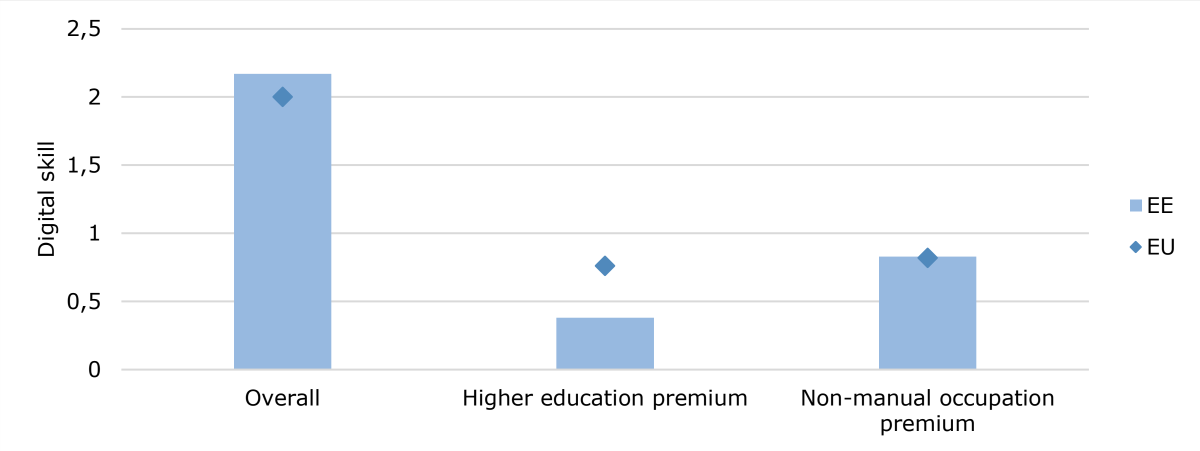
EE 2. Key policy dimensions for a socially fair digital transformation

EE 2.1 Digital skills

A high level of digital skills in the population is a key prerequisite for a successful and socially fair digital transformation. **Estonia has a high overall level of digital skills**, with the DESI index[178] (Figure 5, section "Other dimensions) for human capital and the authors' estimate of overall digital skills[179] (Figure 3, bar "Overall") ranking Estonia eighth and seventh in the EU27, respectively. Significantly, the digital skill premium of individuals with tertiary education ("Higher education premium" in Figure 3) is the lowest in the EU, meaning that inequalities in digital skills are not very pronounced. Differences in digital skills between individuals in manual and non-manual occupations ("Non-manual occupation premium" in Figure 3) are higher, with Estonia ranking 18th in the EU27, and align with the EU rate. It should also be noted that Estonia has the highest percentage of ICT graduates in the EU, as well as a high proportion of ICT specialists in employment, though Estonian companies nevertheless report shortages in skilled workers[180].

[176] The most affected in the EU27 are Trades workers, Professionals, and Service and sales workers.
[177] Eurostat code: lfsa_egai2d.
[178] European Commission (2022). Digital Economy and Society Index. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi
[179] The construction of the digital skill index is described in detail in the introductory section.
[180] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance

Figure 3 – Estimated Digital Skills in EE and the EU (2019)



Source: Authors' own estimation based on Eurostat ICT survey
Note: Higher education premium refers to the difference in digital skills between individuals with tertiary and lower than tertiary education. Non-manual occupation premium refers to the difference in digital skills between individuals in manual and non-manual occupations.

The Digital Agenda for Estonia 2030[181], while not featuring digital skills as one of the three main priorities, sets out further measures to develop digital literacy as well as ICT and advanced digital skills in Estonia, including increasing the number of ICT and cyber specialists. The Education Strategy 2035 also sets out further measures and objectives for digital skills to be reached for young people and the general population by 2035. Within the digital expenditure in the Estonian NRRP, which constitutes 22% of overall planned spending, a minor share (4.7%) is allocated to digital skills. This funding is devoted to a measure supporting digital skills development through pathways, including developing ICT skills for managers in companies, revising training for ICT experts, piloting a programme for the redesign of the ICT specialist qualification framework and upskilling and retraining of ICT specialists[182].

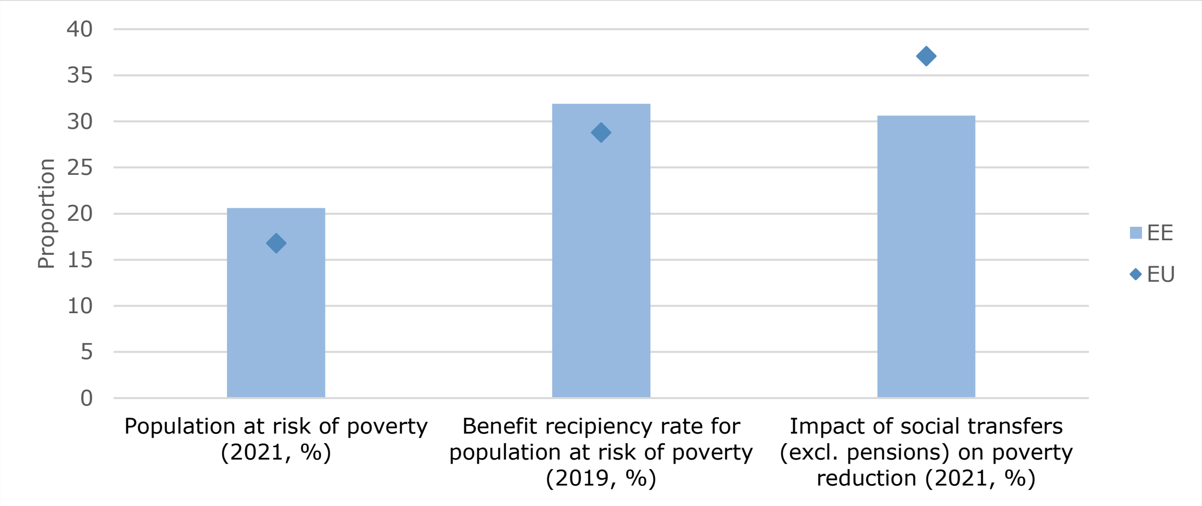
EE 2.2 Social protection and social policy

Alongside investment in digital skills, a well-functioning social protection system can play a key role in providing safeguards against the potential labour market impact of the digital transformation. Key indicators on social protection (Figure 4) indicate, however, that **Estonia is not particularly well positioned when it comes to social protection**. The rate of the population at risk of poverty after social transfers[183] (20.6%) is the fifth highest in the EU. While the benefit recipiency rate for the population at risk of poverty before social transfers[184]

[181] For more information, see https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwiG2Lu5iPr-AhX6gv0HHdDsCPgQFnoECA8QAQ&url=https%3A%2F%2Fwww.mkm.ee%2Fmedia%2F6970%2Fdownload&usg=AOvVaw3Yp9xrZNPO7_dwAT82gHZm
[182] European Commission (2022); Recovery and Resilience Scoreboard Thematic Analyses. Digital Skills. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_digital_skills.pdf
[183] Eurostat (2023). TPS00184: At-risk-of-poverty rate after social transfers by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/tps00184/default/table?lang=en
[184] Eurostat indicator as re-elaborated by JRC (2022) “Monitoring the effective coverage and adequacy of social protection in the EU”.

(31.9%) is higher than in the majority of EU countries, the impact of social transfers on poverty reduction (30.6%)[185], conversely, is lower than the EU level. Moreover, the employment status of platform workers, one of the key groups affected by digitalisation of the labour market, has been the subject of only little regulatory action so far[186].

Figure 4 – Social Protection in EE and the EU



Source: Eurostat (2023) and JRC (2022)

However, the Estonian national implementation plan for the Recommendation on access to social protection for nonstandard workers and the self-employed[187] contains several planned and actual measures to increase formal coverage and adequacy in access to social protection, which are expected to address some of the gaps in access to social protection, though specific measures for platform workers are not included[188]. The social expenditure contained within the Estonian RRP is almost exclusively dedicated to health and long-term care. However, on the reform side, the plan contains significant measures on social protection, including an extension of unemployment benefits[189].

[185] Eurostat (2023). TESPM050:Impact of social transfers (excluding pensions) on poverty reduction by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/TESPM050/bookmark/table?lang=en&bookmarkId=b001ae62-ce34-4b49-9741-28a3ef99477f

[186] PPMI (2021). Study to support the impact assessment on improving working conditions in platform work. Available at: https://ec.europa.eu/social/main.jsp?catId=738&furtherPubs=yes&langId=en&pubId=8428

[187] European Commission (2023). Access to social protection. Available at: https://ec.europa.eu/social/main.jsp?catId=1312&langId=en=en

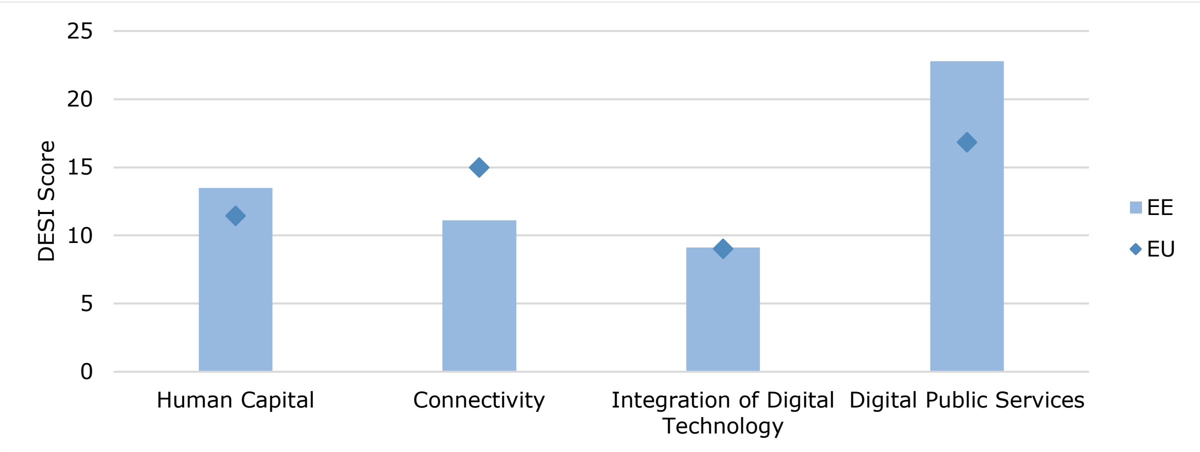
[188] European Commission (2023). Report from the Commission to the Council on the implementation of the Council Recommendation on access to social protection for workers and the self-employed. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023DC0043&qid=1676473347749

[189] European Commission (2022). Recovery and Resilience Scoreboard Thematic Analyses. Social Protection. Available at : https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_social_protection.pdf

EE 3. Other dimensions relevant to the digital transformation

The level of digitalisation in firms as well as digital infrastructure and public services are both significant contextual factors relevant for a successful and socially fair digital transformation. Turning first to the former, the DESI Index for integration of digital technology in firms (Figure 5) indicates that Estonia is ranked in the middle of EU countries (15th). Looking at specific technologies, levels of robot density[190] – across the economy and in manufacturing – are significantly below the EU average[191], as are levels of digital capital intensity[192]. However, more encouragingly, growth in both of these indicators over the last decade has been significantly higher in Estonia than the average growth rate across EU countries, pointing to a potentially accelerating trend for digitalisation in firms in Estonia. Generally, while there are some newly emerged, highly digitalized companies and start-ups in Estonia, other businesses, particularly SMEs, lag behind in digitalisation[193]. As part of the Estonian RRP, 38.1% of digital expenditure is allocated towards the digitalisation of firms, including investment to support the digital transformation of SMEs[194], but also measures targeting specific industries (construction, road freight) and competitiveness on export markets[195].

Figure 5 – DESI Index for EE and the EU



Source: European Commission (2022)

Turning to digital infrastructure and digital public services, diverging trends can be observed. While, according to the DESI Index, connectivity levels are the second lowest in the EU, digital public services are highly advanced, placing Estonia first in the EU27. Both the further development of digital public services and the improvement of connectivity across the country are key priorities within

[190] As described in the Annex, based on data from the International Federation of Robotics (2010-2019). Data is not available for Cyprus, Greece, Luxembourg and Slovenia.
[191] For Member States where data was available – not the whole EU27
[192] As described in the Annex, based on data from EU-KLEMS (2008-2018). Data is not available for Cyprus, Croatia, Ireland and Romania.
[193] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[194] European Commission (2022): Recovery and Resilience Scoreboard Thematic Analysis. SME Support. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/3_SME.pdf
[195] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance

the Digital Agenda 2030[196]. Further investment in digital public services is also foreseen as part of the Estonian NRRP (45.8% of total digital expenditure), with several measures to further digitalise Estonian public administration[197]. Despite the low overall connectivity levels, connectivity has a more minor share of digital expenditure in the NRRP (11.4% of digital expenditure), though the plan does include a measure to improve connectivity in the most remote Estonian areas[198].

[196] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[197] European Commission (2021); Recovery and Resilience Scoreboard Thematic Analyses. Digital public services. Available at :https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/2_Digital.pdf
[198] European Commission (2023); Recovery and Resilience Scoreboard Thematic Analyses. Connectivity. https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_connectivity.pdf

7. IRELAND: elements of a socially fair digital transformation

Key Points

Labour market: Currently, the sector with the second largest employment share in the Irish economy - the Wholesale and retail trade sector – has the seventh highest degree of digital transformation (based on the current digital capital intensity in a sector)[199]. The Wholesale and retail trade sector's employment share in the economy is projected to marginally grow further in the decade to come (whereas it will stay constant at the EU27 level). ICT services, Energy supply services, and Water and waste treatment are the three sectors with the highest degree of digital transformation currently, and their employment shares, except for Water and waste treatment, are projected to grow in the decade to come, slightly less than in the EU27. Professionals are most at risk of their occupation being automated.

Digital skills: Ireland has a fairly developed level of digital skills overall. Significant policy action for skills development has been advanced in recent years. While gaps in digital skill levels between different occupational groups are small, those between educational groups are more pronounced.

Social protection: Ireland has relatively generous social transfers and a low rate of people at-risk-of-poverty in comparison to the EU, although some important social challenges remain.[200] . Ireland has also been active in regulating the employment status of platform workers.

IE 1. The labour market and the digital transformation

IE 1.1 Sectoral composition (current and forward-looking perspectives)

In Ireland ("IE"), in 2022, the sectors with the largest employment shares in the economy were Health and social care (13.2% vs 11.0% at the EU27 level), Wholesale and retail trade (12.4% vs 13.6% at the EU27 level), and Manufacturing (11.4% vs 16.0% at the EU27 level). For the period 2022-2035, Cedefop data

[199] The ranking based on digital capital intensity is used in the key points only when the sector with the largest employment share is not rankable according to the percentage of enterprises that employ ICT specialists. In this case, the ranking for the first largest employment share in the economy was not available.
[200] In this respect, it should be mentioned that the low access to social services for vulnerable groups and their high at-risk of poverty and social exclusion remain important social challenges in Ireland.

projects[201] the annual growth rate of a sector's employment share. For Ireland's Health and social care sector, the annual growth rate is -1.7% (0.6% for the EU27), for the Wholesale and retail trade sector it is 0.2% (0.0% for the EU27), and for the Manufacturing sector it is 0.0% (-0.2% for the EU27).

Table 1 presents each sector's employment share in 2022, the projected annual growth rates (2022-2035) of its employment share, and its resulting employment share in the economy by 2035. Along with these elements relating to employment, Table 1 also presents the degree of "digital transformation" of each sector. Table 1 thus enables a comparison between the digital transformation of a sector and its employment or employment prospects. The degree of digital transformation is proxied for each sector in Table 1 using the percentage of enterprises in the sector that employ ICT specialists. Table 1 presents the ranking of each sector according to this indicator (with rank n°1 corresponding to the most digitised sector). According to this indicator, the three sectors with the highest degree of digital transformation in Ireland, in order, are ICT services (sector's employment share: 6.6% in IE vs 3.7% in the EU27), Energy supply services (0.6% vs 0.7%), and Water and waste treatment (0.6% vs 0.8%). These sectors' employment shares have a projected annual growth rate for 2022-2035 in Ireland of 0.1% for ICT services (vs 0.8% for the EU27), 0.4% for Energy supply services (vs 0.1% for the EU27), and -0.2% for Water and waste treatment (vs -0.1% for the EU27).

As can be seen in Table 1, only one of the four sectors with the highest degree of digital transformation – Professional services – is also among the top four sectors in terms of the projected annual growth rate of employment share in the next decade in Ireland. Furthermore, the second and the third largest sectors in terms of employment share (2022)[202] – Wholesale and retail trade and Manufacturing - rank seventh and fifth on the first proxy indicator of digital transformation (% of enterprises that employ ICT specialists).

Table 1 – IE. Sector's share of employment, annual growth rate, and ranking of "digital transformation" (the sectors are ranked according to the ranking in the "proxy 1" column of the table).

Sectors	Sector's employment share in 2022 (%)		Projected annual growth rate of the sector's employment share (2022 - 2035, %)		Projected sector's employment share in 2035 (%)		Proxy 1 for digital transformation (ranking)	Proxy 2 for digital transformation (ranking)
	IE	**EU**	**IE**	**EU**	**IE**	**EU**	**% enterprises that employ ICT specialists**	**Digital capital intensity**
J - ICT services	6.6	3.7	0.1	0.8	6.7	4.2	1	n.a.
D - Energy supply services	0.6	0.7	0.4	0.1	0.6	0.8	2	n.a.
E- Water and waste treatment	0.6	0.8	-0.2	-0.1	0.6	0.8	3	n.a.
M - Professional services	6.4	5.7	1.3	0.6	7.7	6.3	4	n.a.
C - Manufacturing	11.4	16.0	0.0	-0.2	11.4	15.6	5	n.a.
N - Administrative services	4.2	4.1	0.3	0.0	4.4	4.1	6	n.a.
G - Wholesale & retail trade	12.4	13.6	0.2	0.0	12.7	13.6	7	n.a.

[201] Own elaboration on Cedefop 'Skill forecast 2023' data.
[202] The first sector in terms of employment share (in 2022) - Health and social care - was not rankable with either of the proxy indicators for digital transformation.

H - Transport & storage	4.3	5.3	0.5	-0.1	4.6	5.3	8	n.a.
F - Construction	6.6	6.8	0.5	-0.3	7.0	6.5	9	n.a.
I - Accommodation & food	6.7	4.5	2.2	0.6	9.1	4.9	10	n.a.
A - Agriculture, forestry & fishing	3.2	3.5	-1.1	-3.1	2.7	2.3	n.a.	n.a.
B - Mining & quarrying	0.2	0.3	-2.3	-1.7	0.2	0.2	n.a.	n.a.
K - Finance & insurance	4.8	2.8	0.8	0.2	5.4	2.8	n.a.	n.a.
L - Real Estate	0.4	0.9	4.6	0.9	0.8	1.0	n.a.	n.a.
O - Public sector & defence	5.3	7.1	-0.9	-0.1	4.6	7.0	n.a.	n.a.
P - Education	8.3	7.4	-0.9	0.3	7.3	7.7	n.a.	n.a.
Q - Health & social care	13.2	11.0	-1.7	0.6	10.3	11.9	n.a.	n.a.
R - Arts & recreation and other services	2.0	1.7	-0.4	0.3	1.9	1.7	n.a.	n.a.
S - Other service activities	2.2	2.6	-0.4	0.0	2.1	2.6	n.a.	n.a.
T - Activities of households as employers	n.a.	0.9	-0.9	-0.3	n.a.	0.9	n.a.	n.a.
U - Activities of extraterritorial org.	n.a.	0.1	n.a.	n.a.	n.a.	0.1	n.a.	n.a.

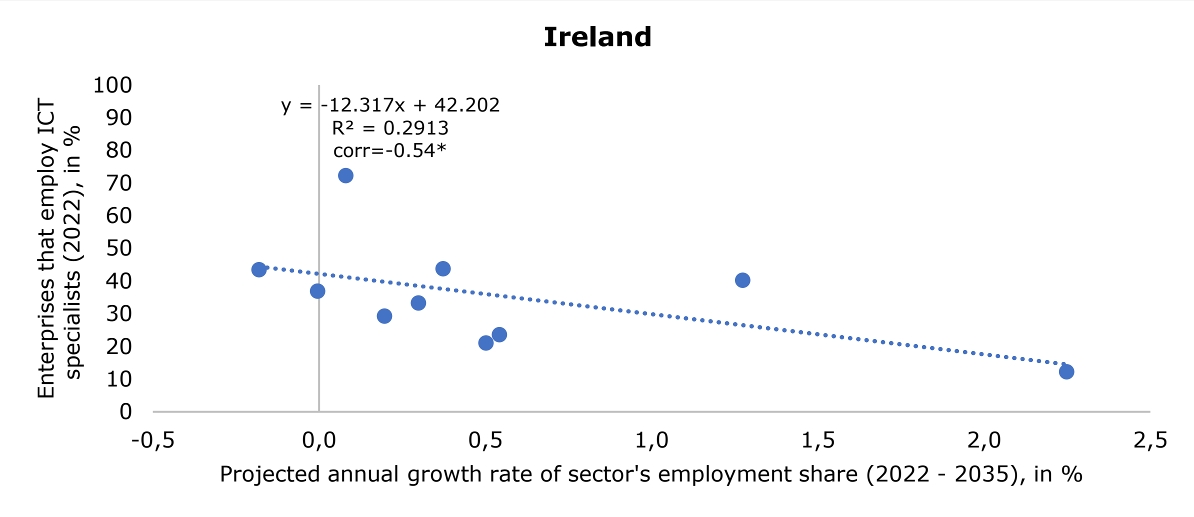
Source: For the employment-related indicators own elaboration on Eurostat data (share of employment, 2022 calculated based on lfsa_egan) and on Cedefop 'Skill forecast data 2023' (annual growth rate of sector's employment share, 2022-2035), for the digital transformation-related indicators: own elaboration on Eurostat data (share of enterprises that employ ICT specialists, Eurostat code: lfsa_egais) and on EUKLEMS & INTANProd data (digital capital intensity).
Note: In the first column of the table, the letter preceding the sectors is the code of the NACE Rev.2 classification. In the last two columns of the table, the two proxy indicators used for digital transformation are: i) the share of enterprises that employ ICT specialists (Eurostat code: lfsa_egais) and ii) the digital capital intensity (EUKLEMS & INTANProd data, average 2014-2017) with rank n°1 corresponding to the most digitally intense sector.

To complement Table 1, Figure 1 below examines the relationship between the projected annual growth rates of the sectors' employment shares in the economy and their degree of digital transformation[203].

In **Figure 1**, we present a scatterplot of the proxy of the digital transformation (percentage of enterprises that employ ICT specialists) and the projected annual growth rate of a sector's employment share between 2022 and 2035. The correlation is negative - -0.54 - and statistically significant (it is 0.62 and statistically significant for the EU27). Among the ten Member States that present a significant correlation, Ireland is the only one with a negative correlation. **The negative correlation could suggest that the employment shares of those sectors with a higher 'percentage of enterprises that employ ICT specialists' are more likely to experience a *lower* rate of growth over 2022-2035 than those of other sectors.** However, this correlation does not imply causal links.

[203] With the caveat that the correlation coefficients presented in Figure 1a and Figure 1b cannot be directly compared, as they pertain to a combination of sectors that varies across different Member States.

Figure 1 – IE. Relationship between the percentage of enterprises that employ ICT specialists (in 2022) and the projected annual growth rate of sector's employment share (2022-2035).



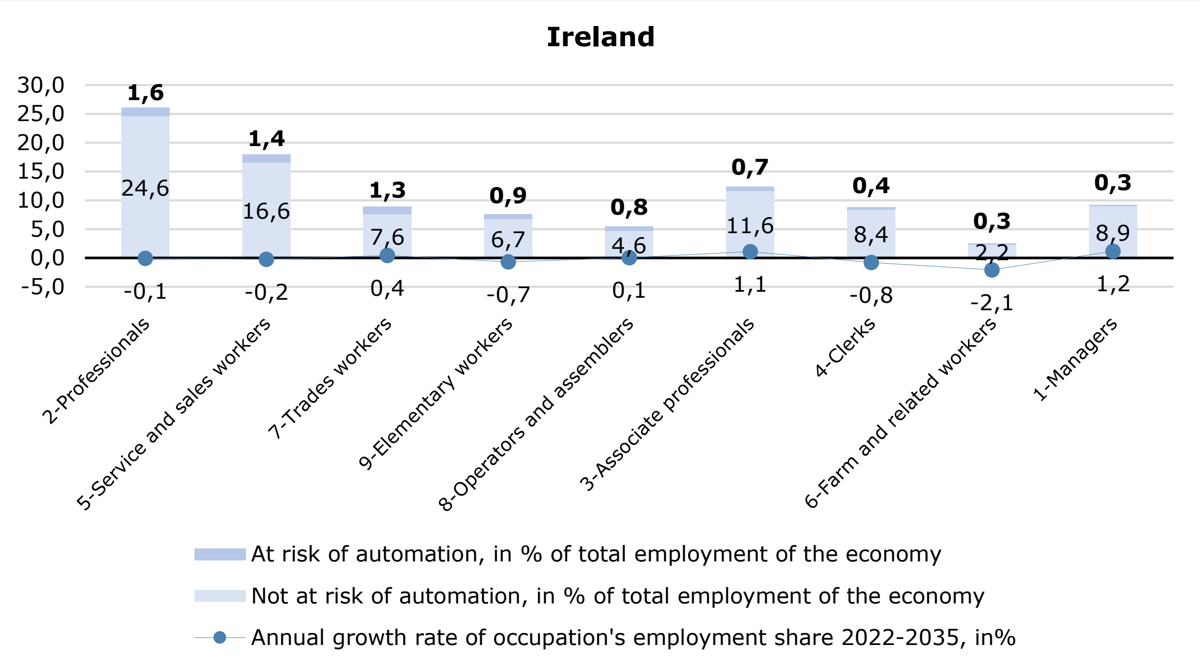
Source: Own elaboration on Eurostat and Cedefop 'Skill forecast 2023' data.

IE 1.2 Occupational composition at ISCO-08 1 digit and risk of automation (current and forward-looking perspectives)

Different types of occupations are subject to differing levels of automation risk. CEDEFOP developed[204] a "risk of automation" index by occupation at the EU27 level, most recently updated for 2022[205]. We apply this indicator at the Member State level, with the assumption that the risk of automation for a given occupation is relatively constant across Member States[206]. As such, any variation in the vulnerability to automation of a Member State's workforce across all occupations can be attributed to the employment composition effect. Thus, while the automation risk for a given occupation stays constant across Member States, the overall automation risk of a Member State can be considered greater for those Member States with larger employment shares in occupations with higher automation risks.

[204] Based on the methodology in Pouliakas, K. (2018) "The risk of automation in EU labour markets: a skill-requirements approach", in Economy, Employment and Skills: European and global perspectives in an age of uncertainty, Fondazione Giacomo Brodolini Quaderni Series, also IZA DP 11829.
[205]As retrieved at https://www.cedefop.europa.eu/en/tools/skills-intelligence/automation-risk-occupations#1
[206] While this assumption may be considered strong, Cedefop data are the only ones available that are at the same time, up to date and available for all the occupations at the ISCO-08 level.

Figure 2 – IE. Employment shares of occupations (at ISCO-08 1 digit level) - split into sub shares 'not at risk' and 'at risk' of automation (2022) - and projected annual growth rate



Source: Own elaboration on Cedefop data (risk of automation calculated by Cedefop at EU27 level by ISCO-08 1 digit level for 2022) applied to Eurostat data (share of employment by occupation, lfsa_egais, 2022).
Note: The numbers preceding the occupations are the ISCO-08 codes. Occupations are ranked from the highest to the lowest share of workers that present a risk of automation. The vertical sum of the two components (darker blue and lighter blue) gives back the total employment share by occupation (in % of total employment in the Member State). The ISCO nomenclature used in the text and the figure is the Cedefop one. For examples of specific occupations see: https://esco.ec.europa.eu/en/classification/occupation_main.

As can be seen in **Figure 2**, in Ireland, the occupation with the largest employment sub-share (in % of total employment in the economy) 'at risk of automation' is "Professionals" (which is a specific occupation type in the ISCO-08 classification of occupations), with an employment sub-share of workers 'at risk of automation' representing 1.6% of total employment in the country (vs 1.3% for the EU27). The second largest employment sub-share of workers 'at risk of automation' are Service and sales workers, with the 'at risk' sub-share at 1.4% of total employment in Ireland (vs 1.3% for the EU27). Ranking third are Trades workers, with a share of workers 'at risk' of 1.3% in total employment in Ireland (vs 1.3% for the EU27). **These three occupations are however not the most affected by the risk of automation across the EU27[207].**

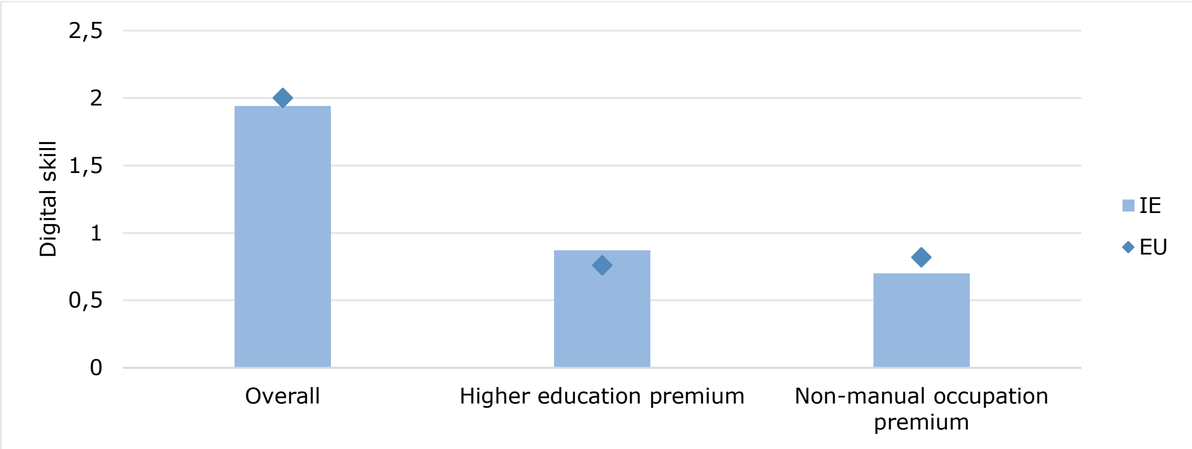
For **ICT professionals (ISCO 25)**[208], the 2022 employment share is 3.5% in Ireland (vs 2.3% for the EU27), consisting of an employment sub-share of 0.2% (vs 0.1% for the EU27) 'at risk of automation', and a remaining employment sub-share of 3.3% (vs 2.2% for the EU27 'not at risk of automation'. The projected annual growth rate 2022-2035 of the employment share of ICT professionals is 0.7% in Ireland (vs 1.9% for the EU27).

[207] The most affected in the EU27 are Trades workers, Professionals, and Service and sales workers.
[208] Eurostat code: lfsa_egai2d.

IE 2. Key policy dimensions for a socially fair digital transformation

IE 2.1 Digital skills

Figure 3 – Estimated Digital Skills in IE and the EU (2019)



Source: Authors' own estimation based on Eurostat ICT survey
Note: Higher education premium refers to the difference in digital skills between individuals with tertiary and lower than tertiary education. Non-manual occupation premium refers to the difference in digital skills between individuals in manual and non-manual occupations.

One of the key prerequisites to ensuring a successful and socially fair digital transformation is a high level of digital skills within the population. According to the study's estimated index of digital skills[209] (Figure 3, bar "Overall"), the overall level of digital skills in Ireland ranks in the lower mid field of EU countries (17th). However, in the DESI Index for Human Capital[210] (Figure 5, section "Other dimensions"), which combines a broader range of human capital-related indicators, Ireland scores rather highly, placing third. Results with respect to digital divides are mixed. Differences in the level of digital skills between individuals with different levels of education are higher than at the EU level ("Non-manual occupation premium" in Figure 3; Ireland ranks 19th in the EU27), whereas with respect to differences in levels of digital skills between individuals in different occupations, the skill divide is rather low compared to other countries ("Non-manual occupation premium" in Figure 3; Ireland ranks seventh in the EU27).

Ireland has taken significant policy action in digital skills development in recent years. In 2022, the Irish government released the new digital strategy "Harnessing Digital – the Digital Ireland Framework", with four priority areas covering skills, businesses, public services and infrastructure[211]. More specifically, the National Employment Strategy "Pathways to Work 2021-2025" sets several targets for training, including for instance, a new training support grant for jobseekers[212]. The 2022 ICT Skills Action Plan released by the Irish government

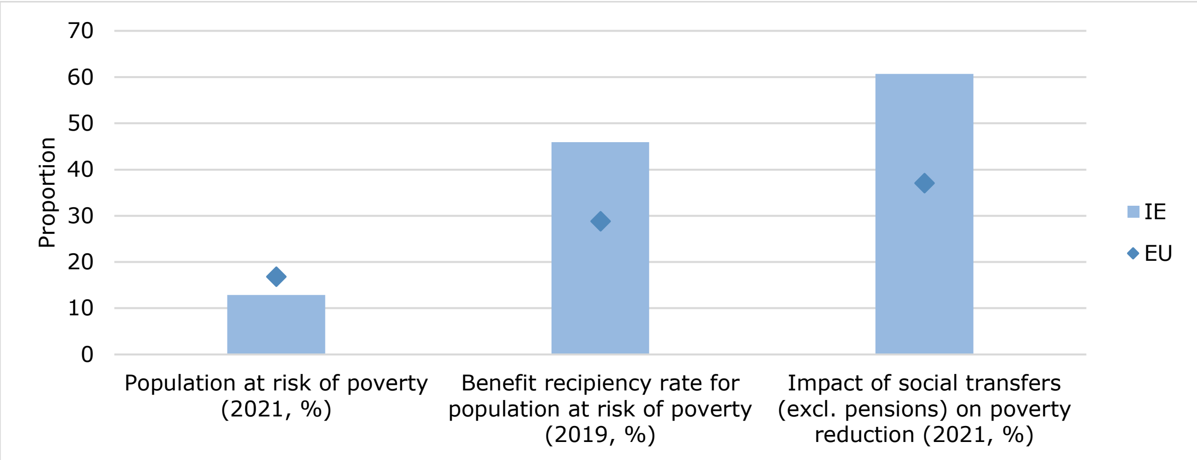
[209] The construction of the digital skill index is described in detail in the introductory section.
[210] European Commission (2022). Digital Economy and Society Index. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi
[211] For more information, see https://www.gov.ie/en/press-release/3a922-online-launch-of-harnessing-digital-the-digital-ireland-framework/
[212] For more information, see https://www.gov.ie/en/publication/1feaf-pathways-to-work-2021/

sets out actions to increase the number of graduates with high-level ICT skills, including commitments to providing new or additional training for individuals through several pathways[213]. Digital skills are also further promoted within the STEM Education Policy[214]. Digital expenditure also constitutes a significant share of the Irish NRRP (31.6%), of which 20.3% is dedicated to human capital. The RRP includes investments for the digitalisation of education and a reform to enhance digital skills and address the digital divide[215].

IE 2.2 Social protection and social policy

An additional significant factor to consider with regard to a socially fair digital transformation is the degree of social protection to which individuals have access. In this regard, Ireland is well positioned relative to the rest of the EU (Figure 4). The rate of the population at risk of poverty after social transfers[216] (12.9%) is one of the lowest within the EU27. Conversely, both the benefit recipiency rate for the population at risk of poverty before social transfers (45.9%)[217] and the impact of social transfers on poverty (60.7%)[218] are high, the latter being the highest in the EU. Furthermore, Ireland has also been active in taking action to regulate the employment status of platform workers[219].

Figure 4 – Social Protection in IE and the EU



Source: Eurostat (2023) and JRC (2022)

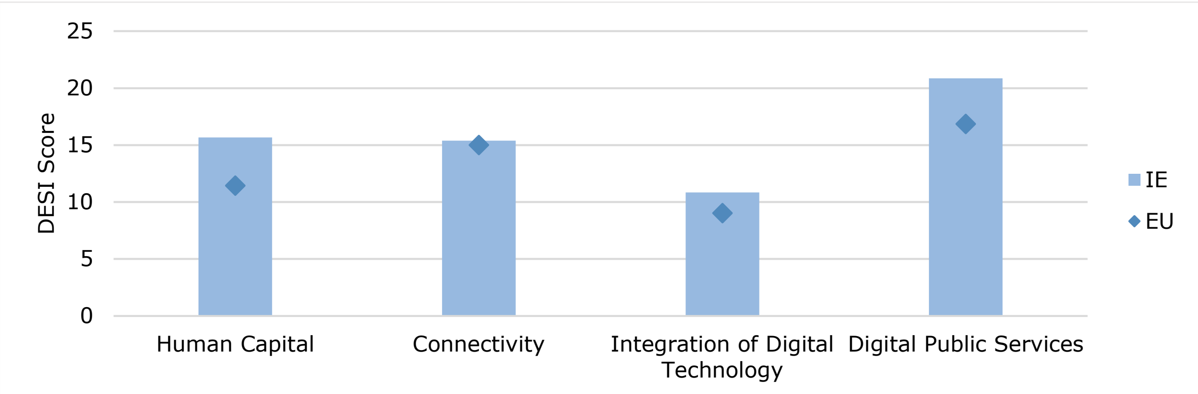
[213] For more information, see https://assets.gov.ie/24702/90df5645cbac4ed3bf6fa6f832507933.pdf
[214] For more information, see https://www.gov.ie/en/policy-information/4d40d5-stem-education-policy/
[215] European Commission (2022); Recovery and Resilience Scoreboard Thematic Analyses. Digital Skills. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_digital_skills.pdf
[216] Eurostat (2023). TPS00184: At-risk-of-poverty rate after social transfers by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/tps00184/default/table?lang=en
[217] Eurostat indicator as re-elaborated by JRC (2022) "Monitoring the effective coverage and adequacy of social protection in the EU".
[218] Eurostat (2023). TESPM050:Impact of social transfers (excluding pensions) on poverty reduction by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/TESPM050/bookmark/table?lang=en&bookmarkId=b001ae62-ce34-4b49-9741-28a3ef99477f
[219] European Commission (2023). Access to social protection. Available at: https://ec.europa.eu/social/main.jsp?catId=1312&langId=en=en

While the Irish national implementation plan for the Recommendation on access to social protection[220] contains some implemented measures to improve the formal coverage of social protection, gaps in access to social protection are expected to remain[221]. Further measures on platform work are not foreseen in the plan. The Irish NRRP does not contain measures specifically targeted at social protection. Social expenditure within the Irish NRRP mostly focuses on employment and skills (45.8%) and education (31.4%), and the plan also includes a pension reform[222].

IE 3. Other dimensions relevant to the digital transformation

Two further dimension, that are relevant for a successful and socially fair digital transformation are the level of digitalisation in businesses and digitalisation of infrastructure and public services. Turning first to the former, Ireland can be considered a leader in the EU, ranking seventh in the DESI Index (Figure 5) for integration of digital technology in companies. However, when looking specifically at robotics, the country is lagging behind the rest of Europe. Both in the economy overall and in manufacturing, robot density is significantly lower than the EU average[223], as is growth in robot density over the last decade. The National Digital Strategy sets out measures to further accelerate digitalisation in businesses, with an emphasis on cloud, big data and AI[224]. In line with this, within the Irish NRRP, 27.2% of planned digital expenditure is allocated towards the digitalisation of businesses, with an investment specifically targeted at the digitalisation of enterprises, particularly SMEs[225].

Figure 5 – DESI Index for IE and the EU (2022)



Source: European Commission (2022)

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220 European Commission (2023). Access to social protection. Available at: https://ec.europa.eu/social/main.jsp?catId=1312&langId=en=en

221 European Commission (2023). Report from the Commission to the Council on the implementation of the Council Recommendation on access to social protection for workers and the self-employed. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023DC0043&qid=1676473347749

222 European Commission (2022). Recovery and Resilience Scoreboard Thematic Analyses. Social protection. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_social_protection.pdf

223 For Member States with available data

224 European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance

225 European Commission (2022): Recovery and Resilience Scoreboard Thematic Analysis. SME Support. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/3_SME.pdf

With regard to digital infrastructure and public services, Ireland similarly performs well. In particular, Ireland ranks sixth in the EU in the DESI Index for digital public services. Connectivity levels are also well-developed, equally ranking sixth highest in the EU. While connectivity plays only a minor role (6%) in the planned digital expenditure in the Irish NRRP, a large amount (27.1%) of this expenditure is allocated towards digital public services , with investments targeted at developing an online option for the population census and various eHealth projects[226].

[226] European Commission (2021); Recovery and Resilience Scoreboard Thematic Analyses. Digital public services. Available at :https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/2_Digital.pdf

8. GREECE: elements of a socially fair digital transformation

Key Points

Labour market: The sector with the largest employment share in the Greek economy – the Wholesale and retail sector – has the fifth highest degree of digital transformation (based on the current percentage of enterprises that employ ICT specialists in a sector). The Wholesale and retail sector's employment share in the economy is projected to grow further in the decade to come (slightly more than the EU trends). ICT services, Professional services, and Energy supply services are the three sectors with the highest degree of digital transformation currently, and their employment shares, except for Professional services, are projected to grow in the decade to come, much more than in the EU27. The type of occupation that is most vulnerable to being automated is Service and sales workers.

Digital skills: The overall level of digital skills in the Greek population is low, and gaps in skill levels between different socio-economic groups are pronounced.

Social protection: The Greek social protection has several shortcomings, and the rate of the population at risk of poverty is among the highest in the EU. There has been some policy action on the misclassification of platform workers' employment status, but less on working conditions.

EL 1. The labour market and the digital transformation

EL 1.1 Sectoral composition (current and forward-looking perspectives)

In Greece ("EL"), in 2022, the sectors with the largest employment shares in the economy were: Wholesale and retail trade (17.4% vs 13.6% at the EU27 level), Agriculture, forestry and fishing (10.5% vs 3.5% at the EU27 level), and Manufacturing (10.0% vs 16.0% at the EU27 level). For the period 2022-2035, CEDEFOP data projects[227] the annual growth rate of a sector's employment share. For Greece's Wholesale and retail sector, the annual growth rate is 0.5% (0.0% for the EU27), for the Agriculture, forestry and fishing sector it is -2.4% (-3.1% for the EU27), and for the Manufacturing sector, it is 0.4% (-0.2% for the EU27).

[227] Own elaboration on CEDEFOP 'Skill forecast 2023' data.

Table 1 presents each sector's employment share in 2022, the projected annual growth rates (2022-2035) of its employment share, and its resulting employment share in the economy by 2035. Along with these elements relating to employment, Table 1 also presents the degree of digital transformation of each sector. Table 1 thus enables comparison between the digital transformation of a sector and its employment share or its employment share's prospects. The degree of digital transformation for each sector is proxied in Table 1 using two indicators: i) the percentage of enterprises that employ ICT specialists in the considered sector and ii) the digital capital intensity[228] of the considered sector. Table 1 presents the ranking of each sector according to these two proxy indicators (with rank n°1 corresponding to the most digitised sector). According to the first indicator, the three sectors with the highest degree of digital transformation in Greece, in order, are ICT services (sector's employment share: 2.6% in EL vs 3.7% in the EU27), Professional services (6.3% vs 5.7%), and Energy supply services (0.8% vs 0.7%). According to the second indicator (digital capital intensity), the three sectors with the highest degree of digital transformation, in order, are the Finance and insurance (sector's employment share: 2.8% in EL vs 2.8% in the EU27), Professional services (6.3% vs 5.7%), and ICT services (2.6% vs 3.7%) sectors. These sectors' employment shares have a projected annual growth rate for 2022-2035 in Greece of 1.4% for ICT services (vs 0.8% for the EU27), -0.6% for Professional services (vs 0.6% for the EU27), 2.0% for Energy supply services (vs 0.1% for the EU27), and 0.5% for Finance and insurance (vs 0.2% for the EU27).

It can be noted in Table 1 that two of the four sectors with the highest degree of digital transformation – Energy supply services and ICT services – are also among the four sectors with the largest predicted annual growth rate of employment share in the decade to come in Greece. Furthermore, in terms of employment share (in 2022), the first and the third sectors[229] - Wholesale and retail trade and Manufacturing - rank fifth and eighth on the first proxy for digital transformation (% of enterprises that employ ICT specialists), and rank fourth and eighth on the second proxy indicator (digital capital intensity).

Table 1 – EL. Sector's share of employment, annual growth rate, and ranking of "digital transformation" (the sectors are ranked according to the ranking in the last column of the table).

Sectors	Sector's employment share in 2022 (%)		Projected annual growth rate of the sector's employment share (2022 - 2035, %)		Projected sector's employment share in 2035 (%)		Proxy 1 for digital transformation (ranking)	Proxy 2 for digital transformation (ranking)
	EL	**EU**	**EL**	**EU**	**EL**	**EU**	**% enterprises that employ ICT specialists**	**Digital capital intensity**
J - ICT services	2.6	3.7	1.4	0.8	3.2	4.2	1	1
K - Finance & insurance	1.8	2.8	0.5	0.2	1.9	2.8	n.a.	2
M - Professional services	6.3	5.7	-0.6	0.6	5.8	6.3	2	3

[228] 'Digital capital intensity' is an index – built in the context of this study – that looks at the ratio between the stock of capital the firms have in software and databases and the overall stock of capital excluding non-residential buildings. Its construction is based on the integrated EUKLEMS & INTANProd database, run by the Luiss Lab of European Economics at Luiss University in Rome, Italy. For more in-depth information on the source, and the availability of the indicator for Member States/sectors, please refer to the Annex.

[229] The second sector in terms of employment share (in 2022) - Agriculture, forestry and fishing - was not rankable with either of the proxy indicators for digital transformation.

G - Wholesale & retail trade	17.4	13.6	0.5	0.0	18.8	13.6	5	4
I - Accommodation & food	9.2	4.5	0.2	0.6	9.4	4.9	9	5
N - Administrative services	2.2	4.1	-0.9	0.0	2.0	4.1	6	6
Q - Health & social care	7.0	11.0	1.0	0.6	8.0	11.9	n.a.	7
C - Manufacturing	10.0	16.0	0.4	-0.2	10.5	15.6	8	8
P - Education	8.4	7.4	-0.4	0.3	8.0	7.7	n.a.	9
E- Water and waste treatment	0.9	0.8	-0.1	-0.1	0.9	0.8	7	10
D - Energy supply services	0.8	0.7	2.0	0.1	1.1	0.8	3	11
O - Public sector & defence	9.1	7.1	-0.1	-0.1	9.0	7.0	n.a.	12
F - Construction	3.6	6.8	1.1	-0.3	4.2	6.5	10	13
R - Arts & recreation and other services	1.5	1.7	1.7	0.3	1.9	1.7	n.a.	14
H - Transport & storage	5.0	5.3	0.1	-0.1	5.1	5.3	4	15
B - Mining & quarrying	0.3	0.3	-2.1	-1.7	0.2	0.2	n.a.	16
A - Agriculture, forestry & fishing	10.5	3.5	-2.4	-3.1	7.6	2.3	n.a.	n.a.
L - Real Estate	0.3	0.9	-0.8	0.9	0.2	1.0	n.a.	n.a.
S - Other service activities	2.2	2.6	0.2	0.0	2.3	2.6	n.a.	n.a.
T - Activities of households as employers	0.7	0.9	-0.5	-0.3	0.6	0.9	n.a.	n.a.
U - Activities of extraterritorial org.	0.1	0.1	n.a.	n.a.	0.1	0.1	n.a.	n.a.

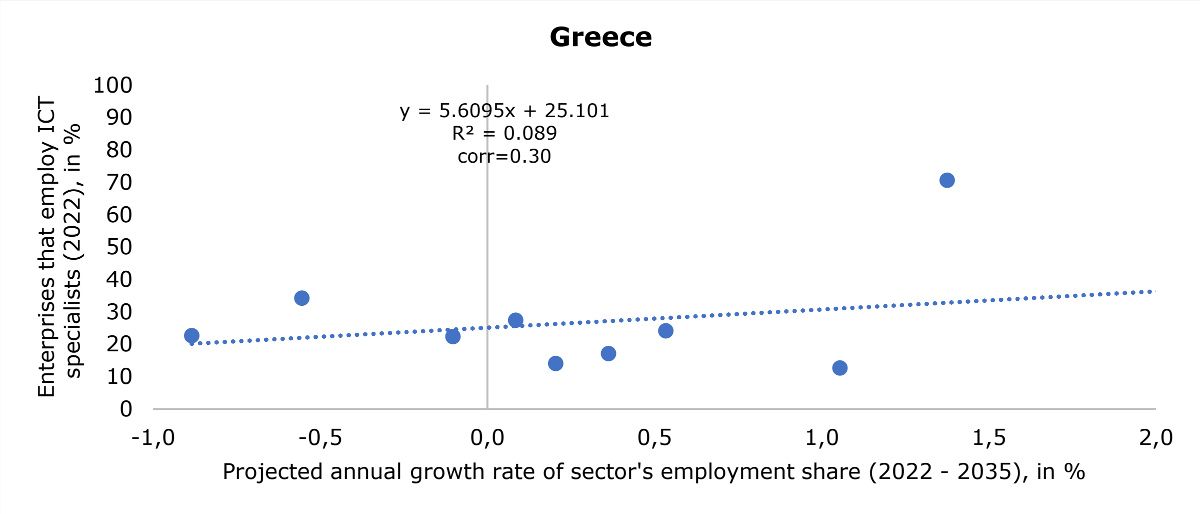
Source: For the employment-related indicators own elaboration on Eurostat data (share of employment, 2022 calculated based on lfsa_egan) and on Cedefop 'Skill forecast data 2023' (annual growth rate of sector's employment share, 2022-2035), for the digital transformation-related indicators: own elaboration on Eurostat data (share of enterprises that employ ICT specialists, Eurostat code: lfsa_egais) and on EUKLEMS & INTANProd data (digital capital intensity).
Note: In the first column of the table, the letter preceding the sectors is the code of the NACE Rev.2 classification. In the last two columns of the table, the two proxy indicators used for digital transformation are: i) the share of enterprises that employ ICT specialists (Eurostat code: lfsa_egais) and ii) the digital capital intensity (EUKLEMS & INTANProd data, average 2014-2017) with rank n°1 corresponding to the most digitally intense sector.

Figures 1a and 1b build on Table 1 to explore the extent to which there may be said to be a relationship between the degree of digital transformation of a sector and its projected employment share growth rates[230].

In **Figure 1a**, we present a scatterplot of the first proxy of digital transformation used (percentage of enterprises that employ ICT specialists) and the projected annual growth rate of a sector's employment share between 2022 and 2035. The correlation is positive at 0.30, but not statistically significant (it is 0.62 and statistically significant for the EU27). The statistically insignificant result implies that an **association between the percentage of enterprises in a sector that employ ICT specialists, and that sector's projected annual employment share growth rate cannot be inferred at the sectoral level in Greece.**

[230] With the caveat that the correlation coefficients presented in Figure 1a and Figure 1b cannot be directly compared, as they pertain to a combination of sectors that varies across different Member States.

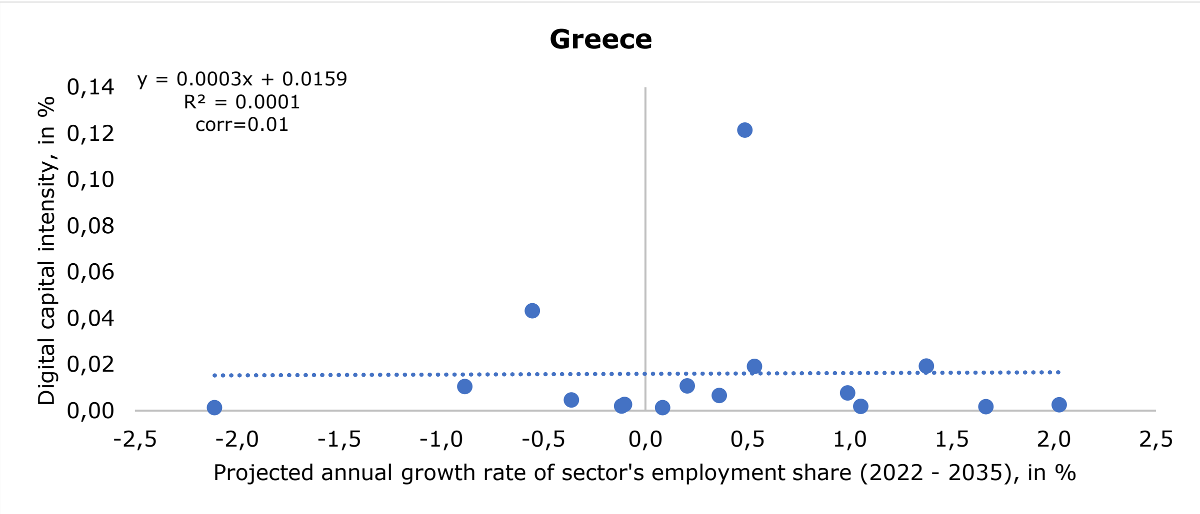
Figure 1a – EL. Relationship between the percentage of enterprises that employ ICT specialists (in 2022) and the projected annual growth rate of sector's employment share (2022-2035).



Source: Own elaboration on Eurostat and Cedefop 'Skill forecast 2023' data.

Figure 1b shows the correlation between the second digital transformation proxy ('digital capital intensity') and the projected annual growth rate of a sector's employment share between 2022 and 2035. The correlation coefficient exhibits a value of 0.01, and it is not statistically significant in Greece. The statistically insignificant result implies that, again, in Greece, **an association between the digital capital intensity of a sector and that sector's projected annual employment share growth rate cannot be inferred at the sectoral level.**

Figure 1b – EL. Relationship between 'digital capital intensity' and the projected annual growth rate of sector's employment share (2022-2035).

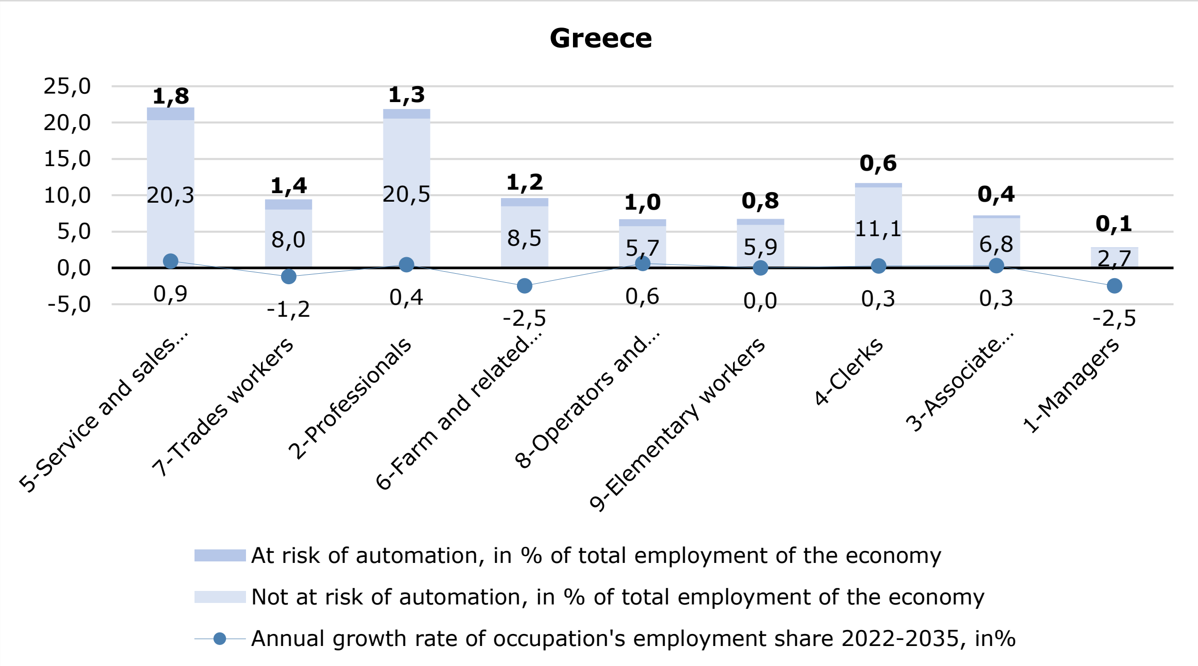


Source: Own elaboration on EUKLEMS & INTANProd, and Cedefop 'Skill forecast 2023' data.

EL 1.2 Occupational composition at ISCO-08 1 digit and risk of automation (current and forward-looking perspectives)

Different types of occupation are subject to differing levels of automation risk. CEDEFOP developed[231] a "risk of automation" index by occupation at the EU27 level, most recently updated for 2022[232]. We apply this indicator at the Member State level, with the assumption that the risk of automation for a given occupation is relatively constant across Member States[233]. As such, any variation in the vulnerability to automation of a Member State's workforce across all occupations can be attributed to the employment composition effect. Thus, while the automation risk for a given occupation stays constant across Member States, the overall automation risk of a Member State can be considered greater for those Member States with larger employment shares in occupations with a higher automation risk.

Figure 2 – EL. Employment shares of occupations (at ISCO-08 1 digit level) - split into sub shares 'not at risk' and 'at risk' of automation (2022) - and projected annual growth rate



Source: Own elaboration on Cedefop data (risk of automation calculated by Cedefop at EU27 level by ISCO-08 1 digit level for 2022) applied to Eurostat data (share of employment by occupation, lfsa_egais, 2022).
Note: The numbers preceding the occupations are the ISCO-08 codes. Occupations are ranked from the highest to the lowest share of workers that present a risk of automation. The vertical sum of the two components (darker blue and lighter blue) gives back the total employment share by occupation (in % of total employment in the Member State). The ISCO nomenclature used in the text and the figure is the Cedefop one. For examples of specific occupations see: https://esco.ec.europa.eu/en/classification/occupation_main.

[231] Based on the methodology in Pouliakas, K. (2018) "The risk of automation in EU labour markets: a skill-requirements approach", in Economy, Employment and Skills: European and global perspectives in an age of uncertainty, Fondazione Giacomo Brodolini Quaderni Series, also IZA DP 11829.
[232] As retrieved at https://www.cedefop.europa.eu/en/tools/skills-intelligence/automation-risk-occupations#1
[233] While this assumption may be considered strong, Cedefop data are the only ones available that are at the same time, up to date and available for all the occupations at the ISCO-08 level.

As is visible in **Figure 2,** in Greece, workers in Service and sales occupations have the largest employment sub-share (% of total employment in the economy) 'at risk of automation, representing 1.8% of total employment in Greece (vs 1.3% for the EU27). Trades workers, with an employment sub-share of workers 'at risk' of 1.4% of total employment in Belgium (vs 1.3% for the EU27), are the second most 'at risk of automation'. Finally, ranking third are Professionals, with a share of workers 'at risk' of 1.3% in total employment in Belgium (vs 1.3% for the EU27). **These three occupations are not the most affected across the EU27[234].**

The 2022 employment share for **ICT professionals (ISCO 25)**[235] is 1.1% in Greece (vs 2.3% in the EU27). Of that, 0.1% (vs 0.1% in the EU27) is 'at risk of automation', with the remaining employment sub-share of 1.0% (vs 2.2% at EU27 level) not expected to be 'at risk of automation'. The projected annual growth rate between 2022 and 2035 of the employment share of ICT professionals is 2.4% in Greece (vs 1.9% in EU27).

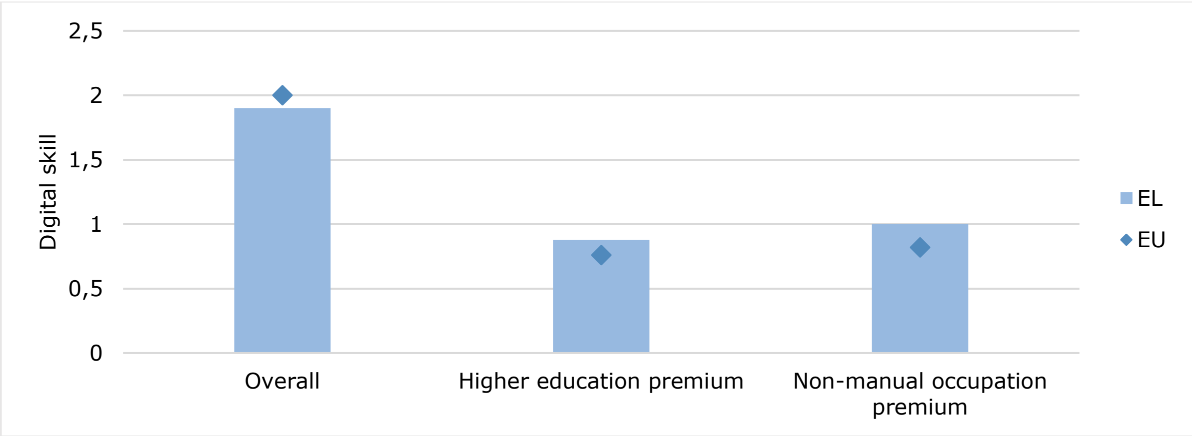
EL 2. Key policy dimensions for a socially fair digital transformation

EL 2.1 Digital skills

One of the key policy dimensions influencing the extent to which the digital transformation is socially fair is the level of digital skills of the population. **Digital skills are an issue in Greece overall.** According to the study's own estimate of the level of digital skills[236] (Figure 3, bar "Overall") and the DESI Index for Human Capital[237] (Figure 5), the country ranks 20th and 22nd in the EU, respectively. Pronounced gaps in digital skill are also observed between individuals with different levels of education ("Higher education premium" in Figure 3, ranking 20th in EU27) and between individuals in different types of occupations ("Non-manual occupation premium" in Figure 3, ranking 24th in EU27).

[234] The most affected in the EU27 are Trades workers, Professionals, and Service and sales workers.
[235] Eurostat code: lfsa_egai2d.
[236] The construction of the digital skill index is described in detail in the introductory section.
[237] European Commission (2022). Digital Economy and Society Index. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi

Figure 3 – Estimated Digital Skills in EL and the EU (2019)



Source: Authors' own estimation based on Eurostat ICT survey
Note: Higher education premium refers to the difference in digital skills between individuals with tertiary and lower than tertiary education. Non-manual occupation premium refers to the difference in digital skills between individuals in manual and non-manual occupations.

In this context, investment in digital skills and training is an important policy priority to mitigate against the potentially negative labour market consequences of the digital transformation. In the Greek Digital Transformation Strategy 2020-2025 (also called the "Digital Transformation Bible")[238], the development of digital skills for all citizens is recognized as one of seven main objectives. One of the items under the digital skills pillar is a National Coalition for Digital Skills and Employment, containing various initiatives to invest in digital skills in Greece. Under the strategy, Greece has also launched the Citizen's Digital Academy[239], which seeks to enable free access to high-quality digital education services for all citizens. Looking, for instance,at the RRF, of overall spending on the digital pillar (23.3% of total expenditure), only 10.6% are devoted to human capital expenditure. However, the plan does contain measures related to digital skills, including reforms to vocational education and training curricula to include digital skills and investments in up- and re-skilling of the workforce in the context of digitalisation[240].

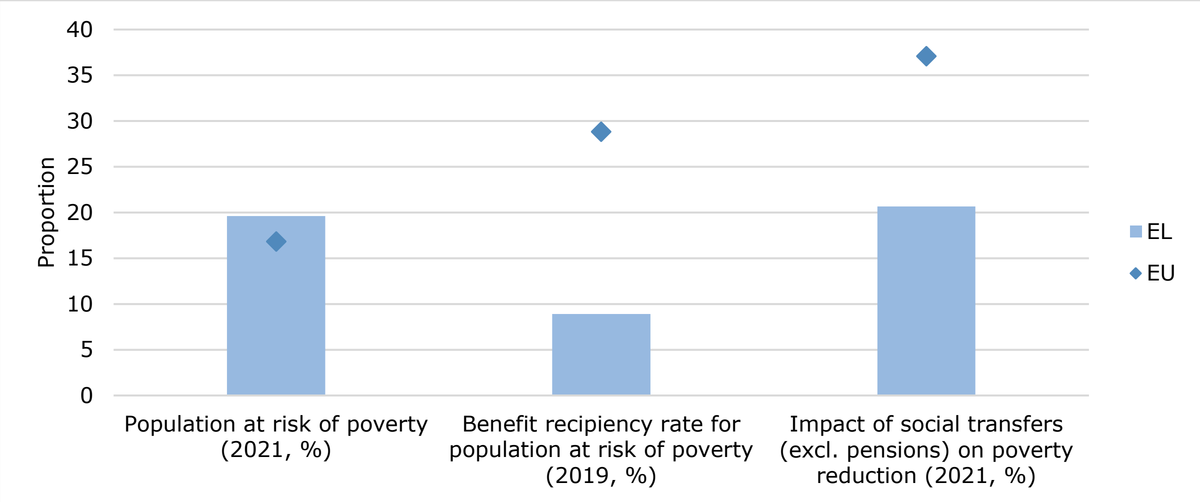
EL 2.2 Social protection and social policy

Next to digital skill investment, a comprehensive social protection system can play a key role in cushioning the impact of the digital transformation on individuals. **With regard to the strength of the social protection system, key indicators indicate that Greece is badly positioned relative to the rest of the EU (Figure 4)**. The rate of the population at risk of poverty after social transfers[241] (19.6%) is the eighth highest in the EU27. Other key indicators point to a limited effectiveness of the social protection system in mitigating poverty. Both the benefit recipiency rate for the population at risk of poverty before social transfers

[238] For more information, see https://digitalstrategy.gov.gr
[239] For more information, see https://nationaldigitalacademy.gov.gr
[240] European Commission (2022); Recovery and Resilience Scoreboard Thematic Analyses. Digital Skills. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_digital_skills.pdf
[241] Eurostat (2023). TPS00184: At-risk-of-poverty rate after social transfers by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/tps00184/default/table?lang=en

(8.9%)[242] and the impact of social transfers on poverty reduction (20.6%) are among the lowest in the EU27[243]. Looking at platform workers, one of the key groups affected by the digitalisation of work, Greece has taken some action on the misclassification of employment status, but not on working conditions[244].

Figure 4 – Social Protection in EL and the EU



Source: Eurostat (2023) and JRC (2022)

In its national action plan for the Recommendation on access to social protection for non-standard workers and the self-employed[245], Greece does include planned measures to improve formal coverage of social protection, but none to improve effective coverage, adequacy or transparency of social protection, nor measures specifically aimed at platform workers. The measures outlined are therefore not expected to fully close existing gaps in social protection access[246]. Within the Greek NRRP, social expenditure constitutes 17.7% of total expenditure, with the largest share of this spending devoted to employment and skills (37.5%). Some specific measures to improve access to social protection are also included in the plan, specifically by advancing the digital transformation of the social protection system[247].

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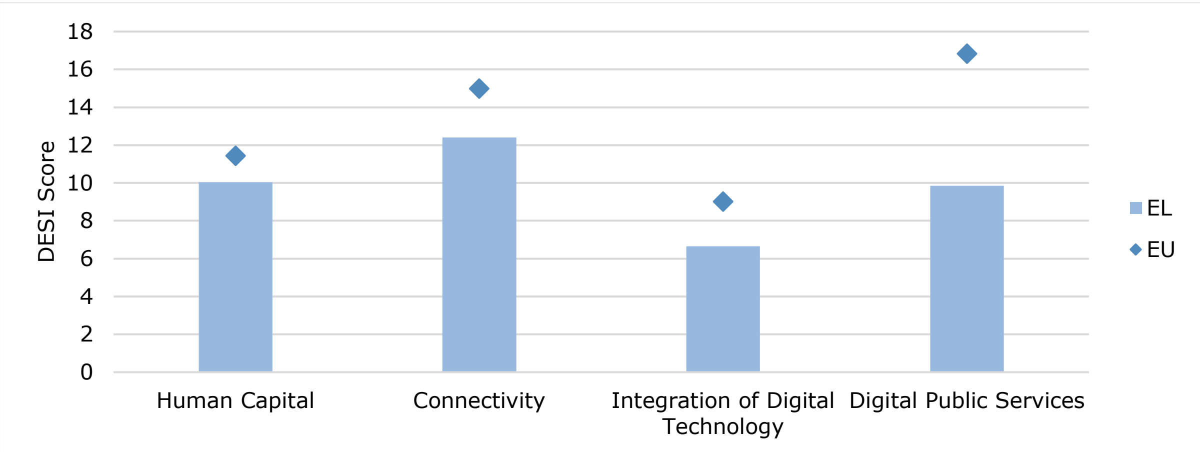
[242] Eurostat indicator as re-elaborated by JRC (2022) "Monitoring the effective coverage and adequacy of social protection in the EU".
[243] Eurostat (2023). TESPM050:Impact of social transfers (excluding pensions) on poverty reduction by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/TESPM050/bookmark/table?lang=en&bookmarkId=b001ae62-ce34-4b49-9741-28a3ef99477f
[244] https://ec.europa.eu/social/main.jsp?catId=738&furtherPubs=yes&langIdIn =en&pubId=8428
[245] European Commission (2023). Access to social protection. Available at: https://ec.europa.eu/social/main.jsp?catId=1312&langId=en=en
[246] European Commission (2023). Report from the Commission to the Council on the implementation of the Council Recommendation on access to social protection for workers and the self-employed. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023DC0043&qid=1676473347749
[247] European Commission (2022). Recovery and Resilience Scoreboard Thematic Analyses. Social protection. https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_social_protection.pdf

EL 3. Other dimensions relevant to the digital transformation

Beyond digital skills and social protection, it is also important to consider other support factors for a successful and socially fair digital transformation, including the digitalisation of firms, digital infrastructure and digital public services. Considering the former, according to the DESI Index (Figure 5), **levels of the integration of digital technology in firms in Greece are lagging behind other EU Member States** (22nd in EU27). This picture is also confirmed when looking at digital capital intensity[248] in Greece, which is significantly lower than the EU average[249] and, concerningly, has been growing at a much slower rate in the past 10 years. Considering policy action to improve levels of digitalisation in firms, the "Digital Transformation Bible" includes several measures to advance digitalisation of firms, such as a targeted support programme for start-ups and young entrepreneurs and an improved regulatory and investment environment. Within the Greek NRRP, 21.7% of digital expenditure is allocated towards the digitalisation of firms. Examples of measures included are investments to support technologies and services for digitalising SMEs and a Loan Facility Scheme for SMEs to promote the digital transformation, among other objectives[250]. While progress in digitalisation of enterprises remains slow, a successful implementation of the planned RRP investments and reforms, combined with the use of cohesion funds, should help to accelerate the process[251].

Figure 5 – DESI Index for EL and the EU (2022)



Source: European Commission (2022)

Turning to digital infrastructure and digital public services, Greece is similarly in a disadvantageous position relative to other EU member states, considering the DESI dimensions of both connectivity (22nd in EU27) and digital public services (26th in EU27). Within the planned digital expenditure in the Greek NRRP, the largest share of spending is allocated towards the digitalisation

[248] As described in the Annex, based on data from EU-KLEMS (2008-2018). Data is not available for Cyprus, Croatia, Ireland and Romania.
[249] In this section, for Member States for whom data was available.
[250] European Commission (2022): Recovery and Resilience Scoreboard Thematic Analysis. SME Support. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/3_SME.pdf
[251] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance

of public services (39.2%), while 17.3% are targeted towards investments in connectivity. The digitalisation of the public sector is a particular focus of the Greek NRRP, including measures to modernise public sector organisations, advance business process improvements through modern IT systems, increasing interoperability between systems and data and developing strategies for cybersecurity and data governance[252].

[252] European Commission (2021); Recovery and Resilience Scoreboard Thematic Analyses. Digital public services. Available at :https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/2_Digital.pdf

9. SPAIN: elements of a socially fair digital transformation

Key Points

Labour market: Currently, the Wholesale and retail sector – the largest sector by employment share in Spain – has the fourth highest sectoral degree of digital transformation in Spain (based on the current percentage of enterprises that employ ICT specialists in a sector). The Wholesale and retail sector's employment share in the economy is projected to grow further in the decade to come (slightly more than EU trends). ICT services, Professional services, and Energy supply services are the three sectors with the highest degree of digital transformation currently, and their employment shares are projected to grow in the decade to come, slightly more than EU trends. The type of occupation most vulnerable to the risk of automation is Service and sales workers.

Digital skills: The level of digital skills in Spain ranks in the upper mid-field of EU Member States. However, skill divides between socio-economic groups are relatively pronounced.

Social protection: There are shortcomings in the social protection system, Spain having one of the highest rates of the population at risk of poverty in the EU. There has been recent regulatory action on the employment status of platform workers, including measures that form part of the Spanish NRRP.

ES 1. The labour market and the digital transformation

ES 1.1 Sectoral composition (current and forward-looking perspectives)

In Spain ("ES"), in 2022, the sectors with the largest employment shares in the economy were the Wholesale and retail trade (14.7% vs 13.6% at the EU27 level), the Manufacturing (12.4% vs 16.0% at the EU27 level), and the Health and social care (9.2% vs 11.0% at the EU27 level) sectors. For the period 2022-2035, CEDEFOP data projects the annual growth rate of a sector's employment share. For Spain's Wholesale and retail trade sector, the annual growth rate is 0.4% (0.0% for the EU27), for the Manufacturing sector, it is 0.4% (-0.2% for the EU27), and for the Health and social care sector, the annual growth rate is -1.2% (0.6% for the EU27).

Table 1 presents each sector's employment share in 2022, the projected annual growth rates (2022-2035) of its employment share, and its resulting employment share in the economy by 2035. Along with these elements relating to employment, Table 1 also presents the degree of digital transformation of each sector. Table 1 thus enables comparison between the digital transformation of a sector and its employment share or its employment share's prospects. The degree of digital transformation is proxied for each sector in Table 1 using two indicators: i) the percentage of enterprises in the sector that employ ICT specialists and ii) the digital capital intensity[253] of the sector. Table 1 presents the ranking of each sector according to these two proxy indicators (with rank n°1 corresponding to the most digitised sector). According to the first indicator, the three sectors with the highest degree of digital transformation in Spain, in order, are ICT services (sector's employment share: 3.7% in ES, same as in the EU27), Professional services (5.4% vs 5.7%), and Energy supply services (0.5% vs 0.7%). According to the second indicator (digital capital intensity), the three sectors with the highest degree of digital transformation, in order, are Finance and insurance (sector's employment share: 2.3% in ES vs 2.8% in the EU27), ICT services (3.7% vs 3.7%), and Professional services (5.4% vs 5.7%). These sectors' employment shares have a projected annual growth rate for 2022 to 2035 in Spain of 1.1% for ICT services (vs 0.8% for the EU27), 0.8% for Professional services (vs 0.6% for the EU27), 0.5% for Energy supply services (vs 0.1% for the EU27), and -0.6% for Finance and insurance (vs 0.2% for the EU27).

It is worth noting that only one of the top four sectors in terms of digital transformation – ICT services – is also among the top four sectors in terms of the annual growth rate of employment share in the decade to come in Spain. Furthermore, the second and third largest sectors in terms of employment share – Wholesale and retail trade and Manufacturing - rank fourth and sixth, according to the first proxy indicator of digital transformation (% of enterprises that employ ICT specialists).

Table 1 – ES. Sector's share of employment, annual growth rate, and ranking of "digital transformation" (the sectors are ranked according to the ranking in the last column of the table).

Sectors	Sector's employment share in 2022 (%)		Projected annual growth rate of the sector's employment share (2022 - 2035, %)		Projected sector's employment share in 2035 (%)		Proxy 1 for digital transformation (ranking)	Proxy 2 for digital transformation (ranking)
	ES	**EU**	**ES**	**EU**	**ES**	**EU**	**% enterprises that employ ICT specialists**	**Digital capital intensity**
K - Finance & insurance	2.3	2.8	-0.6	0.2	2.1	2.8	n.a.	1
J - ICT services	3.7	3.7	1.1	0.8	4.3	4.2	1	2
M - Professional services	5.4	5.7	0.8	0.6	6.0	6.3	2	3
N - Administrative services	5.1	4.1	0.8	0.0	5.7	4.1	5	4
D - Energy supply services	0.5	0.7	0.5	0.1	0.5	0.8	3	5
G - Wholesale & retail trade	14.7	13.6	0.4	0.0	15.6	13.6	4	6
Q - Health & social care	9.2	11.0	-1.2	0.6	7.8	11.9	n.a.	7

[253] 'Digital capital intensity' is an index – built in the context of this study – that looks at the ratio between the stock of capital the firms have in software and databases and the overall stock of capital excluding non-residential buildings. Its construction is based on the integrated EUKLEMS & INTANProd database, run by the Luiss Lab of European Economics at Luiss University in Rome, Italy. For more in-depth information on the source, and the availability of the indicator for Member States/sectors, please refer to the Annex.

P - Education	7.3	7.4	0.5	0.3	7.9	7.7	n.a.	8
C - Manufacturing	12.4	16.0	0.4	-0.2	13.2	15.6	6	9
H - Transport & storage	5.4	5.3	-0.2	-0.1	5.3	5.3	7	10
E- Water and waste treatment	0.7	0.8	1.6	-0.1	0.9	0.8	n.a.	11
B - Mining & quarrying	0.1	0.3	-1.3	-1.7	0.1	0.2	n.a.	12
I - Accommodation & food	8.1	4.5	0.6	0.6	8.8	4.9	8	13
R - Arts & recreation and other services	2.1	1.7	1.2	0.3	2.5	1.7	n.a.	14
O - Public sector & defence	6.9	7.1	-0.7	-0.1	6.3	7.0	n.a.	15
F - Construction	6.5	6.8	-0.6	-0.3	6.0	6.5	9	16
A - Agriculture, forestry & fishing	3.7	3.5	-3.6	-3.1	2.2	2.3	n.a.	n.a.
L - Real Estate	0.8	0.9	1.2	0.9	0.9	1.0	n.a.	n.a.
S - Other service activities	2.4	2.6	-0.8	0.0	2.1	2.6	n.a.	n.a.
T - Activities of households as employers	2.6	0.9	-0.6	-0.3	2.4	0.9	n.a.	n.a.
U - Activities of extraterritorial org.	0.0	0.1	n.a.	n.a.	0.0	0.1	n.a.	n.a.

Source: For the employment-related indicators own elaboration on Eurostat data (share of employment, 2022 calculated based on lfsa_egan) and on Cedefop 'Skill forecast data 2023' (annual growth rate of sector's employment share, 2022-2035), for the digital transformation-related indicators: own elaboration on Eurostat data (share of enterprises that employ ICT specialists, Eurostat code: lfsa_egais) and on EUKLEMS & INTANProd data (digital capital intensity).

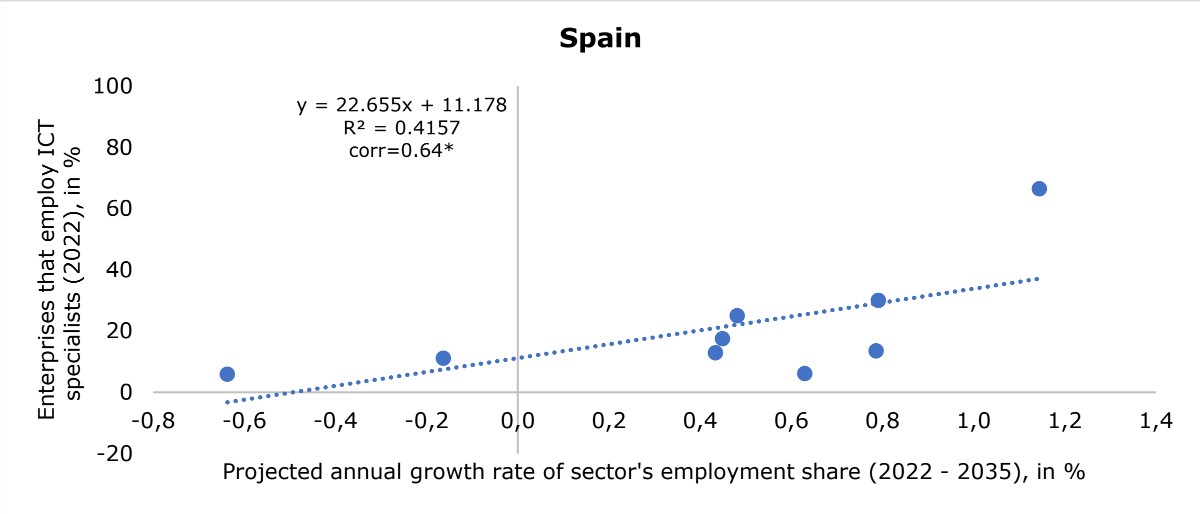
Note: In the first column of the table, the letter preceding the sectors is the code of the NACE Rev.2 classification. In the last two columns of the table, the two proxy indicators used for digital transformation are: i) the share of enterprises that employ ICT specialists (Eurostat code: lfsa_egais) and ii) the digital capital intensity (EUKLEMS & INTANProd data, average 2014-2017) with rank n°1 corresponding to the most digitally intense sector.

In complement to Table 1, Figures 1a and 1b below show to what extent there may be a relationship between the projected annual growth rates of the sectors' employment shares in the economy and the ranking of those sectors in terms of digital transformation[254].

In **Figure 1a**, we present a scatterplot of the first proxy of digital transformation used (percentage of enterprises that employ ICT specialists) and the projected annual growth rate of a sector's employment share between 2022 and 2035. The correlation is positive, and statistically significant in Spain, with a value of 0.64 (it is 0.62 and statistically significant for the EU27). Among the ten Member States with a significant correlation, Spain has the 6th strongest correlation. The positive correlation could suggest that the employment shares of those sectors **with a higher 'percentage of enterprises that employ ICT specialists' are more likely to experience a higher growth (over 2022-2035) than in other sectors.** The relationship is strong and in the range of the one at the EU27 level. Nevertheless, this correlation does not imply causal links.

[254] With the caveat that the correlation coefficients presented in Figure 1a and Figure 1b cannot be directly compared, as they pertain to a combination of sectors that varies across different Member States.

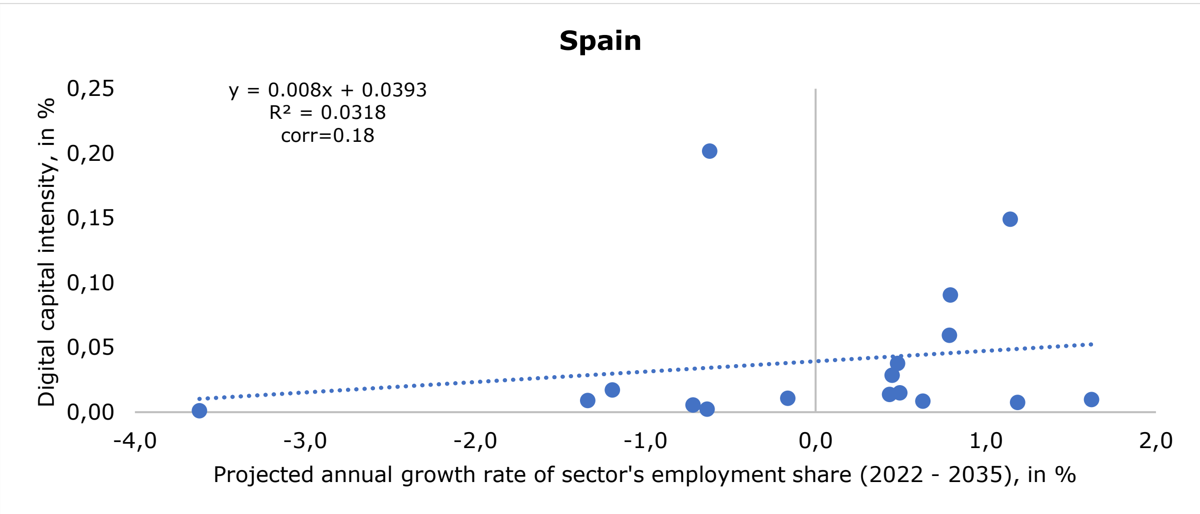
Figure 1a – ES. Relationship between the percentage of enterprises that employ ICT specialists (in 2022) and the projected annual growth rate of sector's employment share (2022-2035).



Source: Own elaboration on Eurostat and Cedefop 'Skill forecast 2023' data.

Figure 1b shows the correlation between the second digital transformation proxy ('digital capital intensity') and the projected annual growth rate of a sector's employment share between 2022 and 2035. The correlation coefficient is 0.18 and is not statistically significant in Spain. Thus, **for the second digital transformation proxy, an association with the projected annual growth rate of a sector's employment share cannot be inferred in Spain**.

Figure 1b – ES. Relationship between 'digital capital intensity' and the projected annual growth rate of sector's employment share (2022-2035).

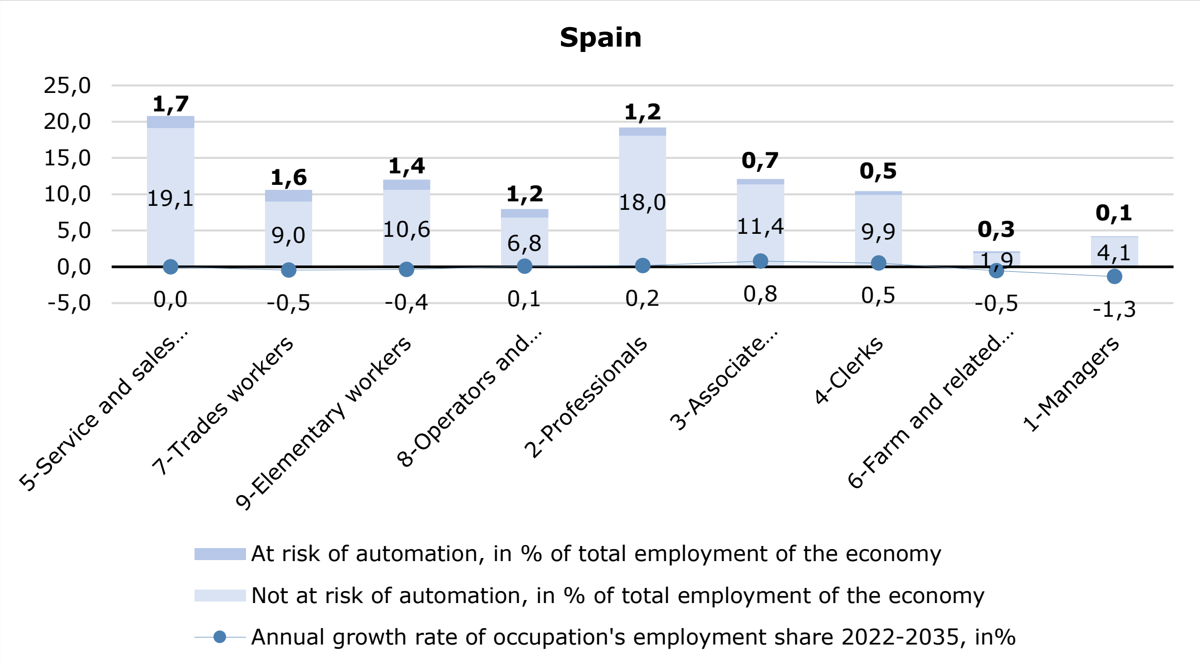


Source: Own elaboration on EUKLEMS & INTANProd, and Cedefop 'Skill forecast 2023' data.

ES 1.2 Occupational composition at ISCO-08 1 digit and risk of automation (current and forward-looking perspectives)

Different occupations are subject to differing levels of automation risk. Cedefop developed[255] a "risk of automation" index by occupation at the EU27 level, most recently updated for 2022[256]. We apply this indicator at the Member State level, with the assumption that the risk of automation for a given occupation is constant across Member States[257]. As such, the variation observed across Member States in the overall susceptibility of the workforce to automation (overall risk across all occupations in that Member State) will be due to the employment composition effect. That is, that while the automation risk for a given occupation stays constant across Member States, the overall automation risk of a Member State will naturally be greater for those Member States having more employment in occupations that have a higher automation risk.

Figure 2 – ES. Employment shares of occupations (at ISCO-08 1 digit level) - split into sub shares 'not at risk' and 'at risk' of automation (2022) - and projected annual growth rate



Source: Own elaboration on Cedefop data (risk of automation calculated by Cedefop at EU27 level by ISCO-08 1 digit level for 2022) applied to Eurostat data (share of employment by occupation, lfsa_egais, 2022).
Note: The numbers preceding the occupations are the ISCO-08 codes. Occupations are ranked from the highest to the lowest share of workers that present a risk of automation. The vertical sum of the two components (darker blue and lighter blue) gives back the total employment share by occupation (in % of total employment in the Member State). The ISCO nomenclature used in the text and the figure is the Cedefop one. For examples of specific occupations see: https://esco.ec.europa.eu/en/classification/occupation_main.

As can be seen in **Figure 2**, in Spain, the occupation where the employment sub-share (in % of total employment in the economy) 'at risk of automation' is the

[255] Based on the methodology in Pouliakas, K. (2018) "The risk of automation in EU labour markets: a skill-requirements approach", in Economy, Employment and Skills: European and global perspectives in an age of uncertainty, Fondazione Giacomo Brodolini Quaderni Series, also IZA DP 11829.
[256] As retrieved at https://www.cedefop.europa.eu/en/tools/skills-intelligence/automation-risk-occupations#1
[257] While this assumption may be considered strong, Cedefop data are the only ones available that are at the same time, up to date and available for all the occupations at the ISCO-08 level.

largest is Service and sales workers. For Service and sales workers, the employment sub-share of workers ‘at risk of automation’ represents 1.7% of total employment in the country (vs 1.3% for the EU27). The second largest employment sub-share of workers ‘at risk of automation’ is for Trades workers, with 1.6% of total employment in Spain ‘at risk’ (vs 1.3% for the EU27). Ranking third is Elementary workers, with a share of workers ‘at risk’ of 1.4% in total employment in Spain (vs 1.0% for the EU27). **These three occupations are not the most affected across the EU27[258].**

The 2022 employment share for **ICT professionals (ISCO 25)**[259] is 1.1% in Spain (vs 2.3% in the EU27). An employment sub-share of 0.1% of those ICT professionals (vs 0.1% in the EU27) are ‘at risk of automation’, and the remaining employment sub-share of 1.1% (vs 2.2% at EU27 level) is ‘not at risk of automation’. The projected annual growth rate 2022-2035 of the employment share of ICT professionals is 1.9% in Spain (vs 1.9% in EU27).

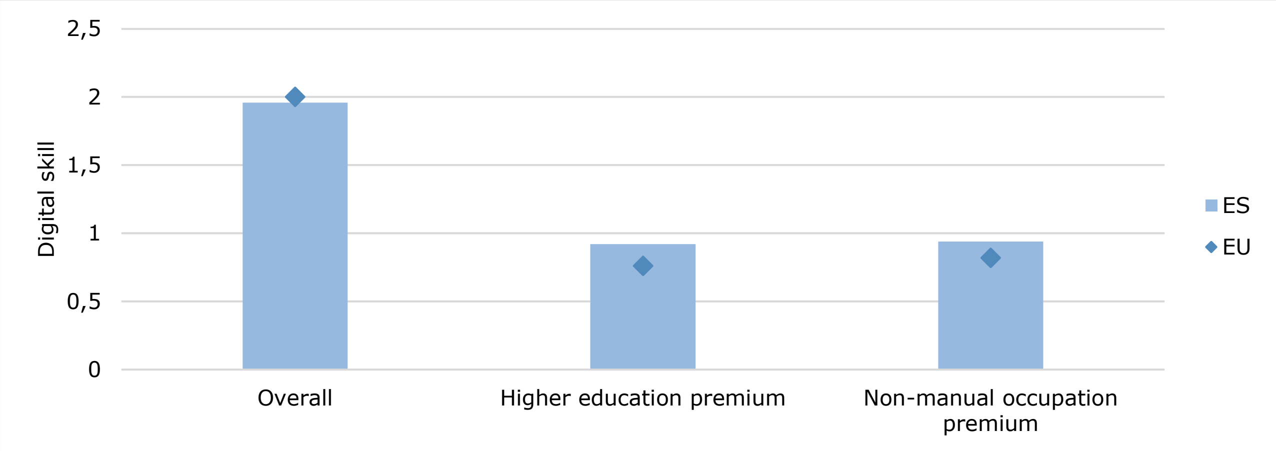
ES 2. Key policy dimensions for a socially fair digital transformation

ES 2.1 Digital skills

A high level of digital skills within the population is an important prerequisite for ensuring a socially fair digital transformation. With regard to digital skills, Spain is positioned in the upper to mid-range relative to other EU countries. In the study’s own estimated index of digital skills[260] across the population (Figure 3, bar “Overall”), the country is ranked 15th within the EU27, whereas in the DESI Index for Human Capital[261] (Figure 5, Section “Other dimensions”), it ranks 10th. Considering gaps in digital skills between different socio-economic groups, some shortcomings can be identified. Both the gap in digital skills between individuals with tertiary versus lower than tertiary education ("Higher education premium" in Figure 3) and between individuals in a manual versus non-manual occupation (“Non-manual occupation premium" in Figure 3) are high, Spain ranking 23rd in the EU on both indicators. **This unequal distribution of digital skills could present a potential issue with respect to mitigating the impact of the digital transformation on the labour market**.

[258] The most affected in the EU27 are Trades workers, Professionals, and Service and sales workers.
[259] Eurostat code: lfsa_egai2d.
[260] The construction of the digital skill index is described in detail in the introductory section.
[261] European Commission (2022). Digital Economy and Society Index. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi

Figure 3 – Estimated Digital Skills in ES and the EU (2019)



Source: Authors' own estimation based on Eurostat ICT survey
Note: Higher education premium refers to the difference in digital skills between individuals with tertiary and lower than tertiary education. Non-manual occupation premium refers to the difference in digital skills between individuals in manual and non-manual occupations.

In this context, investment in digital skills, particularly for disadvantaged groups, is of crucial importance. Within the National Digital Competences Plan[262], the Spanish government proposed a roadmap for digital skills development for all citizens. Measures in the plan include digital skills development for teachers, students and the working population, including investing in the pool of ICT experts and ensuring high-quality training resources. Within the digital pillar of the Spanish NRRP, 22.8% of expenditure is devoted to human capital. A significant set of measures within the plan is dedicated to skills development, including digital skills. These include, in addition to the National Digital Competences Plan mentioned above, investments in digital skills for employment, requalification programmes for the employed and unemployed, digital training for public workers and a programme for digital skills in SMEs[263]. This complements other digital skills training funded through the European Social Fund and the Digital Europe Programme[264].

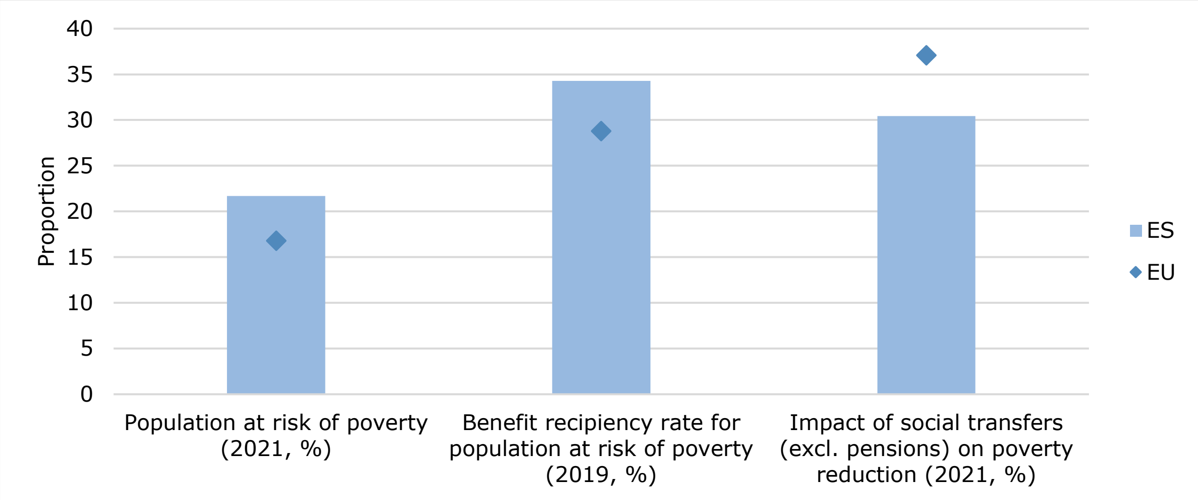
ES 2.2 Social protection and social policy

Alongside high levels of digital skills, countries with more comprehensive social protection systems may be better positioned to mitigate potential effects of the digital transformation on inequality and poverty. With regard to social protection, however, Spain is overall not well positioned compared to the rest of the EU (Figure 4). The rate of the population at risk of poverty after social transfers[265] (21.7%) is the fourth highest in the EU. Conversely, social transfers have only a

[262] For more information, see https://portal.mineco.gob.es/RecursosNoticia/mineco/prensa/noticias/2021/210127_np_digital.pdf
[263] European Commission (2022); Recovery and Resilience Scoreboard Thematic Analyses. Digital Skills. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_digital_skills.pdf
[264] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[265] Eurostat (2023). TPS00184: At-risk-of-poverty rate after social transfers by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/tps00184/default/table?lang=en

relatively low impact on poverty reduction[266] (30.5%). More positively, the benefit recipiency rate for the population at risk of poverty before social transfers[267] (34.3%) is significantly higher than the EU rate. However, overall, **the poverty indicators nevertheless appear to show limited effectiveness of the social protection system in mitigating poverty.**

Figure 4 – Social Protection in ES and the EU



Source: Eurostat (2023) and JRC (2022)

In its national implementation plan for the Recommendation on access to social protection[268], the Spanish government sets out measures to improve both the formal and effective coverage of social protection, including measures to extend social protection coverage to all workers, including the self-employed. Some significant measures on social protection, partially overlapping with the national implementation plan, are also included in the Spanish NRRP, including the establishment of a national minimum income scheme, a minimum level of non-contributory financial benefits for the most vulnerable households, the streamlining of unemployment assistance[269], and the regulation of the working conditions and access to social protection of platform workers[270]. In 2021, the so-called "Riders' Law" was adopted in Spain, establishing a presumption of employment for platform workers in the delivery sector[271]. Of social expenditure

[266] Eurostat (2023). TESPM050:Impact of social transfers (excluding pensions) on poverty reduction by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/TESPM050/bookmark/table?lang=en&bookmarkId=b001ae62-ce34-4b49-9741-28a3ef99477f

[267] Eurostat indicator as re-elaborated by JRC (2022) "Monitoring the effective coverage and adequacy of social protection in the EU".

[268] European Commission (2023). Access to social protection. Available at: https://ec.europa.eu/social/main.jsp?catId=1312&langId=en=en

[269] European Commission (2022). Recovery and Resilience Scoreboard Thematic Analyses. Social protection. Available at : https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_social_protection.pdf

[270] Council of the European Union (2021). Revised Annex to the Council Implementing Decision on the approval of the recovery and resilience plan for Spain. Available at : https://www.consilium.europa.eu/en/documents-publications/public-register/public-register-search/results/?WordsInSubject=&WordsInText=&DocumentNumber=10150%2F21&InterinstitutionalFiles=&DocumentDateFrom=&DocumentDateTo=&MeetingDateFrom=&MeetingDateTo=&DocumentLanguage=EN&OrderBy=DOCUMENT_DATE+DESC&ctl00%24ctl00%24cpMain%24cpMain%24btnSubmit=

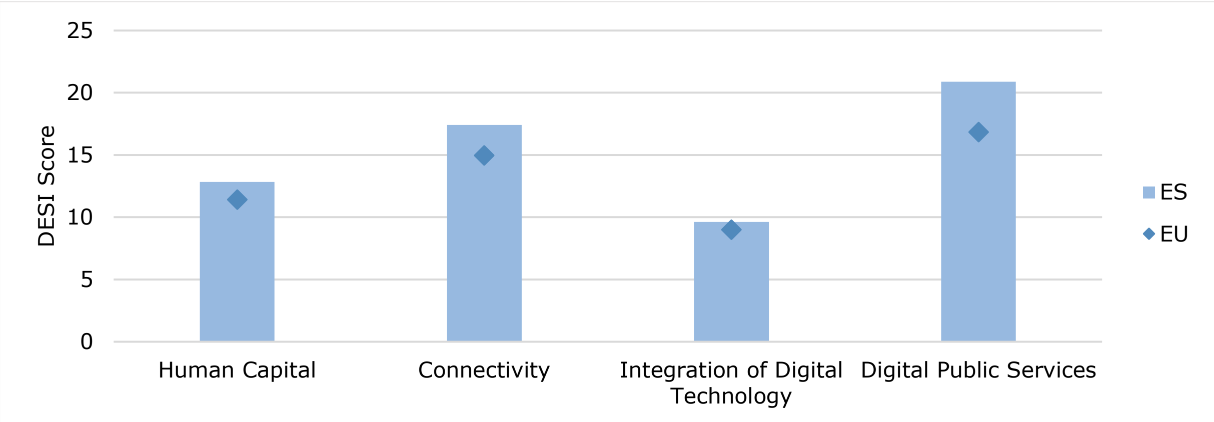
[271] For more information, see https://osha.europa.eu/sites/default/files/2022-01/Spain_Riders_Law_new_regulation_digital_platform_work.pdf

that forms part of the NRRP, the largest share (35.3%) is devoted to employment and skills, with 18.8% allocated to social policies.

ES 3. Other dimensions relevant to the digital transformation

Alongside digital skills and social protection, two key supporting dimensions for a successful digital transformation are (i) the digitalisation of firms and (ii) digital infrastructure and public services. Turning first to the former, the DESI Index (Figure 5) indicates that with regard to the integration of digital technologies in firms, Spain performs slightly above the EU rate, with the country placing 11th among the EU27. This is also reflected in other indicators. Robot density[272] in the economy overall, but particularly in manufacturing, is higher than the EU average[273], though growth over the last decade has been relatively low. Equally, both levels of digital capital intensity [274] in Spanish firms and growth therein over the past decade are higher than the EU average[275]. Overall, **digitalisation of firms is therefore advanced in Spain**. However, Spanish firms are lagging behind when it comes to more advanced technologies like cloud technologies or big data[276]. Several policy initiatives to further advance digitalisation in Spanish businesses have been introduced, including the SME Digitalisation Plan 2021-2025[277]. Within the Spanish NRRP, 23.8% of digital expenditure is allocated to the digitalisation of businesses, particularly focusing on measures to advance digitalisation in SMEs[278].

Figure 5 – DESI Index for ES and the EU



Source: European Commission (2022)

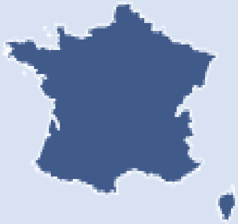
[272] As described in the Annex, based on data from the International Federation of Robotics (2010-2019). Data is not available for Cyprus, Greece, Luxembourg and Slovenia.
[273] For Member States for whom data is available
[274] As described in the Annex, based on data from EU-KLEMS (2008-2018). Data is not available for Cyprus, Croatia, Ireland and Romania.
[275] For Member States for whom data is available
[276] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[277] https://www.lamoncloa.gob.es/lang/en/temas/entrepreneurial-nation/Documents/Spain%20Entrepreneurial%20Nation.pdf
[278] European Commission (2022): Recovery and Resilience Scoreboard Thematic Analysis. SME Support. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/3_SME.pdf

Similarly, **Spain is performing very well when it comes to digital infrastructure and public services**. According to the DESI Index, connectivity levels in Spain are the third highest in the EU, while digital public services rank 5th. The Spanish strategy for the digitalisation of public services is set out in the Plan for the Digitalisation of Spain's public Administration 2021-2025[279]. The NRRP includes measures to further improve connectivity (13.8% of digital expenditure) and digital public services (30.4% of digital expenditure). Connectivity measures include both reforms and investments, focusing particularly on 5G development[280], while the measures for digital public services focus on the digitalisation of administration and services[281].

[279] https://portal.mineco.gob.es/RecursosArticulo/mineco/ministerio/ficheros/210902-digitalisation-of-public-admin-plan.pdf
[280] European Commission (2023); Recovery and Resilience Scoreboard Thematic Analyses. Connectivity. https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_connectivity.pdf
[281] European Commission (2021); Recovery and Resilience Scoreboard Thematic Analyses. Digital public services. Available at :https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/2_Digital.pdf

10. FRANCE: elements of a socially fair digital transformation

Key Points



Labour market: Currently, the sector with the largest employment share in the French economy – the Health and social care sector – has the tenth largest sectoral degree of digital transformation (based on the current digital capital intensity)[282]. The Health and social care sector's employment share in the economy is projected to grow further in the decade to come (slightly more than the EU27 trends). ICT services, Professional services, and Manufacturing are the three sectors with the highest degree of digital transformation currently, and their employment shares, except for Manufacturing, are projected to grow in the decade to come, slightly more than in the EU27. Regarding the risk of automation of occupations, the type of occupation that is most vulnerable is Trades workers.

Digital skills: Levels of digital skills in France are in line with the EU level. Similarly, gaps in digital skill levels between different educational and occupational groups are close to those observed at EU level.

Social protection: France has a relatively comprehensive social protection system, and a rate of the population at risk of poverty significantly lower than the EU rate. Moreover, France is one of the countries that has been most active in regulating the employment status of platform workers.

FR 1. The labour market and the digital transformation

FR 1.1 Sectoral composition (current and forward-looking perspectives)

In France ("FR"), in 2022, the sectors with the largest employment shares in the economy were the Health and social care (13.9% vs 11.0% at the EU27 level), Wholesale and retail trade (13.1% vs 13.6% at the EU27 level), and Manufacturing (11.1% vs 16.0% at the EU27 level) sectors. For the period 2022-2035, Cedefop data projects[283] the annual growth rate of a sector's employment share. For France's Health and social care sector, the annual growth rate is 0.7% (0.6% for

[282] The ranking based on digital capital intensity is used in the key points only when the sector with the largest employment share is not rankable according to the percentage of enterprises that employ ICT specialists.
[283] Own elaboration on Cedefop 'Skill forecast 2023' data.

the EU27), for the Wholesale and retail trade sector it is -0.4% (0.0% for the EU27), and for the Manufacturing sector it is -0.5% (-0.2% for the EU27).

Table 1 presents each sector's employment share in 2022, the projected annual growth rates (2022-2035) of its employment share, and its resulting employment share in the economy by 2035. Along with these elements relating to employment, Table 1 also presents the degree of "digital transformation" of each sector. Table 1 thus enables comparison between the digital transformation of a sector and its employment share or its employment share's prospects. The degree of digital transformation is proxied for each sector in Table 1 using two indicators: i) the percentage of enterprises in the sector that employ ICT specialists and ii) the digital capital intensity[284] of the sector. Table 1 presents the ranking of each sector according to these two proxy indicators (with rank n°1 corresponding to the most digitised sector). According to the first indicator, the three sectors with the highest degree of digital transformation in France, in order, are ICT services (sector's employment share: 3.5% in FR vs 3.7% in the EU27), Professional services (6.5% vs 5.7%), and Manufacturing (11.1% vs 16.0%). According to the second indicator (digital capital intensity), the three sectors with the highest degree of digital transformation, in order, are ICT services (sector's employment share: 3.5% in FR vs 3.7% in the EU27), Professional services (6.5% vs 5.7%), and Finance and insurance (3.4% vs 2.8%). These sectors' employment shares have a projected annual growth rate for 2022-2035 in France of 0.7% for ICT services (vs 0.8% for the EU27), 1.1% for Professional services (vs 0.6% for the EU27), -0.5% for Manufacturing (vs -0.2% for the EU27) and -0.1% for Finance and insurance (vs 0.2% for the EU27).

It should be noted that two of the four sectors with the highest degree of digital transformation – Professional services and ICT services – are also among the top four sectors in terms of the projected annual growth rate of employment share in the decade to come in France[285]. Furthermore, the second and third largest sectors in terms of employment share (in 2022)[286] – Wholesale and retail trade and Manufacturing - rank sixth and third on the first proxy indicator of digital transformation (% of enterprises that employ ICT specialists). Manufacturing also ranks sixth on the second proxy indicator for digital transformation (digital capital intensity).

[284] 'Digital capital intensity' is an index – built in the context of this study – that looks at the ratio between the stock of capital the firms have in software and databases and the overall stock of capital excluding non-residential buildings. Its construction is based on the integrated EUKLEMS & INTANProd database, run by the Luiss Lab of European Economics at Luiss University in Rome, Italy. For more in-depth information on the source, and the availability of the indicator for Member States/sectors, please refer to the Annex.

[285] This is true for both the rankings based on the proxy indicators for digital transformation ('percentage of enterprises with ICT specialists' and 'digital capital intensity').

[286] The first sector in terms of employment share (in 2022) - Health and social care - was not rankable on one of the two proxies of digital transformation (% of enterprises that employ ICT specialists). It ranks tenth with the second proxy indicator for digital transformation (digital capital intensity).

Table 1 – FR. Sector's share of employment, annual growth rate, and ranking of "digital transformation" (the sectors are ranked according to the ranking in the last column of the table).

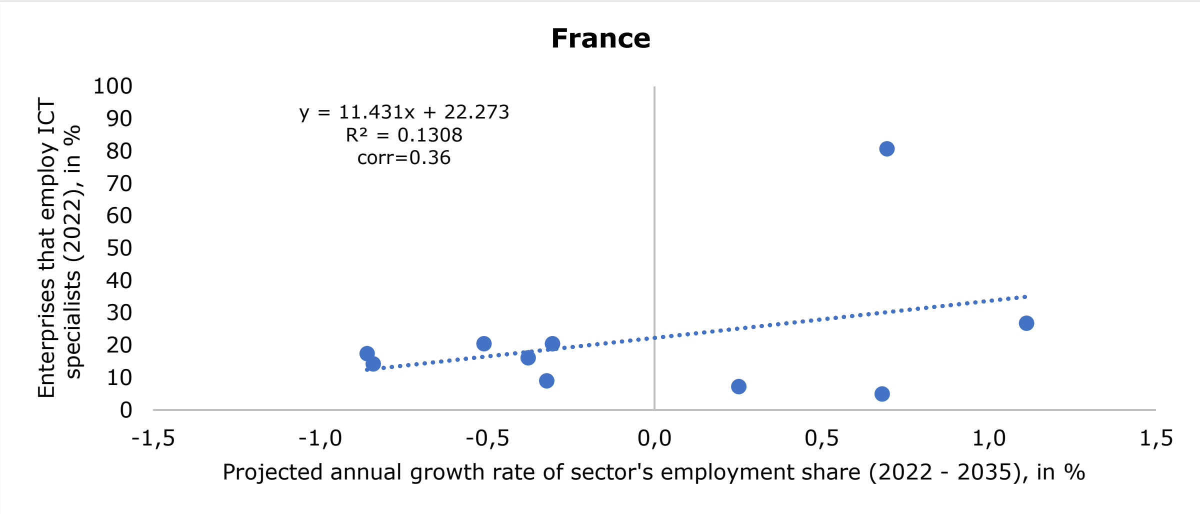
Sectors	Sector's employment share in 2022 (%)		Projected annual growth rate of the sector's employment share (2022 - 2035, %)		Projected sector's employment share in 2035 (%)		Proxy 1 for digital transformation (ranking)	Proxy 2 for digital transformation (ranking)
	FR	**EU**	**FR**	**EU**	**FR**	**EU**	**% enterprises that employ ICT specialists**	**Digital capital intensity**
J - ICT services	3.5	3.7	0.7	0.8	3.8	4.2	1	1
M - Professional services	6.5	5.7	1.1	0.6	7.6	6.3	2	2
K - Finance & insurance	3.4	2.8	-0.1	0.2	3.4	2.8	n.a.	3
C - Manufacturing	11.1	16.0	-0.5	-0.2	10.3	15.6	3	4
N - Administrative services	4.3	4.1	-0.8	0.0	3.8	4.1	7	5
G - Wholesale & retail trade	13.1	13.6	-0.4	0.0	12.5	13.6	6	6
F - Construction	6.5	6.8	0.7	-0.3	7.2	6.5	10	7
H - Transport & storage	5.1	5.3	-0.3	-0.1	4.9	5.3	8	8
P - Education	7.6	7.4	-0.2	0.3	7.4	7.7	n.a.	9
Q - Health & social care	13.9	11.0	0.7	0.6	15.3	11.9	n.a.	10
B - Mining & quarrying	0.1	0.3	-2.3	-1.7	0.1	0.2	n.a.	11
D - Energy supply services	0.7	0.7	-0.3	0.1	0.6	0.8	4	12
R - Arts & recreation and other services	2.2	1.7	0.1	0.3	2.2	1.7	n.a.	13
E- Water and waste treatment	0.8	0.8	-0.9	-0.1	0.7	0.8	5	14
O - Public sector & defence	8.3	7.1	-0.4	-0.1	7.8	7.0	n.a.	15
I - Accommodation & food	4.1	4.5	0.3	0.6	4.2	4.9	9	n.a.
S - Other service activities	3.0	2.6	0.9	0.0	3.3	2.6	n.a.	n.a.
A - Agriculture, forestry & fishing	2.4	3.5	-1.7	-3.1	1.9	2.3	n.a.	n.a.
L - Real Estate	1.2	0.9	-0.1	0.9	1.2	1.0	n.a.	n.a.
T - Activities of households as employers	0.8	0.9	0.6	-0.3	0.9	0.9	n.a.	n.a.
U - Activities of extraterritorial org.	0.1	0.1	n.a.	n.a.	0.1	0.1	n.a.	n.a.

Source: For the employment-related indicators own elaboration on Eurostat data (share of employment, 2022 calculated based on lfsa_egan) and on Cedefop 'Skill forecast data 2023' (annual growth rate of sector's employment share, 2022-2035), for the digital transformation-related indicators: own elaboration on Eurostat data (share of enterprises that employ ICT specialists, Eurostat code: lfsa_egais) and on EUKLEMS & INTANProd data (digital capital intensity).
Note: In the first column of the table, the letter preceding the sectors is the code of the NACE Rev.2 classification. In the last two columns of the table, the two proxy indicators used for digital transformation are: i) the share of enterprises that employ ICT specialists (Eurostat code: lfsa_egais) and ii) the digital capital intensity (EUKLEMS & INTANProd data, average 2014-2017) with rank n°1 corresponding to the most digitally intense sector.

In complement to Table 1, Figures 1a and 1b below further explore the potential relationship between the projected annual growth rates of the sectors' employment shares in the economy and their degree of digital transformation[287].

In **Figure 1a**, we present a scatterplot using the first proxy of digital transformation used (percentage of enterprises that employ ICT specialists) and the projected annual growth rate of a sector's employment share between 2022-2035. The correlation is positive - 0.36 - but not statistically significant (it is 0.62 and statistically significant for the EU27). **The statistically insignificant result implies that an association between the percentage of enterprises in a sector that employ ICT specialists and that sector's projected annual employment share growth rate cannot be inferred at the sectoral level in France.**

Figure 1a – FR. Relationship between the percentage of enterprises that employ ICT specialists (in 2022) and the projected annual growth rate of sector's employment share (2022-2035).

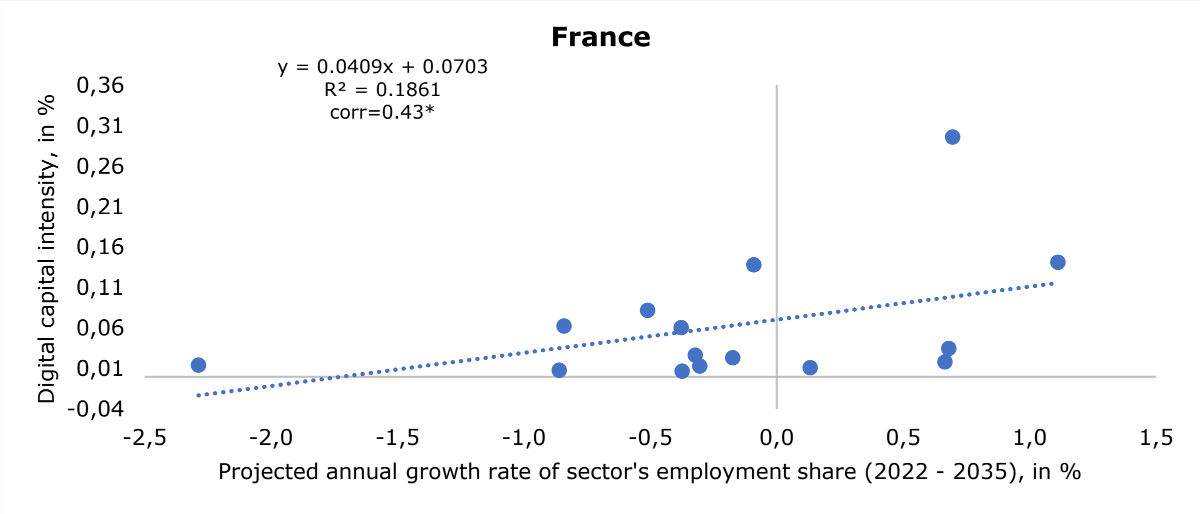


Source: Own elaboration on Eurostat and Cedefop 'Skill forecast 2023' data.

Figure 1b shows the correlation between the second digital transformation proxy ('digital capital intensity') and the projected annual growth rate of a sector's employment share between 2022-2035. The correlation coefficient is 0.43 and is statistically significant in France. Among the 16 Member States for which the 'digital capital intensity' can be computed (7 of which present a positive and significant correlation), France has the fifth strongest. **The positive correlation could suggest that, in France, the employment shares of those sectors with a higher 'digital capital intensity' are more likely to experience a higher rate of growth (over 2022-2035) than those of other sectors.** However, the relationship is only moderately strong and below the average of the seven Member States presenting a positive correlation. As before, this correlation does not imply causal links.

[287] With the caveat that the correlation coefficients presented in Figure 1a and Figure 1b cannot be directly compared, as they pertain to a combination of sectors that varies across different Member States.

Figure 1b – FR. Relationship between 'digital capital intensity' and the projected annual growth rate of sector's employment share (2022-2035).



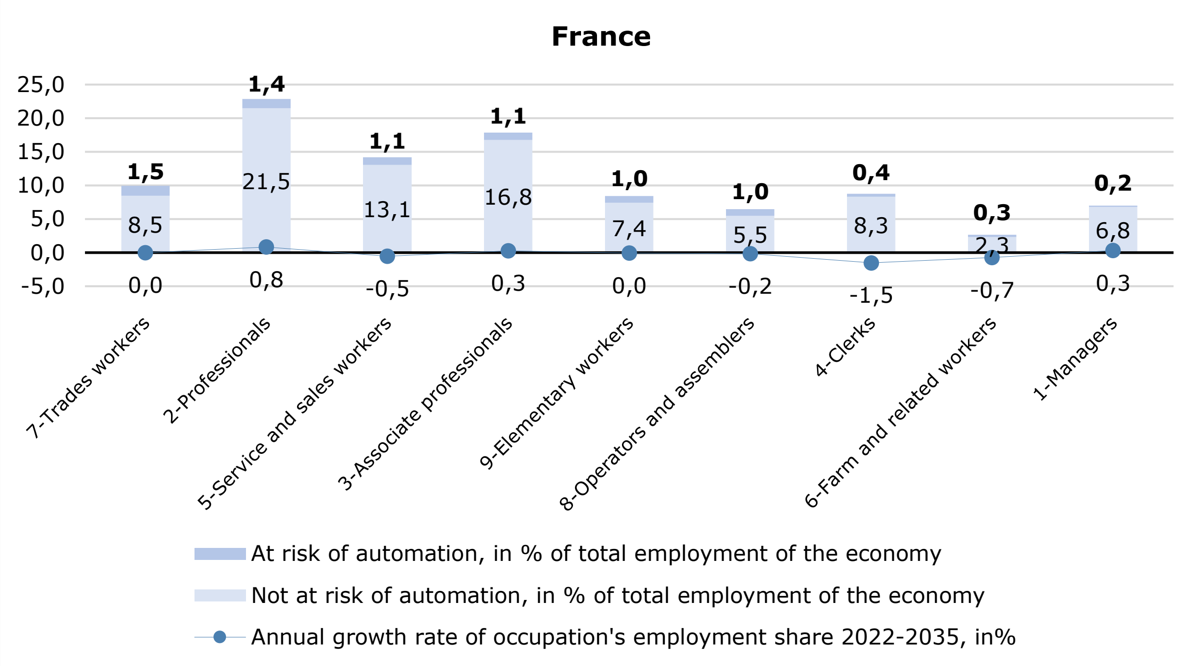
Source: Own elaboration on EUKLEMS & INTANProd, and Cedefop 'Skill forecast 2023' data.

FR 1.2 Occupational composition at ISCO-08 1 digit and risk of automation (current and forward-looking perspectives)

Different types of occupations are subject to differing levels of automation risk. Cedefop developed[288] a "risk of automation" index by occupation at the EU27 level, with the most recent data available for 2022[289]. We apply this indicator at the Member State level, with the assumption that the risk of automation for a given occupation is constant across Member States[290]. As such, Member State variation in the overall susceptibility of the workforce to automation (overall risk across all occupations in that Member State) will be due to the employment composition effect, meaning that while the automation risk for a given occupation stays constant across Member States, the overall automation risk of a Member State will naturally be greater for those Member States having more employment in occupations that have a higher automation risk.

[288] Based on the methodology in Pouliakas, K. (2018) "The risk of automation in EU labour markets: a skill-requirements approach", in Economy, Employment and Skills: European and global perspectives in an age of uncertainty, Fondazione Giacomo Brodolini Quaderni Series, also IZA DP 11829.
[289] As retrieved at https://www.cedefop.europa.eu/en/tools/skills-intelligence/automation-risk-occupations#1
[290] While this assumption may be considered strong, Cedefop data are the only ones available that are at the same time, up to date and available for all the occupations at the ISCO-08 level.

Figure 2 – FR. Employment shares of occupations (at ISCO-08 1 digit level) - split into sub shares 'not at risk' and 'at risk' of automation (2022) - and projected annual growth rate



Source: Own elaboration on Cedefop data (risk of automation calculated by Cedefop at EU27 level by ISCO-08 1 digit level for 2022) applied to Eurostat data (share of employment by occupation, lfsa_egais, 2022).
Note: The numbers preceding the occupations are the ISCO-08 codes. Occupations are ranked from the highest to the lowest share of workers that present a risk of automation. The vertical sum of the two components (darker blue and lighter blue) gives back the total employment share by occupation (in % of total employment in the Member State). The ISCO nomenclature used in the text and the figure is the Cedefop one. For examples of specific occupations see: https://esco.ec.europa.eu/en/classification/occupation_main.

As can be seen in **Figure 2**, in France, the occupation with the largest employment sub-share (in % of total employment in the economy) 'at risk of automation' is Trades workers, with said employment sub-share representing 1.5% of total employment in the country (vs 1.3% for the EU27). The second largest employment sub-share of workers 'at risk of automation' are Professionals, representing 1.4% of total employment in France (vs 1.3% for the EU27). Ranking third are Service and sales workers, with a share of workers 'at risk' of 1.1% in total employment in France (vs 1.3% for the EU27). **These three occupations are also the most affected across the EU27.**

For **ICT professionals (ISCO 25)**[291], the 2022 employment share is 2.7% in France (vs 2.3% in the EU27) and comprises an employment sub-share of 0.2% (vs 0.1% in the EU27) 'at risk of automation', and the remaining employment sub-share of 2.5% (vs 2.2% at EU27 level) 'not at risk of automation'. The projected annual growth rate 2022-2035 of the employment share of ICT professionals is 2.0% in France (vs 1.9% in EU27).

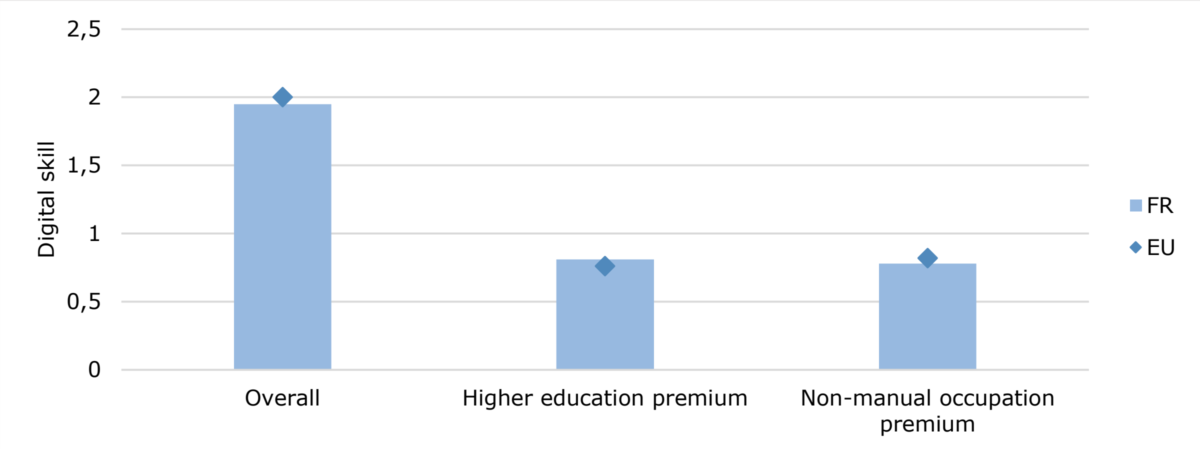
[291] Eurostat code: lfsa_egai2d.

FR 2. Key policy dimensions for a socially fair digital transformation

FR 2.1 Digital skills

A first key policy dimension when it comes to ensuring a socially fair digital transformation is the level of digital skills in the population. **With regard to digital skills, France places in the mid-field of EU countries**, being ranked 16th in the study's estimated index of digital skills[292] (Figure 3, bar "Overall"), and 12th in the DESI Index[293] for Human capital (Figure 5, section "Other dimensions"). Similarly, digital divides in the form of differences in digital skill between individuals with different levels of education ("Higher education premium" in Figure 3) or in different occupations ("Non-manual occupation premium" in Figure 3) are in line with the EU level. France ranks 16th and 13th in the EU27, respectively, with regard to these indicators.

Figure 3 – Estimated Digital Skills in FR and the EU (2019)



Source: Authors' own estimation based on Eurostat ICT survey
Note: Higher education premium refers to the difference in digital skills between individuals with tertiary and lower than tertiary education. Non-manual occupation premium refers to the difference in digital skills between individuals in manual and non-manual occupations.

Considering policy action on digital skills, in 2018, France launched the National Plan for Digital Inclusion[294], which aims to support the development of a safe and human-centric digital society. Among other measures, the plan includes the provision of support and training in digital subjects to 1.5 million people, as well as providing 4.5 million French citizens with basic digital skills. Within planned digital expenditure as part of the French NRRP, which amounts to 22.2% of total NRRP expenditure, 22.3% are allocated to the human capital dimension. The plan includes substantial investment in skills development, including initiatives focused on digital skills, such as a digital inclusion initiative for providing citizens with

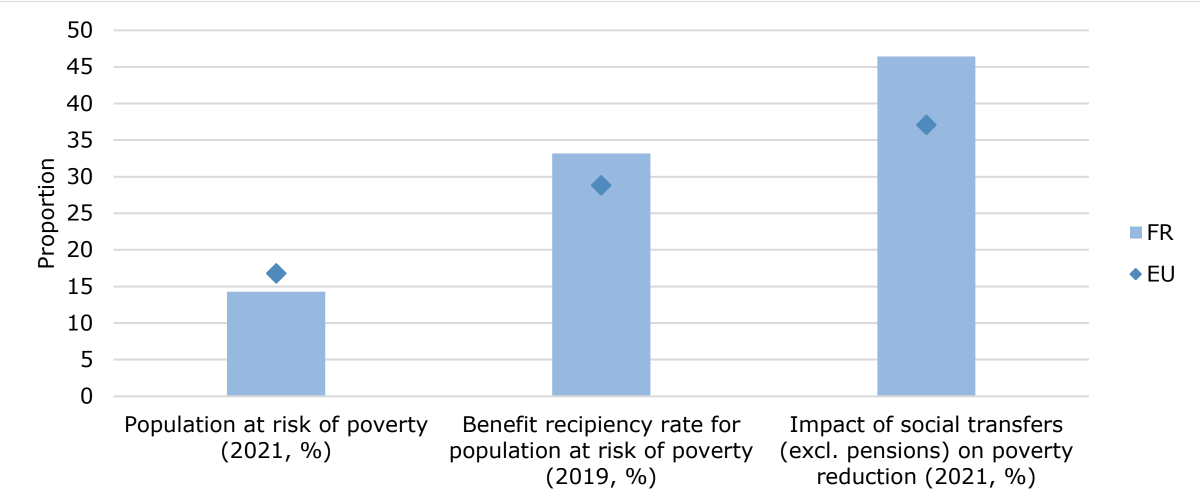
[292] The construction of the digital skill index is described in detail in the introductory section.
[293] European Commission (2022). Digital Economy and Society Index. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi
[294] For more information, see https://societenumerique.gouv.fr/fr/#:~:text=L'Etat%20mobilise%2010%20millions,privé%20et%20les%20collecitivtés%20territoriales.

digital skills and additional funding for individual learning accounts to facilitate digital skills training[295].

FR 2.2 Social protection and social policy

In addition to high levels of digital skills in the population, more encompassing social protection systems may be a way for countries to mitigate the potential effects of digital transformation on poverty and inequality. **Relative to the rest of the EU, France has a fairly well-developed social protection system (Figure 4)**. The rate of the population at risk of poverty after social transfers (14.3%) is significantly lower than the EU27 rate[296] (16.7%). Furthermore, both the benefit recipiency rate for the population at risk of poverty[297] (33.2%) and the impact of social transfers on poverty reduction[298] (46.4%) put the country in the ten best-performing countries in the EU. Moreover, looking specifically at platform work, France has been one of the EU countries most active in the regulation of employment status[299].

Figure 4 – Social Protection in FR and the EU



Source: Eurostat (2023) and JRC (2022)

In its national implementation plan for the Recommendation on access to social protection[300], the French government sets out further measures, already implemented, to increase formal and effective coverage as well as adequacy of

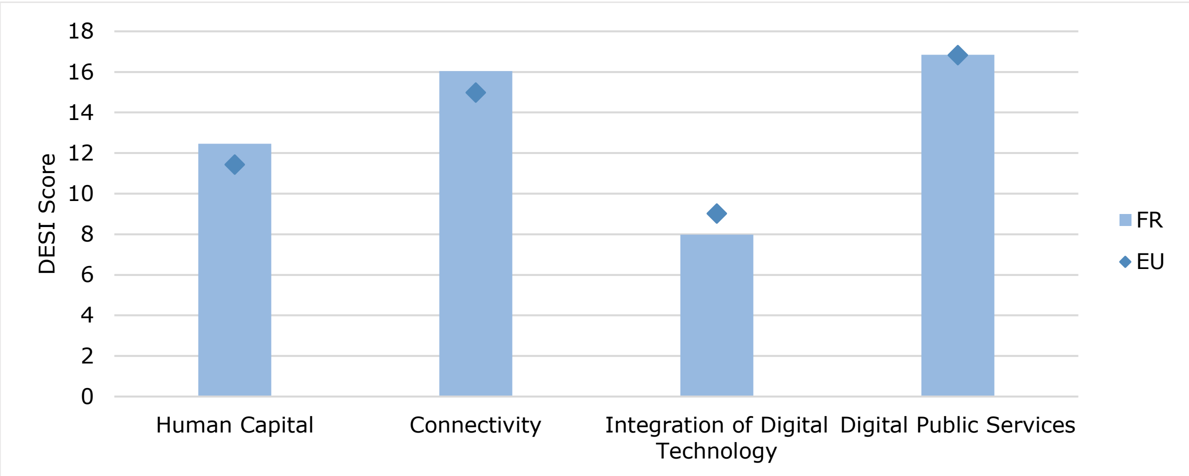
[295] European Commission (2022); Recovery and Resilience Scoreboard Thematic Analyses. Digital Skills. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_digital_skills.pdf
[296] Eurostat (2023). TPS00184: At-risk-of-poverty rate after social transfers by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/tps00184/default/table?lang=en
[297] Eurostat indicator as re-elaborated by JRC (2022) "Monitoring the effective coverage and adequacy of social protection in the EU".
[298] Eurostat (2023). TESPM050:Impact of social transfers (excluding pensions) on poverty reduction by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/TESPM050/bookmark/table?lang=en&bookmarkId=b001ae62-ce34-4b49-9741-28a3ef99477f
[299] PPMI (2021). Study to support the impact assessment on improving working conditions in platform work. Available at: https://ec.europa.eu/social/main.jsp?catId=738&furtherPubs=yes&langId=en&pubId=8428
[300] European Commission (2023). Access to social protection. Available at: https://ec.europa.eu/social/main.jsp?catId=1312&langId=en=en

social protection[301]. These measures address all or most of the gaps in social protection. The NRRP contains no further measures specifically aimed at social protection, but contains broader social expenditure, the largest share of which are aimed at employment and skills (43.8%) and health and long term care (36.6%).

FR 3. Other dimensions relevant to the digital transformation

Beyond digital skills and social protection, other contextual factors can play an important role in the digital transformation. That includes the digitalisation of firms as well as digital infrastructure and digital public services. France fares below the EU average when it comes to the digitalisation of firms, ranking 20th among EU member states, according to the DESI Index (Figure 5), though it is advanced in the uptake of some specific technologies, such as cloud[302]. Other indicators reflect this mixed picture with regard to digitalisation of firms. Robot density in France in the overall economy is below the EU average[303], but in manufacturing, it is relatively high. However, growth in robot density, including in manufacturing, has been much lower than in other countries in the past decade. More positively, levels of digital capital intensity are significantly higher than in other countries, with growth in line with the EU average[304]. Within the French NRRP, only 8.2% of overall expenditure is dedicated to the digitalisation of businesses. However, the plan does include specific measures to facilitate the digital upgrading of SMEs[305]. More broadly, France has developed several strategies to invest in advanced technologies, including AI, cloud and quantum technology, as well as a cybersecurity strategy[306].

Figure 5 – DESI Index for FR and the EU (2022)



Source: European Commission (2022)

[301] https://ec.europa.eu/social/main.jsp?langId=en&catId=750&furtherNews=yes&newsId=10502
[302] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[303] Average drawn from Member States for which data was available
[304] Average drawn from Member States for which data was available
[305] European Commission (2022): Recovery and Resilience Scoreboard Thematic Analysis. SME Support. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/3_SME.pdf
[306] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance

With respect to digital infrastructure and public services, results are also of a mixed nature. The DESI Index indicates that France has one of the highest levels of connectivity in the EU, placing the country fifth in the EU27. However, digital public services are less developed, with France ranking slightly below the EU rate (in 15th place). The digital expenditure contained within the French NRRP places significant emphasis on digital public services (36.6%), however, as well as some investment in connectivity (6.2%), largely targeted at improving connectivity in rural areas[307]. Measures on digital public services focus on the digitalisation of the state and territories, an e-identity system and digitalisation of health[308].

[307] European Commission (2023); Recovery and Resilience Scoreboard Thematic Analyses. Connectivity. https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_connectivity.pdf

[308] European Commission (2021); Recovery and Resilience Scoreboard Thematic Analyses. Digital public services. Available at :https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/2_Digital.pdf

11. CROATIA: elements of a socially fair digital transformation

Key Points

Labour market: Currently, the sector with the largest employment share in the economy – the Manufacturing sector – also has the seventh highest degree of digital transformation (based on the current percentage of enterprises in a sector that employ ICT specialists). The Manufacturing sector's employment share in the economy is projected to grow further in the decade to come (slightly more than EU27 trends). ICT services, Energy supply services, and Water and waste treatment are the three sectors with the highest degree of digital transformation currently, and their employment shares, except for Water and waste treatment, are projected to grow in the decade to come, slightly more than in the EU27. Trades workers are those whose occupations are most at risk of their occupation being automated.

Digital skills: The overall level of digital skills in Croatia is high. However, while digital skill divides between occupational groups are not very pronounced, those between individuals with different levels of education are among the largest in the EU.

Social protection: Croatian social protection appears somewhat insufficiently developed, the rate of the population at risk of poverty being significantly higher than the EU rate. A new Labour Law including regulation for platform work has been introduced as part of the Croatian NRRP.

HR 1. The labour market and the digital transformation

HR 1.1 Sectoral composition (current and forward-looking perspectives)

In Croatia ("HR"), in 2022, the sectors with the largest employment shares in the economy were the Manufacturing (18.0% vs 16.0% at the EU27 level), Wholesale and retail trade (13.9% vs 13.6% at the EU27 level), and Education (8.0% vs 7.4% at the EU27 level) sectors. For the period 2022-2035, Cedefop data projects[309] the annual growth rate of a sector's employment share. For Croatia's Manufacturing sector, the annual growth rate is 0.2% (-0.2% for the EU27), for the Wholesale and retail trade sector it is -0.3% (0.0% for the EU27), and for the Education sector, it is -0.4% (0.3% for the EU27).

[309] Own elaboration on Cedefop 'Skill forecast 2023' data.

Table 1 presents each sector's employment share in 2022, the projected annual growth rates (2022-2035) of its employment share, and its resulting employment share in the economy by 2035. Along with these elements relating to employment, Table 1 also presents the degree of "digital transformation" of each sector. Table 1 thus enables comparison between the digital transformation of a sector and its employment share or its employment share's prospects. The degree of digital transformation is proxied for each sector in Table 1 using the percentage of enterprises that employ ICT specialists in a sector. Table 1 presents the ranking of each sector according to this indicator (with rank n°1 corresponding to the most digitised sector). The three sectors with the highest degree of digital transformation in Croatia, in order, are ICT services (sector's employment share: 3.4% in HR vs 3.7% in the EU27), Energy supply services (0.9% vs 0.7%), and Water and waste treatment (1.7% vs 0.8%). These sectors' employment shares have a projected annual growth rate for 2022-2035 in Croatia of 2.2% for ICT services (vs 0.8% for the EU27), 0.5% for Energy supply services (vs 0.1% for the EU27), and -0.3% for Water and waste treatment (vs -0.1% for the EU27).

As can be seen from Table 1, two of the top four sectors in terms of digital transformation – ICT services and Professional services – are also among the four sectors with the largest projected annual growth rate of employment share over the next decade in Croatia. Furthermore, the first and the second largest sectors by employment share – Manufacturing and Wholesale and retail trade - rank seventh and sixth on the only proxy indicator of digital transformation available (% of enterprises that employ ICT specialists).

Table 1 – HR. Sector's share of employment, annual growth rate, and ranking of "digital transformation" (the sectors are ranked according to the ranking in the "proxy 1" column of the table).

Sectors	Sector's employment share in 2022 (%)		Projected annual growth rate of the sector's employment share (2022 - 2035, %)		Projected sector's employment share in 2035 (%)		Proxy 1 for digital transformation (ranking)	Proxy 2 for digital transformation (ranking)
	HR	**EU**	**HR**	**EU**	**HR**	**EU**	**% enterprises that employ ICT specialists**	**Digital capital intensity**
J - ICT services	3.4	3.7	2.2	0.8	4.6	4.2	1	n.a.
D - Energy supply services	0.9	0.7	0.5	0.1	1.0	0.8	2	n.a.
E- Water and waste treatment	1.7	0.8	-0.3	-0.1	1.7	0.8	3	n.a.
M - Professional services	4.2	5.7	1.9	0.6	5.4	6.3	4	n.a.
N - Administrative services	2.8	4.1	-0.6	0.0	2.6	4.1	5	n.a.
G - Wholesale & retail trade	13.9	13.6	-0.3	0.0	13.3	13.6	6	n.a.
C - Manufacturing	18.0	16.0	0.2	-0.2	18.5	15.6	7	n.a.
H - Transport & storage	6.4	5.3	-0.1	-0.1	6.3	5.3	8	n.a.
I - Accommodation & food	6.2	4.5	0.5	0.6	6.6	4.9	9	n.a.
F - Construction	7.5	6.8	-0.7	-0.3	6.8	6.5	10	n.a.
A - Agriculture, forestry & fishing	5.6	3.5	-1.8	-3.1	4.3	2.3	n.a.	n.a.
B - Mining & quarrying	0.2	0.3	0.4	-1.7	0.2	0.2	n.a.	n.a.
K - Finance & insurance	1.9	2.8	-0.2	0.2	1.9	2.8	n.a.	n.a.
L - Real Estate	0.4	0.9	5.6	0.9	0.8	1.0	n.a.	n.a.

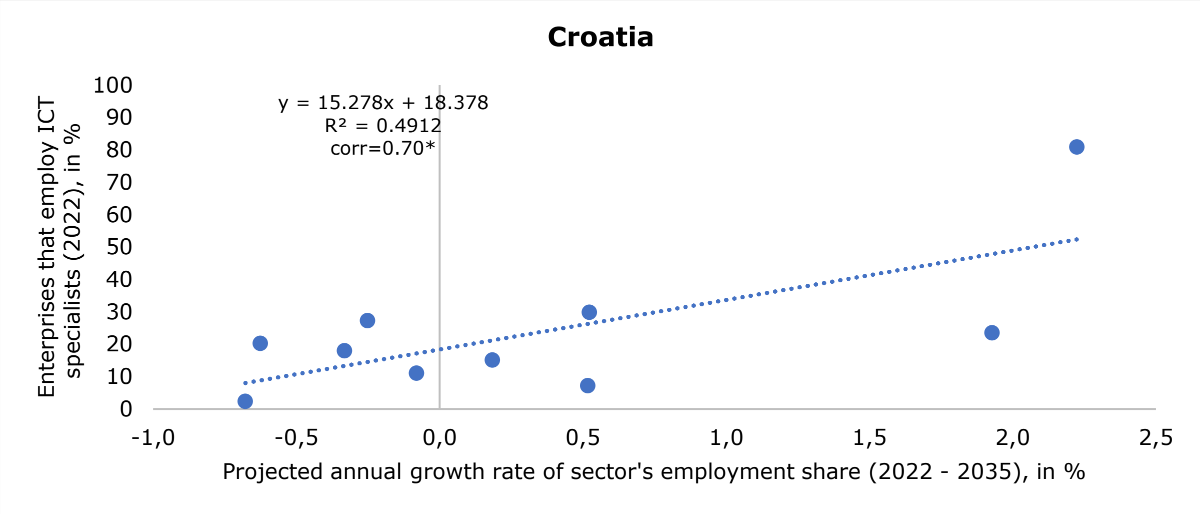
O - Public sector & defence	6.6	7.1	-0.3	-0.1	6.3	7.0	n.a.	n.a.
P - Education	8.0	7.4	-0.4	0.3	7.6	7.7	n.a.	n.a.
Q - Health & social care	7.7	11.0	0.4	0.6	8.1	11.9	n.a.	n.a.
R - Arts & recreation and other services	1.7	1.7	0.0	0.3	1.7	1.7	n.a.	n.a.
S - Other service activities	2.4	2.6	1.3	0.0	2.9	2.6	n.a.	n.a.
T - Activities of households as employers	n.a.	0.9	0.9	-0.3	n.a.	0.9	n.a.	n.a.
U - Activities of extraterritorial org.	n.a.	0.1	n.a.	n.a.	n.a.	0.1	n.a.	n.a.

Source: For the employment-related indicators own elaboration on Eurostat data (share of employment, 2022 calculated based on lfsa_egan) and on Cedefop 'Skill forecast data 2023' (annual growth rate of sector's employment share, 2022-2035), for the digital transformation-related indicators: own elaboration on Eurostat data (share of enterprises that employ ICT specialists, Eurostat code: lfsa_egais) and on EUKLEMS & INTANProd data (digital capital intensity).
Note: In the first column of the table, the letter preceding the sectors is the code of the NACE Rev.2 classification. In the last two columns of the table, the two proxy indicators used for digital transformation are: i) the share of enterprises that employ ICT specialists (Eurostat code: lfsa_egais) and ii) the digital capital intensity (EUKLEMS & INTANProd data, average 2014-2017) with rank n°1 corresponding to the most digitally intense sector.

Figure 1 below complements Table 1, further enabling a comparison between the projected annual growth rates of the sectors' employment shares in the economy and their digital transformation.

In **Figure 1**, we present a scatterplot to shed light on the relationship between the proxy of digital transformation (percentage of enterprises that employ ICT specialists) and the projected annual growth rate of a sector's employment share between 2022-2035. The correlation is positive, and statistically significant in Croatia, with a value of 0.70 (it is of 0.62 and statistically significant for the EU27). Among the ten Member States with a significant correlation, Croatia has the fifth strongest correlation. **The positive correlation could suggest that the employment shares of those sectors with a higher percentage of enterprises that employ ICT specialists are more likely to experience a higher rate of growth between 2022 and 2035 than those of other sectors.** The correlation is strong and stronger than the one at the EU27 level. Nevertheless, it does not imply causal links.

Figure 1 – HR. Relationship between the percentage of enterprises that employ ICT specialists (in 2022) and the projected annual growth rate of sector's employment share (2022-2035).



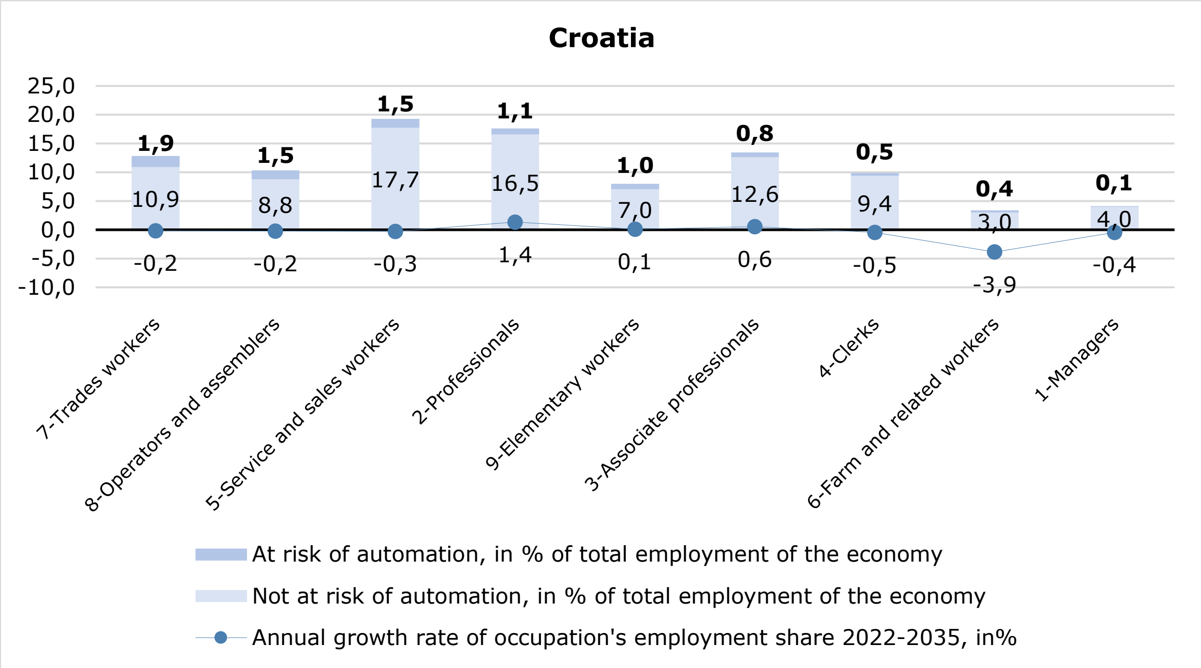
Source: Own elaboration on Eurostat and Cedefop 'Skill forecast 2023' data.

HR 1.2 Occupational composition at ISCO-08 1 digit and risk of automation (current and forward-looking perspectives)

Different occupations are subject to differing levels of automation risk. Cedefop developed[310] a "risk of automation" index by occupation at the EU27 level, most recently updated for 2022[311]. We apply this indicator at the Member State level, with the assumption that the risk of automation for a given occupation is constant across Member States[312]. As such, the variation across Member States in the overall susceptibility of the Member State workforce to automation (overall risk across all occupations in that Member State) will be due to the employment composition effect, meaning that while the automation risk for a given occupation stays constant across Member States, the overall automation risk of a Member State will naturally be greater for those Member States having more employment in occupations that have a higher automation risk.

[310] Based on the methodology in Pouliakas, K. (2018) "The risk of automation in EU labour markets: a skill-requirements approach", in Economy, Employment and Skills: European and global perspectives in an age of uncertainty, Fondazione Giacomo Brodolini Quaderni Series, also IZA DP 11829.
[311] As retrieved at https://www.cedefop.europa.eu/en/tools/skills-intelligence/automation-risk-occupations#1
[312] While this assumption may be considered strong, Cedefop data are the only ones available that are at the same time, up to date and available for all the occupations at the ISCO-08 level.

Figure 2 – HR. Employment shares of occupations (at ISCO-08 1 digit level) - split into sub shares 'not at risk' and 'at risk' of automation (2022) - and projected annual growth rate



Source: Own elaboration on Cedefop data (risk of automation calculated by Cedefop at EU27 level by ISCO-08 1 digit level for 2022) applied to Eurostat data (share of employment by occupation, lfsa_egais, 2022).
Note: The numbers preceding the occupations are the ISCO-08 codes. Occupations are ranked from the highest to the lowest share of workers that present a risk of automation. The vertical sum of the two components (darker blue and lighter blue) gives back the total employment share by occupation (in % of total employment in the Member State). The ISCO nomenclature used in the text and the figure is the Cedefop one. For examples of specific occupations see: https://esco.ec.europa.eu/en/classification/occupation_main

As can be seen in **Figure 2**, in Croatia, the occupation with the largest employment sub-share (in % of total employment in the economy) 'at risk of automation' is Trades workers, with the employment sub-share 'at risk of automation' representing 1.9% of total employment in the country (vs 1.3% for the EU27). The second largest employment sub-share 'at risk of automation' is for Operators and assemblers, with an employment sub-share 'at risk' of 1.5% of total employment in Croatia (vs 1.1% for the EU27). Ranking third are Service and sales workers, with a share of workers 'at risk' of 1.5% in total employment in Croatia (vs 1.3% for the EU27). **Among these three occupations, the first and the third ones are also the most affected across the EU27[313].**

For **ICT professionals (ISCO 25)**[314], the 2022 employment share is 1.5% in Croatia (vs 2.3% in the EU27) and comprises an employment sub-share of 0.1% (vs 0.1% in the EU27) 'at risk of automation', and a remaining employment sub-share of 1.4% (vs 2.2% at EU27 level) 'not at risk of automation'. The projected annual growth rate 2022-2035 of the employment share of ICT professionals is 3.0% in Croatia (vs 1.9% in EU27).

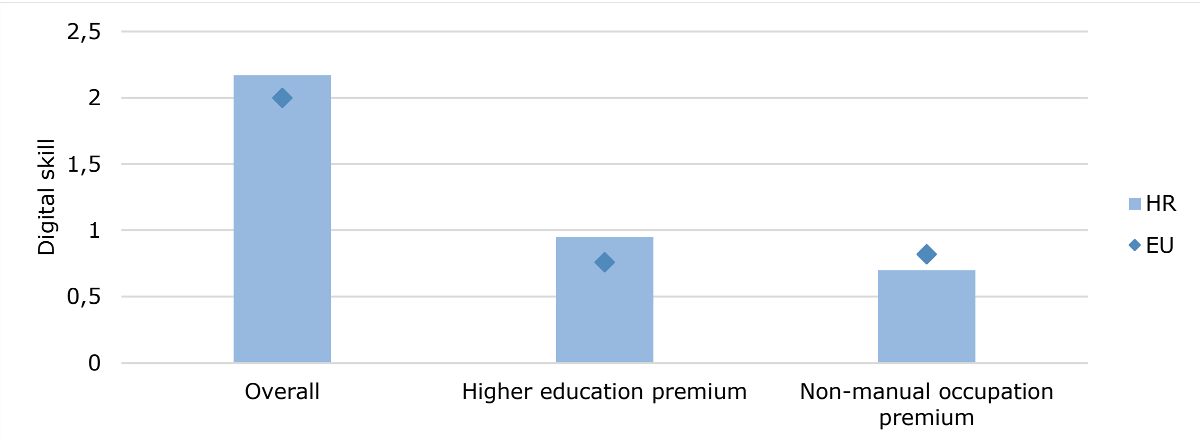
[313] The most affected in the EU27 are Trades workers, Professionals, and Service and sales workers.
[314] Eurostat code: lfsa_egai2d.

HR 2. Key policy dimensions for a socially fair digital transformation

HR 2.1 Digital skills

A first significant policy dimension influencing the extent to which the digital transformation is socially fair is the level of digital skills of the population. Overall, the level of digital skills, as measured by the DESI index[315] on human capital (see Figure 5, section "Other dimensions") is higher than the EU27 average, placing the country ninth in the EU27. This is confirmed by the overall index of digital skills[316] (Figure 3, bar "Overall") where digital skills in Croatia are at the seventh highest level in the EU27. Moreover, digital divides between individuals in manual and non-manual occupations are less pronounced than the EU rate ("Non-manual occupation premium" in Figure 3), with Croatia ranking seventh in the EU27. However, differences in digital skills between individuals with and without a higher education degree are among the most pronounced in the EU ("Higher education premium" in Figure 3; Croatia ranks 24th in the EU27). While this is concerning, overall, **the high level of digital skills in Croatia should be a strength for the country with regard to managing the labour market impact of the digital transformation**.

Figure 3 – Estimated Digital Skills in HR and the EU (2019)



Source: Authors' own estimation based on Eurostat ICT survey
Note: Higher education premium refers to the difference in digital skills between individuals with tertiary and lower than tertiary education. Non-manual occupation premium refers to the difference in digital skills between individuals in manual and non-manual occupations.

Croatia has set up several policy initiatives to strengthen investment in human capital. The 'National Development Strategy of the Republic of Croatia until 2030'[317] envisages four priorities with regard to digital skills: i) digital skills for all citizens (increasing the degree of citizens' basic and advanced digital skills and their participation in digital economy and society); ii) digital skills for the labour force (enhancing the development of digital skills, encouraging the growth of

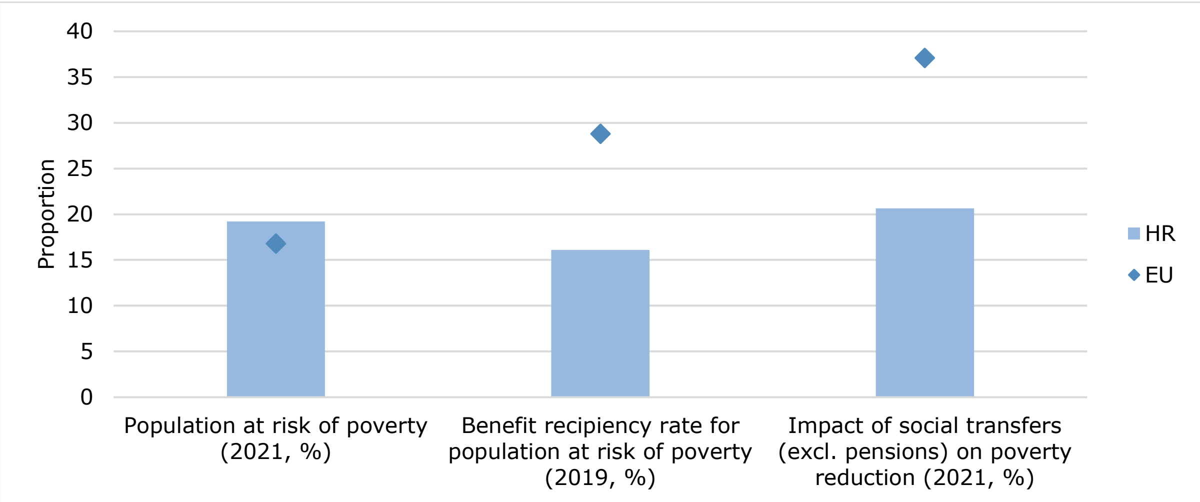
[315] European Commission (2022). Digital Economy and Society Index. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi
[316] The construction of the digital skill index is described in detail in the introductory section.
[317] For more information, see https://hrvatska2030.hr/ Financed by national funds and co-financed by the Operational Program Competitiveness and Cohesion, from the European Regional Development Fund.

digital jobs, increasing digital skills in non-technical and non-ICT occupations, re-skilling employees in acquiring digital skills); iii) digital skills for ICT professionals; iv) digital skills in education. The NRRP for Croatia also includes plans for further investment in human capital[318] as part of the digital pillar (10.2% share of total digital expenditure). The plan includes investments in digital skills development through the educational system and in the labour market. Focusing on the latter, several labour market measures are envisioned, including a voucher system for up- and reskilling and labour market support measures for green and digital skills.

HR 2.2 Social protection and social policy

In addition to digital skills, a robust social protection system can be essential in managing the potential labour market impact of digitalisation. However, relative to the rest of the EU, Croatia is relatively badly positioned in this regard (Figure 4). The rate of the population at risk of poverty after social transfers (19.2%)[319] is the ninth highest in the EU. Furthermore, Croatia is among the countries with comparatively very low benefit recipiency rates for the population at risk of poverty before social transfers (16.1%)[320] and impact of social transfers on poverty reduction (20.7%)[321]. This points to the **limited effectiveness of the social protection system in protecting against poverty, which may be a shortcoming in terms of protecting individuals against adverse poverty and inequality effects of the digital transformation**.

Figure 4 – Social Protection in HR and the EU



Source: Eurostat (2023) and JRC (2022)

[318] European Commission (2022); Recovery and Resilience Scoreboard Thematic Analyses. Digital Skills. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_digital_skills.pdf
[319] Eurostat (2023). TPS00184: At-risk-of-poverty rate after social transfers by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/tps00184/default/table?lang=en
[320] Eurostat indicator as re-elaborated by JRC (2022) "Monitoring the effective coverage and adequacy of social protection in the EU".
[321] Eurostat (2023). TESPM050:Impact of social transfers (excluding pensions) on poverty reduction by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/TESPM050/bookmark/table?lang=en&bookmarkId=b001ae62-ce34-4b49-9741-28a3ef99477f

The Croatian national implementation plan for the Recommendation on access to social protection[322] contains some planned measures to improve the formal coverage of social protection, but none to address effective coverage, adequacy or transparency. As such, existing gaps in access to social protection are not likely to be addressed by these measures[323]. Within the Croatian NRRP, social expenditure constitutes 20% of total expenditure. The largest share of this expenditure by far is devoted to investment in education and childcare (53%), while 15.1% are targeted at employment and skills measures and 4.2% at social policies. Looking specifically at social protection, the plan includes measures to increase the coverage, adequacy and targeting of social benefits, as well as the development of a national application system to increase transparency[324]. Furthermore, the plan includes a **new Labour Law to regulate platform work as a specific form of work and the rights and obligations arising from it, including, among others, compulsory insurance**[325]. The new Labour Law was adopted in 2022 and will come into effect from 2024[326].

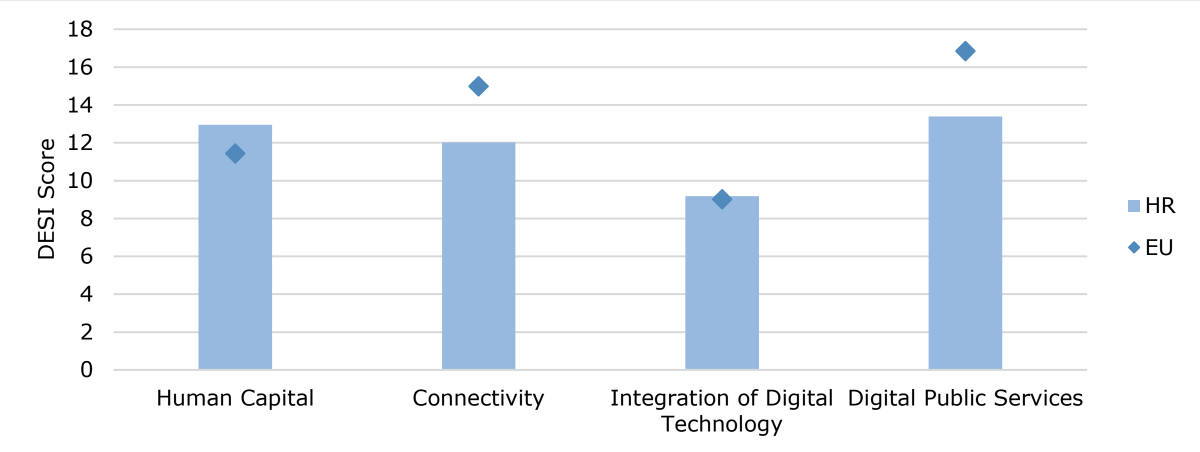
HR 3. Other dimensions relevant to the digital transformation

Alongside the key dimensions of digital skills and social protection, other supporting factors are significant for ensuring a successful digital transformation. The first of these is the level of digitalisation in firms. According to the DESI Index (Figure 5), the level of integration of digital technologies in firms is 14th in the EU27. However, robot density[327] is very low, both in the overall economy as well as, particularly, in manufacturing. Growth in robot density has also been slower than the EU average[328]. In this context, **policy measures to develop digitalisation in firms are of significant importance**. The 2021-2030 National Development Strategy aims to design a strategy to support the development of digital business models and digitalisation in enterprises[329]. Within the planned expenditure on the digital transformation that forms part of the NRRP, expenditure on the digitalisation of businesses is not a salient priority, with a share of 8.9% of overall digital expenditure. These funds are meant to support both SMEs and

[322] European Commission (2023). Access to social protection. Available at: https://ec.europa.eu/social/main.jsp?catId=1312&langId=en=en
[323] European Commission (2023). Report from the Commission to the Council on the implementation of the Council Recommendation on access to social protection for workers and the self-employed. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023DC0043&qid=1676473347492
[324] European Commission (2022). Recovery and Resilience Scoreboard Thematic Analyses. Social protection. Available at : https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_social_protection.pdf
[325] Council of the European Union (2021). Annex to the Council Implementing Decision on the approval of the recovery and resilience plan for Croatia. Available at: https://www.consilium.europa.eu/en/documents-publications/public-register/public-register-search/results/?WordsInSubject=&WordsInText=&DocumentNumber=10687%2F21&InterinstitutionalFiles=&DocumentDateFrom=&DocumentDateTo=&MeetingDateFrom=&MeetingDateTo=&DocumentLanguage=EN&OrderBy=DOCUMENT_DATE+DESC&ctl00%24ctl00%24cpMain%24cpMain%24btnSubmit=
[326] For more information, see https://apps.eurofound.europa.eu/platformeconomydb/croatian-labour-act-amended-and-act-on-elimination-of-unregistered-work-introduced-110032
[327] As described in the Annex, based on data from the International Federation of Robotics (2010-2019). Data is not available for Cyprus, Greece, Luxembourg and Slovenia.
[328] For Member States with available data
[329] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance

larger companies, for instance through grants for companies to buy digital equipment as well as improve digital skills.

Figure 5 – DESI Index for HR and the EU



Source: European Commission (2022)

Next to digitalisation of firms, digital infrastructure and digital public services constitute another broader support factor for the digital transformation. However, **digital infrastructure is an issue in Croatia**. According to the DESI index, connectivity levels in the country rank 24th in the EU27, while digital public services are similarly underdeveloped, as the country ranks 23rd. Looking at planned spending as part of the Croatian NRRP, connectivity represents only a relatively low share of digital expenditure (9.6%). In contrast, a large amount of the total expenditure for the digital pillar is allocated to planned spending on digital public services (64%). In the Croatian RRP, for the connectivity dimension[330], one of the most relevant investments aims to increase national broadband coverage with very high capacity networks (VHCN) in rural and sparsely populated areas. However, **significant improvements at national level are needed to increase connectivity levels in line with the Digital Decade targets**[331].

[330] European Commission (2023); Recovery and Resilience Scoreboard Thematic Analyses. Connectivity. https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_connectivity.pdf

[331] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance

12. ITALY: elements of a socially fair digital transformation

Key Points

Labour market: Currently, Manufacturing is the sector with the largest employment share in the economy and ranks fourth amongst the sectors in terms of digital transformation (based on the current percentage of enterprises that employ ICT specialists in a sector). The Manufacturing sector's employment share in the economy is not projected to grow further in the decade to come (slightly less than EU27 trends). ICT services, Professional services and Energy supply services are currently the three sectors with the highest degree of digital transformation, and except for Energy supply services, their employment shares are projected to grow slightly less than EU27 trends in the decade to come. Regarding the risk of automation of occupations, the most vulnerable occupation is Trades workers.

Digital skills: The average level of digital skills in the Italian population is one of the lowest in the EU. In addition, relative to other EU countries, there are substantial gaps in digital skill levels between different educational and occupational groups.

Social protection: There are several shortcomings in the Italian social protection system, and the rate of the population at risk of poverty is among the highest in the EU. However, Italy has been active in regulating platform work.

IT 1. The labour market and the digital transformation

IT 1.1 Sectoral composition (current and forward-looking perspectives)

In Italy ("IT"), in 2022, the sectors with the largest employment shares in the economy were: Manufacturing (18.7% vs 16.0% at the EU27 level), Wholesale and retail trade (13.5% vs 13.6% at the EU27 level), and Health and social care (8.1% vs 11.0% at the EU27 level). Cedefop data projects[332] the annual growth rate of a sector's employment share for the period 2022-2035. For Italy's Manufacturing sector, the annual growth rate is -0.4% (-0.2% for the EU27), while it is 0.1% for the Wholesale and retail trade sector (0.0% for the EU27), and 0.5% for the Health and social care sector (0.6% for the EU27).

[332] Own elaboration on Cedefop 'Skill forecast 2023' data.

Table 1 shows each sector's employment share in the economy in 2022, its employment share's projected annual growth rate (2022-2035), as well as its resulting employment share in the economy by 2035. Along with these elements relating to employment, Table 1 also presents the degree of "digital transformation" of each sector. Table 1 thus enables comparison between the degree of digital transformation of a sector and its employment share or its employment share's prospects. The aforementioned degree of digital transformation is proxied in Table 1, for each sector, by two indicators: i) the percentage of enterprises that employ ICT specialists in the sector and ii) the digital capital intensity[333] of the sector. Table 1 presents the ranking of each sector according to these two proxy indicators (with rank n°1 corresponding to the most digitised sector). According to the first indicator, the three sectors with the highest degree of digital transformation in Italy, in order, are: ICT services (employment share: 3.0% in IT vs 3.7% in the EU27), Professional services (6.4% vs 5.7%) and Energy supply services (0.5% vs 0.7%). According to the second indicator (digital capital intensity), the three sectors with the highest degree of digital transformation, in order, are: ICT services (employment share: 3.0% in IT vs 3.7% in the EU27), Professional services (6.4% vs 5.7%) and Finance and insurance (2.6% vs 2.8%). For 2022-2035, these sectors' employment shares are projected to grow by 0.6% annually for ICT services (vs 0.8% for the EU27), 0.1% for Professional services (vs 0.6% for the EU27), decrease by -1.4% for Energy supply services (vs 0.1% for the EU27), and grow by 0.2% for Finance and insurance (equal to the projected EU27 growth).

As can be seen from Table 1, notably, only one of the top four sectors in terms of the degree of digital transformation – ICT services – is also among the top four sectors in terms of the projected annual growth rate of employment share in the coming decade in Italy[334]. Furthermore, in terms of employment share (in 2022), the top two sectors – Manufacturing and Wholesale and retail trade - rank fourth and fifth with respect to one of the two proxy indicators of the digital transformation (% of enterprises that employ ICT specialists).

Table 1 – IT. Sector's share of employment, annual growth rate, and ranking of "digital transformation" (the sectors are ranked according to the ranking in the last column of the table).

Sectors	Sector's employment share in 2022 (%)		Projected annual growth rate of the sector's employment share (2022 - 2035, %)		Projected sector's employment share in 2035 (%)		Proxy 1 for digital transformation (ranking)	Proxy 2 for digital transformation (ranking)
	IT	**EU**	**IT**	**EU**	**IT**	**EU**	**% enterprises that employ ICT specialists**	**Digital capital intensity**
J - ICT services	3.0	3.7	0.6	0.8	3.3	4.2	1	1
M - Professional services	6.4	5.7	0.1	0.6	6.5	6.3	2	2
K - Finance & insurance	2.6	2.8	0.2	0.2	2.7	2.8	n.a.	3
N - Administrative services	4.4	4.1	0.3	0.0	4.6	4.1	6	4

[333] 'Digital capital intensity' is an index – built in the context of this study – that looks at the ratio between the stock of capital the firms have in software and databases and the overall stock of capital excluding non-residential buildings. Its construction is based on the integrated EUKLEMS & INTANProd database, run by the Luiss Lab of European Economics at Luiss University in Rome, Italy. For more in-depth information on the source, and the availability of the indicator for Member States/sectors, please refer to the Annex.

[334] This is true for both the rankings based on the proxy indicators for the digital transformation ('percentage of enterprises with ICT specialists' and 'digital capital intensity').

R - Arts & recreation and other services	1.3	1.7	0.2	0.3	1.4	1.7	n.a.	5
C - Manufacturing	18.7	16.0	-0.4	-0.2	17.6	15.6	4	6
P - Education	6.9	7.4	0.0	0.3	7.0	7.7	n.a.	7
E- Water and waste treatment	1.1	0.8	-0.3	-0.1	1.0	0.8	n.a.	8
Q - Health & social care	8.1	11.0	0.5	0.6	8.7	11.9	n.a.	9
F - Construction	6.7	6.8	0.2	-0.3	6.9	6.5	8	10
D - Energy supply services	0.5	0.7	-1.4	0.1	0.4	0.8	3	11
O - Public sector & defence	5.0	7.1	-0.6	-0.1	4.6	7.0	n.a.	12
B - Mining & quarrying	0.1	0.3	-0.7	-1.7	0.1	0.2	n.a.	13
A - Agriculture, forestry & fishing	3.6	3.5	-3.3	-3.1	2.3	2.3	n.a.	14
G - Wholesale & retail trade	13.5	13.6	0.1	0.0	13.8	13.6	5	n.a.
I - Accommodation & food	6.1	4.5	1.0	0.6	7.1	4.9	9	n.a.
H - Transport & storage	5.1	5.3	0.1	-0.1	5.2	5.3	7	n.a.
S - Other service activities	3.2	2.6	1.2	0.0	3.7	2.6	n.a.	n.a.
T - Activities of households as employers	2.7	0.9	-0.1	-0.3	2.7	0.9	n.a.	n.a.
L - Real Estate	0.6	0.9	0.9	0.9	0.7	1.0	n.a.	n.a.
U - Activities of extraterritorial org.	0.1	0.1	n.a.	n.a.	0.1	0.1	n.a.	n.a.

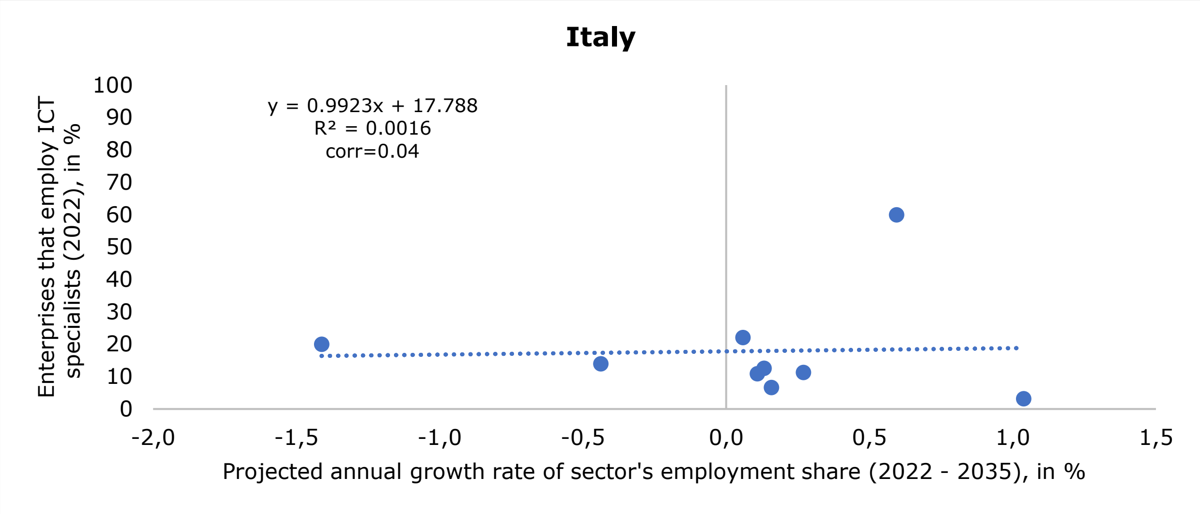
Source: For the employment-related indicators own elaboration on Eurostat data (share of employment, 2022 calculated based on lfsa_egan) and on Cedefop 'Skill forecast data 2023' (annual growth rate of sector's employment share, 2022-2035), for the digital transformation-related indicators: own elaboration on Eurostat data (share of enterprises that employ ICT specialists, Eurostat code: lfsa_egais) and on EUKLEMS & INTANProd data (digital capital intensity).
Note: In the first column of the table, the letter preceding the sectors is the code of the NACE Rev.2 classification. In the last two columns of the table, the two proxy indicators used for the digital transformation are: i) the share of enterprises that employ ICT specialists (Eurostat code: lfsa_egais) and ii) the digital capital intensity (EUKLEMS & INTANProd data, average 2014-2017) with rank n°1 corresponding to the most digitally intense sector.

Complementing Table 1, Figures 1a and 1b below examine the potential relationship between the projected annual growth rates of the sectors' employment shares in the economy and the sectors' degree of digital transformation [335].

In **Figure 1a**, we present a scatterplot to shed light on the relationship between the first proxy of the digital transformation (percentage of enterprises that employ ICT specialists) and the projected annual growth rate of a sector's employment share between 2022-2035. The correlation (0.04) is positive, but not statistically significant (it is 0.62 and statistically significant at EU27 level). The lack of correlation implies that **in Italy, a sectoral-level association between the percentage of enterprises that employ ICT specialists and the projected annual growth rate of a sector's employment share cannot be inferred.**

[335] With the caveat that the correlation coefficients presented in Figure 1a and Figure 1b cannot be directly compared, as they pertain to a combination of sectors that varies across different Member States.

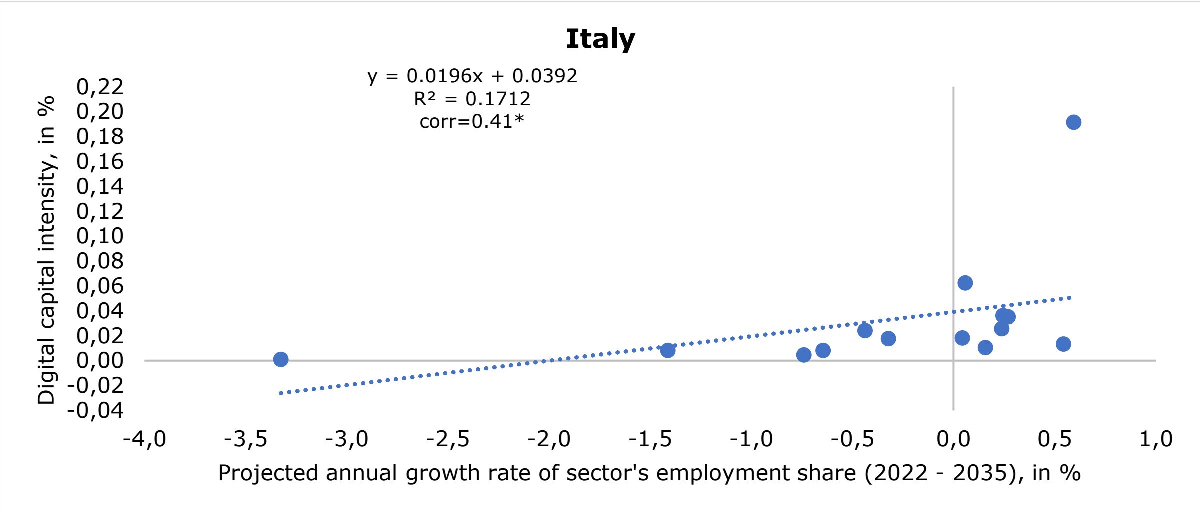
Figure 1a – IT. Relationship between the percentage of enterprises that employ ICT specialists (in 2022) and the projected annual growth rate of sector's employment share (2022-2035).



Source: Own elaboration on Eurostat and Cedefop 'Skill forecast 2023' data.

Figure 1b shows the correlation between the second digital transformation proxy ('digital capital intensity') and the projected annual growth rate of a sector's employment share between 2022-2035. In this case, the correlation coefficient is larger (0.41) and statistically significant in Italy. Among the 16 Member States for whom 'digital capital intensity' can be computed – with a positive and significant correlation observed in seven of them - Italy ranks sixth. **The positive correlation could suggest that, in Italy, the employment shares of those sectors with a higher 'digital capital intensity' are more likely to grow (over 2022-2035) than those of other sectors. However, the relationship is only moderate** and below the average of the seven Member States where we find a positive correlation. Moreover, this correlation does not imply causal links.

Figure 1b – IT. Relationship between 'digital capital intensity' and the projected annual growth rate of sector's employment share (2022-2035).

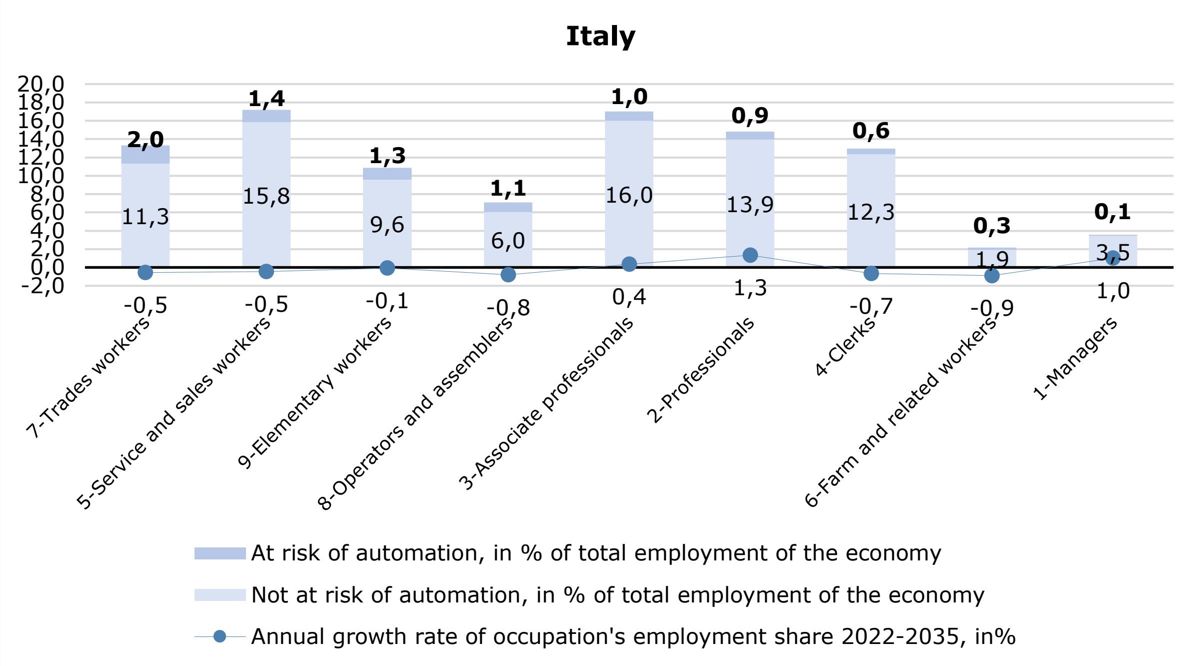


Source: Own elaboration on EUKLEMS & INTANProd, and Cedefop 'Skill forecast 2023' data.

IT 1.2 Occupational composition at ISCO-08 1 digit and risk of automation (current and forward-looking perspectives)

Different occupations are subject to differing levels of automation risk. Cedefop developed[336] a "risk of automation" index by occupation at the EU27 level, most recently updated for 2022[337]. We apply this indicator at the Member State level, with the assumption that the risk of automation for a given occupation is constant across Member States[338]. As such, Member State variation in the overall susceptibility of the workforce to automation (i.e., the overall risk across all occupations in that Member State) will be due to an employment composition effect. That is, while the automation risk for a given occupation stays constant across Member States, the overall automation risk of a Member State will naturally be greater for those Member States having larger shares of employment in occupations with a higher automation risk.

Figure 2 – IT. Employment shares of occupations (at ISCO-08 1 digit level) - split into sub shares 'not at risk' and 'at risk' of automation (2022) - and projected annual growth rate



Source: Own elaboration on Cedefop data (risk of automation calculated by Cedefop at EU27 level by ISCO-08 1 digit level for 2022) applied to Eurostat data (share of employment by occupation, lfsa_egais, 2022).
Note: The numbers preceding the occupations are the ISCO-08 codes. Occupations are ranked from the highest to the lowest share of workers that present a risk of automation. The vertical sum of the two components (darker blue and lighter blue) gives back the total employment share by occupation (in % of total employment in the Member State). The ISCO nomenclature used in the text and the figure is the Cedefop one. For examples of specific occupations see: https://esco.ec.europa.eu/en/classification/occupation_main.

As can be seen in **Figure 2**, in Italy, the occupation with the largest employment sub-share (in % of total employment in the economy) 'at risk of automation' is

[336] Based on the methodology in Pouliakas, K. (2018) "The risk of automation in EU labour markets: a skill-requirements approach", in Economy, Employment and Skills: European and global perspectives in an age of uncertainty, Fondazione Giacomo Brodolini Quaderni Series, also IZA DP 11829.
[337] As retrieved at https://www.cedefop.europa.eu/en/tools/skills-intelligence/automation-risk-occupations#1
[338] While this assumption may be considered strong, Cedefop data are the only ones available that are at the same time, up to date and available for all the occupations at the ISCO-08 level.

Trades workers, with an employment sub-share of workers 'at risk of automation' representing 2.0% of total employment in the country (vs 1.3% for the EU27). The employment sub-share of workers 'at risk of automation' in Service and sales workers ranks second, with an employment sub-share of workers 'at risk' of 1.4% of total employment in Italy (vs 1.3% for the EU27). Ranking third are Elementary workers, with a share of workers 'at risk' of 1.3% in total employment in Italy (vs 1.0% for the EU27). **Among these three occupations, only the first one is also the most affected across the EU27**[339]**.**

For **ICT professionals (ISCO 25)**[340], the 2022 employment share is 1.0% in Italy (vs 2.3% in the EU27) and its composition (as regards the risk of automation) is as follows: an employment sub-share of 0.1% (equal to 0.1% in the EU27) is 'at risk of automation', whereas the remaining employment sub-share of 0.9% (vs 2.2% at EU27 level) is 'not at risk of automation'. The projected annual growth rate of the employment share of ICT professionals for 2022-2035 is 1.6% in Italy (vs 1.9% in the EU27).

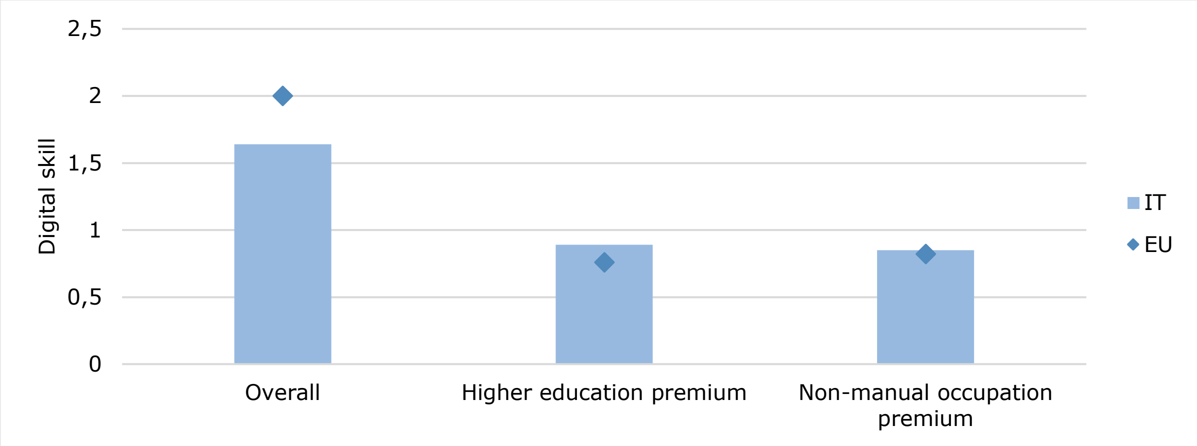
IT 2. Key policy dimensions for a socially fair digital transformation

IT 2.1 Digital skills

Investment in digital skills is essential to mitigate against potential negative employment impacts of the digital transition. However, **Italy ranks at the bottom of EU Member States in terms of digital skills**, both when looking at the DESI Human Capital indicator[341] (Figure 5, Section "Other dimensions") and the study's own estimated index of digital skills (Figure 3, "Overall")[342], for both of which Italy ranks 25th in the EU27. There are also pronounced divides in the population when it comes to digital skills. Italy ranks 21st in the EU with regard to gaps in digital skills between both individuals with different levels of education ("Higher education premium" in Figure 3) and in different occupations ("Non-manual occupation premium" in Figure 3).

[339] The most affected in the EU27 are Trades workers, Professionals, and Service and sales workers.
[340] Eurostat code: lfsa_egai2d.
[341] European Commission (2022). Digital Economy and Society Index. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi
[342] The construction of the digital skill index is described in detail in the Annex.

Figure 3 – Estimated Digital Skills in IT and the EU (2019)



Source: Authors' own estimation based on Eurostat ICT survey
Note: Higher education premium refers to the difference in digital skills between individuals with tertiary and lower than tertiary education. Non-manual occupation premium refers to the difference in digital skills between individuals in manual and non-manual occupations.

In this context, policy measures and infrastructure to encourage the development of digital skills are of importance. A number of initiatives have been put forward as part of the 'Italian National Strategy for Digital Skills'[343] in order to reach targets for the digital skills of Italian citizens and workers by 2026. The necessity of measures to encourage up- and re-skilling has also been recognised in the Italian NRRP, where a fifth of the digital transformation component is devoted to human capital (19.9%). For instance, through the National Plan for an Employability Guarantee and the National Plan for New Skills, various measures for up- and reskilling of workers, particularly vulnerable workers, have been taken up[344]. Among other targets, these measures aim to provide 300,000 workers with digital skills training.

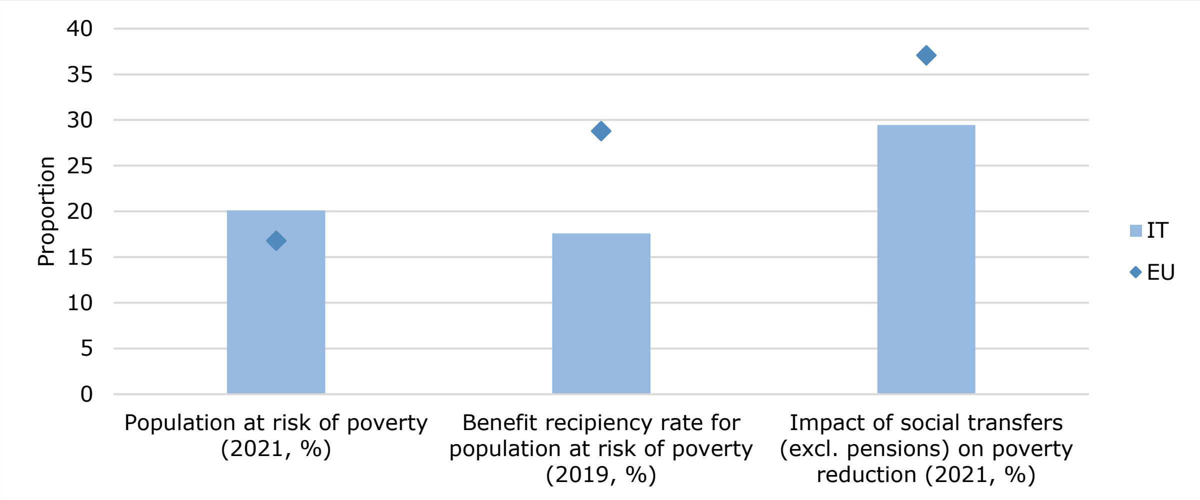
IT 2.2 Social protection and social policy

A robust social protection system can be very important in mitigating the potential labour market impacts of the digital transformation. In Italy, the proportion of the population at risk of poverty after social transfers is 20.1%, one of the highest rates in the EU[345] (Figure 4). Other indicators also point to **shortcomings of the social protection system in mitigating against poverty.** The benefit recipiency rate for the population at risk of poverty before social transfers[346] is relatively low, at 17.6%, as is the impact of social transfers on poverty reduction[347], at 29.5%. Therefore, existing social protection measures may not

343 For more information, see https://repubblicadigitale.innovazione.gov.it/assets/docs/national-strategy-for-digital-skills.pdf
344 European Commission (2022); Recovery and Resilience Scoreboard Thematic Analyses. Digital Skills. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_digital_skills.pdf
345 Eurostat (2023). TPS00184: At-risk-of-poverty rate after social transfers by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/tps00184/default/table?lang=en
346 Eurostat indicator as re-elaborated by JRC (2022) "Monitoring the effective coverage and adequacy of social protection in the EU".
347 Eurostat (2023). TESPM050:Impact of social transfers (excluding pensions) on poverty reduction by sex. Available at:

adequately cover all workers, particularly vulnerable workers, within the context of digitalisation. However, **Italy is one of the countries putting forward measures to actively regulate the employment status of platform workers**, one of the significant groups affected by digitalisation in the labour market[348].

Figure 4 – Social Protection in IT and the EU



Source: Eurostat (2023) and JRC (2022)

From a forward-looking perspective, the Italian national implementation plan for the Recommendation on access to social protection[349] sets out measures for increasing the formal and effective coverage of social protection, such as increasing access to unemployment benefits for non-standard workers, as well as further measures specifically aimed at platform workers. However, these measures will likely not address all or most of the social protection coverage gaps[350]. The Italian NRRP does not include specific measures on social protection. Looking more broadly at social policies, Italy plans to devote 28.2% of the NRRP to social expenditure. Of this portion, the largest share goes to education and childcare (39.8%) while the smallest share goes to employment and skills (13%).

IT 3. Other dimensions relevant to the digital transformation

For a successful digital transformation that harnesses the potential economic and social benefits from digitalisation, broader support structures need to be in place. This includes digitalisation in firms, digital infrastructure and digital public services.

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https://ec.europa.eu/eurostat/databrowser/view/TESPM050/bookmark/table?lang=en&bookmarkId=b001ae62-ce34-4b49-9741-28a3ef99477f

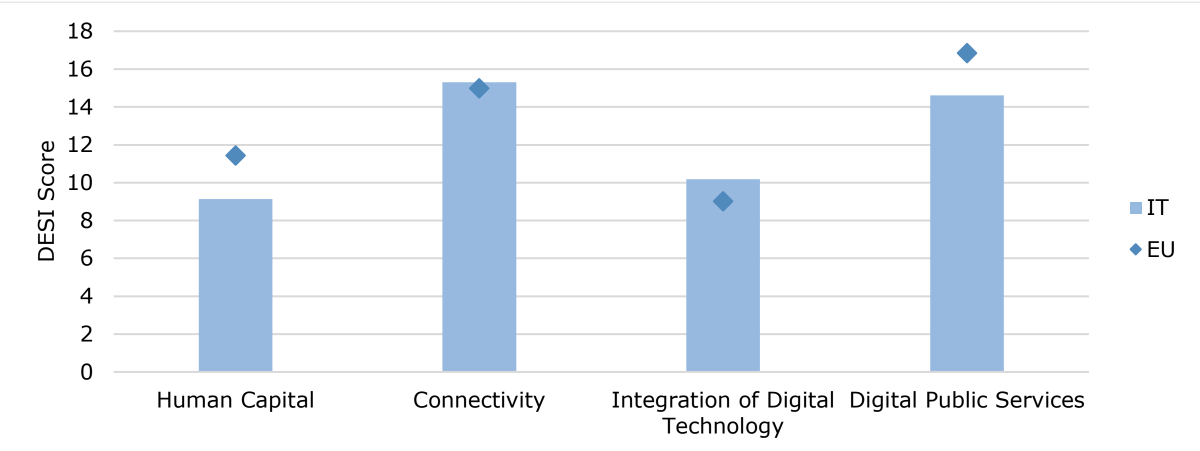
[348] PPMI (2021). Study to support the impact assessment on improving working conditions in platform work. Available at: https://ec.europa.eu/social/main.jsp?catId=738&furtherPubs=yes&langId=en&pubId=8428

[349] European Commission (2023). Access to social protection. Available at: https://ec.europa.eu/social/main.jsp?catId=1312&langId=en=en

[350] European Commission (2023). Report from the Commission to the Council on the implementation of the Council Recommendation on access to social protection for workers and the self-employed. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023DC0043&qid=16764733477492

Compared to the EU average, absolute levels of digitalisation in firms are relatively advanced in Italy. According to the DESI index (Figure 5), the level of integration of digital technologies in companies is the eighth highest in the EU. Equally, both robot density[351] in the overall economy and in manufacturing are higher than the EU average[352], as is digital capital intensity in firms[353]. However, the rate at which both of these have increased in Italy in the past decade is much lower than it is across other EU countries. Moreover, investment in some key technologies, such as AI and big data remains limited[354]. This aspect is however addressed in the Italian National Strategy for Digital Skills, which includes a number of targets aimed at businesses, such as doubling the number of companies using big data. The uptake of digital technologies is also supported through the National Plan Transition 4.0 and the Strategic Program on Artificial Intelligence 2022-2024[355]. Equally, 26.1% of planned expenditure on the digital transformation in the Italian RRP is devoted to the digitalisation of businesses. Part of this expenditure will be used to fund tax benefits under the plan Transition 4.0.

Figure 5 – DESI Index for IT and the EU (2022)



Source: European Commission (2022)

Furthermore, in order to benefit from the potential opportunities created by the digital transformation, adequate digital infrastructure is essential. In this regard, Italy ranks in the middle of EU countries. According to the DESI index (Figure 5), levels of connectivity are relatively high in Italy (seventh in the EU27), with substantial improvements in recent years[356], while digital public services rank in the low mid-field among EU countries (19th), though significant progress has also been made in this dimension. Furthermore, expenditure on digital infrastructure is foreseen in the Italian NRRP. Of the total expenditure devoted to the digital transformation, 11.9% will be spent on digital infrastructure relating to

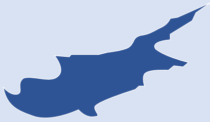
[351] As described in the Annex, based on data from the International Federation of Robotics (2010-2019). Data is not available for Cyprus, Greece, Luxembourg and Slovenia.
[352] For Member States with available data
[353] As described in the Annex, based on data from EU-KLEMS (2008-2018). Data is not available for Cyprus, Croatia, Ireland and Romania.
[354] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[355] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performancenc
[356] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance

connectivity. The aim is to implement five connectivity measures, including targets such as providing seven million street addresses with fixed gigabit connectivity. Investment will also be made in digitalisation of the public sector (31.1% of total digital expenditure), including measures targeted at the interoperability of data across public administrations and the efficiency of digital infrastructure[357].

[357] European Commission (2021); Recovery and Resilience Scoreboard Thematic Analyses. Digital public services. Available at :https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/2_Digital.pdf

13. CYPRUS: elements of a socially fair digital transformation

Key Points



Labour market: The Wholesale and retail sector - currently, the sector with the largest employment share in the economy – is the sector with the seventh highest degree of digital transformation (based on the current percentage of enterprises that employ ICT specialists in a sector). However, the Wholesale and retail sector's employment share is not projected to grow further in the decade to come (slightly behind EU trends). ICT services, Professional services and Transport and storage are the three sectors with the highest degree of digital transformation currently, and their employment shares, except for Professional services, are projected to grow in the decade to come, slightly more than for the EU27. Elementary workers are most at risk of having their occupations automated.

Digital skills: The overall level of digital skills is low in Cyprus compared to the rest of the EU. Digital divides between different population groups are also very pronounced.

Social protection: While Cyprus has a very low rate of the population at risk of poverty, some gaps in the social protection system are apparent, with a low benefit recipiency rate for the population at risk of poverty. In addition, there have so far been few policy initiatives regulating the employment status of platform workers, but measures to improve social insurance coverage of these workers form part of the Cypriot NRRP.

CY 1. The labour market and the digital transformation

CY 1.1 Sectoral composition (current and forward-looking perspectives)

In Cyprus ("CY"), in 2022, the sectors with the largest employment shares in the economy were the Wholesale and retail trade (16.9% vs 13.6% at the EU27 level), Construction (9.2% vs 6.8% at the EU27 level), and Public sector and defence (9.0% vs 7.1% at the EU27 level). For the period 2022-2035, Cedefop data projects[358] the annual growth rate of a sector's employment share. For Cyprus' Wholesale and retail trade sector, the annual growth rate is -0.3% (0.0% for the EU27), for the Construction sector it is 0.3% (-0.3% for the EU27), and for the Public and defence sector, it is -0.9% (-0.1% for the EU27).

[358] Own elaboration on Cedefop 'Skill forecast 2023' data.

Table 1 presents each sector's employment share in 2022, the projected annual growth rates (2022-2035) of its employment share, and its resulting employment share in the economy by 2035. Along with these elements relating to employment, Table 1 also presents the degree of "digital transformation" of each sector. Table 1 thus enables a comparison between the degree of digital transformation of a sector and its employment share or its employment share's prospects. The digital transformation is proxied in Table 1, for each sector, by the percentage of enterprises in the sector that employ ICT specialists. Table 1 presents the ranking of each sector according to this proxy (with rank n°1 corresponding to the most digitised sector). The three sectors with the highest degree of digital transformation in Cyprus, in order, are: ICT services (employment share: 4.3% in CY vs 3.7% in the EU27), Professional services (8% vs 5.7%), and Transport and storage (3.5% vs 5.3%). These sectors' employment shares have a projected annual growth rate for 2022-2035 in Cyprus of 0.8% for ICT services (the same as across the EU27), -0.3% for Professional services (vs 0.6% for the EU27), and 0.4% for Transport and storage (vs -0.1% for the EU27).

As is visible in Table 1, only one of Cyprus' top five sectors in terms of the degree of digital transformation (as proxied by % of enterprises that employ ICT specialists) – Energy supply services – is also among the five sectors predicted to have the highest annual growth rate of employment share over the next decade. Furthermore, two sectors that have the largest employment shares – Wholesale and retail trade and Construction - rank seventh and tenth for the degree of digital transformation, while the fourth largest - Professional services - ranks second for the degree of digital transformation.

Table 1 – CY. Sector's share of employment, annual growth rate, and ranking of "digital transformation" (the sectors are ranked according to the ranking in the "proxy 1" column of the table).

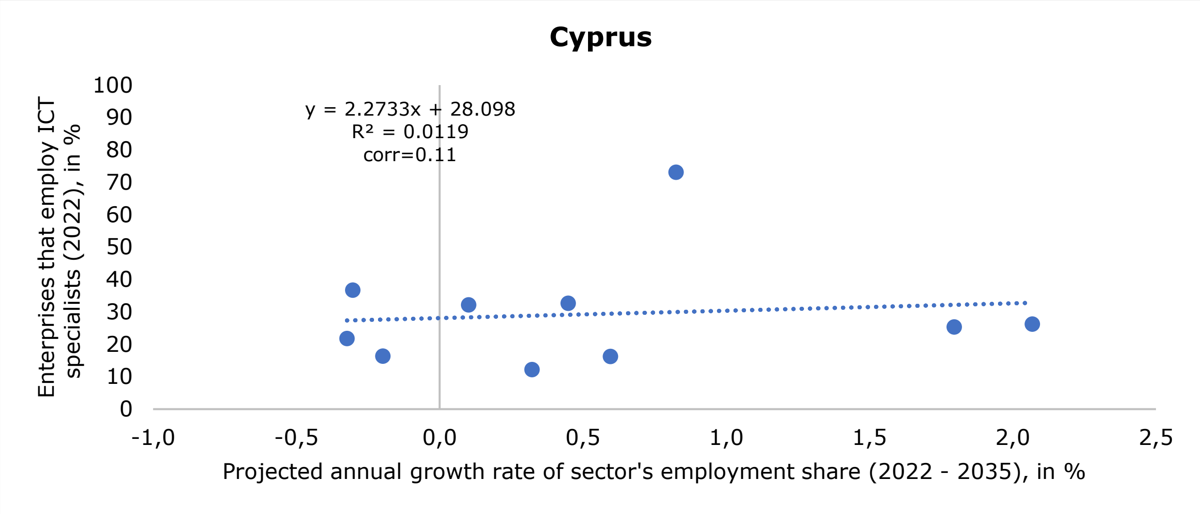
Sectors	Sector's employment share in 2022 (%)		Projected annual growth rate of the sector's employment share (2022 - 2035, %)		Projected sector's employment share in 2035 (%)		Proxy 1 for digital transformation (ranking)	Proxy 2 for digital transformation (ranking)
	CY	**EU**	**CY**	**EU**	**CY**	**EU**	**% enterprises that employ ICT specialists**	**Digital capital intensity**
J - ICT services	4.3	3.7	0.8	0.8	4.9	4.2	1	n.a.
M - Professional services	8.0	5.7	-0.3	0.6	7.7	6.3	2	n.a.
H - Transport & storage	3.5	5.3	0.4	-0.1	3.7	5.3	3	n.a.
N - Administrative services	3.2	4.1	0.1	0.0	3.3	4.1	4	n.a.
D - Energy supply services	0.7	0.7	2.1	0.1	1.0	0.8	5	n.a.
E- Water and waste treatment	0.6	0.8	1.8	-0.1	0.8	0.8	6	n.a.
G - Wholesale & retail trade	16.9	13.6	-0.3	0.0	16.1	13.6	7	n.a.
I - Accommodation & food	8.0	4.5	-0.2	0.6	7.8	4.9	8	n.a.
C - Manufacturing	6.5	16.0	0.6	-0.2	7.0	15.6	9	n.a.
F - Construction	9.2	6.8	0.3	-0.3	9.6	6.5	10	n.a.
A - Agriculture, forestry & fishing	2.0	3.5	-0.8	-3.1	1.8	2.3	n.a.	n.a.
B - Mining & quarrying	0.1	0.3	2.0	-1.7	0.2	0.2	n.a.	n.a.

K - Finance & insurance	6.0	2.8	-0.5	0.2	5.6	2.8	n.a.	n.a.
L - Real Estate	0.7	0.9	0.9	0.9	0.8	1.0	n.a.	n.a.
O - Public sector & defence	9.0	7.1	-0.9	-0.1	7.9	7.0	n.a.	n.a.
P - Education	6.9	7.4	0.2	0.3	7.1	7.7	n.a.	n.a.
Q - Health & social care	5.5	11.0	1.0	0.6	6.3	11.9	n.a.	n.a.
R - Arts & recreation and other services	1.7	1.7	-0.1	0.3	1.7	1.7	n.a.	n.a.
S - Other service activities	3.1	2.6	-0.6	0.0	2.9	2.6	n.a.	n.a.
T - Activities of households as employers	3.6	0.9	0.2	-0.3	3.7	0.9	n.a.	n.a.
U - Activities of extraterritorial org.	0.3	0.1	n.a.	n.a.	0.3	0.1	n.a.	n.a.

Source: For the employment-related indicators own elaboration on Eurostat data (share of employment, 2022 calculated based on lfsa_egan) and on Cedefop 'Skill forecast data 2023' (annual growth rate of sector's employment share, 2022-2035), for the digital transformation-related indicators: own elaboration on Eurostat data (share of enterprises that employ ICT specialists, Eurostat code: lfsa_egais) and on EUKLEMS & INTANProd data (digital capital intensity).
Note: In the first column of the table, the letter preceding the sectors is the code of the NACE Rev.2 classification. In the last two columns of the table, the two proxy indicators used for the digital transformation are: i) the share of enterprises that employ ICT specialists (Eurostat code: lfsa_egais) and ii) the digital capital intensity (EUKLEMS & INTANProd data, average 2014-2017) with rank n°1 corresponding to the most digitally intense sector.

Figure 1 below complements Table 1, exploring the relationship between sectors' degree of digital transformation and the projected annual growth rates of their employment shares. In **Figure 1** we therefore present a scatterplot to shed light on the relationship between the proxy of the digital transformation used (percentage of enterprises that employ ICT specialists) and the projected annual growth rate of a sector's employment share between 2022-2035. The correlation is positive, at 0.11, but not statistically significant (it is 0.62 and statistically significant for the EU27). **The lack of statistically significant correlation implies that we cannot claim there is an association between the percentage of enterprises within a sector that employ ICT specialists and the projected annual growth rate of that same sector's employment share in Cyprus.**

Figure 1 – CY. Relationship between the percentage of enterprises that employ ICT specialists (in 2022) and the projected annual growth rate of sector's employment share (2022-2035).



Source: Own elaboration on Eurostat and Cedefop 'Skill forecast 2023' data.

CY 1.2 Occupational composition at ISCO-08 1 digit and risk of automation (current and forward-looking perspectives)

Different types of occupation are subject to differing levels of automation risk. Cedefop developed[359] a "risk of automation" index by occupation at the EU27 level, most recently updated for 2022[360]. We apply this indicator at the Member State level, with the assumption that the risk of automation for a given occupation is relatively constant across Member States[361]. As such, the variation in the susceptibility to automation of a Member State's workforce across all occupations can be attributed to the employment composition effect. Thus, while the automation risk for a given occupation stays constant across Member States, the overall automation risk of a Member State can be considered greater for those

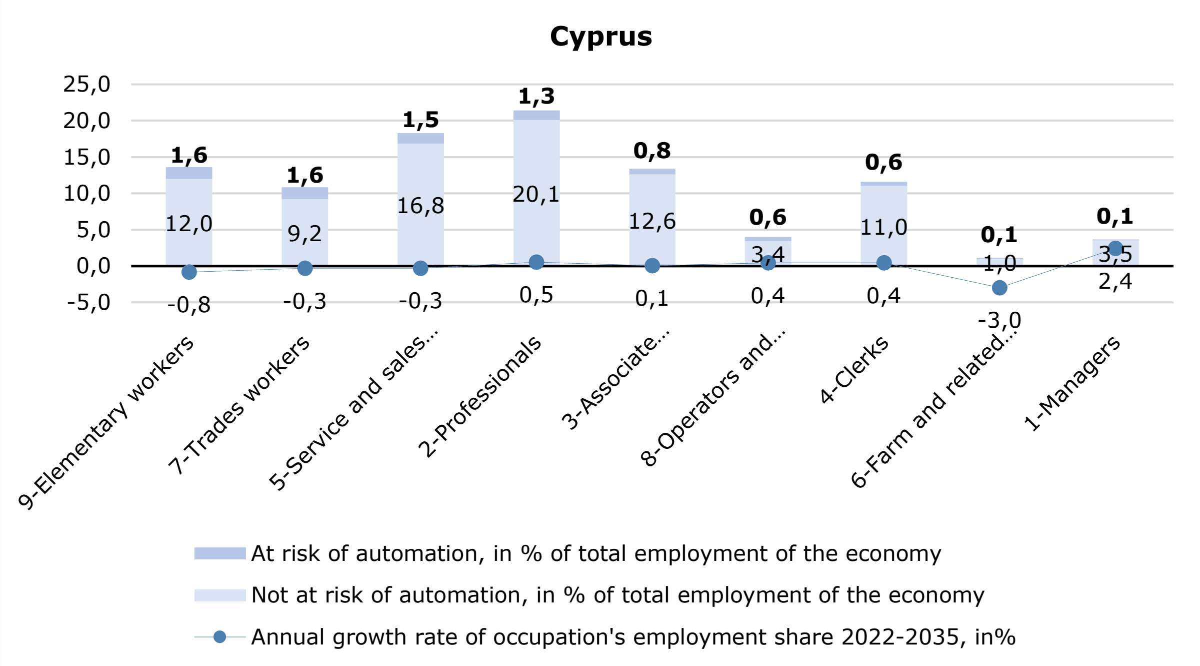
[359] Based on the methodology in Pouliakas, K. (2018) "The risk of automation in EU labour markets: a skill-requirements approach", in Economy, Employment and Skills: European and global perspectives in an age of uncertainty, Fondazione Giacomo Brodolini Quaderni Series, also IZA DP 11829.

[360]As retrieved at https://www.cedefop.europa.eu/en/tools/skills-intelligence/automation-risk-occupations#1

[361] While this assumption may be considered strong, Cedefop data are the only ones available that are at the same time, up to date and available for all the occupations at the ISCO-08 level.

Member States with larger employment shares in occupations with a higher automation risk.

Figure 2 – CY. Employment shares of occupations (at ISCO-08 1 digit level) - split into sub shares 'not at risk' and 'at risk' of automation (2022) - and projected annual growth rate



Source: Own elaboration on Cedefop data (risk of automation calculated by Cedefop at EU27 level by ISCO-08 1 digit level for 2022) applied to Eurostat data (share of employment by occupation, lfsa_egais, 2022).
Note: The numbers preceding the occupations are the ISCO-08 codes. Occupations are ranked from the highest to the lowest share of workers that present a risk of automation. The vertical sum of the two components (darker blue and lighter blue) gives back the total employment share by occupation (in % of total employment in the Member State). The ISCO nomenclature used in the text and the figure is the Cedefop one. For examples of specific occupations see: https://esco.ec.europa.eu/en/classification/occupation_main.

As can be seen in **Figure 2**, in Cyprus, Elementary workers have the largest employment sub-share (% of total employment in the economy) 'at risk of automation', with 1.6% of total employment in the country 'at risk' (vs 1.0% for the EU27). Trades workers, with an employment sub-share of workers 'at risk' of 1.6% (vs 1.3% in the EU27), are second. Ranking third are Service and sales workers, with a share of workers 'at risk' of 1.5% (vs 1.3% for the EU27). **Among these three occupations, only Service and sales workers are the most affected also at the EU27 level[362].**

The 2022 employment share for **ICT professionals (ISCO 25)**[363] is 2.3% in Cyprus (with 2.3% also at the EU27 level). An employment sub-share of 0.2% of all employees are both ICT professionals and 'at risk of automation' (vs 0.1% in the EU27), whilst the remaining employment sub-share of 2.2% (vs 2.2% at EU27 level) is not at risk. The projected annual growth rate for the employment share of ICT professionals, from 2022 to 2035, is 2.6% in Cyprus (vs 1.9% in EU27).

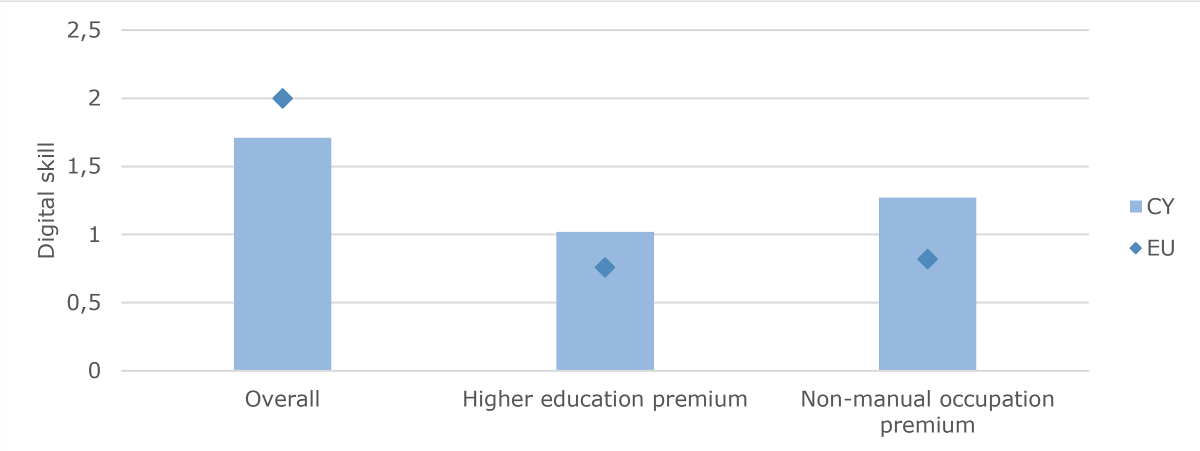
[362] The most affected in the EU27 are Trades workers, Professionals, and Service and sales workers.
[363] Eurostat code: lfsa_egai2d.

CY 2. Key policy dimensions for a socially fair digital transformation

CY 2.1 Digital skills

A high level of digital skills within a population is an important prerequisite for a socially fair digital transformation. However, with regard to digital skills, Cyprus is lagging behind the rest of the EU. The DESI index[364] for human capital (Figure 5 in the section "Other dimensions") and the study's own estimate of digital skills[365] (Figure 3, bar "Overall") place the country at 21st and 23rd in the EU27, respectively. **Moreover, digital divides are very pronounced compared to the EU27 level.** Differences in digital skills between both individuals with different levels of education ("Higher education premium" in Figure 3) and different occupations ("Non-manual occupation premium" in Figure 3) are much larger than the EU27 level. The premium on digital skills for workers in non-manual occupations is the largest in the EU, and the premium for those with tertiary education is the second largest. This is concerning for possible inequalities related to the digital transformation.

Figure 3 –Estimated Digital Skills in CY and the EU (2019)



Source: Authors' own estimation based on Eurostat ICT survey
Note: Higher education premium refers to the difference in digital skills between individuals with tertiary and lower than tertiary education. Non-manual occupation premium refers to the difference in digital skills between individuals in manual and non-manual occupations.

Looking at policy initiatives to address this situation, the Cyprus National Digital Strategy 2020-2025[366] sets out initiatives targeting investment in digital skills, including the development of basic and lifelong digital skills for all. Moreover, 25.5% of the RRP for Cyprus is allocated towards the digital pillar. However, within this pillar, investment in human capital is limited. The Cypriot plan foresees dedicating only 7.8% to human capital investment. However, the NRRP does include a national e-skills action plan which has the aim of increasing the level of

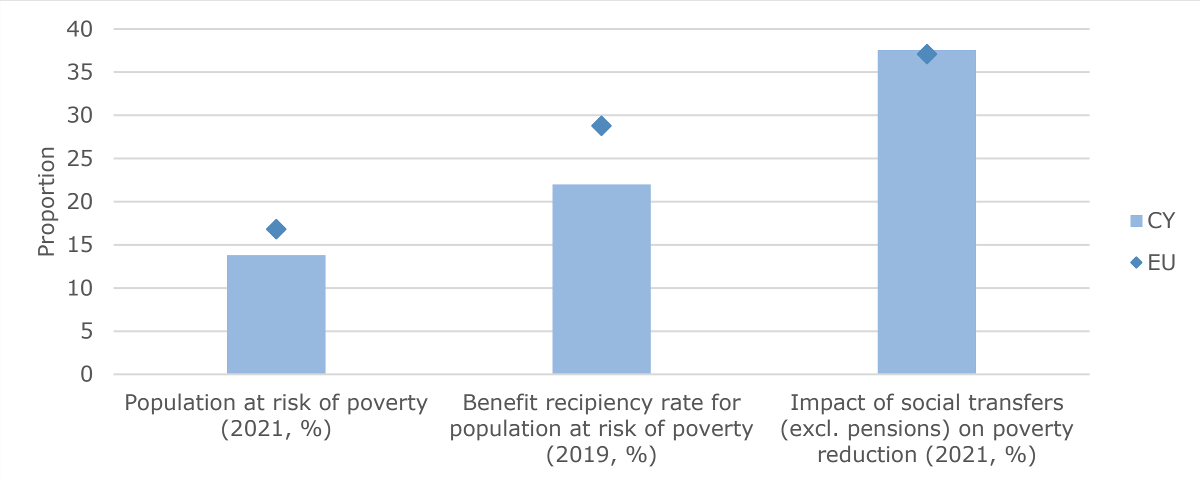
[364] European Commission (2022). Digital Economy and Society Index. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi
[365] The construction of the digital skill index is described in detail in the introductory section.
[366] For more information, see https://www.dmrid.gov.cy/dmrid/research.nsf/all/927EA351714F99EDC22587CE0028C090/$file/Digital%20Strategy%202020-2025.pdf?openelement

digital skills across the population by reforming the educational system and increasing up- and reskilling measures in the workforce[367].

CY 2.2 Social protection and social policy

Next to digital skills, encompassing social protection systems could be important for managing the potential labour market impact of the digital transformation (Figure 4). The population at risk of poverty after social transfers[368] is lower in Cyprus (13.8%), and the impact of social transfers on poverty reduction[369] is marginally higher (37.6%) than the EU rate. However, with regard to the benefit recipiency rate for the population at risk of poverty before social transfers (27%)[370], improvements relative to other European countries could be made. On the regulation of the employment status of platform workers, there has so far been relatively little activity[371].

Figure 4 – Social Protection in CY and the EU



Source: Eurostat (2023) and JRC (2022)

The Cypriot implementation plan for the Recommendation on access to social protection[372] sets out **several measures (some of which have already been implemented) to improve the effectiveness and coverage of social protection**, for instance, by extending social insurance coverage to workers in non-standard forms of employment (including platform workers) and the self-

[367] European Commission (2022); Recovery and Resilience Scoreboard Thematic Analyses. Digital Skills. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_digital_skills.pdf

[368] Eurostat (2023). TPS00184: At-risk-of-poverty rate after social transfers by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/tps00184/default/table?lang=en

[369] Eurostat (2023). TESPM050:Impact of social transfers (excluding pensions) on poverty reduction by sex. Available at:

[370] Eurostat indicator as re-elaborated by JRC (2022) "Monitoring the effective coverage and adequacy of social protection in the EU".

[371] PPMI (2021). Study to support the impact assessment on improving working conditions in platform work. Available at: https://ec.europa.eu/social/main.jsp?catId=738&furtherPubs=yes&langId=en&pubId=8428

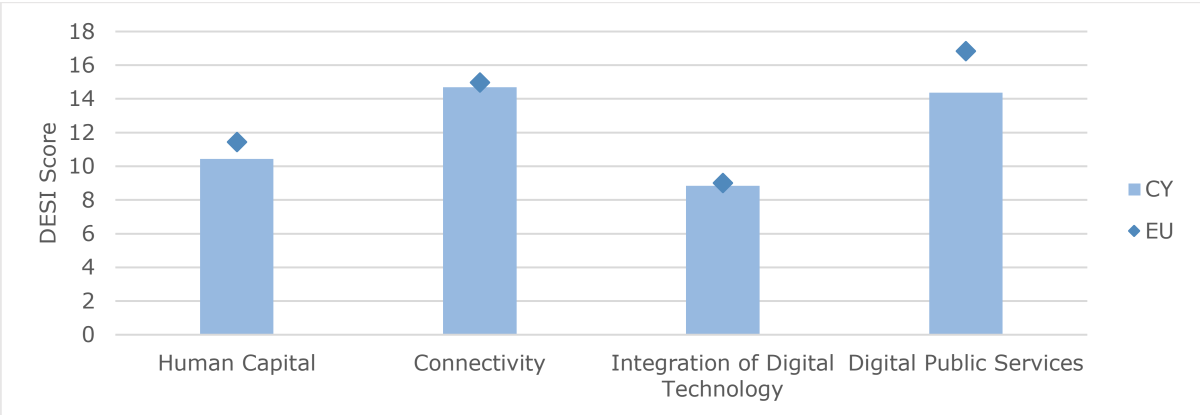
[372] European Commission (2023). Access to social protection. Available at: https://ec.europa.eu/social/main.jsp?catId=1312&langId=en=en

employed, though not all gaps in coverage are anticipated to be closed[373]. The measure to reform the social insurance system also forms part of the Cypriot NRRP[374]. More generally, social expenditure constitutes 23.7% of total planned expenditure in the NRRP for Cyprus. The largest part of this is allocated towards education and childcare (49.7%), with relatively smaller shares for employment and skills (17.1%) and social policies (8.9%).

CY 3. Other dimensions relevant to the digital transformation

Other, contextual dimensions may be relevant for achieving a successful and socially fair digital transformation. First, digitalisation in firms holds significant importance for harnessing the potential economic benefits from digitalisation. According to the DESI index (Figure 5), the **digitalisation of firms in Cyprus is slightly lower than in the EU overall.** Regarding integration of digital technologies in firms, the country ranks 17th in the EU27. However, within the National Digital Strategy 2020-2025, digitalisation of the economy is designated as one of four strategic areas for policy intervention. Under this dimension, policy measures to support the digitalisation of local businesses and business sectors, strengthen digital competitiveness and entrepreneurship and drive up the adoption of emerging technologies are planned. Within the Cypriot NRRP, digitalisation of businesses plays only a minor role, with 3.4% of planned spending devoted to this dimension.

Figure 5 – DESI Index for CY and the EU



Source: European Commission (2022)

Besides digitalisation of enterprises, **digital infrastructure and public services are important contextual factors for managing the digital transformation**. Looking at levels of connectivity, according to the DESI index (Figure 5), the Cypriot performance is in line with the rest of the EU27, placing the country 12th. In contrast, digital public services are somewhat less advanced in Cyprus than in the EU27 - According to the DESI index, Cyprus is ranked 20th in the EU27. Taking a forward-looking view, the Cyprus National Digital Strategy 2020-2025

[373] European Commission (2023). Report from the Commission to the Council on the implementation of the Council Recommendation on access to social protection for workers and the self-employed. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023DC0043&qid=1676473347749
[374] European Commission (2022); Recovery and Resilience Scoreboard Thematic Analyses. Social protection. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-

designates digital government as one of the priority areas for action. Digital infrastructure and public services also play a significant role in the Cypriot NRRP. Indeed, of total planned digital expenditure in the NRRP, 51.2% is allocated to the digitalisation of public services. This expenditure is targeted at a range of measures, including the promotion of e-government, the digitalisation of public administration and the digitalisation of the social insurance system, among others[375]. There is also spending planned on connectivity within the NRRP, though not as substantial as for digital public services. Measures mainly aim at increasing the deployment of very high-capacity networks (e.g. 5G)[376]. In the National Broadband Plan 2021-2025, several targets for increasing connectivity are defined. For instance, this includes all premises in organized communities having an internet connection with a download speed of at least 100Mbps[377].

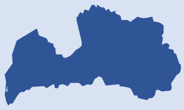
[375] European Commission (2021); Recovery and Resilience Scoreboard Thematic Analyses. Digital public services. Available at :https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/2_Digital.pdf

[376] European Commission (2023); Recovery and Resilience Scoreboard Thematic Analyses. Connectivity. https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_connectivity.pdf

[377] For more information, see https://dec.dmrid.gov.cy/dmrid/dec/ws_dec.nsf/broadband_en/broadband_en?OpenDocument

14. LATVIA: elements of a socially fair digital transformation

Key Points



Labour market: Currently, the Wholesale and retail sector has the largest employment share in the economy and ranks fifth amongst the sectors in terms of degree of digital transformation (based on the current percentage of enterprises that employ ICT specialists in a sector). The sector's employment share in the economy is not projected to grow further in the decade to come (slightly less than EU27 trends). ICT services, Real Estate and Energy supply services are the three sectors with the highest degree of digital transformation currently, and their employment shares, except for Real estate, are projected to grow much more than the EU27 rate in the coming decade. Regarding the risk of automation of occupations, the most vulnerable occupation is Trades workers.

Digital skills: Latvia has one of the lowest overall levels of digital skills in the EU. While digital divides between socio-economic groups are low, this should be seen within the context of the overall low level of digital skills.

Social protection: There are significant shortcomings in the Latvian social protection system, and Latvia has one of the highest rates of the population at risk of poverty in Europe. There has also been only limited policy action on regulating the employment status of platform workers.

LV 1. The labour market and the digital transformation

LV 1.1 Sectoral composition (current and forward-looking perspectives)

In Latvia ("LV"), in 2022, the sectors with the largest employment shares in the economy were: Wholesale and retail trade (15.8% vs 13.6% at the EU27 level), Manufacturing (13.1% vs 16.0% at the EU27 level), and Education (9.0% vs 7.4% at the EU27 level). Cedefop data projects the annual growth rate of the sectors' employment shares for the period 2022-2035. For Latvia's Wholesale and retail trade sector, the annual growth rate is -0.5% (0.0% for the EU27), while it is 0.0% for the Manufacturing sector (-0.2% for the EU27), and -0.5% for the Education sector (0.3% for the EU27).

Table 1 shows each sector's employment share in the economy in 2022, the projected annual growth rate (2022-2035) of its employment share, as well the resulting employment share in the economy by 2035. Along with these elements relating to employment, Table 1 also presents the degree of "digital transformation" of each sector. Hence, Table 1 aims to compare each sector's level of digital transformation with that sector's employment share and projected growth in that share. The aforementioned degree of digital transformation is proxied in Table 1, for each sector, by two indicators: i) the percentage of enterprises that employ ICT specialists in the sector and ii) the sector's digital capital intensity[378]. Table 1 presents the ranking of each sector according to these two proxy indicators (with rank n°1 corresponding to the most digitised sector). According to the first indicator, the three sectors with the highest degree of digital transformation in Latvia, in order, are: ICT services (employment share: 5.0% in LV vs 3.7% in the EU27), Real Estate (1.7% vs 0.9%) and Energy supply services (1.4% vs 0.7%). According to the second indicator (digital capital intensity), the three sectors with the highest degree of digital transformation, in order, are: Finance and insurance (employment share: 2.0% in LV vs 2.8% in the EU27), ICT services (5.0% vs 3.7%) and Professional services (3.9% vs 5.7%). In Latvia, these sectors' employment shares have a projected annual growth rate for 2022-2035 of 2.1% for ICT services (vs 0.8% for the EU27), -0.2% for Real estate (vs 0.9% for the EU27), 2.1% for Energy supply services (vs 0.1% for EU 27), 1.0% for Finance and insurance (vs 0.2% for the EU27), and 0.3% for Professional services (vs 0.6% for the EU27).

As can be seen from Table 1, notably, two of the top four sectors in terms of the degree of digital transformation – ICT services and energy supply services – are also among the top four sectors in terms of the annual growth rate of employment share in the coming decade in Latvia. Furthermore, in terms of employment share (in 2022), the top two sectors – Wholesale and retail trade and Manufacturing - rank fifth and sixth, according to one of the two proxy indicators of the digital transformation (% of enterprises that employ ICT specialists). Moreover, Wholesale and retail trade ranks fourth according to the second proxy indicator of the digital transformation (digital capital intensity).

Table 1 – LV. Sector's share of employment, annual growth rate, and ranking of "digital transformation" (the sectors are ranked according to the ranking in the last column of the table).

Sectors	Sector's employment share in 2022 (%)		Projected annual growth rate of the sector's employment share (2022 - 2035, %)		Projected sector's employment share in 2035 (%)		Proxy 1 for digital transformation (ranking)	Proxy 2 for digital transformation (ranking)
	LV	**EU**	**LV**	**EU**	**LV**	**EU**	**% enterprises that employ ICT specialists**	**Digital capital intensity**
K - Finance & insurance	2.0	2.8	1.0	0.2	2.3	2.8	n.a.	1
J - ICT services	5.0	3.7	2.1	0.8	6.6	4.2	1	2
M - Professional services	3.9	5.7	0.3	0.6	4.1	6.3	8	3
G - Wholesale & retail trade	15.8	13.6	-0.5	0.0	14.7	13.6	5	4
N - Administrative services	2.8	4.1	-1.1	0.0	2.4	4.1	n.a.	5

[378] 'Digital capital intensity' is an index – built in the context of this study – that looks at the ratio between the stock of capital the firms have in software and databases and the overall stock of capital excluding non-residential buildings. Its construction is based on the integrated EUKLEMS & INTANProd database, run by the Luiss Lab of European Economics at Luiss University in Rome, Italy. For more in-depth information on the source, and the availability of the indicator for Member States/sectors, please refer to the Annex.

O - Public sector & defence	7.3	7.1	-0.2	-0.1	7.0	7.0	n.a.	6
D - Energy supply services	1.4	0.7	2.1	0.1	1.9	0.8	3	7
C - Manufacturing	13.1	16.0	0.0	-0.2	13.1	15.6	6	8
Q - Health & social care	6.4	11.0	0.8	0.6	7.1	11.9	n.a.	9
R - Arts & recreation and other services	2.4	1.7	0.2	0.3	2.4	1.7	n.a.	10
H - Transport & storage	7.4	5.3	0.1	-0.1	7.6	5.3	7	11
P - Education	9.0	7.4	-0.5	0.3	8.4	7.7	n.a.	12
F - Construction	8.3	6.8	0.1	-0.3	8.4	6.5	9	13
E- Water and waste treatment	0.9	0.8	-0.1	-0.1	0.9	0.8	4	14
A - Agriculture, forestry & fishing	6.8	3.5	-1.1	-3.1	5.8	2.3	n.a.	15
I - Accommodation & food	3.0	4.5	2.2	0.6	4.1	4.9	10	n.a.
S - Other service activities	2.1	2.6	-0.4	0.0	2.0	2.6	n.a.	n.a.
L - Real Estate	1.7	0.9	-0.2	0.9	1.7	1.0	2	n.a.
B - Mining & quarrying	0.3	0.3	-2.8	-1.7	0.2	0.2	n.a.	n.a.
T - Activities of households as employers	n.a.	0.9	0.8	-0.3	n.a.	0.9	n.a.	n.a.
U - Activities of extraterritorial org.	n.a.	0.1	n.a.	n.a.	n.a.	0.1	n.a.	n.a.

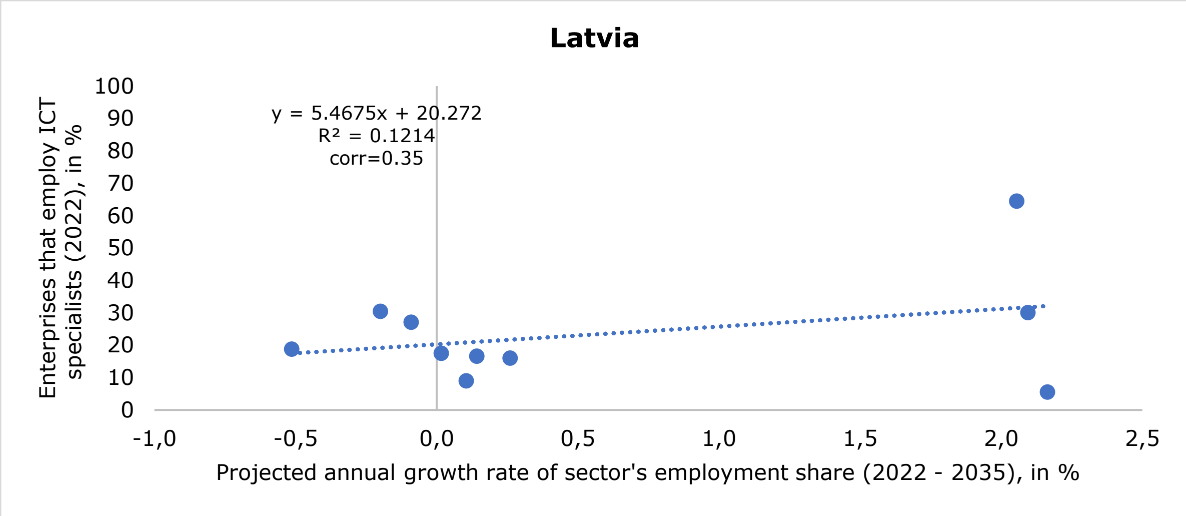
Source: For the employment-related indicators own elaboration on Eurostat data (share of employment, 2022 calculated based on lfsa_egan) and on Cedefop 'Skill forecast data 2023' (annual growth rate of sector's employment share, 2022-2035), for the digital transformation-related indicators: own elaboration on Eurostat data (share of enterprises that employ ICT specialists, Eurostat code: lfsa_egais) and on EUKLEMS & INTANProd data (digital capital intensity).
Note: In the first column of the table, the letter preceding the sectors is the code of the NACE Rev.2 classification. In the last two columns of the table, the two proxy indicators used for the digital transformation are: i) the share of enterprises that employ ICT specialists (Eurostat code: lfsa_egais) and ii) the digital capital intensity (EUKLEMS & INTANProd data, average 2014-2017) with rank n°1 corresponding to the most digitally intense sector.

Further to Table 1, Figures 1a and 1b below look at the extent to which there may be a relationship between the projected annual growth rates of the sectors' employment shares in the economy and their degree of digital transformation [379].

In **Figure 1a**, we present a scatterplot to shed light on the relationship between the first proxy of the digital transformation used (percentage of enterprises that employ ICT specialists) and the projected annual growth rate of a sector's employment share between 2022-2035. The correlation is positive with a value of 0.35, but not statistically significant (it is 0.62 and statistically significant for the EU27). **The lack of correlation implies that an association, at the sectoral level, between the percentage of enterprises that employ ICT specialists and the projected annual growth rate of a sector's employment share cannot be inferred in Latvia.**

[379] With the caveat that the correlation coefficients presented in Figure 1a and Figure 1b cannot be directly compared, as they pertain to a combination of sectors that varies across different Member States.

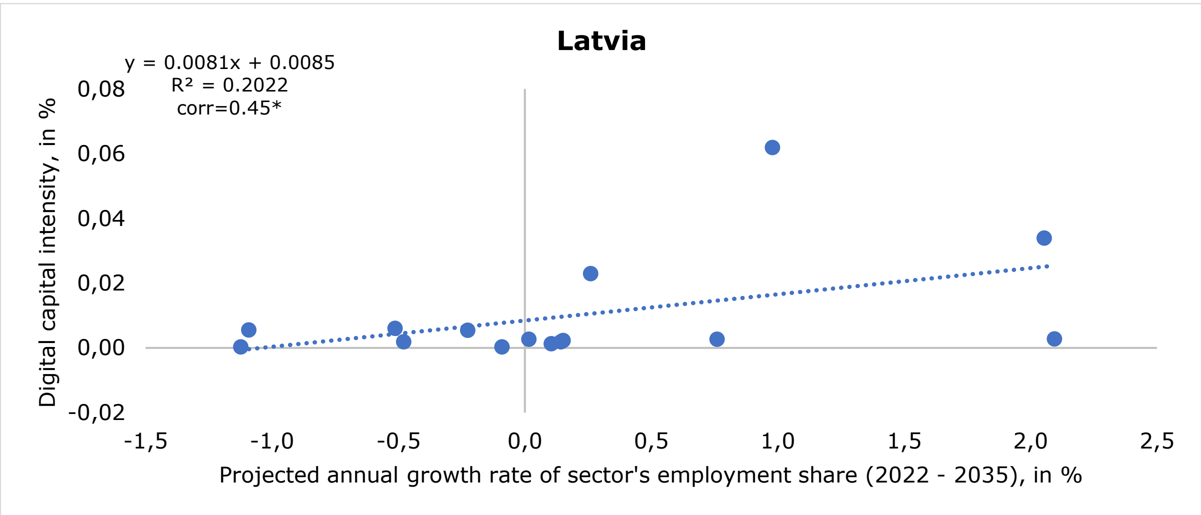
Figure 1a – LV. Relationship between the percentage of enterprises that employ ICT specialists (in 2022) and the projected annual growth rate of sector's employment share (2022-2035).



Source: Own elaboration on Eurostat and Cedefop 'Skill forecast 2023' data.

Figure 1b shows the correlation between the second digital transformation proxy ('digital capital intensity') and the projected annual growth rate of a sector's employment share between 2022-2035. The correlation coefficient exhibits a value of 0.45 and is statistically significant in Latvia. Among the 16 Member States for whom 'digital capital intensity' can be computed (7 of which present a positive and significant correlation), Latvia ranks fourth. In this case, **the positive correlation could suggest that, in Latvia, the employment shares of sectors with a higher 'digital capital intensity' are more likely grow (over 2022-2035) than those of other sectors. However, the relationship is only moderate** and one percentage point below the average of the seven Member States for whom we find a positive correlation. As before, this correlation does not imply causal links.

Figure 1b – LV. Relationship between 'digital capital intensity' and the projected annual growth rate of sector's employment share (2022-2035).

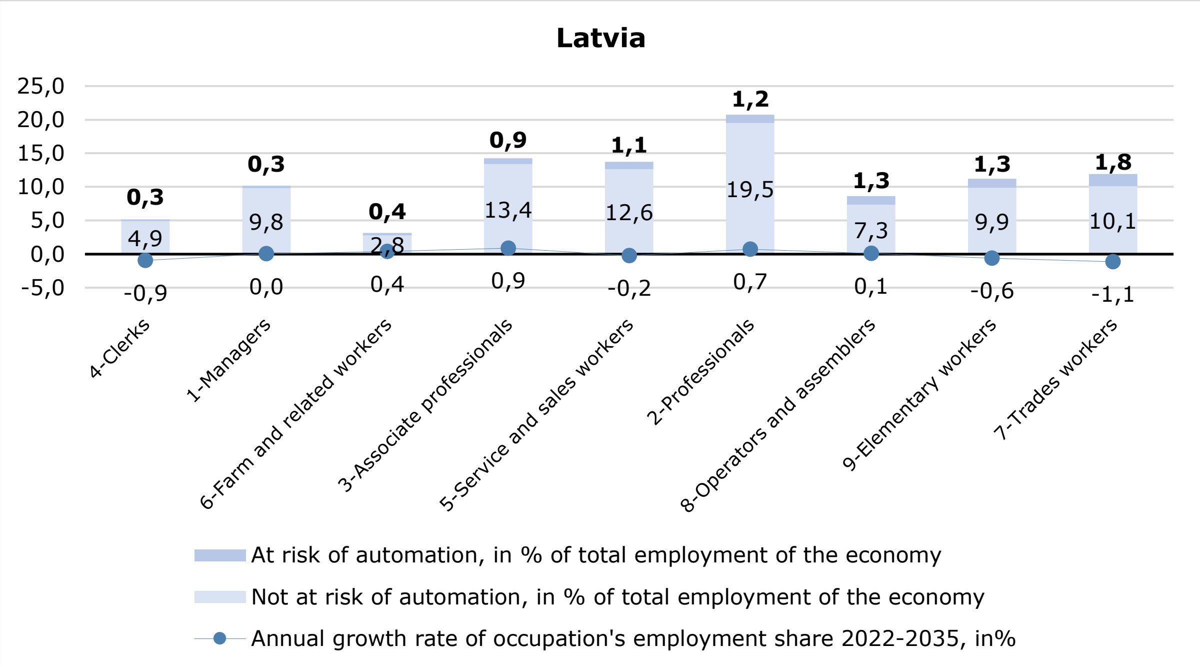


Source: Own elaboration on EUKLEMS & INTANProd, and Cedefop 'Skill forecast 2023' data.

LV 1.2 Occupational composition at ISCO-08 1 digit and risk of automation (current and forward-looking perspectives)

Different occupations are subject to differing levels of automation risk. Cedefop developed[380] a "risk of automation" index by occupation at the EU27 level, most recently updated with data for 2022[381]. We apply this indicator at the Member State level, with the assumption that the risk of automation for a given occupation is constant across Member States[382]. As such, the variation across Member States, in the overall susceptibility of Member States' workforces to automation (overall risk across all occupations in that Member State) will be due to the employment composition effect. This means that while the automation risk for a given occupation stays constant across Member States, the overall automation risk of a Member State will naturally be greater for those Member States having more employment in occupations with a higher automation risk.

Figure 2 Employment shares of occupations (at ISCO-08 1 digit level) - split into sub shares 'not at risk' and 'at risk' of automation (2022) - and projected annual growth rate



Source: Own elaboration on Cedefop data (risk of automation calculated by Cedefop at EU27 level by ISCO-08 1 digit level for 2022) applied to Eurostat data (share of employment by occupation, lfsa_egais, 2022).
Note: The numbers preceding the occupations are the ISCO-08 codes. Occupations are ranked from the highest to the lowest share of workers that present a risk of automation. The vertical sum of the two components (darker blue and lighter blue) gives back the total employment share by occupation (in % of total employment in the Member State). The ISCO nomenclature used in the text and the figure is the Cedefop one. For examples of specific occupations see: https://esco.ec.europa.eu/en/classification/occupation_main.

[380] Based on the methodology in Pouliakas, K. (2018) "The risk of automation in EU labour markets: a skill-requirements approach", in Economy, Employment and Skills: European and global perspectives in an age of uncertainty, Fondazione Giacomo Brodolini Quaderni Series, also IZA DP 11829.
[381] As retrieved at https://www.cedefop.europa.eu/en/tools/skills-intelligence/automation-risk-occupations#1
[382] While this assumption may be considered strong, Cedefop data are the only ones available that are at the same time, up to date and available for all the occupations at the ISCO-08 level.

As shown in **Figure 2**, in Latvia, the occupation with the largest employment sub-share (in % of total employment in the economy) 'at risk of automation' is Trades workers, with an employment sub-share of workers 'at risk of automation' representing 1.8% of total employment in the country (vs 1.3% for the EU27). The occupation with the second- largest employment sub-share of workers 'at risk of automation' is Elementary workers, with an employment sub-share of workers 'at risk' of 1.3% of total employment in Latvia (vs 1.0% for the EU27). The third-ranked occupation is Operators and assemblers, where the share of workers 'at risk' represents 1.3% in total employment in Latvia (vs 1.1% for the EU27). **Among these three occupations, only the first one is also the most affected across the EU27[383].**

For **ICT professionals (ISCO 25)**[384], the 2022 employment share is 2.9% in Latvia (vs 2.3% in the EU27) and its composition (as regards the risk of automation) is as follows: an employment sub-share of 0.2% (vs 0.1% in the EU27) is 'at risk of automation', whereas the remaining employment sub-share of 2.8% (vs 2.2% at EU27 level) is 'not at risk of automation'. The projected annual growth rate 2022-2035 of the employment share of ICT professionals is 2.7% in Latvia (vs 1.9% in EU27).

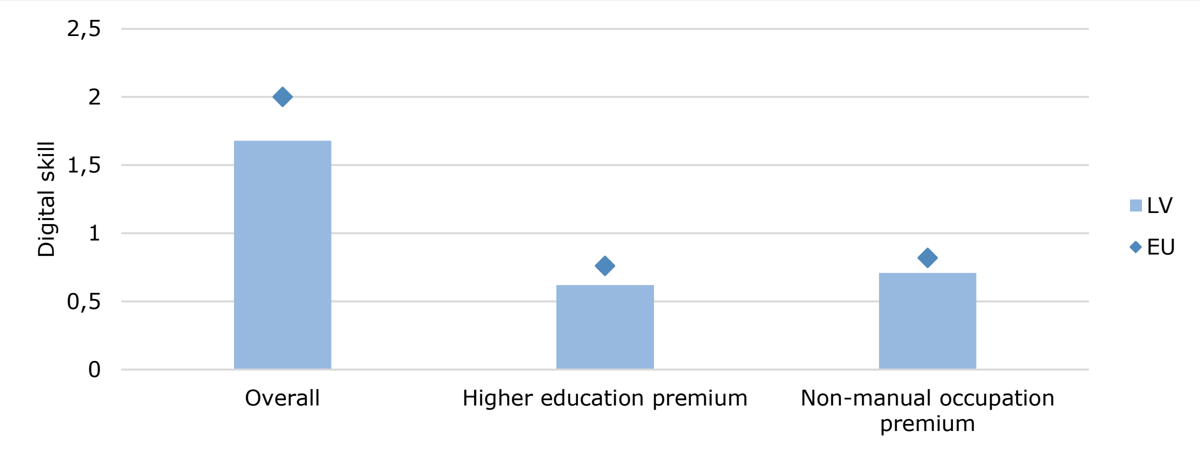
LV 2. Key policy dimensions for a socially fair digital transformation

LV 2.1 Digital skills

One of the key policy dimensions influencing the extent to which the digital transformation is socially fair is the level of digital skills of the population. However, with regard to digital skills, Latvia is lagging behind the rest of the EU. According to the study's estimated index of digital skills[385] (Figure 3, bar "Overall"), the overall level of digital skills in Latvia is the fourth lowest in the EU27. In the DESI Index[386] for Human Capital (Figure 5, section "Other dimensions"), Latvia ranks 18th among EU member states. Among the dimensions included in the DESI index, while the low share of ICT specialists remains an issue, Latvia performs above the EU average with respect to the share of graduates studying ICT[387]. Divides in digital skill between individuals with different levels of education and in manual versus non-manual occupations (respectively "higher-educational premium" and "non-manual premium" in Figure 3) are, however, less pronounced than the EU rate. Latvia ranks sixth in the EU on the former indicator, and 10th on the latter. While this relatively low inequality in digital skill across socio-economic groups is a potential strength with regard to mitigating effects of the digital transformation**, the low overall level of digital skills is a concern and necessitates policy action on digital up- and re-skilling**.

383 The most affected in the EU27 are Trades workers, Professionals, and Service and sales workers.
384 Eurostat code: lfsa_egai2d.
385 The construction of the digital skill index is described in detail in the introductory section.
386 European Commission (2022). Digital Economy and Society Index. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi
387 European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance

Figure 3 – Estimated Digital Skills in LV and the EU (2019)



Source: Authors' own estimation based on Eurostat ICT survey
Note: Higher education premium refers to the difference in digital skills between individuals with tertiary and lower than tertiary education. Non-manual occupation premium refers to the difference in digital skills between individuals in manual and non-manual occupations.

In the Digital Transformation Guidelines for 2021-2027[388], the Latvian government sets out an overarching strategy for the management of digitalisation in Latvia, with digital skills identified as a key policy priority. Several targets are defined under the digital skills pillar, such as 70% of citizens having at least basic digital skills by 2027. These targets are to be achieved through the integration of digital skills into lifelong learning education programmes at all ages[389]. Policy action on digital skills is also part of the Latvian NRRP, where 30.8% of overall digital expenditure focuses on human capital. This includes a number of investments, such as a measure aimed at increasing the number of specialists with advanced digital skills through training modules and the development of individual learning accounts for adults[390].

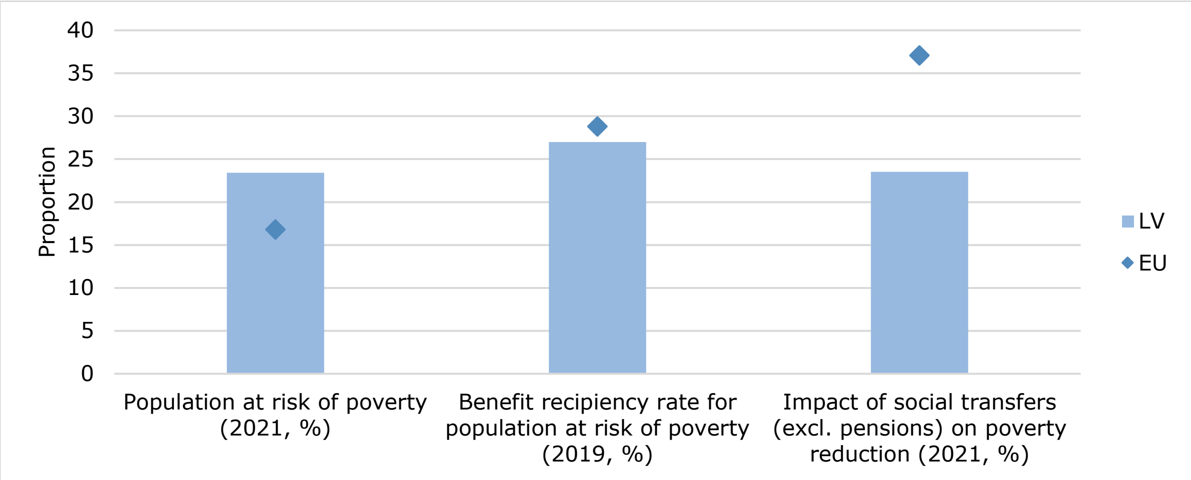
LV 2.2 Social protection and social policy

While digital skills are one significant factor needed to support the digital transformation, social protection systems also play an important role in mitigating potential negative effects of digitalisation on employment. Figure 4 presents some key statistics on social protection in Latvia. **Relative to the rest of the EU, the Latvian social protection system presents significant shortcomings.** The rate of the population at risk of poverty after social transfers[391] (23.4%)[392] is the highest in the EU27. Moreover, the benefit recipiency rate for the population at

[388] For more information, see https://digitalanedela.lv/wp-content/uploads/2021/09/Latvijas-Digitālās-Transformācijas-pamatnostādnes-2021-2027.pdf
[389] For more information, see https://digital-skills-jobs.europa.eu/en/actions/national-initiatives/national-strategies/latvia-digital-transformation-guidelines-2021-2027
[390] European Commission (2022); Recovery and Resilience Scoreboard Thematic Analyses. Digital Skills. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_digital_skills.pdf
[391] Eurostat (2023). TPS00184: At-risk-of-poverty rate after social transfers by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/tps00184/default/table?lang=en
[392] Although it has since decreased to 22.5% in SILC 2022 data.

risk of poverty before social transfers[393] (27.0%) and, particularly, the impact of social transfers on poverty reduction[394] (23.5%) are both significantly lower than the EU27 rates, pointing to limited effectiveness of the social protection system in alleviating poverty. Latvia has also not been particularly active on the regulation of the employment status of platform workers, a form of work significantly shaped by digitalisation[395].

Figure 4 – Social Protection in LV and the EU



Source: Eurostat (2023) and JRC (2022)

In its national implementation plan for the Recommendation on access to social protection, the Latvian government sets out measures that have been implemented to increase the adequacy of social protection but does not include measures on the formal or effective coverage of social protection. These measures are not expected to fully close gaps in coverage[396]. The Latvian NRRP also includes some measures on social protection, specifically, a reform of minimum income benefits to increase their adequacy[397]. More broadly, social expenditure within the Latvian NRRP largely focuses on education and childcare (38.1%) and health and long term care (39.6%), with only around a fifth of social expenditure allocated towards employment and skills (19%).

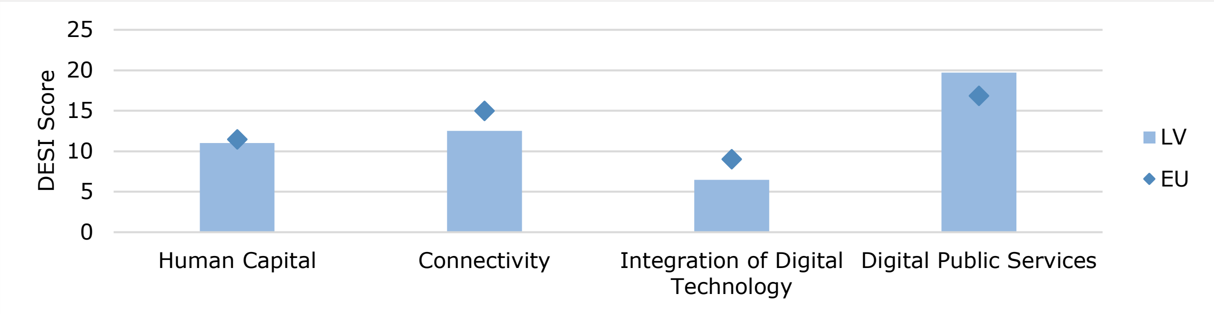
LV 3. Other dimensions relevant to the digital transformation

In addition to digital skills and social protection, broader support structures need to be in place for a successful digital transformation that harnesses the economic

[393] Eurostat indicator as re-elaborated by JRC (2022) "Monitoring the effective coverage and adequacy of social protection in the EU".
[394] Eurostat (2023). TESPM050: Impact of social transfers (excluding pensions) on poverty reduction by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/TESPM050/bookmark/table?lang=en&bookmarkId=b001ae62-ce34-4b49-9741-28a3ef99477f
[395] PPMI (2021). Study to support the impact assessment on improving working conditions in platform work. Available at: https://ec.europa.eu/social/main.jsp?catId=738&furtherPubs=yes&langId=en&pubId=8428
[396] European Commission (2023). Report from the Commission to the Council on the implementation of the Council Recommendation on access to social protection for workers and the self-employed. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023DC0043&qid=16764733477492
[397] European Commission (2022). Recovery and Resilience Scoreboard Thematic Analyses. Social protection. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_social_protection.pdf

benefits from digitalisation. The first significant support factor is digitalisation of businesses. However, levels of digitalisation of businesses in Latvia are relatively low. The DESI Index (Figure 5) indicates that with respect to the level of integration of digital technologies in Firms, Latvia ranks only 23rd in the EU27. Similarly, levels of digital capital intensity in firms are much lower than the EU average[398] and have decreased between 2008 and 2018, while they have increased in other European countries. Finally, robot density in both the overall economy and in manufacturing is, despite relatively high growth over the past decade, very low compared to the EU average[399].

Figure 5 – DESI Index for LV and the EU



Source: European Commission (2022)

In sum, digitalisation of businesses in Latvia is significantly behind the rest of the EU. The National Industrial Policy Guidelines 2021-2027 identify the digital transformation of businesses as a key policy priority[400]. This complements the Latvian NRRP, where a significant share of digital expenditure (31.2%) is targeted at the digitalisation of businesses, including investments targeted at the digitalisation of SMEs, which may help address some of the challenges regarding digitalisation of businesses in Latvia[401].

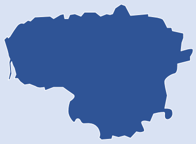
A second significant support factor is digital infrastructure and digital public services. With regard to the latter, Latvia is performing well. According to the DESI Index, levels of digitalisation of public services are significantly higher than the EU average (11th in the EU27). However, digital infrastructure is less advanced, with connectivity in Latvia ranking only 20th in the EU27. Within the Latvian NRRP digital expenditure, connectivity plays only a minor role (4.1%), whereas a large share of digital expenditure is targeted at further digitalisation of public services (30.8%). In the Development Plan for the Electronic Communications Sector[402], the Latvian government sets out measures to boost connectivity through public funding (including among others NRRP funding) but demand-stimulating measures

[398] For Member States with available data
[399] For Member States with available data
[400] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[401] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[402] For more information, see https://www.sam.gov.lv/lv/elektronisko-sakaru-nozares-attistibas-plans-2021-2027gadam

to increase take-up of high-speed broadband by Latvian households would be beneficial[403].

15. LITHUANIA: elements of a socially fair digital transformation

Key Points



Labour market: Currently, the sector with the largest share of employment in the economy – the Manufacturing sector - ranks fifth in terms of the sectoral degree of digital transformation (based on the current percentage of enterprises that employ ICT specialists in a sector). The Manufacturing sector's employment share in the economy is not projected to grow further in the decade to come (at the same level as EU27 trends). ICT services, Energy supply services and Professional services are the three sectors with the highest current degree of digital transformation, and their employment shares are projected to grow slightly more than the EU27 rate in the coming decade. Looking at the risk of automation of occupations, the type of occupation that is most vulnerable is Trades workers.

Digital skills: The level of digital skills in Lithuania aligns with the EU average overall. The picture is mixed with regard to digital skill divides: while divides between different educational groups align with the EU level, those between occupational groups are quite pronounced.

Social protection: The Lithuanian social protection system faces several shortcomings, and the rate of the population at risk of poverty is among the highest in the EU. Discussion on the employment status of platform workers has also been limited.

LT 1. The labour market and the digital transformation

LT 1.1 Sectoral composition (current and forward-looking perspectives)

In Lithuania ("LT"), in 2022, the sectors with the largest employment shares in the economy were: Manufacturing (16.1% vs 16.0% at the EU27 level), Wholesale and retail trade (14.8% vs 13.6% at the EU27 level), and Education (8.6% vs

[403] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance

7.4% at the EU27 level). Cedefop data projects[404] the annual growth rate of a sector's employment share for the period 2022-2035. For Lithuania's Manufacturing sector, the annual growth rate is -0.2% (same for the EU27), while it is 1.0% for the Wholesale and retail trade sector (0.0% for the EU27), and 0.4% for the Education sector (0.3% for the EU27).

Table 1 shows each sector's employment share in the economy in 2022, the projected annual growth rate of its employment share (2022-2035), as well as its resulting employment share in the economy by 2035. Along with these elements relating to employment, Table 1 also presents the degree of "digital transformation" of each sector. The goal of Table 1 is thus to enable a comparison between a sector's degree of digital transformation and its employment share, and projected growth therein. The aforementioned degree of digital transformation is proxied in Table 1, for each sector, by two indicators: i) the percentage of enterprises that employ ICT specialists in the sector and ii) the sector's level of digital capital intensity[405]. Table 1 ranks each sector according to these two proxy indicators (with rank n°1 corresponding to the most digitised sector). According to the first indicator, the three sectors with the highest degree of digital transformation in Lithuania are: ICT services (employment share: 4.1% in LT vs 3.7% in the EU27), Energy supply services (0.9% vs 0.7%) and Professional services (5.0% vs 5.7%). According to the second indicator (digital capital intensity), the three sectors with the highest degree of digital transformation are: Professional services (employment share: 5.0% in LT vs 5.7% in the EU27), Education (8.6% vs 7.4%) and Arts and recreation and other services (2.0% vs 1.7%). In Lithuania, these sectors' employment shares have a projected annual growth rate (2022-2035) of 0.0% for ICT services (vs 0.8% for the EU27), 1.4% for Energy supply services (vs 0.1% for the EU27), 0.4% for Professional services (vs 0.6% for the EU27), 0.4% for Education (vs 0.3% for the EU27), and -1.3% for Arts and recreation services (vs 0.3% for the EU27).

As shown in Table 1, it is worth noting that only one of the top four sectors in terms of the degree of digital transformation – Energy supply services – is also among the top four sectors in terms of the annual growth rate of employment share in the coming decade in Lithuania. Furthermore, in terms of employment share (in 2022), the top two sectors – Wholesale and retail trade and Manufacturing - rank fifth and fourth, according to one of the two proxy indicators of the digital transformation (% of enterprises that employ ICT specialists). Moreover, the third-ranked sector - Education - ranks second according to the second proxy indicator of the digital transformation (digital capital intensity).

Table 1 – LT. Sector's share of employment, annual growth rate, and ranking of "digital transformation" (the sectors are ranked according to the ranking in the last column of the table).

Sectors	Sector's employment share in 2022 (%)	Projected annual growth rate of the sector's employment share (2022 - 2035, %)	Projected sector's employment share in 2035 (%)	Proxy 1 for digital transformation (ranking)	Proxy 2 for digital transformation (ranking)

[404] Own elaboration on Cedefop 'Skill forecast 2023' data.
[405] 'Digital capital intensity' is an index – built in the context of this study – that looks at the ratio between the stock of capital the firms have in software and databases and the overall stock of capital excluding non-residential buildings. Its construction is based on the integrated EUKLEMS & INTANProd database, run by the Luiss Lab of European Economics at Luiss University in Rome, Italy. For more in-depth information on the source, and the availability of the indicator for Member States/sectors, please refer to the Annex.

	LT	EU	LT	EU	LT	EU	% enterprises that employ ICT specialists	Digital capital intensity
M - Professional services	5.0	5.7	0.4	0.6	5.3	6.3	3	1
P - Education	8.6	7.4	0.4	0.3	9.1	7.7	n.a.	2
R - Arts & recreation and other services	2.0	1.7	-1.3	0.3	1.6	1.7	n.a.	3
N - Administrative services	4.0	4.1	0.0	0.0	4.0	4.1	6	4
E- Water and waste treatment	0.9	0.8	-0.5	-0.1	0.9	0.8	n.a.	5
C - Manufacturing	16.1	16.0	-0.2	-0.2	15.6	15.6	5	6
B - Mining & quarrying	0.4	0.3	0.8	-1.7	0.4	0.2	n.a.	7
O - Public sector & defence	6.6	7.1	-0.7	-0.1	6.0	7.0	n.a.	8
D - Energy supply services	0.9	0.7	1.4	0.1	1.1	0.8	2	9
A - Agriculture, forestry & fishing	5.3	3.5	-1.4	-3.1	4.4	2.3	n.a.	10
J - ICT services	4.1	3.7	0.0	0.8	4.1	4.2	1	n.a.
G - Wholesale & retail trade	14.8	13.6	1.0	0.0	17.0	13.6	4	n.a.
H - Transport & storage	7.4	5.3	-1.2	-0.1	6.3	5.3	7	n.a.
F - Construction	7.9	6.8	-0.3	-0.3	7.6	6.5	8	n.a.
I - Accommodation & food	2.8	4.5	1.5	0.6	3.4	4.9	9	n.a.
K - Finance & insurance	2.2	2.8	1.2	0.2	2.6	2.8	n.a.	n.a.
L - Real Estate	1.0	0.9	2.9	0.9	1.5	1.0	n.a.	n.a.
Q - Health & social care	7.4	11.0	-0.1	0.6	7.3	11.9	n.a.	n.a.
S - Other service activities	2.5	2.6	-0.5	0.0	2.3	2.6	n.a.	n.a.
T - Activities of households as employers	n.a.	0.9	1.8	-0.3	n.a.	0.9	n.a.	n.a.
U - Activities of extraterritorial org.	n.a.	0.1	n.a.	n.a.	n.a.	0.1	n.a.	n.a.

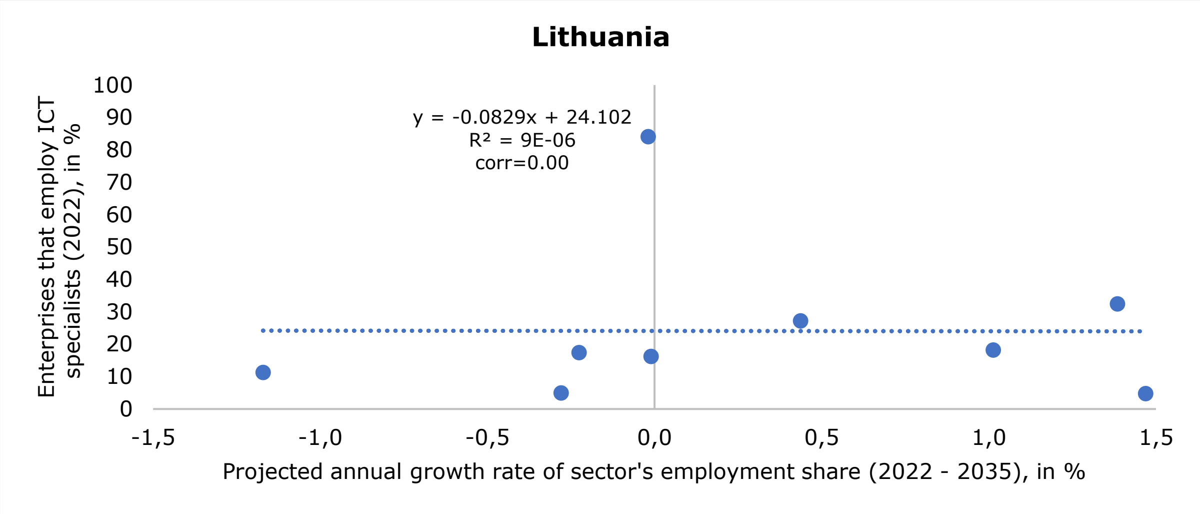
Source: For the employment-related indicators own elaboration on Eurostat data (share of employment, 2022 calculated based on lfsa_egan) and on Cedefop 'Skill forecast data 2023' (annual growth rate of sector's employment share, 2022-2035), for the digital transformation-related indicators: own elaboration on Eurostat data (share of enterprises that employ ICT specialists, Eurostat code: lfsa_egais) and on EUKLEMS & INTANProd data (digital capital intensity).
Note: In the first column of the table, the letter preceding the sectors is the code of the NACE Rev.2 classification. In the last two columns of the table, the two proxy indicators used for the digital transformation are: i) the share of enterprises that employ ICT specialists (Eurostat code: lfsa_egais) and ii) the digital capital intensity (EUKLEMS & INTANProd data, average 2014-2017) with rank n°1 corresponding to the most digitally intense sector.

To complement Table 1, Figures 1a and 1b below examine the extent of a potential relationship between the projected annual growth rates of the sectors' employment shares in the economy and their degree of digital transformation[406].

The correlation is null, 0.00, whereas it is 0.62 and statistically significant for the EU27. **The lack of statistically significant correlation implies that a sectoral-level association between the 'percentage of enterprises that employ ICT specialists' and the projected annual growth rate of a sector's employment share cannot be inferred in Lithuania.**

[406] With the caveat that the correlation coefficients presented in Figure 1a and Figure 1b cannot be directly compared, as they pertain to a combination of sectors that varies across different Member States.

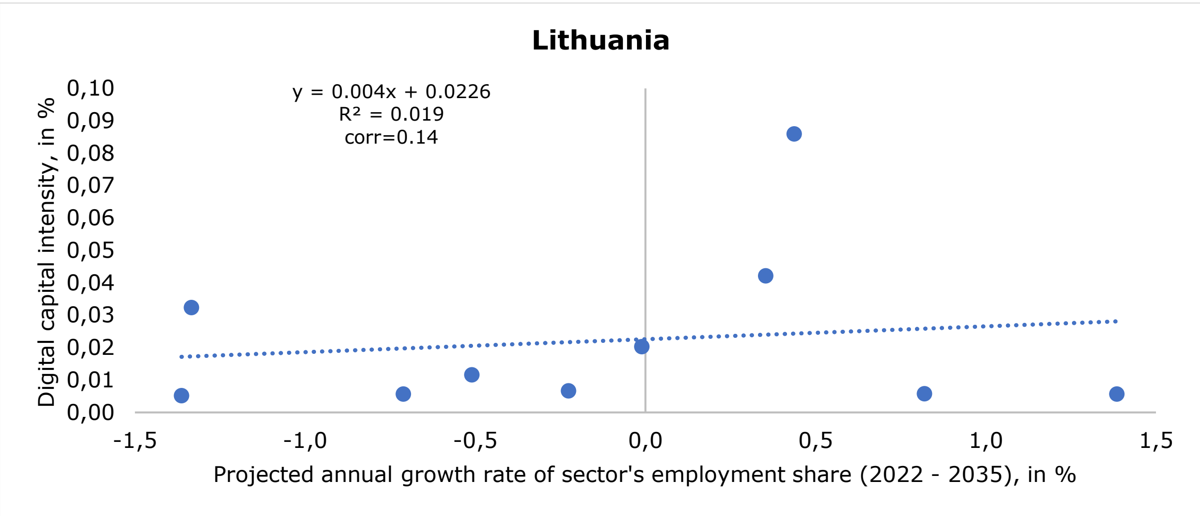
Figure 1a – LT. Relationship between the percentage of enterprises that employ ICT specialists (in 2022) and the projected annual growth rate of sector's employment share (2022-2035).



Source: Own elaboration on Eurostat and Cedefop 'Skill forecast 2023' data.

Figure 1b shows the correlation between the second digital transformation proxy ('digital capital intensity') and the projected annual growth rate of a sector's employment share between 2022-2035. The correlation coefficient exhibits a value of 0.14 and is not statistically significant. Hence, equally, **the lack of correlation implies that an association, at the sectoral level between 'digital capital intensity' and the projected annual growth rate of a sector's employment share cannot be inferred in Lithuania.**

Figure 1b – LT. Relationship between 'digital capital intensity' and the projected annual growth rate of sector's employment share (2022-2035).

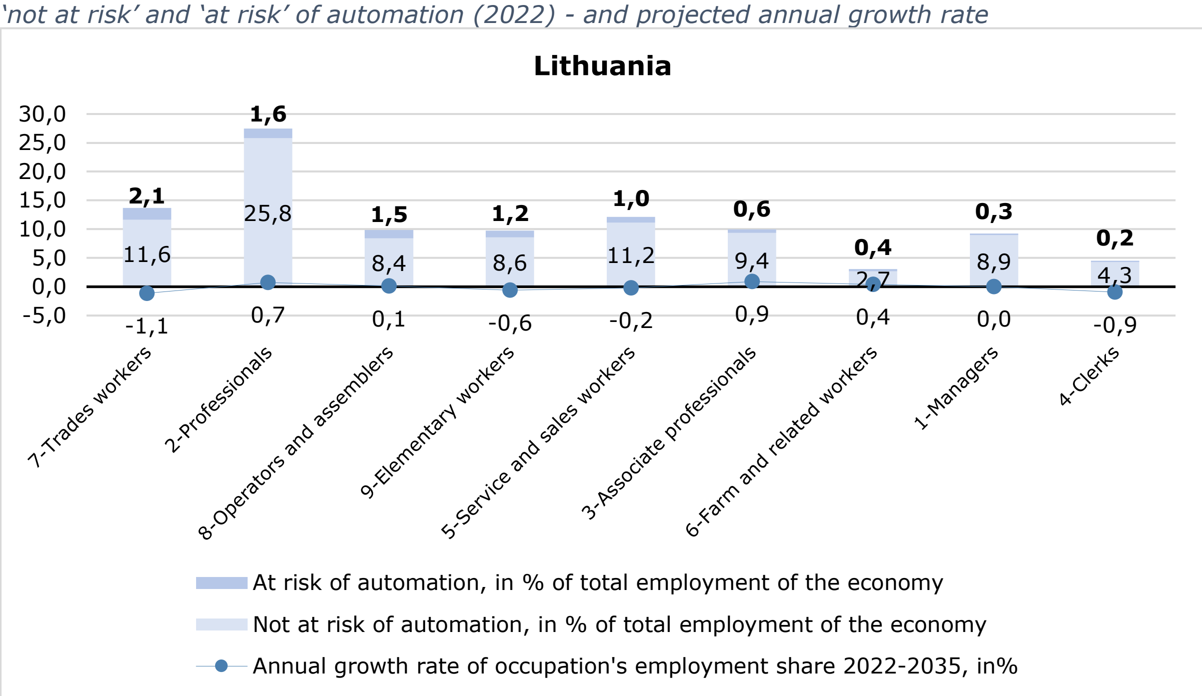


Source: Own elaboration on EUKLEMS & INTANProd, and Cedefop 'Skill forecast 2023' data.

LT 1.2 Occupational composition at ISCO-08 1 digit and risk of automation (current and forward-looking perspectives)

Different occupations are subject to differing levels of automation risk. Cedefop developed[407] a "risk of automation" index by occupation at the EU27 level, with the latest data available for 2022[408]. We apply this indicator at the Member State level, with the assumption that the risk of automation for a given occupation is constant across Member States[409]. As such, variation across Member States in the susceptibility of a Member State's workforce to automation (overall risk across all occupations in that Member State) will be due to an employment composition effect, meaning that while the automation risk for a given occupation stays constant across Member States, the overall automation risk of a Member State will naturally be greater for those Member States having more employment in occupations that have a higher automation risk.

Figure 2 – LT. Employment shares of occupations (at ISCO-08 1 digit level) - split into sub shares 'not at risk' and 'at risk' of automation (2022) - and projected annual growth rate



Source: Own elaboration on Cedefop data (risk of automation calculated by Cedefop at EU27 level by ISCO-08 1 digit level for 2022) applied to Eurostat data (share of employment by occupation, lfsa_egais, 2022).
Note: The numbers preceding the occupations are the ISCO-08 codes. Occupations are ranked from the highest to the lowest share of workers that present a risk of automation. The vertical sum of the two components (darker blue and lighter blue) gives back the total employment share by occupation (in % of total employment in the Member State). The ISCO nomenclature used in the text and the figure is the Cedefop one. For examples of specific occupations see: https://esco.ec.europa.eu/en/classification/occupation_main.

[407] Based on the methodology in Pouliakas, K. (2018) "The risk of automation in EU labour markets: a skill-requirements approach", in Economy, Employment and Skills: European and global perspectives in an age of uncertainty, Fondazione Giacomo Brodolini Quaderni Series, also IZA DP 11829.
[408] As retrieved at https://www.cedefop.europa.eu/en/tools/skills-intelligence/automation-risk-occupations#1
[409] While this assumption may be considered strong, Cedefop data are the only ones available that are at the same time, up to date and available for all the occupations at the ISCO-08 level.

As can be seen in **Figure 2**, in Lithuania, the occupation with the largest employment sub-share (in % of total employment in the economy) 'at risk of automation' is Trades workers, with an employment sub-share of workers 'at risk of automation' representing 2.1% of total employment in the country (vs 1.3% for the EU27). Ranking second regarding the employment sub-share of workers 'at risk of automation' are Professionals, with an employment sub-share of workers 'at risk' of 1.6% of total employment in Lithuania (vs 1.3% for the EU27). Finally, Operators and assemblers are ranked third, with a share of workers 'at risk' of 1.5% in total employment in Lithuania (vs 1.1% for the EU27). **Among these three occupations, the first and second are also the most affected across the EU27[410].**

For **ICT professionals (ISCO 25)** [411], the 2022 employment share is 2.8% in Lithuania (vs 2.3% in the EU27) and its composition (as regards the risk of automation) is as follows: an employment sub-share of 0.2% (vs 0.1% in the EU27) is 'at risk of automation', whereas the remaining employment sub-share of 2.6% (vs 2.2% at EU27 level) is 'not at risk of automation'. The projected annual growth rate 2022-2035 of the employment share of ICT professionals is 3.5% in Lithuania (vs 1.9% in EU27).

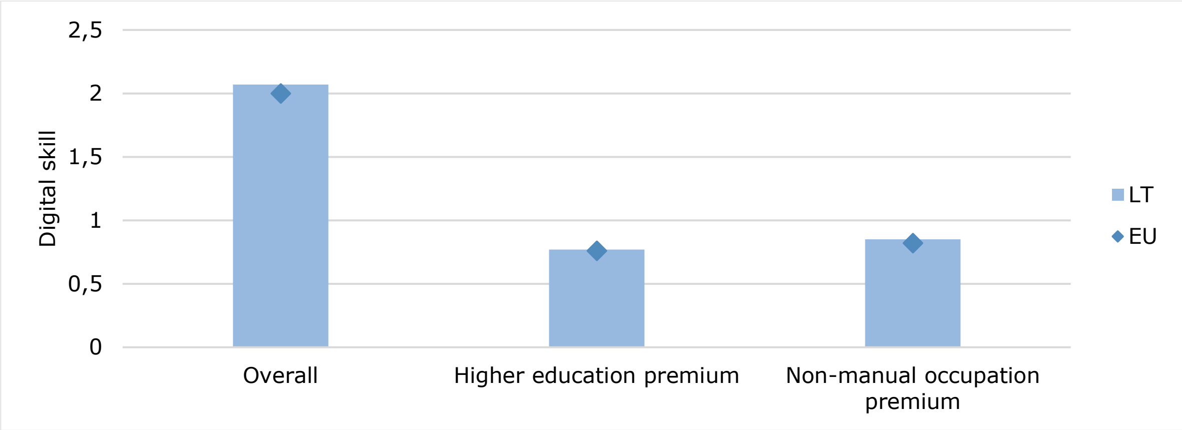
LT 2. Key policy dimensions for a socially fair digital transformation

LT 2.1 Digital skills

A first key policy dimension when it comes to a successful and fair digital transformation is a high level of digital skills within the population. In this regard, Lithuania broadly performs in line with the EU average. In the study's own estimated index of digital skills[412] (Figure 3, bar "Overall"), digital skills are slightly higher than the EU level, with Lithuania ranking 9th in the EU27. However, in the DESI Index for Human Capital[413], which includes further dimensions such as the number of ICT specialists, Lithuania ranks only 20th among EU27 countries. Digital divide indicators also present a mixed picture. While the premium for those with a tertiary education ("Higher education premium" in Figure 3) is in line with the EU27 rate (Lithuania ranks 13th in the EU27), larger differences in digital skills are observed between individuals in manual versus non-manual occupations ("Non-manual occupation premium" in Figure 3; Lithuania ranks 20th in the EU27).

[410] The most affected in the EU27 are Trades workers, Professionals, and Service and sales workers.
[411] Eurostat code: lfsa_egai2d.
[412] The construction of the digital skill index is described in detail in the introductory section.
[413] European Commission (2022). Digital Economy and Society Index. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi

Figure 3 – Estimated Digital Skills in LT and the EU (2019)



Source: Authors' own estimation based on Eurostat ICT survey
Note: Higher education premium refers to the difference in digital skills between individuals with tertiary and lower than tertiary education. Non-manual occupation premium refers to the difference in digital skills between individuals in manual and non-manual occupations.

Further policy action on and investment in digital skills will be essential in this context. In its State Digitisation Development Programme 2021-2030, the Lithuanian government sets out several policy measures to advance digitisation. In the area of skills, the focus is on the establishment of an efficient and effective adult lifelong learning system, as well as digital inclusion of people with disabilities[414]. As part of the Lithuanian NRRP, 23% of total planned digital expenditure is allocated towards human capital. Skill-related measures in the plan include a number of measures for digital skills training as well as the digitalisation of education[415]. However, the development of a dedicated digital skills strategy could be a further step towards improving skills policy in Lithuania[416].

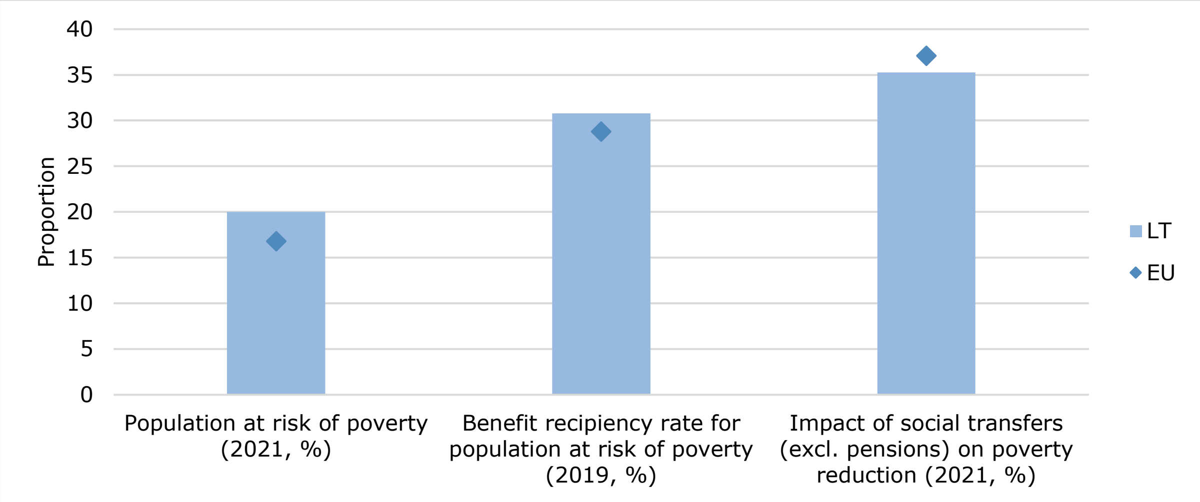
LT 2.2 Social protection and social policy

Social protection systems can play a key role in the digital transformation by protecting individuals from the potential negative impacts of digitalisation on employment, inequalities and poverty. Figure 4 presents key indicators on social protection in Lithuania compared to the EU27. The rate of the population at risk of poverty after social transfers[417] (20.0%) is the seventh highest in the EU27. While the benefit recipiency rate for the population at risk of poverty before social transfers[418] (30.8%) is relatively high, the impact of social transfers on poverty

[414] For more information, see https://digital-skills-jobs.europa.eu/en/actions/national-initiatives/national-strategies/lithuania-state-digitisation-development-programme
[415] European Commission (2022); Recovery and Resilience Scoreboard Thematic Analyses. Digital Skills. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_digital_skills.pdf
[416] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[417] Eurostat (2023). TPS00184: At-risk-of-poverty rate after social transfers by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/tps00184/default/table?lang=en
[418] Eurostat indicator as re-elaborated by JRC (2022) "Monitoring the effective coverage and adequacy of social protection in the EU".

reduction[419] (35.3%) is below the EU27 rate. The employment status of platform workers – an issue with significant implications for access to social protection – has also been discussed only to a limited extent[420]. Overall, **some shortcomings in the social protection system can therefore be observed relative to the rest of the EU.**

Figure 4 – Social Protection in LT and the EU



Source: Eurostat (2023) and JRC (2022)

In the Lithuanian implementation plan for the Recommendation on access to social protection for non-standard workers and the self-employed, several planned measures to improve formal and effective coverage of social protection are set out, though these are not expected to close the majority of gaps in social protection and do not address platform workers specifically[421]. The Lithuanian NRRP also contains measures on social protection, such as a reform to increase the adequacy and sustainability of social benefits by increasing the coverage of unemployment benefits, introducing additional benefits for some vulnerable groups and improving the pension indexation mechanisms. A reform of the guaranteed minimum income scheme and an assessment of the effectiveness of the tax and social insurance system in alleviating poverty and inequality[422] are also included in the plan. Within the broader social expenditure contained in the NRRP, the main focus is on education and childcare (49%) and health and long term care (32.9%).

[419] Eurostat (2023). TESPM050:Impact of social transfers (excluding pensions) on poverty reduction by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/TESPM050/bookmark/table?lang=en&bookmarkId=b001ae62-ce34-4b49-9741-28a3ef99477f

[420] PPMI (2021). Study to support the impact assessment on improving working conditions in platform work. Available at: https://ec.europa.eu/social/main.jsp?catId=738&furtherPubs=yes&langId=en&pubId=8428

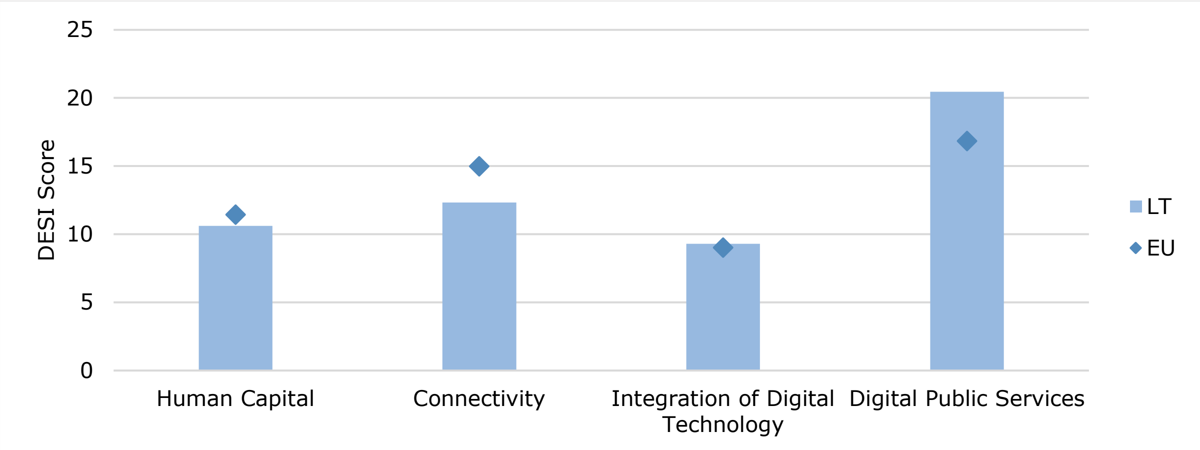
[421] European Commission (2023). Report from the Commission to the Council on the implementation of the Council Recommendation on access to social protection for workers and the self-employed. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023DC0043&qid=16764733477492

[422] European Commission (2022). Recovery and Resilience Scoreboard Thematic Analyses. Social protection. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_social_protection.pdf

LT 3. Other dimensions relevant to the digital transformation

In addition to digital skills and social protection, other support factors can play an important role in the digital transformation process. First, the level of digitalisation of businesses is of central importance. In this regard, Lithuania performs in line with the EU average. The DESI Index (Figure 5) indicates that in terms of the level of integration of digital technologies in firms, Lithuania ranks 13th in the EU27. Levels of digital capital intensity[423] are above the EU average[424], though with a slightly lower growth in the past decade compared to other countries. Looking specifically at robotics, however, Lithuania is lagging behind other European countries. While there has been significant growth in robot density[425] between 2010 and 2019, the overall stock of robots in both the overall economy and in manufacturing are significantly lower than the EU average[426] across countries. In this context, **further measures in favour of digitisation of businesses are crucial**. Policy measures to this end are set out in the Lithuanian industry digitalisation roadmap[427]. Within the Lithuanian NRRP, digitalisation of businesses plays only a relatively small role in terms of digital expenditure (3.8%). More generally, while there has been progress in the development of digital technologies in recent years, further strategic reforms are needed to advance digitalisation of firms, particularly SMEs[428].

Figure 5 – DESI Index for LT and the EU (2022)



Source: European Commission (2022)

A second contextual factor is digitalisation of infrastructure and of public services. On the latter, Lithuania performs well, ranking 10th in the EU27 in the DESI Index for digital public services. However, connectivity levels are significantly less advanced, Lithuania being ranked 23rd in the EU27. Within the planned digital

[423] As described in the Annex, based on data from EU-KLEMS (2008-2018). Data is not available for Cyprus, Croatia, Ireland and Romania.
[424] For Member States with available data
[425] As described in the Annex, based on data from the International Federation of Robotics (2010-2019). Data is not available for Cyprus, Greece, Luxembourg and Slovenia.
[426] For Member States with available data
[427] For more information, see https://eimin.lrv.lt/uploads/eimin/documents/files/Lithuanian%20Industry%20Digitisation%20Roadmap%202020-2030%20UPDATED%20EN%20(1).pdf
[428] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance

expenditure in the Lithuanian NRRP, connectivity investments are relatively minor (9.2%), while a large part is allocated towards digitalisation of public services (56.1%). The plan includes 15 public services digitalisation projects to implement the use of AI and data analytics, and develop a public cloud infrastructure[429]. RRF Funding on connectivity is being used to test 5G technologies. Addressing low levels of 5G assignments will be critical to increase coverage[430].

[429] European Commission (2021); Recovery and Resilience Scoreboard Thematic Analyses. Digital public services. Available at:https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/2_Digital.pdf

[430] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance

16. LUXEMBOURG: elements of a socially fair digital transformation

Key Points

Labour market: Currently, the sector with the largest employment share in the economy – Public sector and defence - ranks eleventh with regard to the sectors' degree of digital transformation (based on the current digital capital intensity in a sector)[431]. This sector's employment share in the economy is not projected to grow further in the decade to come (much less than EU27 trends). ICT services, Energy supply services and Professional services are currently the three sectors with the highest degree of digital transformation, and their employment shares are projected to grow slightly less than the corresponding EU27 trends in the coming decade. Considering the risk of automation of occupations, Professionals are the most vulnerable group.

Digital skills: The overall level of digital skills in Luxembourg aligns with the EU level. However, digital divides between socio-economic groups are relatively pronounced. The skill premiums for highly-educated individuals and individuals in non-manual occupations are both among the largest in the EU.

Social protection: The Luxembourgish social protection system demonstrates several shortcomings, with a rate of the population at risk of poverty significantly higher than the EU rate. However, Luxembourg has been active in regulating the employment status of platform workers.

LU 1. The labour market and the digital transformation

LU 1.1 Sectoral composition (current and forward-looking perspectives)

In Luxembourg ("LU"), in 2022, the sectors with the largest employment shares in the economy were: Public sector and defence (11.5% vs 7.1% at the EU27 level), Finance and insurance (11.2% vs 2.8% at EU27 level), and Health and social care (11.0%, as in the EU27). Cedefop data projects[432] the annual growth rate of a sector's employment share for 2022-2035. For the Public and defence sector in Luxembourg, the annual growth rate is -1.0% (-0.1% for the EU27),

[431] The ranking based on digital capital intensity is used in the key points only when the sector with the largest employment share is not rankable according to the percentage of enterprises that employ ICT specialists. In this case, the ranking for the first largest employment share in the economy was not available.
[432] Own elaboration on Cedefop 'Skill forecast 2023' data.

whereas it is 0.1% for the Finance and insurance sector (0.2% for the EU27), and 0.4% for the Health and social care sector (0.6% for the EU27).

Table 1 presents each sector's employment share in the economy in 2022, its employment share's projected annual growth rate (2022-2035), as well as its resulting employment share in the economy by 2035. Along with these elements relating to employment, Table 1 also presents each sector's degree of "digital transformation". The goal of Table 1 is thus to compare the sectors' degree of digital transformation with their employment share or their employment share prospects. The degree of digital transformation is proxied in Table 1, for each sector, by two indicators: i) the percentage of enterprises that employ ICT specialists in the sector and ii) the digital capital intensity[433] of the sector. Table 1 presents the ranking of each sector according to these two proxy indicators (with rank n°1 corresponding to the most digitised sector). According to the first indicator, the three sectors with the highest degree of digital transformation in Luxembourg, in order, are: ICT services (employment share: 5.2% in LU vs 3.7% in the EU27), Energy supply services (0.6% vs 0.7%) and Professional services (8.8% vs 5.7%). According to the second indicator (digital capital intensity), the three sectors with the highest degree of digital transformation, in order, are: Finance and insurance (employment share: 11.2% in LU vs 2.8% in the EU27), Professional services (8.8% vs 5.7%) and ICT services (5.2% vs 3.7%). In Luxembourg, these sectors' employment shares have a projected annual growth rate (2022-2035) of 0.3% for ICT services (vs 0.8% for the EU27), 0.5% for Energy supply services (vs 0.1% for the EU27), 0.2% for Professional services (vs 0.6% for the EU27), and 0.1% for Finance and insurance (0.2% for the EU27).

As can be seen from Table 1, it is worth noting that only one of the top five sectors in terms of the degree of digital transformation – Energy supply services – is also among the top two sectors in terms of the annual growth rate of employment share in the decade to come in Luxembourg. Furthermore, in terms of employment share (in 2022), the first, second and third sectors[434] – Public sector and defence, Finance and insurance and Health and social care - rank eleventh, first and ninth, respectively, on one of the two proxy indicators of the digital transformation (Digital capital intensity).

Table 1 – LU. Sector's share of employment, annual growth rate, and ranking of "digital transformation" (the sectors are ranked according to the ranking in the last column of the table).

Sectors	Sector's employment share in 2022 (%)		Projected annual growth rate of the sector's employment share (2022 - 2035, %)		Projected sector's employment share in 2035 (%)		Proxy 1 for digital transformation (ranking)	Proxy 2 for digital transformation (ranking)
	LU	**EU**	**LU**	**EU**	**LU**	**EU**	**% enterprises that employ ICT specialists**	**Digital capital intensity**
K - Finance & insurance	11.2	2.8	0.1	0.2	11.4	2.8	n.a.	1

[433] 'Digital capital intensity' is an index – built in the context of this study – that looks at the ratio between the stock of capital the firms have in software and databases and the overall stock of capital excluding non-residential buildings. Its construction is based on the integrated EUKLEMS & INTANProd database, run by the Luiss Lab of European Economics at Luiss University in Rome, Italy. For more in-depth information on the source, and the availability of the indicator for Member States/sectors, please refer to the Annex.

[434] The top three sectors in terms of employment share (in 2022) - were not rankable on one of the two proxies of the digital transformation (% of enterprises that employ ICT specialists).

M - Professional services	8.8	5.7	0.2	0.6	9.0	6.3	3	2
J - ICT services	5.2	3.7	0.3	0.8	5.5	4.2	1	3
G - Wholesale & retail trade	7.9	13.6	-0.2	0.0	7.6	13.6	6	4
F - Construction	4.7	6.8	-0.4	-0.3	4.5	6.5	9	5
C - Manufacturing	3.0	16.0	-0.6	-0.2	2.8	15.6	5	6
D - Energy supply services	0.6	0.7	0.5	0.1	0.7	0.8	2	7
I - Accommodation & food	3.4	4.5	-0.3	0.6	3.3	4.9	8	8
Q - Health & social care	11.0	11.0	0.4	0.6	11.7	11.9	n.a.	9
H - Transport & storage	4.3	5.3	0.7	-0.1	4.8	5.3	7	10
O - Public sector & defence	11.5	7.1	-1.0	-0.1	10.0	7.0	n.a.	11
P - Education	7.8	7.4	0.5	0.3	8.4	7.7	n.a.	12
R - Arts & recreation and other services	1.2	1.7	0.4	0.3	1.3	1.7	n.a.	13
E- Water and waste treatment	0.4	0.8	0.9	-0.1	0.4	0.8	n.a.	14
N - Administrative services	3.3	4.1	0.5	0.0	3.5	4.1	4	n.a.
A - Agriculture, forestry & fishing	1.0	3.5	-0.7	-3.1	0.9	2.3	n.a.	n.a.
B - Mining & quarrying	n.a.	0.3	-1.3	-1.7	n.a.	0.2	n.a.	n.a.
L - Real Estate	0.8	0.9	0.6	0.9	0.8	1.0	n.a.	n.a.
S - Other service activities	1.7	2.6	-0.1	0.0	1.7	2.6	n.a.	n.a.
T - Activities of households as employers	1.6	0.9	-2.0	-0.3	1.2	0.9	n.a.	n.a.
U - Activities of extraterritorial org.	6.5	0.1	n.a.	n.a.	6.5	0.1	n.a.	n.a.

Source: For the employment-related indicators own elaboration on Eurostat data (share of employment, 2022 calculated based on lfsa_egan) and on Cedefop 'Skill forecast data 2023' (annual growth rate of sector's employment share, 2022-2035), for the digital transformation-related indicators: own elaboration on Eurostat data (share of enterprises that employ ICT specialists, Eurostat code: lfsa_egais) and on EUKLEMS & INTANProd data (digital capital intensity).
Note: In the first column of the table, the letter preceding the sectors is the code of the NACE Rev.2 classification. In the last two columns of the table, the two proxy indicators used for the digital transformation are: i) the share of enterprises that employ ICT specialists (Eurostat code: lfsa_egais) and ii) the digital capital intensity (EUKLEMS & INTANProd data, average 2014-2017) with rank n°1 corresponding to the most digitally intense sector.

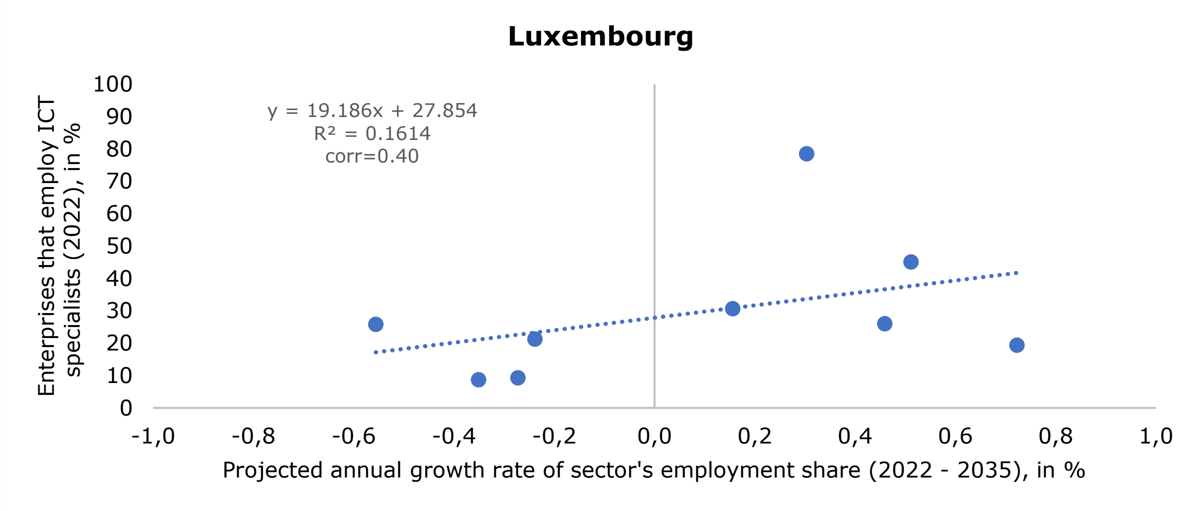
To complement Table 1, Figures 1a and 1b examine to what extent there may be a relationship between the projected annual growth rates of the sectors' employment shares in the economy and the ranking of the sectors in terms of the degree of digital transformation [435].

In **Figure 1a**, we present a scatterplot to shed light on the relationship between the first proxy of the digital transformation used (percentage of enterprises that employ ICT specialists) and the projected annual growth rate of a sector's employment share between 2022-2035. The correlation is positive with a value of 0.40, but not statistically significant (it is 0.62 and statistically significant for the EU27). **The lack of correlation implies that in Luxembourg a sectoral-level association between the percentage of enterprises that employ ICT**

[435] With the caveat that the correlation coefficients presented in Figure 1a and Figure 1b cannot be directly compared, as they pertain to a combination of sectors that varies across different Member States.

specialists and the projected annual growth rate of a sector's employment share cannot be inferred.

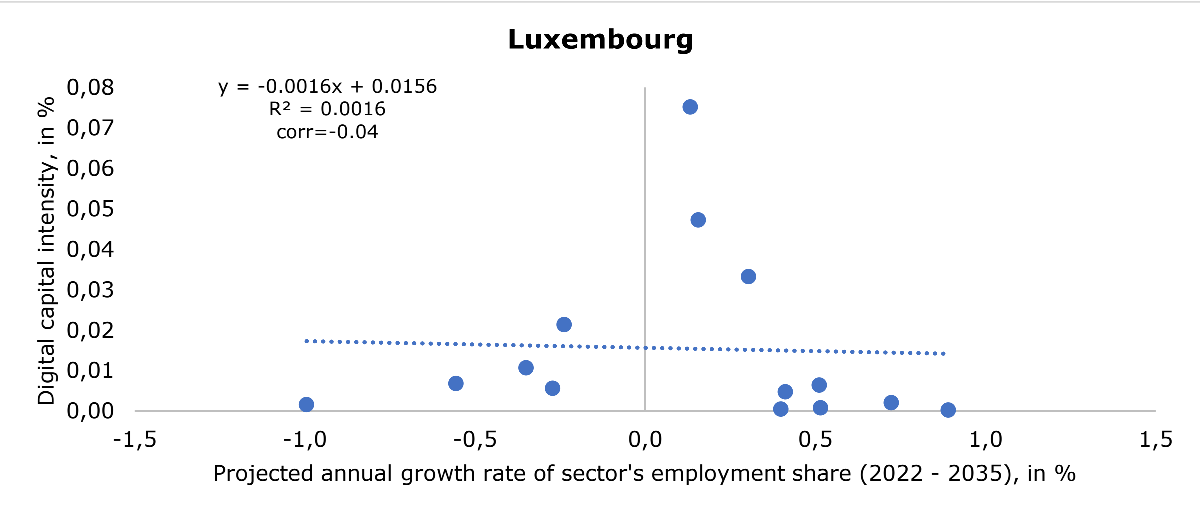
Figure 1a – LU. Relationship between the percentage of enterprises that employ ICT specialists (in 2022) and the projected annual growth rate of sector's employment share (2022-2035).



Source: Own elaboration on Eurostat and Cedefop 'Skill forecast 2023' data.

Figure 1b shows the correlation between the second digital transformation proxy ('digital capital intensity') and the projected annual growth rate of a sector's employment share (2022-2035). The correlation coefficient exhibits a value of -0.04, and it is not statistically significant in Luxembourg. Hence, as previously, **the lack of correlation implies that in Luxembourg an association, at sectoral level, between 'digital capital intensity' and the projected annual growth rate of a sector's employment share cannot be inferred.**

Figure 1b – LU. Relationship between 'digital capital intensity' and the projected annual growth rate of sector's employment share (2022-2035).

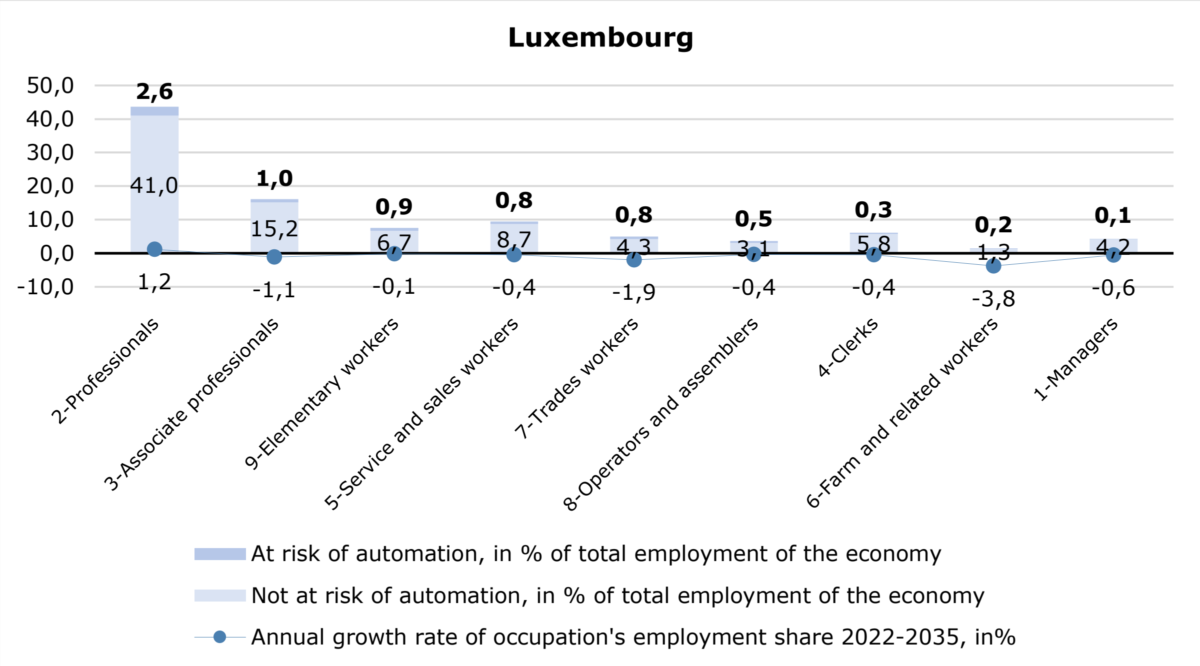


Source: Own elaboration on EUKLEMS & INTANProd, and Cedefop 'Skill forecast 2023' data.

LU 1.2 Occupational composition at ISCO-08 1 digit and risk of automation (current and forward-looking perspectives)

Different occupations are subject to differing levels of automation risk. Cedefop developed[436] a "risk of automation" index by occupation at the EU27 level, the most recent version of which is available for 2022[437]. We apply this indicator at the Member State level, with the assumption that the risk of automation for a given occupation is constant across Member States[438]. As such, the variation, across Member States in the overall susceptibility of a Member State' workforce to automation (overall risk across all occupations in that Member State) will be due to the employment composition effect. That is, while the automation risk for a given occupation stays constant across Member States, the overall automation risk of a Member State will naturally be greater for those Member States having more employment in occupations that have a higher automation risk.

Figure 2 – LU. Employment shares of occupations (at ISCO-08 1 digit level) - split into sub shares 'not at risk' and 'at risk' of automation (2022) - and projected annual growth rate



Source: Own elaboration on Cedefop data (risk of automation calculated by Cedefop at EU27 level by ISCO-08 1 digit level for 2022) applied to Eurostat data (share of employment by occupation, lfsa_egais, 2022).
Note: The numbers preceding the occupations are the ISCO-08 codes. Occupations are ranked from the highest to the lowest share of workers that present a risk of automation. The vertical sum of the two components (darker blue and lighter blue) gives back the total employment share by occupation (in % of total employment in the Member State). The ISCO nomenclature used in the text and the figure is the Cedefop one. For examples of specific occupations see: https://esco.ec.europa.eu/en/classification/occupation_main.

[436] Based on the methodology in Pouliakas, K. (2018) "The risk of automation in EU labour markets: a skill-requirements approach", in Economy, Employment and Skills: European and global perspectives in an age of uncertainty, Fondazione Giacomo Brodolini Quaderni Series, also IZA DP 11829.
[437] As retrieved at https://www.cedefop.europa.eu/en/tools/skills-intelligence/automation-risk-occupations#1
[438] While this assumption may be considered strong, Cedefop data are the only ones available that are at the same time, up to date and available for all the occupations at the ISCO-08 level.

As can be seen in **Figure 2**, in Luxembourg, the occupation with the largest employment sub-share (in % of total employment in the economy) 'at risk of automation' is Professionals, with an employment sub-share of workers 'at risk of automation' representing 2.6% of total employment in the country (vs 1.3% for the EU27). The second-ranked occupation is Associate professionals, with an employment sub-share of workers 'at risk' of 1.0% of total employment in Luxembourg (vs 1.3% for the EU27). Ranking third are Elementary workers, with a share of workers 'at risk' of 0.9% in total employment in Luxembourg (vs 1.0% for the EU27). **These three occupations are not the most affected across the EU27[439].**

For **ICT professionals (ISCO 25)**[440], the 2022 employment share is 4.9% in Luxembourg (vs 2.3% in the EU27) and its composition (as regards the risk of automation) is as follows: an employment sub-share of 0.3% (vs 0.1% in the EU27) is 'at risk of automation', whereas the remaining employment sub-share of 4.6% (vs 2.2% at EU27 level) is 'not at risk of automation'. The projected annual growth rate 2022-2035 of the employment share of ICT professionals is 1.3% in Luxembourg (vs 1.9% in EU27).

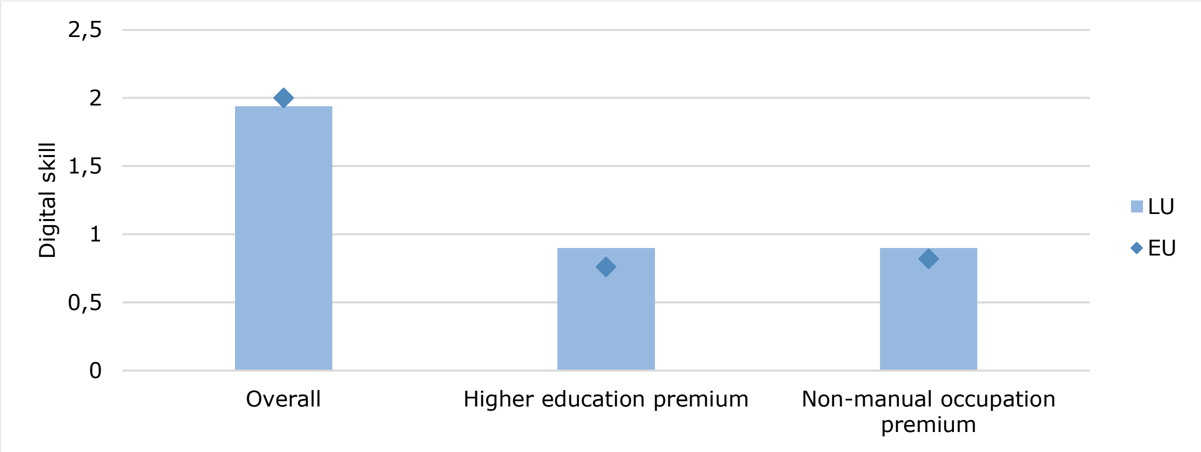
LU 2. Key policy dimensions for a socially fair digital transformation

LU 2.1 Digital skills

One of the key policy dimensions influencing the extent to which the digital transformation is socially fair is the level of digital skills within the population. In the study's estimated index of digital skills[441] (Figure 3, bar "Overall"), Luxembourg ranks in the lower mid-field of EU countries, with a level of digital skills that is just below the EU average. However, when looking at the DESI Index[442] for Human Capital (Figure 5, section "Other dimensions"), Luxembourg performs better, ranking sixth in the EU27. At the same time, though, the premium on digital skills for individuals with a tertiary degree or in a non-manual occupation is significant (Respectively, "Higher education premium" and "Non-manual occupation premium" in Figure 3; ranking 22nd in the EU27 on both indicators). **Such socio-economic inequalities in digital skills could present a challenge in managing the digital transformation in a socially fair way**.

[439] The most affected in the EU27 are Trades workers, Professionals, and Service and sales workers.
[440] Eurostat code: lfsa_egai2d.
[441] The construction of the digital skill index is described in detail in the introductory section.
[442] European Commission (2022). Digital Economy and Society Index. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi

Figure 3 – Estimated Digital Skills in LU and the EU (2019)



Source: Authors' own estimation based on Eurostat ICT survey
Note: Higher education premium refers to the difference in digital skills between individuals with tertiary and lower than tertiary education. Non-manual occupation premium refers to the difference in digital skills between individuals in manual and non-manual occupations.

Further investment in digital skills is therefore of key policy importance. The Digital Luxembourg Strategic Initiative[443] was introduced in 2014 as a collaboration-based government initiative to increase digitalisation in Luxembourg, with digital skills being designated as one of five key pillars. Since its launch, 26 joint digital skills initiatives have been launched as part of this strategic initiative[444]. There are also several initiatives to promote digital skills development jointly launched by the Chamber of Commerce and the Employment Agency[445]. Furthermore, in June 2023, the new platform digitalskills.lu, gathering information on training offers and other initiatives and news related to digital skills, was launched. Within the NRRP for Luxembourg, 19% of digital expenditure is allocated towards human capital. The plan includes training courses at different levels of digital skills, including for instance a Future Skills initiative targeted at jobseekers aged 45 and above[446].

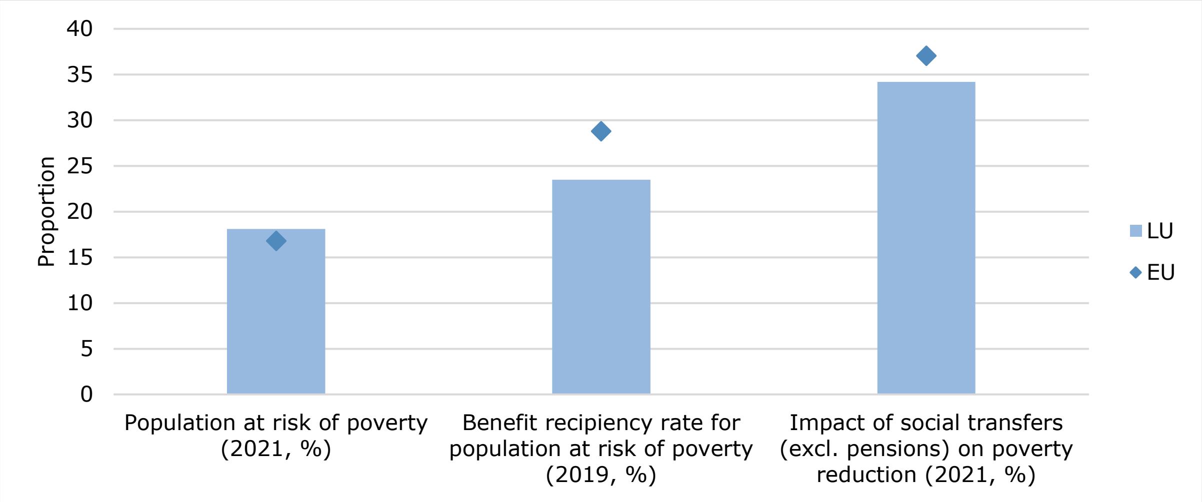
LU 2.2 Social protection and social policy

While a high level of digital skills in the population is an important prerequisite for facilitating a socially fair digital transformation, social protection systems could also play a key role in cushioning citizens from the potential negative impact of digitalisation on employment. In Luxembourg, the rate of the population at risk of poverty[447] (18.1%) is significantly higher than the EU27 rate. Moreover, both the

[443] For more information, see https://digital-luxembourg.public.lu
[444] For more information, see https://digital-skills-jobs.europa.eu/en/actions/national-initiatives/national-strategies/luxembourg-digital-luxembourg-initiative
[445] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[446] European Commission (2022); Recovery and Resilience Scoreboard Thematic Analyses. Digital Skills. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_digital_skills.pdf
[447] Eurostat (2023). TPS00184: At-risk-of-poverty rate after social transfers by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/tps00184/default/table?lang=en

benefit recipiency rate for the population at risk of poverty[448] (23.5%) and the impact of social transfers on poverty reduction[449] (34.2%) are lower than the EU average, pointing to limited effectiveness of social transfers in alleviating poverty. While Luxembourg has been active in regulating the specific issue of platform work[450], overall, **shortcomings in the social protection system with regard to protecting against poverty can be identified**.

Figure 4 – Social Protection in LU and the EU



Source: Eurostat (2023) and JRC (2022)

The national implementation plan for the Recommendation on access to social protection put forward by Luxembourg[451] argues that the country already implements the principles set out in the Recommendation. The national recovery and resilience plan also does not include specific measures focused on social protection[452]. Broader social spending is however included in the NRRP of Luxembourg, with 63% of social expenditure focused on social policies, including for instance investment in social housing[453], while 33.9% are allocated towards employment and skills.

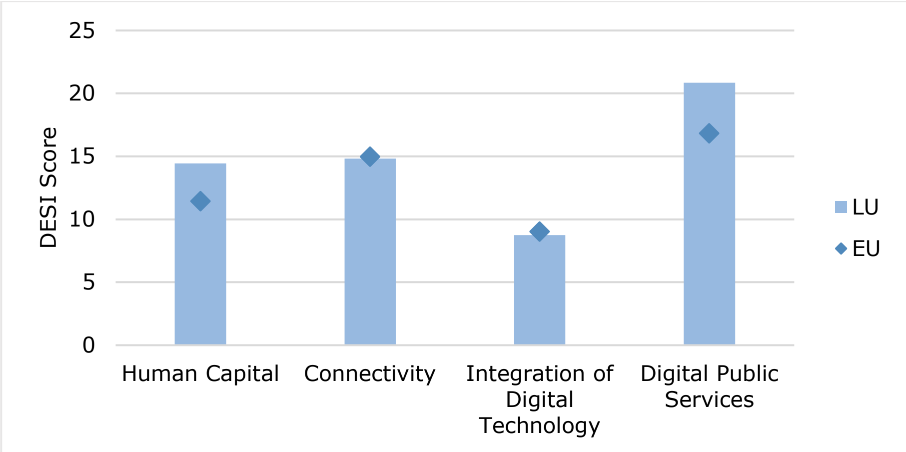
LU 3. Other dimensions relevant to the digital transformation

Two significant supporting dimensions for the digital transformation are the level of digitalisation in firms and the digitalisation of infrastructure and of public

[448] Eurostat indicator as re-elaborated by JRC (2022) "Monitoring the effective coverage and adequacy of social protection in the EU".
[449] Eurostat (2023). TESPM050:Impact of social transfers (excluding pensions) on poverty reduction by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/TESPM050/bookmark/table?lang=en&bookmarkId=b001ae62-ce34-4b49-9741-28a3ef99477f
[450] PPMI (2021). Study to support the impact assessment on improving working conditions in platform work. Available at: https://ec.europa.eu/social/main.jsp?catId=738&furtherPubs=yes&langId=en&pubId=8428
[451] European Commission (2023). Access to social protection. Available at: https://ec.europa.eu/social/main.jsp?catId=1312&langId=en=en
[452] European Commission (2022); Recovery and Resilience Scoreboard Thematic Analyses. Social protection. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_social_protection.pdf
[453] European Commission (2022); Recovery and Resilience Scoreboard Thematic Analyses. Social protection. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_social_protection.pdf

services. Turning first to the digitalisation of businesses, several indicators point to Luxembourg lagging behind the rest of the EU. The DESI Index (Figure 5) shows that on integration of digital technologies in firms, Luxembourg ranks only 18th in the EU. Similarly, data shows that the overall levels of digital capital intensity in firms are significantly lower than the EU average[454], though growth between 2008 and 2018 has been higher than average. Overall, hence, **further investment in the digitalisation of firms is crucial within Luxembourg**. It has launched several programmes to advance the digitalisation of businesses, mainly focusing on the government sector[455]. However, no funding is allocated towards the digitalisation of firms as part of the NRRP for Luxembourg.

Figure 5 – DESI Index for LU and the EU (2022)



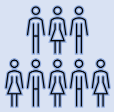
Source: European Commission (2022)

With regard to the digitalisation of infrastructure and of public services, the picture is more positive. Levels of digital public services are very advanced in Luxembourg, with the country ranking seventh in the EU27 according to the DESI Index. Connectivity levels are not as advanced, but Luxembourg still ranks 11th in the EU27, with a DESI value just below the EU27 average. The Strategy for ultra-high-speed connectivity sets out actions to further improve connectivity by developing Very High Capacity Network (VHCN) infrastructure and related services. To further encourage infrastructural development, the development of a strategy to streamline permit procedures and facilitate access to public property to extend networks would be of help[456]. While the NRRP for Luxembourg contains no planned further investment on connectivity, it puts a strong focus on digital public services, to which it allocates 47% of its total digital expenditure. These measures are mainly focused on the digitalisation of public administration and of the health system[457].

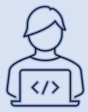
454 For Member States with available data
455 European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
456 European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
457 European Commission (2021); Recovery and Resilience Scoreboard Thematic Analyses. Digital public services. Available at :https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/2_Digital.pdf

17. HUNGARY: elements of a socially fair digital transformation

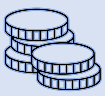
Key Points



Labour market: Currently, the sector with the largest employment share in the Hungarian economy – the Manufacturing sector – also has the fifth highest degree of digital transformation (based on the current percentage of enterprises that employ ICT specialists in a sector). The Manufacturing sector's employment share in the economy is not projected to grow further in the decade to come (slightly less than the EU trend). ICT services, Water and waste treatment, and Professional services are the three sectors with the highest degree of digital transformation currently. Among them, only the employment shares of Professional services will grow, and will do so more than for the EU trend. Operators and assemblers are most at risk of their occupation being automated.



Digital skills: The overall level of digital skills within the Hungarian population is significantly lower than the EU level[458]. Divides in digital skill between different socio-economic groups are in line with EU rates.



Social protection: Hungary has one of the lowest rates of the population at risk of poverty in the EU[459] but significant challenges in its social protection system remain (e.g. low adequacy of minimum income benefits). Moreover, the regulation of platform work has only received limited attention so far.

HU 1. The labour market and the digital transformation

HU 1.1 Sectoral composition (current and forward-looking perspectives)

In Hungary ("HU"), in 2022, the sectors with the largest employment shares in the economy were Manufacturing (21.3% vs 16.0% at the EU27 level), Wholesale and retail trade (12.6% vs 13.6% at the EU27 level), and Public sector and defence (8.9% vs 7.1% at the EU27 level). For the period 2022-2035, Cedefop data projects[460] the annual growth rate of a sector's employment share. For Hungary's Manufacturing sector, the annual growth rate is -0.5% (-0.2% for the EU27), for

[458] It should be noted that data for DESI 2023 shows however a different picture, with HU having 58.9% of individuals with at least basic overall digital skills vs. 55.5% for the EU average.
[459] However, it should be noted that on another poverty indicator such as the Severe material and social deprivation rate, HU performs worse than the EU average.
[460] Own elaboration on Cedefop 'Skill forecast 2023' data.

the Wholesale and retail trade sector it is -0.2% (0.0% for the EU27), and for the Public sector and defence, it is 2.0% (-0.1% for the EU27).

Table 1 presents each sector's employment share in 2022, the projected annual growth rates (2022-2035) of its employment share, and its resulting employment share in the economy by 2035. Along with these elements relating to employment, Table 1 also presents the degree of "digital transformation" of each sector. Table 1 thus enables comparison between the digital transformation of a sector and its employment share or its employment share's prospects. The degree of digital transformation is proxied for each sector in Table 1 using the percentage of enterprises in the sector that employ ICT specialists[461]. Table 1 presents the ranking of each sector according to this indicator (with rank n°1 corresponding to the most digitised sector). The three sectors with the highest degree of digital transformation in Hungary, in order, are ICT services (sector's employment share: 3.6% in HU vs 3.7% in the EU27), Water and waste treatment (1.2% vs 0.8%), and Professional services (4.7% vs 5.7%). These sectors' employment shares have a projected annual growth rate for 2022-2035 in Hungary of -0.2% for ICT services (vs 0.8% for the EU27), -1.1% for Water and waste treatment (vs -0.1% for the EU27), and 1.3% for Professional services (vs 0.6% for the EU27).

As visible in Table 1, only one of the four sectors with the highest degree of digital transformation – Professional services – is also among the four sectors with the highest projected annual growth rate of employment share in the decade to come in Hungary. Furthermore, the first and second largest sectors by projected growth rate of employment share – Manufacturing and Wholesale and retail trade - rank fifth and eighth on the first proxy indicator of digital transformation (% of enterprises that employ ICT specialists).

Table 1 – HU. Sector's share of employment, annual growth rate, and ranking of "digital transformation" (the sectors are ranked according to the ranking in the "proxy 1" column of the table).

Sectors	Sector's employment share in 2022 (%)		Projected annual growth rate of the sector's employment share (2022 - 2035, %)		Projected sector's employment share in 2035 (%)		Proxy 1 for digital transformation (ranking)	Proxy 2 for digital transformation (ranking)
	HU	**EU**	**HU**	**EU**	**HU**	**EU**	**% enterprises that employ ICT specialists**	**Digital capital intensity**
J - ICT services	3.6	3.7	-0.2	0.8	3.5	4.2	1	n.a.
E- Water and waste treatment	1.2	0.8	-1.1	-0.1	1.0	0.8	2	n.a.
M - Professional services	4.7	5.7	1.3	0.6	5.6	6.3	3	n.a.
D - Energy supply services	0.8	0.7	-0.1	0.1	0.8	0.8	4	n.a.
C - Manufacturing	21.3	16.0	-0.5	-0.2	19.9	15.6	5	n.a.
N - Administrative services	2.8	4.1	-0.5	0.0	2.6	4.1	6	n.a.
H - Transport & storage	6.2	5.3	-1.1	-0.1	5.3	5.3	7	n.a.
G - Wholesale & retail trade	12.6	13.6	-0.2	0.0	12.3	13.6	8	n.a.

[461] 'Digital capital intensity' is an index – built in the context of this study – that looks at the ratio between the stock of capital the firms have in software and databases and the overall stock of capital excluding non-residential buildings. Its construction is based on the integrated EUKLEMS & INTANProd database, run by the Luiss Lab of European Economics at Luiss University in Rome, Italy. For more in-depth information on the source, and the availability of the indicator for Member States/sectors, please refer to the Annex.

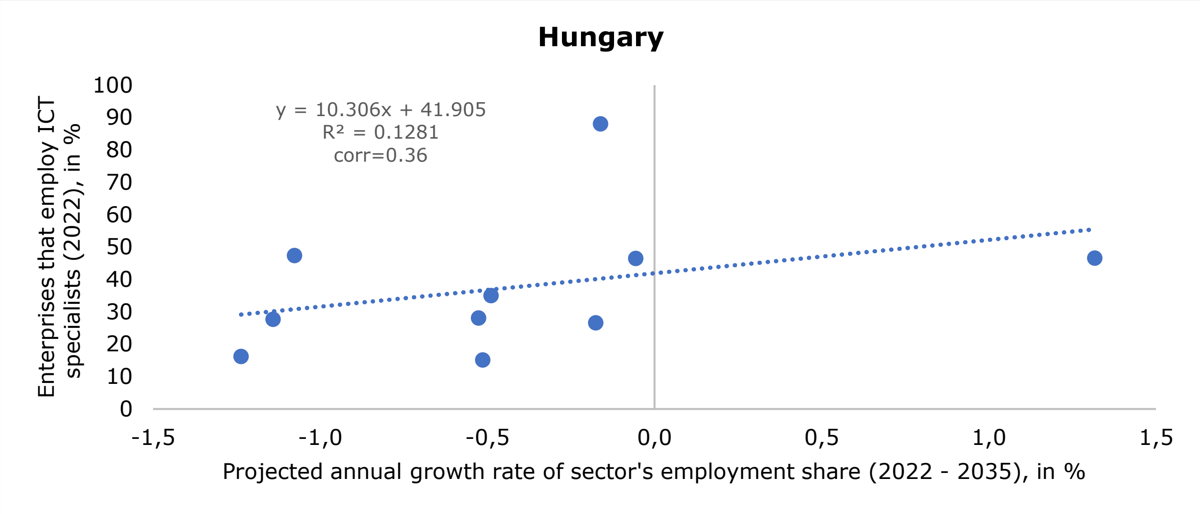
I - Accommodation & food	4.0	4.5	-1.2	0.6	3.3	4.9	9	n.a.
F - Construction	8.2	6.8	-0.5	-0.3	7.6	6.5	10	n.a.
A - Agriculture, forestry & fishing	4.3	3.5	-1.7	-3.1	3.4	2.3	n.a.	n.a.
B - Mining & quarrying	0.2	0.3	1.8	-1.7	0.2	0.2	n.a.	n.a.
K - Finance & insurance	2.1	2.8	1.3	0.2	2.5	2.8	n.a.	n.a.
L - Real Estate	0.7	0.9	0.5	0.9	0.8	1.0	n.a.	n.a.
O - Public sector & defence	8.9	7.1	2.0	-0.1	11.7	7.0	n.a.	n.a.
P - Education	7.6	7.4	0.8	0.3	8.5	7.7	n.a.	n.a.
Q - Health & social care	6.6	11.0	1.0	0.6	7.6	11.9	n.a.	n.a.
R - Arts & recreation and other services	1.7	1.7	-1.1	0.3	1.5	1.7	n.a.	n.a.
S - Other service activities	2.4	2.6	-0.3	0.0	2.3	2.6	n.a.	n.a.
T - Activities of households as employers	n.a.	0.9	1.9	-0.3	n.a.	0.9	n.a.	n.a.
U - Activities of extraterritorial org.	n.a.	0.1	n.a.	n.a.	n.a.	0.1	n.a.	n.a.

Source: For the employment-related indicators own elaboration on Eurostat data (share of employment, 2022 calculated based on lfsa_egan) and on Cedefop 'Skill forecast data 2023' (annual growth rate of sector's employment share, 2022-2035), for the digital transformation-related indicators: own elaboration on Eurostat data (share of enterprises that employ ICT specialists, Eurostat code: lfsa_egais) and on EUKLEMS & INTANProd data (digital capital intensity).
Note: In the first column of the table, the letter preceding the sectors is the code of the NACE Rev.2 classification. In the last two columns of the table, the two proxy indicators used for digital transformation are: i) the share of enterprises that employ ICT specialists (Eurostat code: lfsa_egais) and ii) the digital capital intensity (EUKLEMS & INTANProd data, average 2014-2017) with rank n°1 corresponding to the most digitally intense sector.

Figure 1, below, complements Table 1, further enabling a comparison between the projected annual growth rates of the sectors' employment shares in the economy and their degree of digital transformation.

In **Figure 1**, we present a scatterplot of the first proxy of digital transformation used (percentage of enterprises that employ ICT specialists) and the projected annual growth rate of a sector's employment share between 2022-2035. The correlation is 0.36, but not statistically significant (it is 0.62 and statistically significant for the EU27). **The statistically insignificant result implies that an association between the percentage of enterprises in a sector that employ ICT specialists, and that sector's projected annual employment share growth rate cannot be inferred at the sectoral level in Hungary.**

Figure 1 – HU. Relationship between the percentage of enterprises that employ ICT specialists (in 2022) and the projected annual growth rate of sector's employment share (2022-2035).



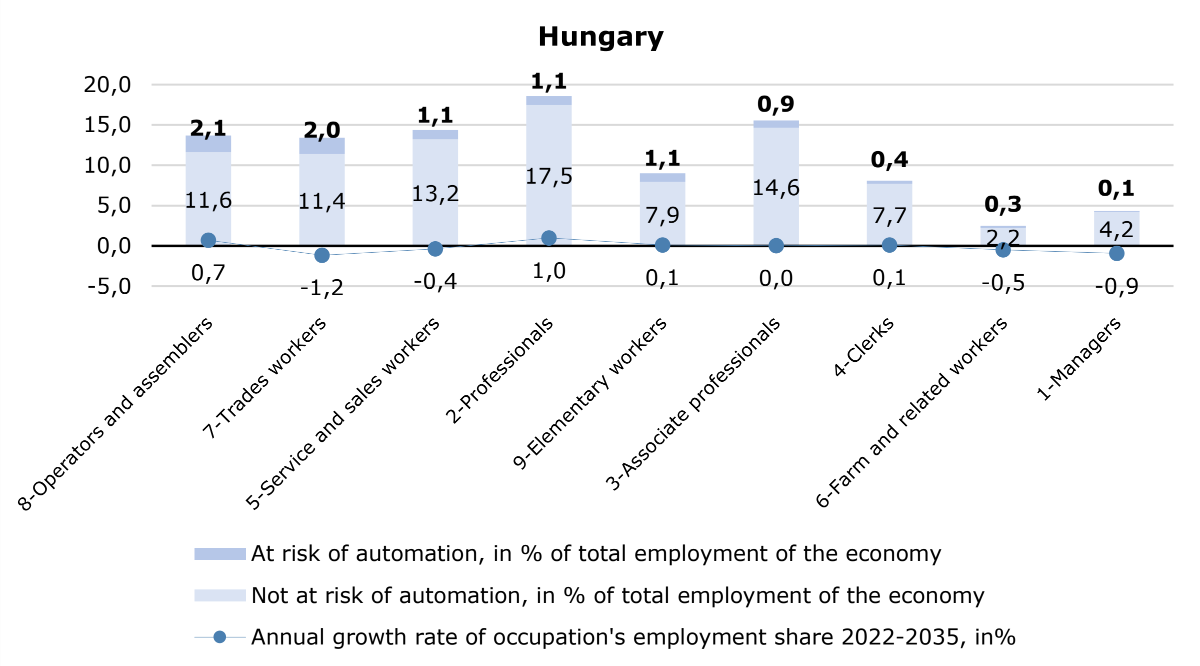
Source: Own elaboration on Eurostat and Cedefop 'Skill forecast 2023' data.

HU 1.2 Occupational composition at ISCO-08 1 digit and risk of automation (current and forward-looking perspectives)

Different types of occupation are subject to differing levels of automation risk. CEDEFOP have developed[462] a "risk of automation" index by occupation at the EU27 level, most recently updated for 2022[463]. We apply this indicator at the Member State level, with the assumption that the risk of automation for a given occupation is constant across Member States[464]. As such, any variation in the vulnerability to automation of a Member State's workforce across all occupations can be attributed to the employment composition effect. Thus, while the automation risk for a given occupation stays constant across Member States, the overall automation risk of a Member State can be considered greater for those Member States with larger employment shares in occupations with higher automation risks.

[462] Based on the methodology in Pouliakas, K. (2018) "The risk of automation in EU labour markets: a skill-requirements approach", in Economy, Employment and Skills: European and global perspectives in an age of uncertainty, Fondazione Giacomo Brodolini Quaderni Series, also IZA DP 11829.
[463]As retrieved at https://www.cedefop.europa.eu/en/tools/skills-intelligence/automation-risk-occupations#1
[464] While this assumption may be considered strong, Cedefop data are the only ones available that are at the same time, up to date and available for all the occupations at the ISCO-08 level.

Figure 2 – HU. Employment shares of occupations (at ISCO-08 1 digit level) - split into sub shares 'not at risk' and 'at risk' of automation (2022) - and projected annual growth rate



Source: Own elaboration on Cedefop data (risk of automation calculated by Cedefop at EU27 level by ISCO-08 1 digit level for 2022) applied to Eurostat data (share of employment by occupation, lfsa_egais, 2022).
Note: The numbers preceding the occupations are the ISCO-08 codes. Occupations are ranked from the highest to the lowest share of workers that present a risk of automation. The vertical sum of the two components (darker blue and lighter blue) gives back the total employment share by occupation (in % of total employment in the Member State). The ISCO nomenclature used in the text and the figure is the Cedefop one. For examples of specific occupations see: https://esco.ec.europa.eu/en/classification/occupation_main.

As can be seen in **Figure 2**, in Hungary, the occupation where the employment sub-share (in % of total employment in the economy) 'at risk of automation' is the largest is Operators and assemblers, with an employment sub-share of workers 'at risk of automation' representing 2.1% of total employment in the country (vs 1.1% for the EU27). Trades workers, with an employment sub-share of workers 'at risk' of 2.0% of total employment in Hungary (vs 1.3% for the EU27), are the second most 'at risk' occupation. Third are Service and sales workers, with a share of workers 'at risk' of 1.1% in total employment in Hungary (vs 1.3% for the EU27). **Among these three occupations, only the third one is also the most affected also across the EU27**[465]**.**

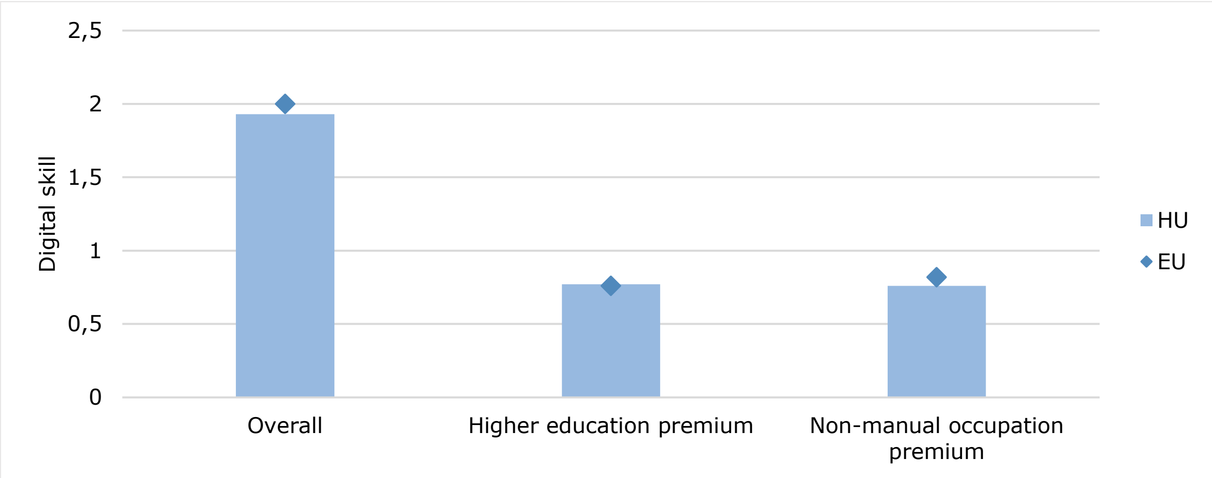
For **ICT professionals (ISCO 25)**[466], the 2022 employment share is 2.4% in Hungary (vs 2.3% in the EU27), made up of an employment sub-share of 0.1% (vs 0.1% in the EU27) 'at risk of automation' and an employment sub-share of 2.2% (vs 2.2% at EU27 level) is 'not at risk of automation'. The projected annual growth rate 2022-2035 of the employment share of ICT professionals is 1.5% in Hungary (vs 1.9% in EU27).

[465] The most affected in the EU27 are Trades workers, Professionals, and Service and sales workers.
[466] Eurostat code: lfsa_egai2d.

HU 2. Key policy dimensions for a socially fair digital transformation

HU 2.1 Digital skills

Figure 3 – Estimated Digital Skills in HU and the EU (2019)



Source: Authors' own estimation based on Eurostat ICT survey
Note: Higher education premium refers to the difference in digital skills between individuals with tertiary and lower than tertiary education. Non-manual occupation premium refers to the difference in digital skills between individuals in manual and non-manual occupations.

A first dimension of central importance to managing the digital transformation in a socially fair way is the level of digital skills in the population. **In Hungary, however, the level of digital skills lags behind the rest of the EU,** with the country ranking 23rd in the DESI Index for Human Capital[467] (Figure 5, section "Other dimensions")[468]. Hungary also ranks 19th on the study's own estimated index of digital skills[469] (Figure 3, bar "Overall"). Somewhat more positively, digital divides between educational and occupational groups ("Higher education premium" and "Non-manual occupation premium" respectively, in Figure 3) are in line with the EU27 level, with Hungary ranking 15th and 12th in the EU, respectively. Nevertheless, in view of the overall low level of digital skills, investment in digital skills development is of crucial importance within the Hungarian context.

Policy strategies for digitalisation are set out in the National Digitalisation Strategy, where digital skills are designated as one of the key pillars[470]. Moreover, the Hungarian Digital Workforce Program[471] was introduced in 2019, which aims

[467] European Commission (2022). Digital Economy and Society Index. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi
[468] It should be noted that data for DESI 2023 shows however a different picture, with HU having 58.9% of individuals with at least basic overall digital skills vs. 55.5% for the EU average (note: nevertheless, individuals with low-education, individuals that are unemployed and individuals above 55 years are lagging behind the rest of the HU population. For instance, the rate of individuals having at least basic overall digital skills in HU reaches only: 33.4% for adults with no or low formal education, 44.1% for the unemployed and 36.1% for those aged 55 or older).
[469] The construction of the digital skill index is described in detail in the introductory section.
[470] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[471] For more information, see https://digitalisjoletprogram.hu/en/content/dwp-digital-workforce-program

to train an additional 20,000 IT professionals and provide digital skills for all citizens. The Hungarian NRRP also includes measures in the areas of digital education and digitalisation of vocational education and training[472].

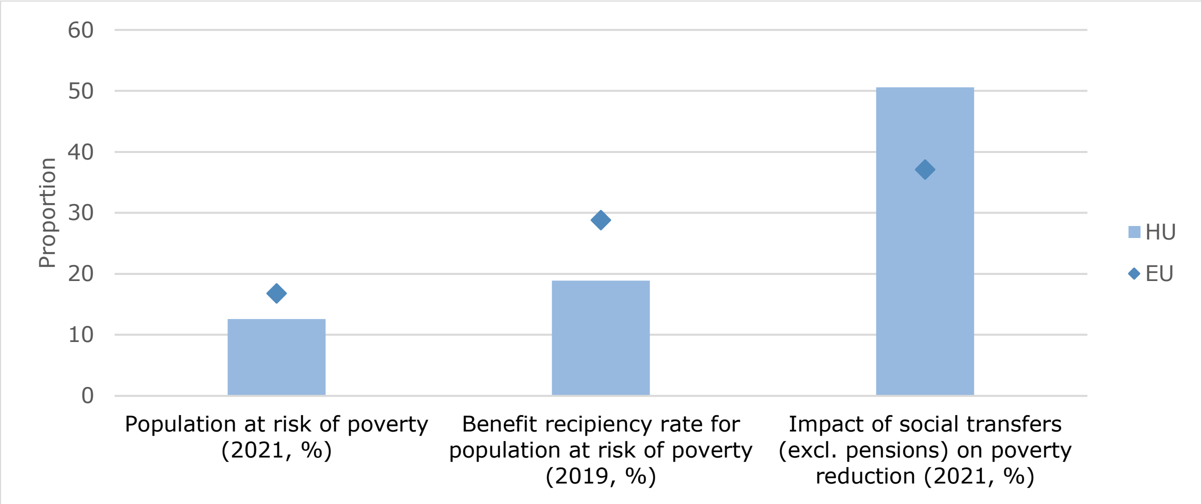
HU 2.2 Social protection and social policy

Next to digital skills, it is important to consider the quality of social protection systems within a country, which may play a key role in mitigating adverse effects of the digital transformation on workers (Figure 4). In Hungary, the rate of the population at risk of poverty after social transfers[473] (12.6%) is among the lowest in the EU27 but in regard to another poverty indicator - the severe material and social deprivation rate - the country performs much worse than the EU average[474]. The impact of social transfers on poverty reduction[475] is usually around the EU average in Hungary.

It should be mentioned, however, that there are a number of significant challenges in the social protection system. For instance, the benefit recipiency rate for the population at risk of poverty before social transfers[476] (18.3%) is significantly lower than the EU27 rate. As well, the adequacy of minimum income benefits[477] is amongst the lowest in the EU27. One should also mention that the issue of the regulation of platform work, one of the forms of work emerging from the digitalisation of labour markets, has so far been discussed only to a limited extent[478] in Hungary. Moreover, while the Hungarian implementation plan for the Recommendation on access to social protection[479] contains measures to improve the formal coverage and adequacy of social protection, specific measures for platform workers are not included in the plan. Furthermore, within the Hungarian NRRP, only a marginal share of the planned expenditure concerns social policies (6%).

[472] For more information, see https://www.europarl.europa.eu/RegData/etudes/BRIE/2023/747098/EPRS_BRI(2023)747098_EN.pdf
[473] Eurostat (2023). TPS00184: At-risk-of-poverty rate after social transfers by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/tps00184/default/table?lang=en
[474] Severe material and social deprivation rate was – for SILC 2022 data – of 9.1% in HU vs 6.7% for EU27.
[475] Eurostat (2023). TESPM050:Impact of social transfers (excluding pensions) on poverty reduction by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/TESPM050/bookmark/table?lang=en&bookmarkId=b001ae62-ce34-4b49-9741-28a3ef99477f
[476] Eurostat indicator as re-elaborated by JRC (2022) "Monitoring the effective coverage and adequacy of social protection in the EU".
[477] Not shown in this country fiche.
[478] PPMI (2021). Study to support the impact assessment on improving working conditions in platform work. Available at: https://ec.europa.eu/social/main.jsp?catId=738&furtherPubs=yes&langId=en&pubId=8428
[479] European Commission (2023). Access to social protection. Available at: https://ec.europa.eu/social/main.jsp?catId=1312&langId=en=en

Figure 4 – Social Protection in HU and the EU



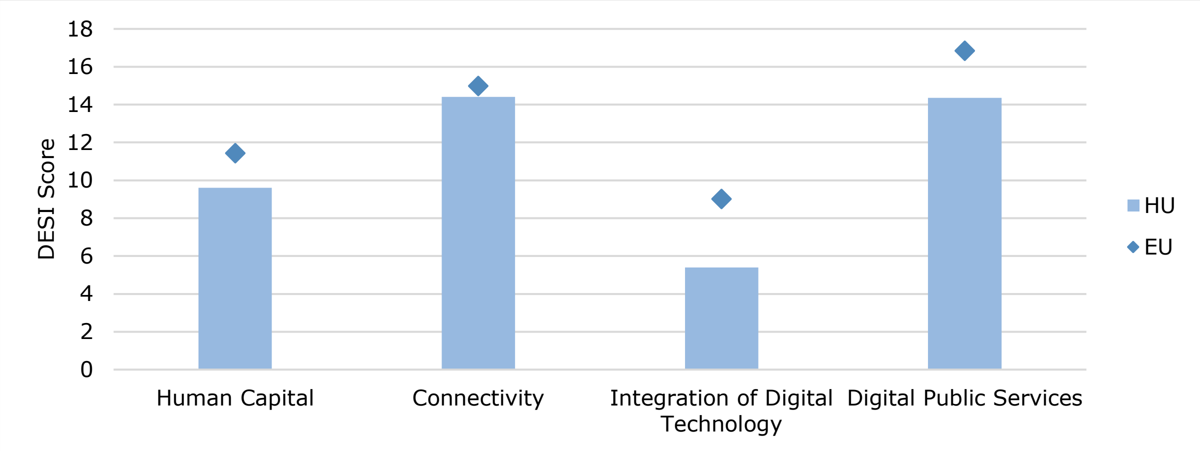
Source: Eurostat (2023) and JRC (2022)

HU 3. Other dimensions relevant to the digital transformation

Furthermore, two significant supporting factors relevant to the digital transformation are digitalisation of firms and digitalisation of infrastructure and of public services. With regard to digitalisation of firms, the DESI Index (Figure 5) shows that **the integration of digital technologies in Hungarian firms lags significantly behind the EU average** - the Hungarian DESI score in this dimension being the third lowest in the EU27. Levels of digital capital intensity[480] in firms are also significantly lower than the EU average[481] and, importantly, growth in digital capital intensity over the last 10 years has been significantly slower than in other countries. In terms of robot density[482], the situation is somewhat more positive, with levels and growth rates around the EU average[483]. Nevertheless, overall, digitalisation of firms is clearly a shortcoming in Hungary. The National Digitalisation Strategy identifies four key areas for policy action on digitalisation of firms: (1) increasing SME's use of digital technology, (2) developing digital start-ups, (3) targeted development of the ICT industry, (4) using state data assets for economic purposes. Significant policy action will be needed in each of these areas to facilitate the digitisation of businesses[484]. Within the Hungarian NRRP, planned digital expenditure allocated towards digitalisation of businesses amounts to 8.9% of total digital expenditure.

[480] As described in the Annex, based on data from EU-KLEMS (2008-2018). Data is not available for Cyprus, Croatia, Ireland and Romania.
[481] For Member States with available data
[482] As described in the Annex, based on data from the International Federation of Robotics (2010-2019). Data is not available for Cyprus, Greece, Luxembourg and Slovenia.
[483] For Member States with available data
[484] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance

Figure 5 – DESI Index for HU and the EU (2022)



Source: European Commission (2022)

With regard to digital infrastructure and public services, Hungary is equally lagging behind the rest of the EU. In particular, Hungary ranks 21st in the EU when it comes to the DESI for digital public services. Performance on connectivity is better, with Hungary ranking in the mid-field of EU countries (13th)[485]. However, further ambitious policy action will be needed in specific policy areas, such as 5G, to reach the Digital Decade targets[486]. Within the Hungarian NRRP, 70% of planned digital spending is allocated towards digital public services[487].

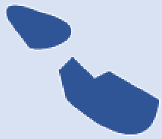
[485] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance

[486] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance

[487] As well, one could mention that there are some measures on connectivity foreseen under the ESF+ programme "Digital Renewal Operational Programme Plus 2021-2027" for Hungary.

18. MALTA: elements of a socially fair digital transformation

Key Points



Labour market: Currently, the Wholesale and retail sector has the largest share of employment in the economy and ranks sixth in terms of the sectors' degree of digital transformation (based on the current percentage of enterprises that employ ICT specialists in a sector). The Wholesale and retail sector's employment share in the economy is projected to grow further in the decade to come (slightly more than EU trends). ICT services, Professional services, Water and waste treatment are currently the three sectors with the highest degree of digital transformation, and their employment shares are projected to grow, in the decade to come, slightly more than the corresponding EU27 rate. Regarding the risk of automation of occupations, the most vulnerable occupation is Service and sales workers.

Digital skills: Malta has a high overall level of digital skills compared to other EU Member States. However, socio-economic inequality in digital skill levels is pronounced.

Social protection: The rate of the population at risk of poverty is similar to the EU rate, yet some shortcomings in the effectiveness and adequacy of social protection are apparent. In addition, policy discussion on regulating the employment status of platform workers has been limited.

MT 1. The labour market and the digital transformation

MT 1.1 Sectoral composition (current and forward-looking perspectives)

In Malta ("MT"), in 2022, the sectors with the largest employment shares in the economy were: Wholesale and retail trade (12.1% vs 13.6% at the EU27 level), Manufacturing (9.9% vs 16.0% at the EU27 level), and Health and social care (9.7% vs 11.0% at the EU27 level). For the period 2022-2035, Cedefop data projects the annual growth rate of a sector's employment share. For Malta's Wholesale and retail trade sector, the annual growth rate is 0.2% (0.0% for the EU27), while it is 0.0% for the Manufacturing sector (-0.2% for the EU27), and -0.6% for the Health and social care sector (0.6% for the EU27).

Table 1 presents, for each sector, the employment share in the economy in 2022, the projected annual growth rate (2022-2035) of its employment share, as well as its resulting employment share in the economy by 2035. Along with these elements relating to employment, Table 1 also presents the degree of “digital transformation” of each sector. Hence, Table 1 enables comparison between a sector’s degree of digital transformation, its employment share and the projected growth in its employment share. The aforementioned degree of digital transformation is proxied in Table 1, for each sector, by the percentage of enterprises in the sector that employ ICT specialists. Table 1 presents the ranking of each sector according to this proxy (with rank n°1 corresponding to the most digitised sector). The three sectors with the highest degree of digital transformation in Malta, in order, are: ICT services (employment share: 4.5% in MT vs 3.7% in the EU27), Professional services (5.6% vs 5.7%) and Water and waste treatment (1.1% vs 0.8%). These sectors’ employment shares have a projected annual growth rate (2022-2035) of 1.7% for ICT services (vs 0.8% for the EU27), 0.4% for Professional services (vs 0.6% for the EU27), and 1.2% for Water and waste treatment (vs -0.1% for the EU27) in Malta.

As can be seen from Table 1, it is worth noting that only one of the top three sectors in terms of the degree of digital transformation – ICT services – is also among the top three sectors in terms of the annual growth rate of employment share in the decade to come in Malta. Furthermore, in terms of employment share (in 2022), the first and second sectors – Wholesale and retail trade and Manufacturing - rank sixth and seventh, on the only proxy indicator of the digital transformation available (% of enterprises that employ ICT specialists).

Table 1 – MT. Sector's share of employment, annual growth rate, and ranking of "digital transformation" (the sectors are ranked according to the ranking in the “proxy 1” column of the table).

Sectors	Sector's employment share in 2022 (%)		Projected annual growth rate of the sector's employment share (2022 - 2035, %)		Projected sector's employment share in 2035 (%)		Proxy 1 for digital transformation (ranking)	Proxy 2 for digital transformation (ranking)
	MT	**EU**	**MT**	**EU**	**MT**	**EU**	**% enterprises that employ ICT specialists**	**Digital capital intensity**
J - ICT services	4.5	3.7	1.7	0.8	5.7	4.2	1	n.a.
M - Professional services	5.6	5.7	0.4	0.6	6.0	6.3	2	n.a.
E- Water and waste treatment	1.1	0.8	1.2	-0.1	1.3	0.8	3	n.a.
N - Administrative services	5.4	4.1	-0.6	0.0	5.0	4.1	4	n.a.
H - Transport & storage	5.5	5.3	2.3	-0.1	7.5	5.3	5	n.a.
G - Wholesale & retail trade	12.1	13.6	0.2	0.0	12.4	13.6	6	n.a.
C - Manufacturing	9.9	16.0	0.0	-0.2	9.9	15.6	7	n.a.
F - Construction	6.3	6.8	-0.3	-0.3	6.1	6.5	8	n.a.
I - Accommodation & food	6.7	4.5	-1.0	0.6	5.8	4.9	9	n.a.
A - Agriculture, forestry & fishing	0.8	3.5	-0.2	-3.1	0.8	2.3	n.a.	n.a.
B - Mining & quarrying	n.a.	0.3	-1.7	-1.7	n.a.	0.2	n.a.	n.a.
D - Energy supply services	n.a.	0.7	6.4	0.1	n.a.	0.8	n.a.	n.a.
K - Finance & insurance	6.3	2.8	1.2	0.2	7.4	2.8	n.a.	n.a.
L - Real Estate	1.3	0.9	1.3	0.9	1.6	1.0	n.a.	n.a.
O - Public sector & defence	6.8	7.1	-0.5	-0.1	6.4	7.0	n.a.	n.a.
P - Education	8.9	7.4	-0.4	0.3	8.4	7.7	n.a.	n.a.

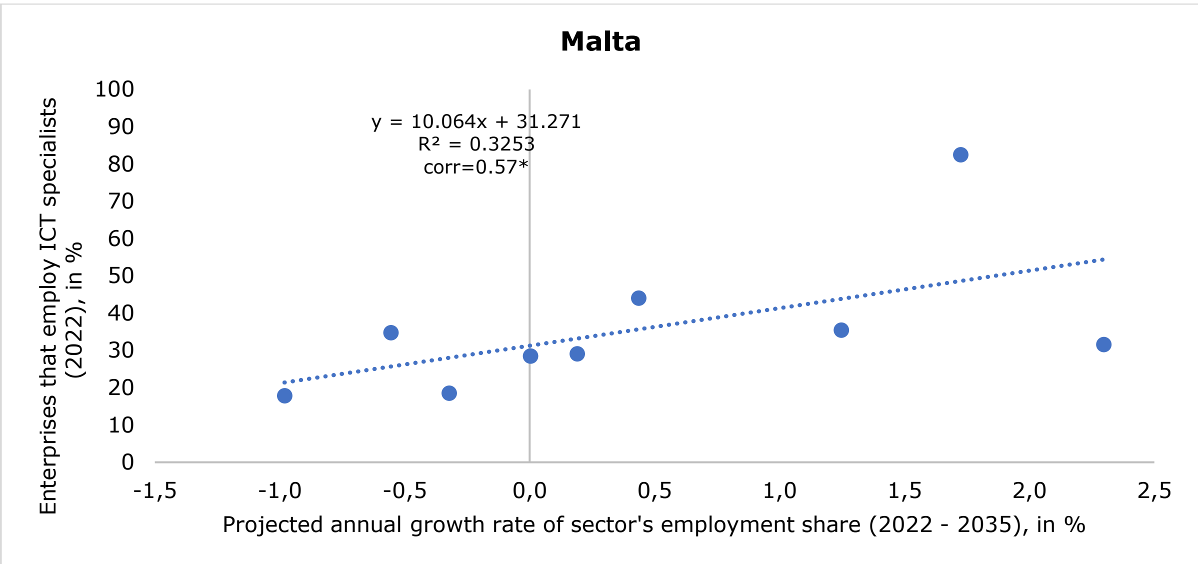
Q - Health & social care	9.7	11.0	-0.6	0.6	9.0	11.9	n.a.	n.a.
R - Arts & recreation and other services	5.3	1.7	-0.3	0.3	5.1	1.7	n.a.	n.a.
S - Other service activities	2.0	2.6	-2.0	0.0	1.5	2.6	n.a.	n.a.
T - Activities of households as employers	1.3	0.9	0.6	-0.3	1.5	0.9	n.a.	n.a.
U - Activities of extraterritorial org.	0.3	0.1	n.a.	n.a.	0.3	0.1	n.a.	n.a.

Source: For the employment-related indicators own elaboration on Eurostat data (share of employment, 2022 calculated based on lfsa_egan) and on Cedefop 'Skill forecast data 2023' (annual growth rate of sector's employment share, 2022-2035), for the digital transformation-related indicators: own elaboration on Eurostat data (share of enterprises that employ ICT specialists, Eurostat code: lfsa_egais) and on EUKLEMS & INTANProd data (digital capital intensity).
Note: In the first column of the table, the letter preceding the sectors is the code of the NACE Rev.2 classification. In the last two columns of the table, the two proxy indicators used for the digital transformation are: i) the share of enterprises that employ ICT specialists (Eurostat code: lfsa_egais) and ii) the digital capital intensity (EUKLEMS & INTANProd data, average 2014-2017) with rank n°1 corresponding to the most digitally intense sector.

To complement Table 1, Figure 1 below shows to what extent there may be a relationship between the sectors' degree of digital transformation and the projected annual growth rates of their employment shares in the economy.

In **Figure 1**, we present a scatterplot to shed light on the relationship between the proxy of the digital transformation used (percentage of enterprises that employ ICT specialists) and the projected annual growth rate of a sector's employment share for 2022-2035. The correlation is positive, and statistically significant in Malta, with a value of 0.57 (it is 0.62 and statistically significant for the EU27). Among the ten Member States with a significant correlation, Malta ranks 8th in terms of the highest correlation. **The positive correlation could suggest that the employment shares of those sectors with a higher 'percentage of enterprises that employ ICT specialists' are more likely to a grow (over 2022-2035) than those of other sectors**. The relationship is strong, though the correlation coefficient is slightly lower than the one observed at the EU27 level. However, this correlation does not imply causal links.

Figure 1 – MT. Relationship between the percentage of enterprises that employ ICT specialists (in 2022) and the projected annual growth rate of sector's employment share (2022-2035).

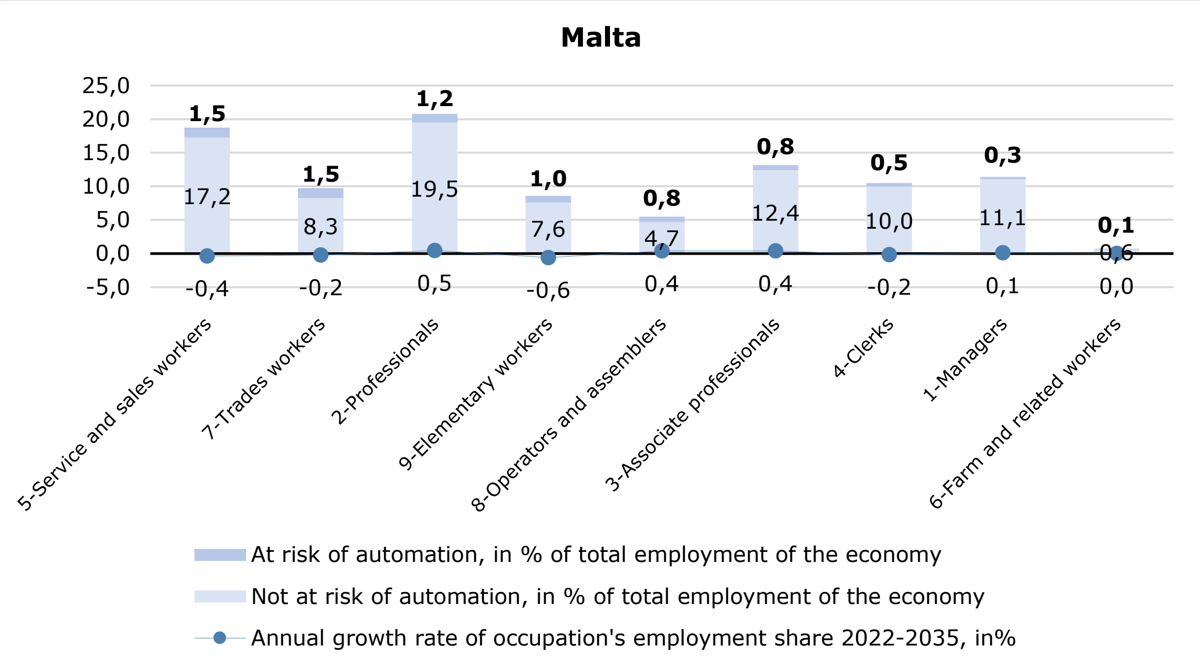


Source: Own elaboration on Eurostat and Cedefop 'Skill forecast 2023' data.

MT 1.2 Occupational composition at ISCO-08 1 digit and risk of automation (current and forward-looking perspectives)

Different occupations are subject to differing levels of automation risk. Cedefop developed[488] a "risk of automation" index by occupation at the EU27 level, most recently updated for 2022[489]. We apply this indicator at the Member State level, with the assumption that the risk of automation for a given occupation is constant across Member States[490]. As such, the variation, across Member States in the overall susceptibility of a Member State's workforce to automation (overall risk across all occupations in that Member State) will be due to the employment composition effect, meaning that while the automation risk for a given occupation stays constant across Member States, the overall automation risk of a Member State will naturally be greater for those Member States having more employment in occupations that have a higher automation risk.

Figure 2 – MT. Employment shares of occupations (at ISCO-08 1 digit level) - split into sub shares 'not at risk' and 'at risk' of automation (2022) - and projected annual growth rate



Source: Own elaboration on Cedefop data (risk of automation calculated by Cedefop at EU27 level by ISCO-08 1 digit level for 2022) applied to Eurostat data (share of employment by occupation, lfsa_egais, 2022).
Note: The numbers preceding the occupations are the ISCO-08 codes. Occupations are ranked from the highest to the lowest share of workers that present a risk of automation. The vertical sum of the two components (darker blue and lighter blue) gives back the total employment share by occupation (in % of total employment in the Member State). The ISCO nomenclature used in the text and the figure is the Cedefop one. For examples of specific occupations see: https://esco.ec.europa.eu/en/classification/occupation_main.

[488] Based on the methodology in Pouliakas, K. (2018) "The risk of automation in EU labour markets: a skill-requirements approach", in Economy, Employment and Skills: European and global perspectives in an age of uncertainty, Fondazione Giacomo Brodolini Quaderni Series, also IZA DP 11829.
[489] As retrieved at https://www.cedefop.europa.eu/en/tools/skills-intelligence/automation-risk-occupations#1
[490] While this assumption may be considered strong, Cedefop data are the only ones available that are at the same time, up to date and available for all the occupations at the ISCO-08 level.

As can be seen in **Figure 2**, in Malta, the occupation with the largest employment sub-share (in % of total employment in the economy) 'at risk of automation' is Service and sales workers, with an employment sub-share of workers 'at risk of automation' representing 1.5% of total employment in the country (vs 1.3% for the EU27). Ranking second regarding the employment sub-share of workers 'at risk of automation' are Trades workers, with an employment sub-share of workers 'at risk' of 1.5% of total employment in Malta (vs 1.3% for the EU27). The third-ranked occupation is Professionals, with a share of workers 'at risk' of 1.2% in total employment in Malta (vs 1.3% for the EU27). **These three occupations are not the most affected across the EU27[491].**

For **ICT professionals (ISCO 25)**[492], the 2022 employment share is 2.5% in Malta (vs 2.3% in the EU27) and its composition (as regards the risk of automation) is as follows: an employment sub-share of 0.1% (vs 0.1% in the EU27) is 'at risk of automation', whereas the remaining employment sub-share of 2.3% (vs 2.2% at EU27 level) is 'not at risk of automation'. The projected annual growth rate 2022-2035 of the employment share of ICT professionals is 1.7% in Malta (vs 1.9% in EU27).

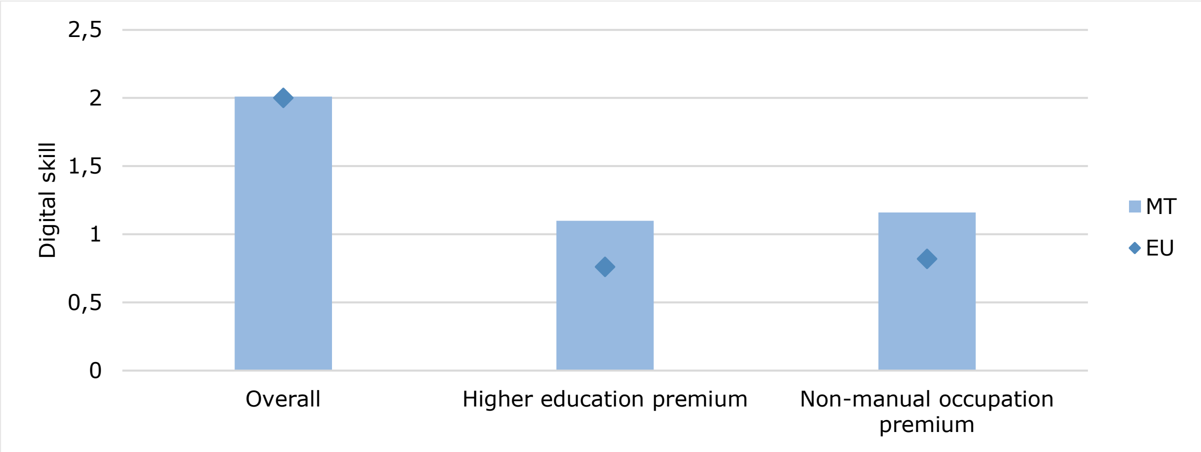
MT 2. Key policy dimensions for a socially fair digital transformation

MT 2.1 Digital skills.

One of the key policy dimensions influencing the extent to which the digital transformation is socially fair is the level of digital skills within the population. With regard to the overall level of digital skills, Malta performs well relative to the EU average. In the study's own estimated index of digital skills[493] (Figure 3, bar "Overall"), Malta ranks 10th among EU countries, while in the DESI Index[494] for Human Capital (Figure 5, section "Other dimensions"), it ranks seventh. When it comes to divides in digital skills between different socio-economic groups, however, the picture is less positive. The digital skills premium for individuals with a tertiary education degree ("Higher education premium" in Figure 3) is the highest in the EU, while the premium for individuals in non-manual occupations ("Non-manual occupation premium" in Figure 3) is the second highest. These pronounced inequalities in digital skills are a significant concern in the context of managing the digital transformation in a socially fair manner.

[491] The most affected in the EU27 are Trades workers, Professionals, and Service and sales workers.
[492] Eurostat code: lfsa_egai2d.
[493] The construction of the digital skill index is described in detail in the introductory section.
[494] European Commission (2022). Digital Economy and Society Index. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi

Figure 3 – Estimated Digital Skills in MT and the EU (2019)



Source: Authors' own estimation based on Eurostat ICT survey
Note: Higher education premium refers to the difference in digital skills between individuals with tertiary and lower than tertiary education. Non-manual occupation premium refers to the difference in digital skills between individuals in manual and non-manual occupations.

Hence, investment in digital skills, particularly in the digital skills of individuals from more disadvantaged socio-economic backgrounds, is of key importance. In its national eSkills Strategy 2022-2025, the Maltese government sets out policy objectives and strategies for strengthening the digital skills of the population. Strategic pillars within the strategy include improving digital capabilities, promoting inclusive, ethical and responsible use of digital technologies, promoting careers in digital and contributing to the digital economy through increases in the availability of skills[495]. Within the Maltese NRRP, only a marginal share of digital expenditure (3.2%) is allocated towards human capital. However, it includes a reform which aims to reduce the digital divide by introducing training for low-skilled individuals, and to promote digital skills to increase the pool of ICT professionals[496].

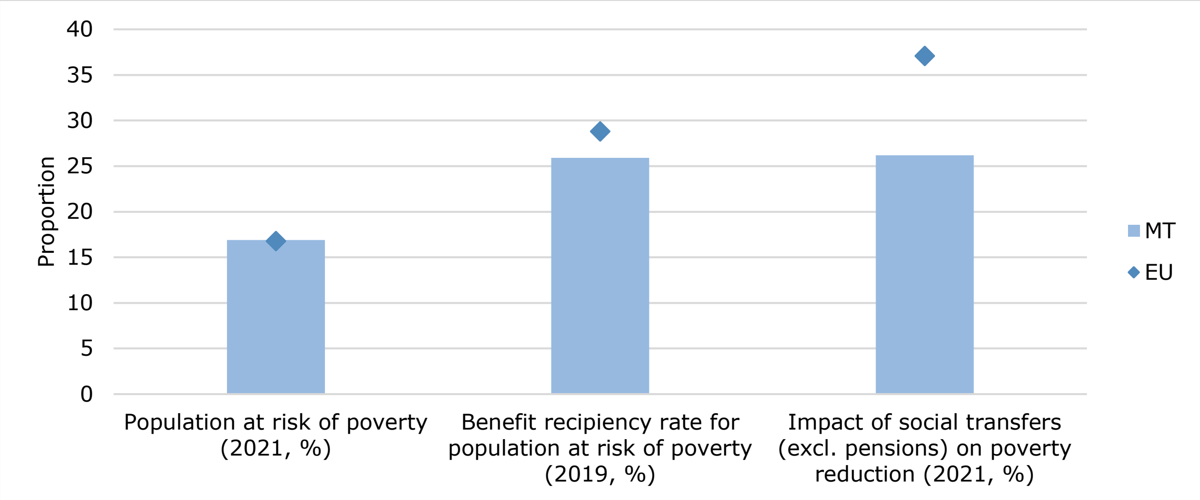
MT 2.2 Social protection and social policy

Beyond digital skills, countries with more comprehensive social protection systems may be better positioned to mitigate the potential impact of the digital transformation on employment. Key indicators on social protection in Malta are presented in Figure 4. The rate of the population at risk of poverty after social transfers[497] is 16.9%, marginally higher than the EU27 rate. Moreover, the data indicate that both the benefit recipiency rate for the population at risk of poverty[498]

[495] https://digital-skills-jobs.europa.eu/en/actions/national-initiatives/national-strategies/malta-national-eskills-strategy-2022-2025
[496] European Commission (2022); Recovery and Resilience Scoreboard Thematic Analyses. Digital Skills. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_digital_skills.pdf
[497] Eurostat (2023). TPS00184: At-risk-of-poverty rate after social transfers by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/tps00184/default/table?lang=en
[498] Eurostat indicator as re-elaborated by JRC (2022) "Monitoring the effective coverage and adequacy of social protection in the EU".

(25.9%) and the impact of social transfers on poverty reduction[499] (26.2%) are lower than the EU27 rates. This points to some potential shortcomings of the social protection system in effectively reducing poverty risks. As regards the regulation of the employment status of platform workers – which has important implications for access to social protection – there has only been limited discussion on the issue so far[500].

Figure 4 – Social Protection in MT and the EU



Source: Eurostat (2023) and JRC (2022)

In its national implementation plan for the Recommendation on access to social protection[501], the Maltese government sets out measures that have been introduced to improve the formal and effective coverage of social protection, as well as its adequacy. However, these measures are not expected to fully close existing gaps in access to social protection and platform workers are not explicitly considered[502]. Within the NRRP, social expenditure is largely focused on education and childcare (47.8%) and health and long-term care (50.4%). Besides a study to assess the system of unemployment benefits, measures specifically focused on social protection are not included[503].

[499] Eurostat (2023). TESPM050:Impact of social transfers (excluding pensions) on poverty reduction by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/TESPM050/bookmark/table?lang=en&bookmarkId=b001ae62-ce34-4b49-9741-28a3ef99477f

[500] PPMI (2021). Study to support the impact assessment on improving working conditions in platform work. Available at: https://ec.europa.eu/social/main.jsp?catId=738&furtherPubs=yes&langId=en&pubId=8428

[501] European Commission (2023). Access to social protection. Available at: https://ec.europa.eu/social/main.jsp?catId=1312&langId=en=en

[502] European Commission (2023). Report from the Commission to the Council on the implementation of the Council Recommendation on access to social protection for workers and the self-employed. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023DC0043&qid=16764733477492

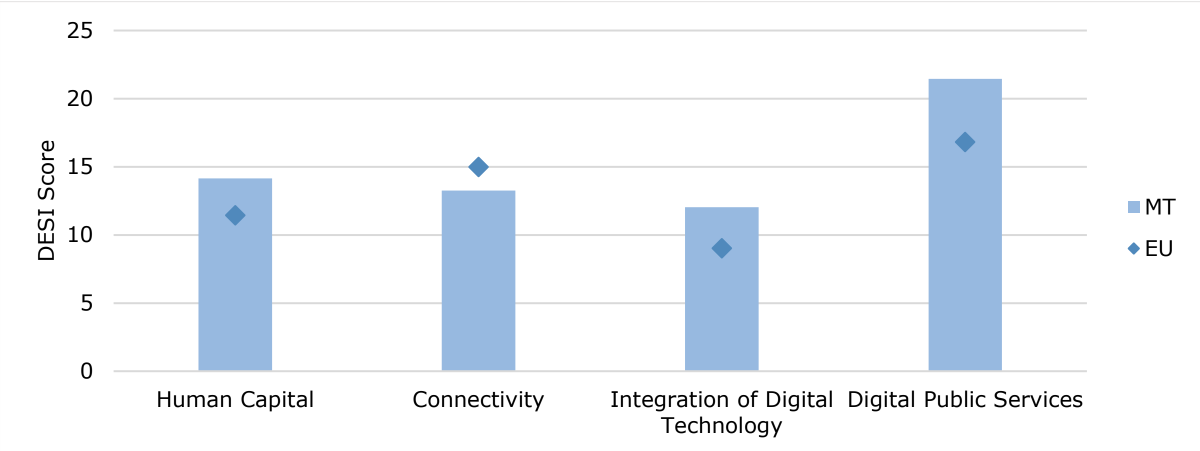
[503] European Commission (2022). Recovery and Resilience Scoreboard Thematic Analyses. Social protection. Available at : https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_social_protection.pdf

MT 3. Other dimensions relevant to the digital transformation

In addition to digital skills and social protection, further support factors for the digital transformation are of significant importance, including the digitalisation of businesses, as well as the digitalisation of infrastructure and of public services.

With regard to the digitalisation of businesses, Malta is performing well above the EU average. The DESI Index (Figure 5) indicates that the level of integration of digital technologies in firms in Malta is the fifth highest in the EU27. Other indicators also confirm the high level of digitalisation of businesses in Malta. Levels of digital capital intensity[504] are very high relative to the EU average[505], and growth on this indicator between 2008 and 2018 is much higher than the one observed across other countries on average. However, looking specifically at robot density[506], progress is less advanced. While growth rates over the past decade are significantly higher than in other countries, the overall stock of robots in both the total economy and in manufacturing is less developed than across Europe on average[507]. Malta has launched several policy strategies to support the development of specific technologies in recent years, including the Smart Specialisation Strategy[508] and the AI Strategy[509]. Within the NRRP for Malta, the digitalisation of businesses is allocated 18.6% of the overall digital expenditure. This includes a grant scheme for the digitalisation of the private sectors, with SMEs being a specific target of this scheme[510].

Figure 5 – DESI Score for MT and the EU (2022)



Source: European Commission (2022)

[504] As described in the Annex, based on data from EU-KLEMS (2008-2018). Data is not available for Cyprus, Croatia, Ireland and Romania.
[505] For Member States with available data
[506] As described in the Annex, based on data from the International Federation of Robotics (2010-2019). Data is not available for Cyprus, Greece, Luxembourg and Slovenia.
[507] For Member States with available data
[508] For more information, see https://mcst.gov.mt/wp-content/uploads/2022/01/RIS3-Strategy-2020-2027.pdf
[509] For more information, see https://malta.ai/wp-content/uploads/2019/11/Malta_The_Ultimate_AI_Launchpad_vFinal.pdf
[510] European Commission (2022): Recovery and Resilience Scoreboard Thematic Analysis. SME Support. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/3_SME.pdf

With regard to digital infrastructure and public services, a mixed picture emerges. On digital public services, Malta is significantly ahead of many European countries, ranking third in the EU in the DESI Index for public services. However, connectivity levels are not as developed. On this dimension, Malta ranks 16th in the DESI Index. Yet within the NRRP for Malta, no spending is foreseen for connectivity, while 78.2% of total digital expenditure is allocated towards the digitalisation of public services, with significant investment to support three measures for the digitalisation of public administration and services[511].

[511] European Commission (2021); Recovery and Resilience Scoreboard Thematic Analyses. Digital public services. Available at :https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/2_Digital.pdf

19. THE NETHERLANDS: elements of a socially fair digital transformation

Key Points

Labour market: Currently, the sector with the second largest employment share in the economy - the Wholesale and retail trade sector - ranks seventh amongst the sectors in terms of the degree of digital transformation (based on the current digital capital intensity in a sector)[512]. The Wholesale and retail trade sector's employment share in the economy is not projected to grow further in the decade to come (as for EU27 trends). ICT services, Professional services and Energy supply services are the three sectors with the highest degree of digital transformation currently, and their employment shares are projected to grow, in the decade to come, more than for the EU27 trends. Regarding the risk of automation of occupations, the most vulnerable occupation is Professionals.

Digital skills: The level of digital skills in the Netherlands is one of the highest in the EU27. Socio-economic divides in digital skill levels are small.

Social protection: The Netherlands has a relatively low rate of the population at risk of poverty, but other indicators point to some shortcomings in the coverage and adequacy of the social protection system. The Netherlands have been active in regulating the employment status of platform workers.

NL 1. The labour market and the digital transformation

NL 1.1 Sectoral composition (current and forward-looking perspectives)

In the Netherlands ("NL"), in 2022, the sectors with the largest employment shares in the economy were: Health and social care (16.9% vs 11.0% at the EU27 level), Wholesale and retail trade (15.1% vs 13.6% at the EU27 level), and Professional services (8.8% vs 5.7% at the EU27 level). For the period 2022-2035, Cedefop data projects[513] the annual growth rate of a sector's employment share. For the Netherlands' Health and social care sector, the annual growth rate is 0.5% (0.6% for the EU27), while it is -0.1% for the Wholesale and retail trade sector -

[512] The ranking based on digital capital intensity is used in the key points only when the sector with the largest employment share is not rankable according to the percentage of enterprises that employ ICT specialists. In this case, the ranking for the first largest employment share in the economy was not available.
[513] Own elaboration on Cedefop 'Skill forecast 2023' data.

0.1% (0.0% for the EU27), and 0.5% for the Professional services sector (0.6% for the EU27).

Table 1 shows each sector's employment share in the economy in 2022, the projected annual growth rate (2022-2035) of its employment share, as well as its resulting employment share in the economy by 2035. Along with these elements relating to employment, Table 1 also presents the degree of "digital transformation" of each sector. The goal of Table 1 is thus to enable a comparison between a sector's degree of digital transformation, its employment share and the projected annual growth rate of its employment share. The aforementioned degree of digital transformation is proxied in Table 1, for each sector, by the percentage of enterprises in the sector that employ ICT specialists.. Table 1 presents the ranking of each sector according to this proxy (with rank n°1 corresponding to the most digitised sector). The three sectors with the highest degree of digital transformation in the Netherlands, in order, are: ICT services (employment share: 4.6% in NL vs 3.7% in the EU27), Professional services (8.8% vs 5.7%) and Energy supply services (0.4% vs 0.7%). In the Netherlands, these sectors' employment shares have a projected annual growth rate for 2022-2035 of 0.9% for ICT services (vs 0.8% for the EU27), 0.5% for Professional services (vs 0.6% for the EU27), and 2.1% for Energy supply services (vs 0.1% for the EU27).

As can be seen from Table 1, notably, two of the top four sectors in terms of digital transformation – ICT services and energy supply services – are also among the top four sectors in terms of the annual growth rate of employment share in the coming decade. Furthermore, in terms of employment share (in 2022), the second, third and fourth sectors[514] – Wholesale and retail trade, Professional services and Manufacturing - rank fifth, second and fourth respectively, according to the only proxy indicator of the digital transformation available (% of enterprises that employ ICT specialists).

Table 1 – NL. Sector's share of employment, annual growth rate, and ranking of "digital transformation" (the sectors are ranked according to the ranking in the last column of the table).

Sectors	Sector's employment share in 2022 (%)		Projected annual growth rate of the sector's employment share (2022 - 2035, %)		Projected sector's employment share in 2035 (%)		Proxy 1 for digital transformation (ranking)	Proxy 2 for digital transformation (ranking)
	NL	**EU**	**NL**	**EU**	**NL**	**EU**	**% enterprises that employ ICT specialists**	**Digital capital intensity**
J - ICT services	4.6	3.7	0.9	0.8	5.2	4.2	1	n.a.
M - Professional services	8.8	5.7	0.5	0.6	9.4	6.3	2	n.a.
D - Energy supply services	0.4	0.7	2.1	0.1	0.6	0.8	3	n.a.
C - Manufacturing	8.5	16.0	-0.2	-0.2	8.2	15.6	4	n.a.
G - Wholesale & retail trade	15.1	13.6	-0.1	0.0	14.8	13.6	5	n.a.
E- Water and waste treatment	0.4	0.8	1.4	-0.1	0.5	0.8	6	n.a.
H - Transport & storage	4.6	5.3	-0.3	-0.1	4.4	5.3	7	n.a.
N - Administrative services	4.7	4.1	-0.9	0.0	4.1	4.1	8	n.a.
F - Construction	4.3	6.8	-0.2	-0.3	4.2	6.5	9	n.a.

[514] the first sector in terms of employment share (in 2022) - Health and social care - was not rankable with either of the proxy indicators for digital transformation.

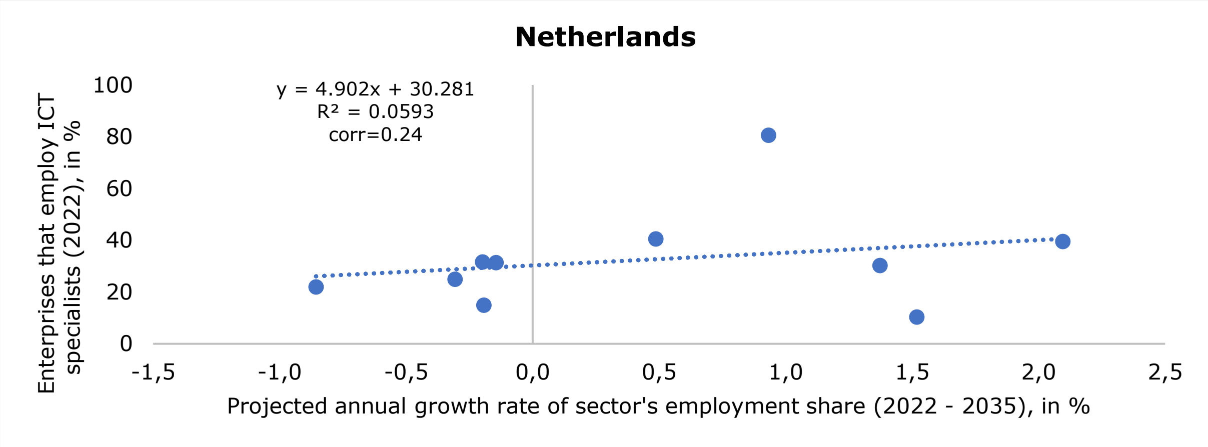
I - Accommodation & food	4.6	4.5	1.5	0.6	5.7	4.9	10	n.a.
A - Agriculture, forestry & fishing	1.8	3.5	-4.0	-3.1	1.0	2.3	n.a.	n.a.
B - Mining & quarrying	0.2	0.3	-1.0	-1.7	0.1	0.2	n.a.	n.a.
K - Finance & insurance	3.2	2.8	0.5	0.2	3.4	2.8	n.a.	n.a.
L - Real Estate	0.7	0.9	-0.3	0.9	0.7	1.0	n.a.	n.a.
O - Public sector & defence	7.0	7.1	-0.2	-0.1	6.8	7.0	n.a.	n.a.
P - Education	7.8	7.4	0.5	0.3	8.3	7.7	n.a.	n.a.
Q - Health & social care	16.9	11.0	0.5	0.6	18.1	11.9	n.a.	n.a.
R - Arts & recreation and other services	2.4	1.7	-0.6	0.3	2.2	1.7	n.a.	n.a.
S - Other service activities	1.9	2.6	-0.4	0.0	1.8	2.6	n.a.	n.a.
T - Activities of households as employers	0.1	0.9	0.9	-0.3	0.1	0.9	n.a.	n.a.
U - Activities of extraterritorial org.	n.a.	0.1	n.a.	n.a.	n.a.	0.1	n.a.	n.a.

Source: For the employment-related indicators own elaboration on Eurostat data (share of employment, 2022 calculated based on lfsa_egan) and on Cedefop 'Skill forecast data 2023' (annual growth rate of sector's employment share, 2022-2035), for the digital transformation-related indicators: own elaboration on Eurostat data (share of enterprises that employ ICT specialists, Eurostat code: lfsa_egais) and on EUKLEMS & INTANProd data (digital capital intensity).
Note: In the first column of the table, the letter preceding the sectors is the code of the NACE Rev.2 classification. In the last two columns of the table, the two proxy indicators used for the digital transformation are: i) the share of enterprises that employ ICT specialists (Eurostat code: lfsa_egais) and ii) the digital capital intensity (EUKLEMS & INTANProd data, average 2014-2017) with rank n°1 corresponding to the most digitally intense sector.

To complement Table 1, Figure 1 below shows to what extent there may be a relationship between a sector's degree of digital transformation and the projected annual growth rate of the sector's employment share in the economy.

In **Figure 1**, we present a scatterplot to shed light on the relationship between the only proxy of the digital transformation used (percentage of enterprises that employ ICT specialists) and the projected annual growth rate of a sector's employment share between 2022-2035. The correlation is positive, but statistically not significant in the Netherlands, with a value of 0.24 (it is 0.61 and statistically significant for the EU27). **The lack of correlation implies that, for the Netherlands, an association cannot be inferred, at the sectoral level, between the 'percentage of enterprises that employ ICT specialists' and the projected annual growth rate of a sector's employment share.**

Figure 1 – NL. Relationship between the percentage of enterprises that employ ICT specialists (in 2022) and the projected annual growth rate of sector's employment share (2022-2035).



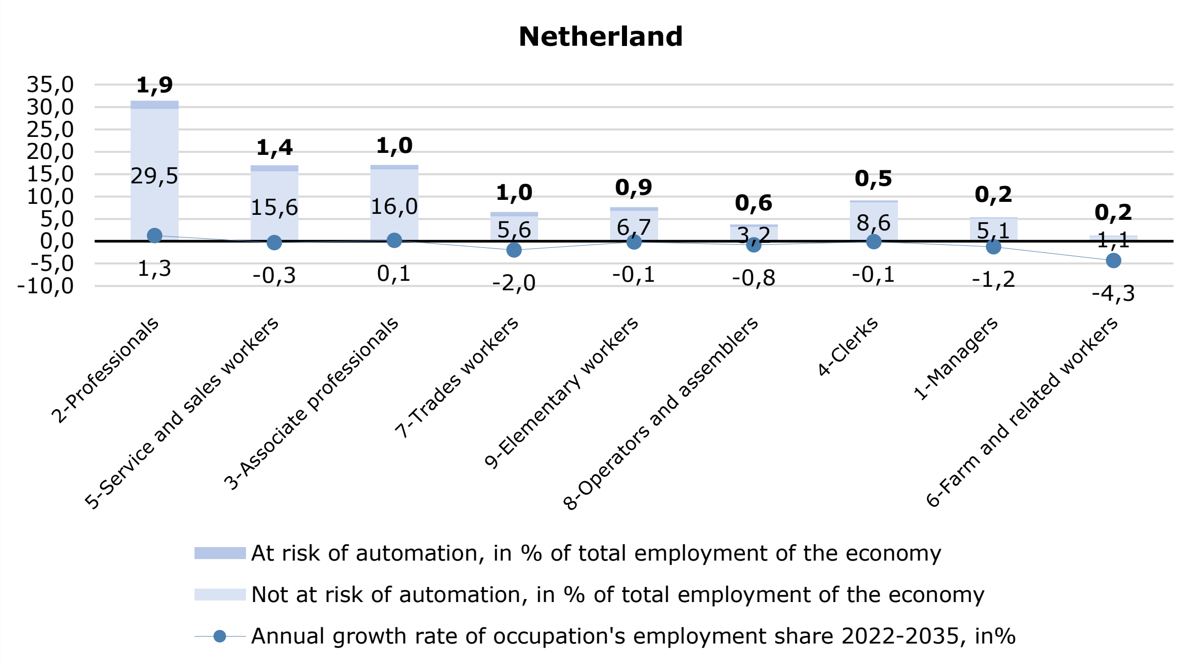
Source: Own elaboration on Eurostat and Cedefop 'Skill forecast 2023' data.

NL 1.2 Occupational composition at ISCO-08 1 digit and risk of automation (current and forward-looking perspectives)

Different occupations are subject to differing levels of automation risk. Cedefop developed[515] a "risk of automation" index by occupation at the EU27 level, with the most recent data available for 2022[516]. We apply this indicator at the Member State level, with the assumption that the risk of automation for a given occupation is constant across Member States[517]. As such, the variation across Member States, in the overall susceptibility to automation of a Member State's workforce (overall risk across all occupations in that Member State) will be due to the employment composition effect, meaning that while the automation risk for a given occupation stays constant across Member States, the overall automation risk of a Member State will naturally be greater for those Member States having more employment in occupations that have a higher automation risk.

Figure 2 – NL. Employment shares of occupations (at ISCO-08 1 digit level) - split into sub shares 'not at risk' and 'at risk' of automation (2022) - and projected annual growth rate

[515] Based on the methodology in Pouliakas, K. (2018) "The risk of automation in EU labour markets: a skill-requirements approach", in Economy, Employment and Skills: European and global perspectives in an age of uncertainty, Fondazione Giacomo Brodolini Quaderni Series, also IZA DP 11829.
[516] As retrieved at https://www.cedefop.europa.eu/en/tools/skills-intelligence/automation-risk-occupations#1
[517] While this assumption may be considered strong, Cedefop data are the only ones available that are at the same time, up to date and available for all the occupations at the ISCO-08 level.



Source: Own elaboration on Cedefop data (risk of automation calculated by Cedefop at EU27 level by ISCO-08 1 digit level for 2022) applied to Eurostat data (share of employment by occupation, lfsa_egais, 2022).
Note: The numbers preceding the occupations are the ISCO-08 codes. Occupations are ranked from the highest to the lowest share of workers that present a risk of automation. The vertical sum of the two components (darker blue and lighter blue) gives back the total employment share by occupation (in % of total employment in the Member State). The ISCO nomenclature used in the text and the figure is the Cedefop one. For examples of specific occupations see: https://esco.ec.europa.eu/en/classification/occupation_main.

As can be seen in **Figure 2**, in the Netherlands, the occupation with the largest employment sub-share (in % of total employment in the economy) 'at risk of automation' is Professionals, with an employment sub-share of workers 'at risk of automation' representing 1.9% of total employment in the country (vs 1.3% for the EU27). Ranking second regarding the employment sub-share of workers 'at risk of automation' are Service and sales workers, with an employment sub-share of workers 'at risk' of 1.4% of total employment in the Netherlands (vs 1.3% for the EU27). The third-ranking occupation are Associate professionals, with a share of workers 'at risk' of 1.0% in total employment in the Netherlands (vs 1.3% for the EU27). **These three occupations are not the most affected across the EU27[518].**

For ICT **professionals (ISCO 25)**[519], the 2022 employment share is 5.0% in the Netherlands (vs 2.3% in the EU27) and its composition (as regards the risk of automation) is as follows: an employment sub-share of 0.3% (vs 0.1% in the EU27) is 'at risk of automation', whereas the remaining employment sub-share of 4.7% (vs 2.2% at EU27 level) is 'not at risk of automation'. The projected annual growth rate 2022-2035 of the employment share of ICT professionals is 1.7% in The Netherlands (vs 1.9% in EU27).

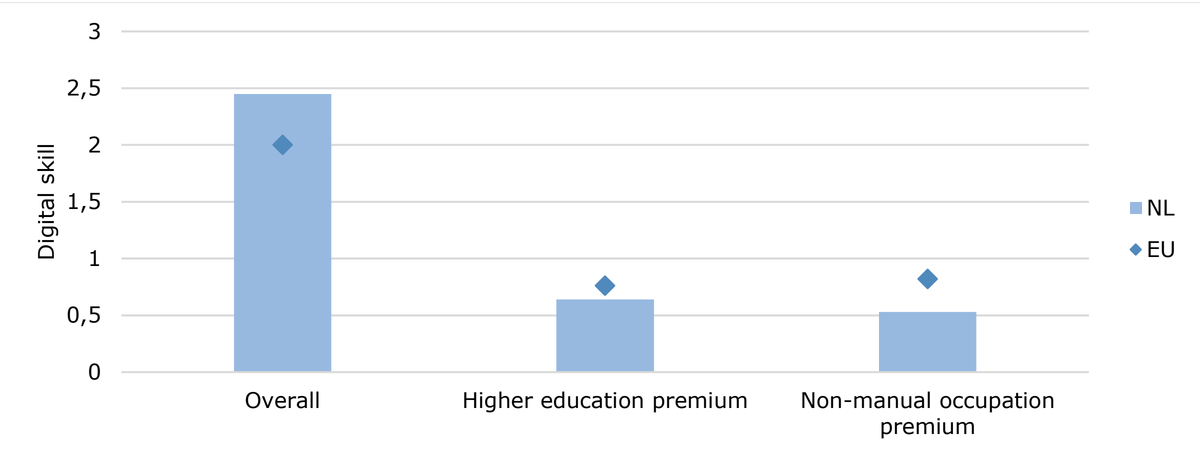
[518] The most affected in the EU27 are Trades workers, Professionals, and Service and sales workers.
[519] Eurostat code: lfsa_egai2d.

NL 2. Key policy dimensions for a socially fair digital transformation

NL 2.1 Digital skills

One significant policy dimension influencing the extent to which the digital transformation is socially fair is the level of digital skills within the population. **The Netherlands is one of the leading countries in Europe with regard to digital skills.** According to the study's own estimated index of digital skills, the overall level of digital skills in the population[520] (Figure 3, bar "Overall") is the highest in the EU. Similarly, in the DESI Index for Human Capital[521] (Figure 5, Section "Other dimensions") the Netherlands ranks second in the EU27. Digital divides are also relatively small in the Netherlands: on the premium for those with tertiary education on digital skills ("Higher education premium" in Figure 3), the Netherlands ranks seventh in the EU27, while on the non-manual occupation premium, it ranks fourth. This relative equality in digital skills positions the Netherlands well when it comes to managing the potential labour market impact of the digital transformation. However, a remaining shortcoming in the Netherlands is the relatively low share of ICT graduates, and structural difficulties remain for firms in finding qualified ICT personnel[522].

Figure 3 – Estimated Digital Skills in NL and the EU (2019)



Source: Authors' own estimation based on Eurostat ICT survey
Note: Higher education premium refers to the difference in digital skills between individuals with tertiary and lower than tertiary education. Non-manual occupation premium refers to the difference in digital skills between individuals in manual and non-manual occupations.

The Netherlands sets out its policy strategy for the digital transformation in the Dutch Digitalisation Strategy[523]. As part of this strategy, digital skills of the labour force are to be improved through several actions, including measures to strengthen digital inclusion and initiatives to encourage retraining for individuals

[520] The construction of the digital skill index is described in detail in the introductory section.
[521] European Commission (2022). Digital Economy and Society Index. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi
[522] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[523] For more information, see https://www.nederlanddigitaal.nl/english/the-dutch-digitalisation-strategy-2021

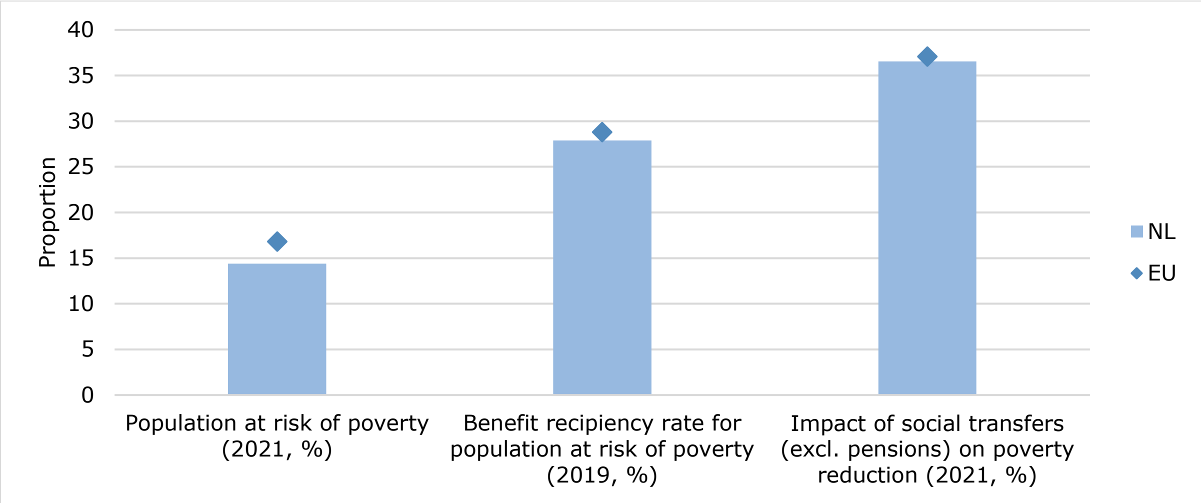
at risk of job loss, among others[524]. Digital skills investment is also foreseen as part of the Dutch NRRP, with 23.7% of digital expenditure allocated towards human capital. For instance, this includes an investment for three subsidy schemes for training and professional development[525].

NL 2.2 Social protection and social policy

Countries with more comprehensive social protection systems may be better positioned to mitigate against the labour market impact of the digital transformation for individuals who could be exposed to job changes or losses. In this regard, Figure 4 shows some key figures for the Netherlands. The rate of the population at risk of poverty[526] (14.4%) is significantly lower than the EU27 rate, ranking as the 11th-lowest in Member States. However, **other indicators point to a somewhat limited effectiveness of the social protection system in alleviating poverty.** Both the benefit recipiency rate for the population at risk of poverty before social transfers [527] (27.9%) and the impact of social transfers on poverty reduction[528] (36.6%) are below the EU27 rates. However, on the issue of platform work, a form of labour strongly shaped by labour market digitalisation, the Netherlands has been active in introducing measures to regulate the employment status of platform workers[529].

[524] For more information, see https://digital-skills-jobs.europa.eu/en/actions/national-initiatives/national-strategies/netherlands-dutch-digitalisation-strategy-20
[525] Council of the European Union (2022). Annex to the Proposal for a Council Implementing Decision on the approval of the recovery and resilience plan for the Netherlands. Available at: https://data.consilium.europa.eu/doc/document/ST-12275-2022-ADD-1/en/pdf
[526] Eurostat (2023). TPS00184: At-risk-of-poverty rate after social transfers by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/tps00184/default/table?lang=en
[527] Eurostat indicator as re-elaborated by JRC (2022) "Monitoring the effective coverage and adequacy of social protection in the EU".
[528] Eurostat (2023). TESPM050:Impact of social transfers (excluding pensions) on poverty reduction by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/TESPM050/bookmark/table?lang=en&bookmarkId=b001ae62-ce34-4b49-9741-28a3ef99477f
[529] PPMI (2021). Study to support the impact assessment on improving working conditions in platform work. Available at: https://ec.europa.eu/social/main.jsp?catId=738&furtherPubs=yes&langId=en&pubId=8428

Figure 4 – Social Protection in NL and the EU



Source: Eurostat (2023) and JRC (2022)

While the Dutch national implementation plan[530] for the Recommendation on access to social protection sets out some planned policy measures to improve the formal (though not effective) coverage and the adequacy of social protection, these measures are not expected to close existing gaps in access to social protection[531]. Additional measures on platform work are not foreseen. The Dutch NRRP also includes some reforms specific to social protection, including an introduction of disability insurance for the self-employed[532]. The social spending within the NRRP is however largely focused on education and childcare (52.8%), with the rest allocated to employment and skills (19.9%), and to health and long-term care (27.4%).

NL 3. Other dimensions relevant to the digital transformation

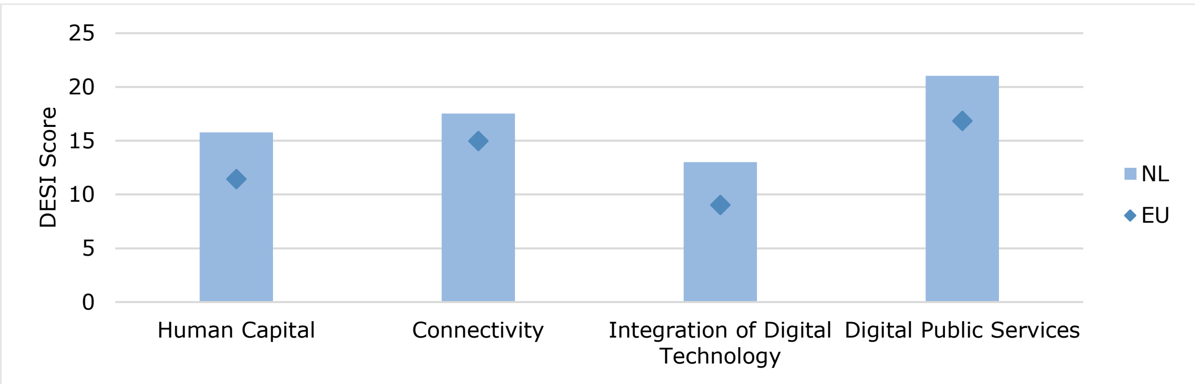
In addition to digital skills and access to social protection, other contextual factors can play a significant role in supporting a socially fair digital transformation more broadly. These include the digitalisation of businesses as well as digitalisation of infrastructure and of public services.

In terms of the level of digitalisation of businesses, the Netherlands is a leader in the EU. The DESI Index (Figure 5) indicates that the level of integration of technology in firms in the Netherlands is the fourth highest among EU member states. Data on digital capital intensity[533] also depicts the Netherlands to be far

[530] European Commission (2023). Access to social protection. Available at: https://ec.europa.eu/social/main.jsp?catId=1312&langId=en=en
[531] European Commission (2023). Report from the Commission to the Council on the implementation of the Council Recommendation on access to social protection for workers and the self-employed. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023DC0043&qid=16764733477492
[532] Council of the European Union (2022). Annex to the Proposal for a Council Implementing Decision on the approval of the recovery and resilience plan for the Netherlands. Available at: https://data.consilium.europa.eu/doc/document/ST-12275-2022-ADD-1/en/pdf
[533] As described in the Annex, based on data from EU-KLEMS (2008-2018). Data is not available for Cyprus, Croatia, Ireland and Romania.

ahead of the EU average[534] in terms of absolute levels, with growth rates between 2009 and 2019 that are slightly higher than the country average. Finally, looking at robot density[535], levels and growth rates in the overall economy are slightly lower than the EU average[536], but in manufacturing, there is a relatively high stock of robots, though again growth is slightly below the EU average rate. While the DESI Index shows that levels of integration of digital technologies are high, it similarly observes relatively low growth compared to previous years for various indicators – such as electronic information sharing or SMEs selling online - showing that more policy action is needed to increase performance for the future[537].There are also some specific areas where adoption of specific types of digital technologies by businesses is limited so far, such as AI[538]. The Dutch government has launched several initiatives to further increase digitalisation of businesses, including the Dutch Artificial Intelligence Coalition and Blockchain Coalition, as well as projects of common European interest[539]. Within the Dutch NRRP, no expenditure is targeted at the digitalisation of businesses.

Figure 5 – DESI Score for NL and the EU (2022)



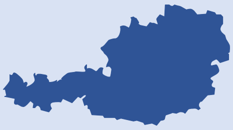
Source: European Commission (2022)

With regards to digital infrastructure and public services, the Netherlands similarly performs very well. The DESI Index indicates that connectivity levels in the Netherlands are the second highest in the EU, while levels of digital public services are the fourth highest. The Netherlands have taken further policy action to improve connectivity, including improvements to 5G coverage, but there are some obstacles including low take-up of higher broadband speed and VHCN connection in areas that currently lack coverage[540]. The Dutch NRRP foresees further substantial investment in digital public services (50.7% of total expenditure), but no investment in connectivity.

[534] For Member States with available data
[535] As described in the Annex, based on data from the International Federation of Robotics (2010-2019). Data is not available for Cyprus, Greece, Luxembourg and Slovenia.
[536] For Member States with available data
[537] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[538] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[539] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[540] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance

20. AUSTRIA: elements of a socially fair digital transformation

Key Points



Labour market: The Manufacturing sector, which currently has the largest employment share in the Austrian economy, has the third highest degree of digital transformation (based on the current percentage of enterprises that employ ICT specialists in a sector). The Manufacturing sector's employment share in the economy is not projected to grow further in the decade to come (slightly less than EU trends). ICT services, Professional services and Manufacturing are currently the three sectors with the highest degree of digital transformation, and their employment shares, except for Manufacturing, are projected to grow in the decade to come, slightly more than in the EU27. Regarding the risk of automation of occupations, the most vulnerable type of occupation vulnerable is Trades workers.

Digital skills: Austria has a rather high level of digital skills in the population. Compared to other EU countries, digital divides between individuals with different levels of education are relatively low, while those between individuals in different occupations rank in the mid-field of EU countries.

Social protection: The social protection system in Austria is well-developed relative to most other Member States, with a low rate of the population at risk of poverty compared to other countries. The country has also been active in regulating platform work.

AT 1. The labour market and the digital transformation

AT 1.1 Sectoral composition (current and forward-looking perspectives)

In Austria ("AT"), in 2022, the sectors with the largest employment shares in the economy were: Manufacturing (17.0% vs 16.0% at the EU27 level), Wholesale and retail trade (13.7% vs 13.6% at the EU27 level), and Health and social care (11.2% vs 11.0% at the EU27 level). For the period 2022-2035, Cedefop data projects[541] the annual growth rate of a sector's employment share. For Austria's Manufacturing sector, the annual growth rate is -0.4% (-0.2% for the EU27), for

[541] Own elaboration on Cedefop 'Skill forecast 2023' data.

the Wholesale and retail trade sector it is 0.3% (0.0% for the EU27), and for the Health and social care sector, it is 0.6% (same as for the EU27).

Table 1 presents each sector's employment share in the economy in 2022, the projected annual growth rate (2022-2035) of its employment share, as well as its resulting employment share in the economy by 2035. Along with these elements relating to employment, Table 1 also presents the degree of "digital transformation" of each sector. Hence, Table 1 facilitates a comparison between the degree of digital transformation of a sector and its employment share or its employment share's prospects. The aforementioned degree of digital transformation is proxied in Table 1, for each sector, by two indicators: i) the percentage of enterprises that employ ICT specialists in the sector and ii) the digital capital intensity[542] of the sector. Table 1 presents the ranking of each sector according to these two proxy indicators (with rank n°1 corresponding to the most digitised sector). According to the first indicator, the three sectors with the highest degree of digital transformation in Austria, in order, are: ICT services (employment share: 3.6% in AT vs 3.7% in the EU27), Professional services (6.0% vs 5.7%) and Manufacturing (17.0% vs 16.0%). According to the second indicator (digital capital intensity), the three sectors with the highest degree of digital transformation, in order, are: Finance & insurance (employment share: 3.1% in AT vs 2.8% in the EU27), ICT services (3.6% vs 3.7%) and Professional services (6.0% vs 5.7%). In Austria, these sectors' employment shares have a projected annual growth rate of 1.2% for ICT services (vs 0.8% for the EU27), 0.7% for Professional services (vs 0.6% for EU27), -0.4% for Manufacturing (vs -0.2% for EU27) and -0.4% for Finance & insurance (vs 0.2% for EU27) for 2022-2035.

As can be seen from Table 1, it is interesting to note that two of the top four sectors in terms of digital transformation – ICT services and Professional services – are also among the top four sectors in terms of the annual growth rate of employment share in the decade to come in Austria. It is also interesting to note that the largest sector in terms of employment share (in 2022) ranks third on one of the two proxy indicators of digital transformation (% of enterprises that employ ICT specialists).

Table 1 – AT. Sector's share of employment, annual growth rate, and ranking of "digital transformation" (the sectors are ranked according to the ranking in the last column of the table)

Sectors	Sector's employment share in 2022 (%)		Projected annual growth rate of the sector's employment share (2022 - 2035, %)		Projected sector's employment share in 2035 (%)		Proxy 1 for digital transformation (ranking)	Proxy 2 for digital transformation (ranking)
	AT	**EU**	**AT**	**EU**	**AT**	**EU**	**(% enterprises that employ ICT specialists)**	**(Digital capital intensity)**
K - Finance & insurance	3.1	2.8	-0.4	0.2	3.0	2.8	n.a.	1
J - ICT services	3.6	3.7	1.2	0.8	4.3	4.2	1	2

[542] 'Digital capital intensity' is an index – built in the context of this study – that looks at the ratio between the stock of capital the firms have in software and databases and the overall stock of capital excluding non-residential buildings. Its construction is based on the integrated EUKLEMS & INTANProd database, run by the Luiss Lab of European Economics at Luiss University in Rome, Italy. For more in-depth information on the source, and the availability of the indicator for Member States/sectors, please refer to the Annex.

M - Professional services	6.0	5.7	0.7	0.6	6.6	6.3	2	3
G - Wholesale & retail trade	13.7	13.6	0.3	0.0	14.2	13.6	4	4
C - Manufacturing	17.0	16.0	-0.4	-0.2	15.9	15.6	3	5
N - Administrative services	3.6	4.1	0.0	0.0	3.6	4.1	6	6
F - Construction	8.3	6.8	-0.1	-0.3	8.2	6.5	8	7
B - Mining & quarrying	0.2	0.3	-0.6	-1.7	0.2	0.2	n.a.	8
D - Energy supply services	0.7	0.7	-0.2	0.1	0.6	0.8	n.a.	9
P - Education	6.7	7.4	-0.1	0.3	6.6	7.7	n.a.	10
O - Public sector & defence	6.8	7.1	-0.1	-0.1	6.7	7.0	n.a.	11
R - Arts & recreation and other services	1.7	1.7	-1.2	0.3	1.4	1.7	n.a.	12
Q - Health & social care	11.2	11.0	0.6	0.6	12.2	11.9	n.a.	13
H - Transport & storage	4.7	5.3	-1.3	-0.1	3.9	5.3	5	14
I - Accommodation & food	5.7	4.5	1.3	0.6	6.8	4.9	7	n.a.
S - Other service activities	2.4	2.6	-0.4	0.0	2.3	2.6	n.a.	n.a.
L - Real Estate	0.8	0.9	0.4	0.9	0.9	1.0	n.a.	n.a.
T - Activities of households as employers	0.2	0.1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
U - Activities of extraterritorial organisations & bodies	0.1	0.9	1.0	-0.3	0.1	0.9	n.a.	n.a.

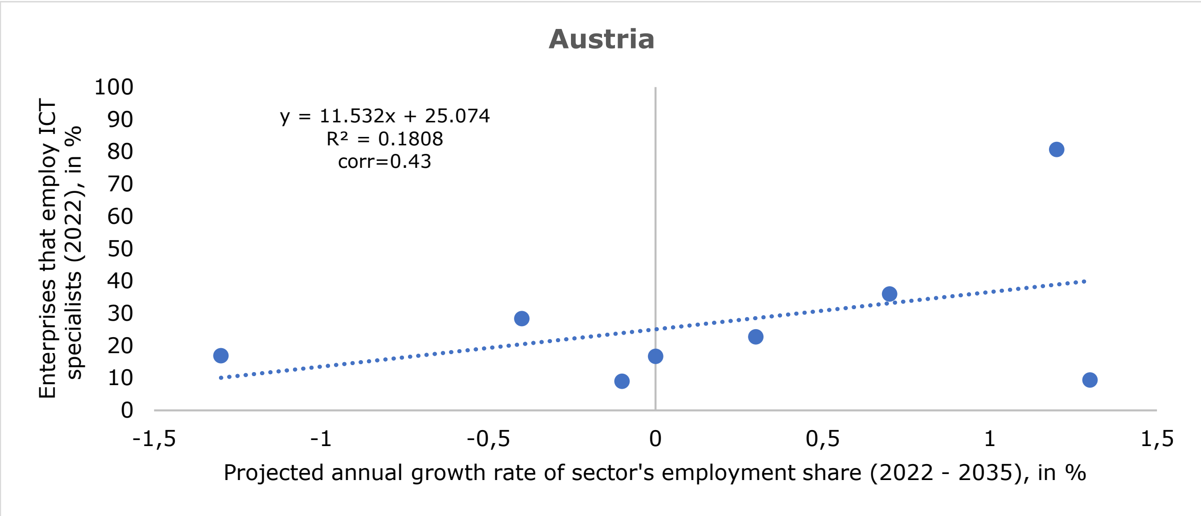
Source: For the employment-related indicators own elaboration on Eurostat data (share of employment, 2022 calculated based on lfsa_egan) and on Cedefop 'Skill forecast data 2023' (annual growth rate of sector's employment share, 2022-2035), for the digital transformation-related indicators: own elaboration on Eurostat data (share of enterprises that employ ICT specialists) and on EUKLEMS data (digital capital intensity).
Note: In the first column of the table, the letter preceding the sectors is the code of the NACE Rev.2 classification. In the last two columns of the table, the two proxy indicators used for digital transformation are: i) percentage of enterprises that employ ICT specialists and ii) the digital capital intensity (EUKLEMS & INTANProd data, average 2014-2017) with rank n°1 corresponding to the most digitally intense sector.

In complement to Table 1, Figures 1a and 1b below show the extent to which there may be a relationship between the projected annual growth rates of the sectors' employment shares in the economy and sectors' degree of digital transformation[543].

In **Figure 1a**, we present a scatterplot to shed light on the relationship between the first proxy of the digital transformation used (percentage of enterprises that employ ICT specialists) and the projected annual growth rate of a sector's employment share between 2022-2035. The correlation is positive, but statistically not significant in Austria, with a value of 0.43 (whereas it is 0.61 and statistically significant for the EU27). **The lack of correlation implies that, at the sectoral level, a relationship between the percentage of enterprises that employ ICT specialists and the projected annual growth rate of a sector's employment share cannot be inferred in Austria.**

[543] With the caveat that the correlation coefficients presented in Figure 1a and Figure 1b cannot be directly compared, as they pertain to a combination of sectors that varies across different Member States.

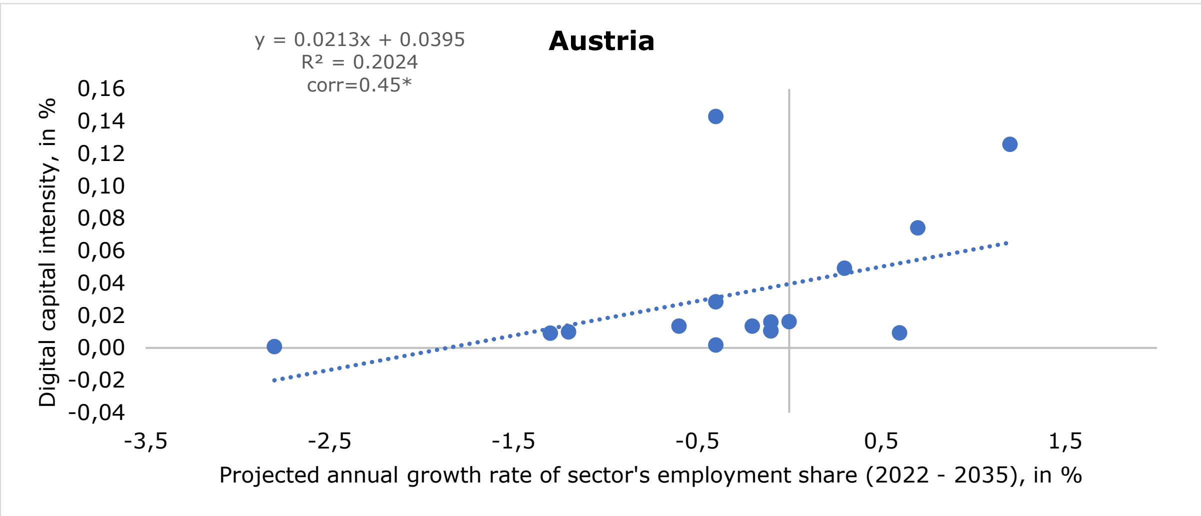
Figure 1a – AT. Relationship between the percentage of enterprises that employ ICT specialists (in 2022) and the projected annual growth rate of sector's employment share (2022-2035).



Source: Own elaboration on Eurostat and Cedefop 'Skill forecast 2023' data.

Figure 1b shows the correlation between the second digital transformation proxy ('digital capital intensity') and the projected annual growth rate of a sector's employment share between 2022-2035. The correlation coefficient exhibits a value of 0.45 and is statistically significant in Austria. Among the 16 Member States for which sectoral 'digital capital intensity' can be computed (7 of whom showcase a positive and significant correlation), Austria ranks third. In this case, the positive correlation could suggest that the employment shares of **those sectors with a higher 'digital capital intensity' are more likely to grow (over 2022-2035) than other sectors. The relationship is only moderate and at a similar level to other Member States. This correlation does not imply causal links.**

Figure 1b – AT. Relationship between 'digital capital intensity' and the projected annual growth rate of sector's employment share (2022-2035).

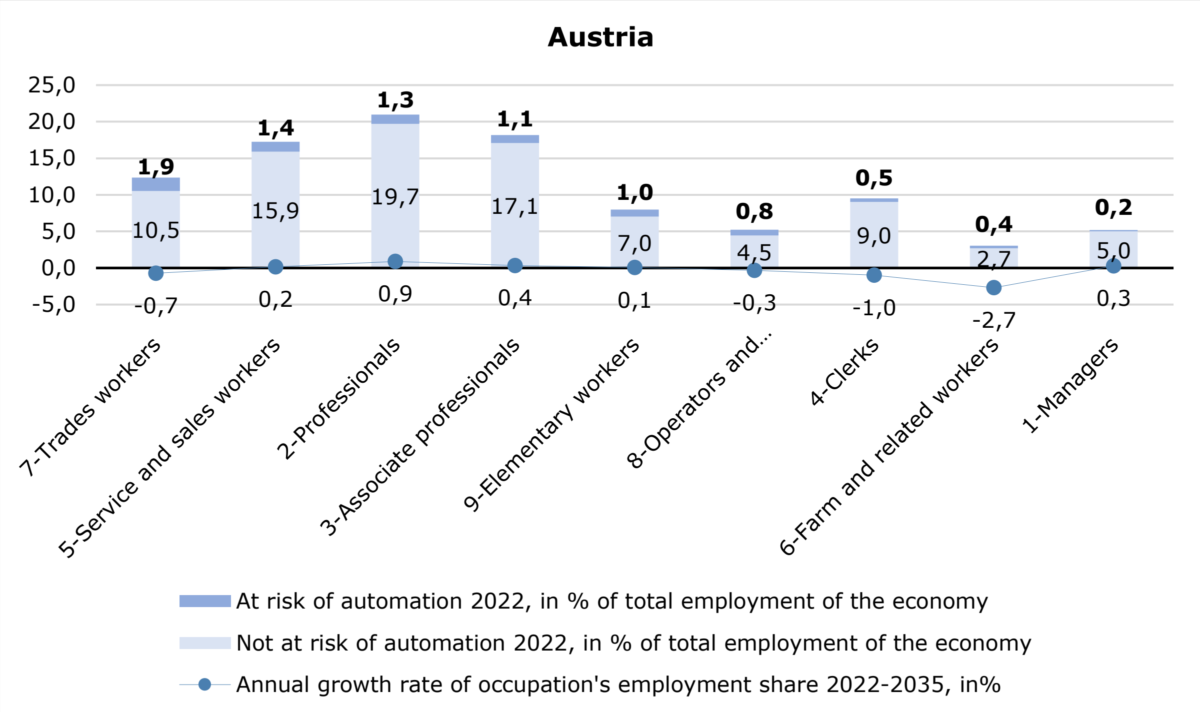


Source: Own elaboration on EUKLEMS & INTANprod, and Cedefop 'Skill forecast 2023' data.

AT 1.2 Occupational composition at ISCO-08 1 digit and risk of automation (current and forward-looking perspectives)

Different occupations are subject to differing levels of automation risk. Cedefop developed[544] a "risk of automation" index by occupation at the EU27 level, most recently available for 2022[545]. We apply this indicator at the Member State level, with the assumption that the risk of automation for a given occupation is constant across Member States[546]. As such, the variation, across Member States, in the overall susceptibility to automation of a Member State's workforce (overall risk across all occupations in that Member State) will be due to the employment composition effect, meaning that while the automation risk for a given occupation stays constant across Member States, the overall automation risk of a Member State will naturally be greater for those Member States having more employment in occupations that have a higher automation risk.

Figure 2 – AT. Employment shares of occupations (at ISCO-08 1 digit level) - split into sub shares 'not at risk' and 'at risk' of automation (2022) - and projected annual growth rate



Source: Own elaboration on Cedefop data (risk of automation calculated by Cedefop at EU27 level by ISCO-08 1 digit level for 2022) applied to Eurostat data (share of employment by occupation, lfsa_egais, 2022).
Note: The numbers preceding the occupations are the ISCO-08 codes. Occupations are ranked from the highest to the lowest share of workers that present a risk of automation. The vertical sum of the two components (dark blue and light blue) gives back the total employment share by occupation (in % of total employment in the Member State). The ISCO nomenclature used in the text and the figure is the Cedefop one. For examples of specific occupations see: https://esco.ec.europa.eu/en/classification/occupation_main.

[544] Based on the methodology in Pouliakas, K. (2018) "The risk of automation in EU labour markets: a skill-requirements approach", in Economy, Employment and Skills: European and global perspectives in an age of uncertainty, Fondazione Giacomo Brodolini Quaderni Series, also IZA DP 11829.
[545] As retrieved at https://www.cedefop.europa.eu/en/tools/skills-intelligence/automation-risk-occupations#1
[546] While this assumption may be considered strong, Cedefop data are the only ones available that are at the same time, up to date and available for all the occupations at the ISCO-08 level.

As can be seen in **Figure 2**, in Austria, the occupation with the largest employment sub-share (in % of total employment in the economy) at risk of automation is Trades workers, with an employment sub-share of workers 'at risk of automation' representing 1.9% of total employment in the country (vs 1.7% for the EU27). Ranking second with regard to the employment sub-share of workers at risk of automation are Service and sales workers, with an employment sub-share of workers 'at risk' of 1.4% of total employment in Austria (vs 1.3% for the EU27). Finally, Professionals rank third, with a share of workers 'at risk' of 1.2% in total employment in Austria (vs 1.3% for the EU27). **Among these three occupations, only the first one (Trades workers) is also the most affected across the EU27.**

For **ICT professionals (ISCO 25),** the 2022 employment share is 2.7% in Austria (vs 2.3% in EU27) and its composition (as regards the risk of automation) is as follows: an employment sub-share of 0.2% (vs 0.1% at EU27) is at risk of automation, whereas the remaining employment sub-share of 2.6% (vs 2.2% at EU27 level) is not at risk of automation. The projected annual growth rate (2022-2035) of the employment share of ICT professionals is 1.3% in Austria (vs 1.9% in EU27).

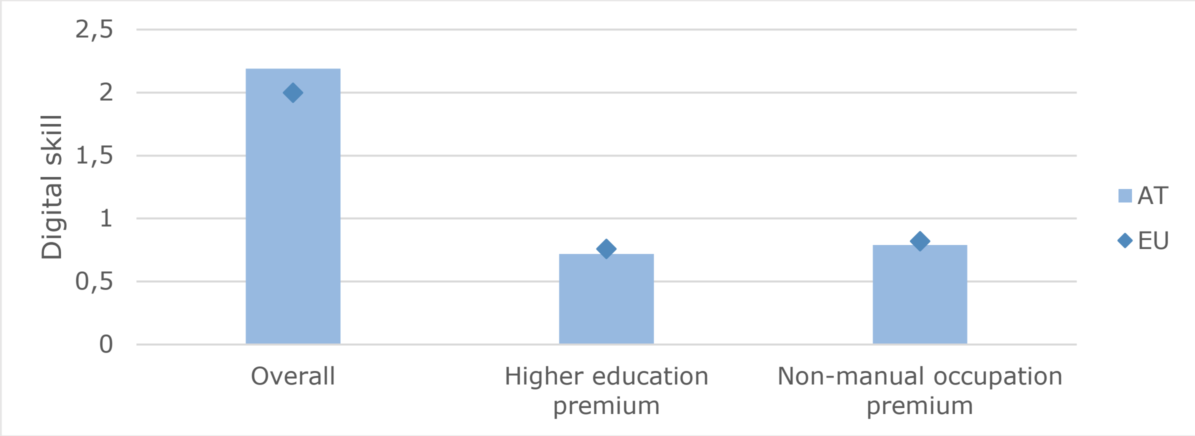
AT 2. Key policy dimensions for a socially fair digital transformation

AT 2.1 Digital skills

One of the key policy dimensions influencing the extent to which the digital transformation is socially fair is the level of digital skills of the population. Austria exhibits a rather high level of digital skills. This is evident both when looking at the DESI Index for human capital[547] (Austria ranks 11th in EU; see **Figure 6** in Section "Other dimensions") and at an estimate of digital skills that was developed for this study[548] (Austria ranks 6th in EU; see **Figure 4**, bar "Overall"). Moreover, **digital divides between individuals with different levels of education and types of occupation are** slightly lower than in the EU. Concerning the gap in digital skills by level of education ("higher education premium" in Figure 4), Austria has the 10th–lowest gap in the EU. However, while the digital skill gap between individuals in manual and non-manual occupations is still below the EU27 rate ("non-manual occupation premium" in Figure 4), the ranking compared to other countries is somewhat worse (16th). Its rather good ranking on the digital divide regarding the education dimension is a potential strength for Austria when it comes to mitigating the inequality effects of the digital transformation.

[547] European Commission (2022). Digital Economy and Society Index.
Available at: https://digital-strategy.ec.europa.eu/en/policies/desi
[548] The construction of the digital skill index is described in detail in the Annex.

Figure 4 – Estimated digital skill in AT and the EU



Source: Authors' own estimation based on Eurostat ICT survey
Note: Higher education premium refers to the difference in digital skills between individuals with tertiary and lower than tertiary education. Non-manual occupation premium refers to the difference in digital skills between individuals in manual and non-manual occupations.

When it comes to ensuring a socially fair digital transformation in the future, Austria has put forward the Digital Austria 2050 Strategic Action Plan[549] , which proposes initiatives targeted at improving digital skills for citizens and workers and the digital transformation of the educational system. In addition, a very large share of the Austrian NRRP (53.2%) is allocated to digital transformation, of which 20.9% is dedicated to human capital. The NRRP measures include initiatives targeted at up- and re-skilling of the unemployed, focusing on ICT skills[550].

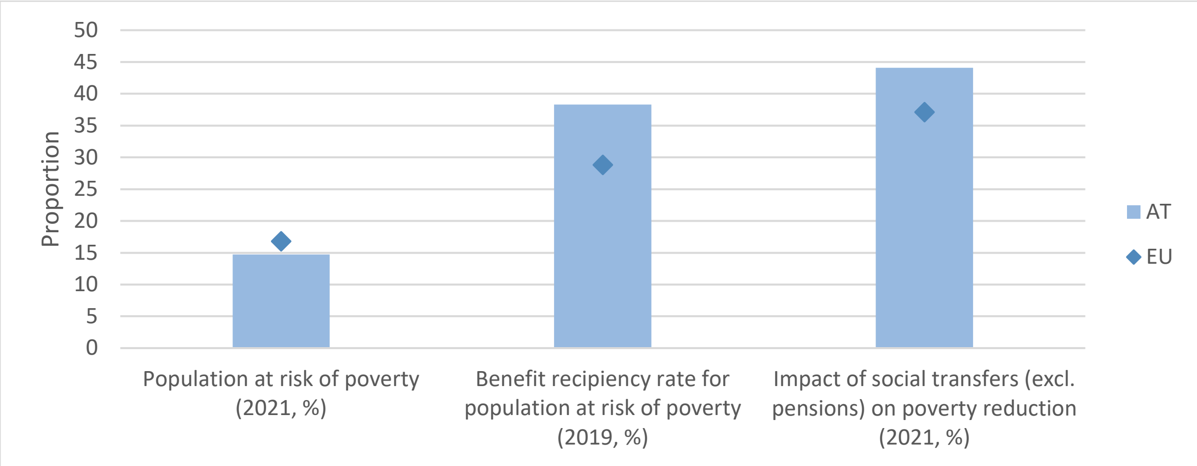
AT 2.2 Social protection and social policy

More encompassing social protection systems may be better equipped to compensate for the potential impact of the digital transformation on employment, poverty and inequality. The following section briefly summarizes the Austrian situation with regard to selected social protection indicators and social policies. The Austrian rate of the population at risk of poverty[551], 14.7% (**Figure 5**), is below the EU27 rate. Other social protection indicators point to Austria being among the European countries with high levels of coverage. The benefit recipiency rate for the population at risk of poverty before social transfers[552] (38.3%) is the seventh highest in the EU27, while the estimated impact of social transfers on poverty[553] is the 10th-highest (44.1%). Moreover, Austria is **currently one of the Member States most active in regulating platform work[554]**, which is a

[549] For more information, see https://www.digitalaustria.gv.at
[550] European Commission (2023); Recovery and Resilience Scoreboard Thematic Analyses. Digital Skills. Available at : https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_digital_skills.pdf
[551] Eurostat (2023). TPS00184: At-risk-of-poverty rate after social transfers by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/tps00184/default/table?lang=en
[552] Eurostat indicator as re-elaborated by JRC (2022) "Monitoring the effective coverage and adequacy of social protection in the EU".
[553] Eurostat (2023). TESPM050: Impact of social transfers (excluding pensions) on poverty reduction by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/TESPM050/bookmark/table?lang=en&bookmarkId=b001ae62-ce34-4b49-9741-28a3ef99477f
[554] PPMI (2021). Study to support the impact assessment on improving working conditions in platform work. Available at: https://ec.europa.eu/social/main.jsp?catId=738&furtherPubs=yes&langId=en&pubId=8428

significant channel through which the digital transformation could impact the social situation.

Figure 5 – Social protection in AT and the EU



Source: Eurostat (2023) and JRC (2022)

With regard to specific policy plans for social protection, the Austrian implementation plan on the Recommendation for access to social protection for workers and the self-employed[555] does not foresee measures to improve the formal or effective coverage of social protection, though it includes some planned measures to improve adequacy. The document does not include specific measures on platform work. According to the European Commission assessment, existing gaps in both formal and effective access to social protection are not expected to be closed by the measures set out in the implementation plan[556]; however, as detailed above, the overall social protection system is already relatively developed compared to other EU countries. Moreover, the Austrian NRRP includes a reform of the pension system to increase fairness and reduce the gender pension gap, ultimately reducing social vulnerabilities[557]. More generally, the social expenditure in the NRRP largely focuses on education and childcare (34.1%), while only a very small share is devoted to social policies (5.7%).

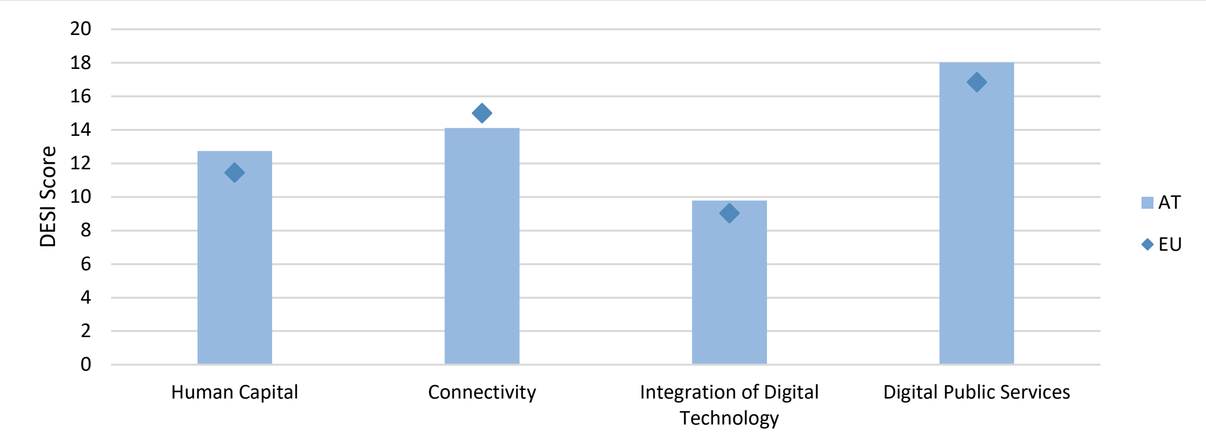
AT 3. Other dimensions relevant to the digital transformation

To harness the potential of the digital transformation, several key dimensions are of relevance. One of these dimensions is the digitalisation of businesses. **In Austrian firms, the level of digitalisation is higher than the EU average**. According to the DESI index (Figure 6), the level of integration of digital technologies is the 10th highest in the EU. Other factors also confirm this picture.

[555] European Commission (2023). Access to social protection. Available at: https://ec.europa.eu/social/main.jsp?catId=1312&langId=en=en
[556] European Commission (2023). Report from the Commission to the Council on the implementation of the Council Recommendation on access to social protection for workers and the self-employed. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023DC0043&qid=1676473347749
[557] European Commission (2022); Recovery and Resilience Scoreboard Thematic Analyses. Social protection. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_social_protection.pdf

Compared to the country average, robot density[558] in manufacturing and in the overall economy are relatively high in Austria, as is digital capital intensity[559] of firms. However, while digital capital intensity is growing at a higher rate than in European countries on average, this is not the case for robot density, where the average increase rate in the EU in the last 10 years is more than double than the one in Austria. in Austria's NRRP, expenditure on the digitalisation of firms is less of a priority since it constitutes only 6.4% of the overall planned expenditure on digital transformation This funding is intended to increase levels of digital investment in firms, with a particular focus on SMEs[560].

Figure 6 – DESI Index for AT and the EU (2022)



Source: European Commission (2022)

Next to digitalisation of businesses, other dimensions are of relevance. Concerning digital infrastructure, Austria lags slightly behind the EU as a whole. The DESI index (Figure 7) for connectivity puts the country 14th in the EU27, with connectivity levels somewhat lower than the EU average. Coverage and take-up rates of very high-capacity networks lag significantly behind the rest of the EU27[561]. In contrast, levels of digital public services are more advanced, with Austria ranking 12th in the EU27 according to the DESI Index for digital public services.

From a forward-looking perspective, substantial investment in connectivity is included within the Austrian NRRP, as 48.4% of planned digital expenditure is devoted to connectivity. Expenditure on digital public services is smaller (9.2%) in comparison. However, given the overall size of the digital pillar, this latter investment can still be considered substantial. The RRF expenditure on connectivity focuses in particular on the need to increase broadband coverage in

[558] As described in the Annex, based on data from the International Federation of Robotics (2010-2019). Data is not available for Cyprus, Greece, Luxembourg and Slovenia.
[559] As described in the Annex, based on data from EU-KLEMS (2008-2018). Data is not available for Cyprus, Croatia, Ireland and Romania.
[560] European Commission (2022): Recovery and Resilience Scoreboard Thematic Analysis. SME Support. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/3_SME.pdf
[561] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance

rural areas[562]. The Austrian Broadband Strategy 2030[563] equally defines several targets for increased broadband coverage in Austria, specifically in less densely populated areas. However, quick policy action in this area will be necessary for meaningful advancement[564]. Measures foreseen in the RRF for digital public services include, among others, a digitalisation fund for public administration[565], complementing measures set out in the Digital Austria Action Plan.

[562] European Commission (2023); Recovery and Resilience Scoreboard Thematic Analyses. Connectivity. https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_connectivity.pdf
[563] For more information, see https://info.bml.gv.at/en/topics/telecommunications-and-postal-services/broadband/broadband-strategy.html
[564] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[565] European Commission (2021); Recovery and Resilience Scoreboard Thematic Analyses. Digital public services. Available at :https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/2_Digital.pdf

21. POLAND: elements of a socially fair digital transformation

Key Points

Labour market: Currently, the Manufacturing sector has the largest share of employment in the economy and ranks fifth amongst the sectors in terms of the degree of digital transformation (based on the current percentage of enterprises that employ ICT specialists in a sector). The Manufacturing sector's employment share in the economy is not projected to grow further in the decade to come (slightly less than EU27 trends). ICT services, Professional services and Energy supply services are the three sectors with the highest degree of digital transformation currently, and their employment shares are projected to grow much more than the corresponding EU27 trends in the coming decade. Regarding the risk of automation of occupations, Trades workers are the most vulnerable.

Digital skills: Poland is lagging behind the rest of the EU when it comes to the overall level of digital skills. Digital skill divides between occupational groups are in line with the EU level, but those between educational groups are more pronounced.

Social protection: Poland has one of the lowest rates of the population at risk of poverty in the EU, but other indicators point to some shortcomings in the effectiveness of the social protection system. There has also been only limited discussion on regulating the employment status of platform workers.

PL 1. The labour market and the digital transformation

PL 1.1 Sectoral composition (current and forward-looking perspectives)

In Poland ("PL"), in 2022, the sectors with the largest employment shares in the economy were: Manufacturing (19.7% vs 16.0% at the EU27 level), Wholesale and retail trade (13.6%, same at the EU27 level), and Agriculture, forestry and fishing (8.2% vs 3.5% at the EU27 level). For the period 2022-2035, Cedefop data projects[566] the annual growth rate of the sectors' employment shares. Poland's Manufacturing sector has a projected annual growth rate of -0.3% (-0.2% for the EU27), while it is 0.1% for the Wholesale and retail trade sector (0.0% for the EU27), and -3.2% for the Agriculture, forestry and fishing sector (-3.1% for the EU27).

[566] Own elaboration on Cedefop 'Skill forecast 2023' data.

Table 1 presents, for each sector, the employment share in the economy in 2022, the projected annual growth rate (2022-2035) of its employment share, as well as its resulting employment share in the economy by 2035. Along with these elements relating to employment, Table 1 also presents the degree of "digital transformation" of each sector. Hence, Table 1 enables a comparison between a sector's degree of digital transformation, its employment share and its employment share prospects. The aforementioned degree of digital transformation is proxied in Table 1, for each sector, by the percentage of enterprises in the sector that employ ICT specialists. Table 1 presents the ranking of each sector according to this proxy (with rank n°1 corresponding to the most digitised sector). The three sectors with the highest degree of digital transformation in Poland, in order, are: ICT services (employment share: 3.0% in PL vs 3.7% in the EU27), Professional services (4.1% vs 5.7%) and Energy supply services (1.2% vs 0.7%). In Poland, these sectors' employment shares have a projected annual growth rate of 2.0% for ICT services (vs 0.8% for the EU27), 2.6% for Professional services (vs 0.6% for the EU27), and 0.8% for Energy supply services (vs 0.1% for the EU27) for 2022-2035.

As shown by Table 1, two of the top four sectors in terms of digital transformation – ICT services and professional services – are also among the top four sectors in terms of the annual growth rate of employment share in the decade to come in Poland. Furthermore, in terms of employment share (in 2022), the first and second sectors – Manufacturing and Wholesale and retail trade - rank fifth and seventh, according to the only proxy indicator of the degree of digital transformation available (% of enterprises that employ ICT specialists).

Table 1 – PL. Sector's share of employment, annual growth rate, and ranking of "digital transformation" (the sectors are ranked according to the ranking in the "proxy 1" column of the table).

Sectors	Sector's employment share in 2022 (%)		Projected annual growth rate of the sector's employment share (2022 - 2035, %)		Projected sector's employment share in 2035 (%)		Proxy 1 for digital transformation (ranking)	Proxy 2 for digital transformation (ranking)
	PL	**EU**	**PL**	**EU**	**PL**	**EU**	**% enterprises that employ ICT specialists**	**Digital capital intensity**
J - ICT services	3.0	3.7	2.0	0.8	3.9	4.2	1	n.a.
M - Professional services	4.1	5.7	2.6	0.6	5.9	6.3	2	n.a.
D - Energy supply services	1.2	0.7	0.8	0.1	1.3	0.8	3	n.a.
E- Water and waste treatment	1.1	0.8	-0.3	-0.1	1.1	0.8	4	n.a.
C - Manufacturing	19.7	16.0	-0.3	-0.2	19.0	15.6	5	n.a.
N - Administrative services	2.7	4.1	1.7	0.0	3.4	4.1	6	n.a.
G - Wholesale & retail trade	13.6	13.6	0.1	0.0	13.8	13.6	7	n.a.
H - Transport & storage	6.6	5.3	-0.2	-0.1	6.4	5.3	8	n.a.
I - Accommodation & food	2.4	4.5	2.5	0.6	3.4	4.9	9	n.a.
F - Construction	7.9	6.8	-1.4	-0.3	6.5	6.5	10	n.a.
A - Agriculture, forestry & fishing	8.2	3.5	-3.2	-3.1	5.2	2.3	n.a.	n.a.
B - Mining & quarrying	1.1	0.3	-1.9	-1.7	0.8	0.2	n.a.	n.a.
K - Finance & insurance	2.4	2.8	1.1	0.2	2.8	2.8	n.a.	n.a.

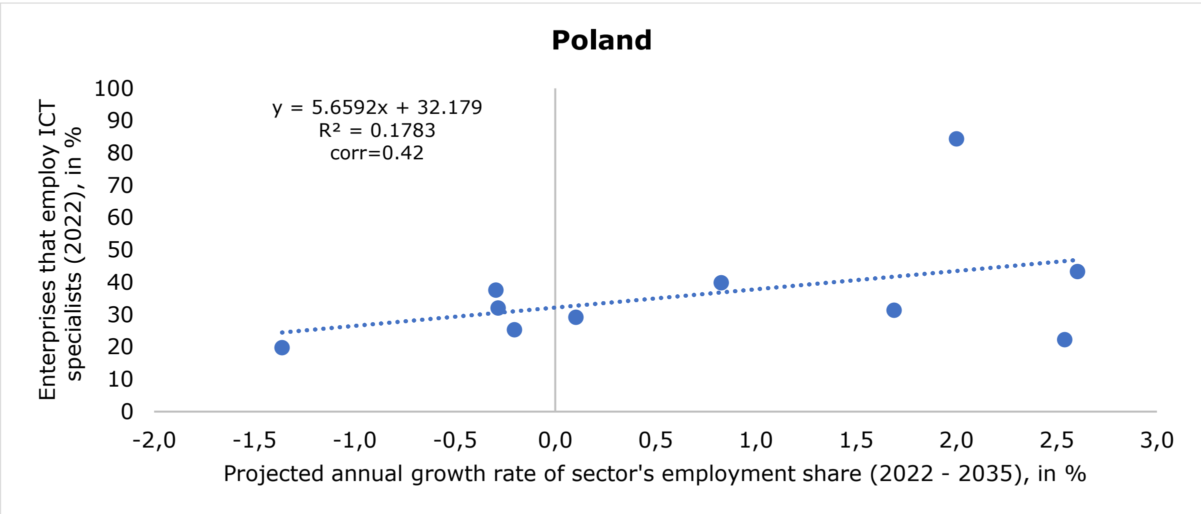
L - Real Estate	0.9	0.9	2.8	0.9	1.3	1.0	n.a.	n.a.
O - Public sector & defence	6.8	7.1	0.7	-0.1	7.5	7.0	n.a.	n.a.
P - Education	7.7	7.4	-0.3	0.3	7.3	7.7	n.a.	n.a.
Q - Health & social care	6.6	11.0	1.6	0.6	8.2	11.9	n.a.	n.a.
R - Arts & recreation and other services	1.3	1.7	2.0	0.3	1.7	1.7	n.a.	n.a.
S - Other service activities	1.8	2.6	-0.4	0.0	1.7	2.6	n.a.	n.a.
T - Activities of households as employers	0.4	0.9	1.9	-0.3	0.6	0.9	n.a.	n.a.
U - Activities of extraterritorial org.	n.a.	0.1	n.a.	n.a.	n.a.	0.1	n.a.	n.a.

Source: For the employment-related indicators own elaboration on Eurostat data (share of employment, 2022 calculated based on lfsa_egan) and on Cedefop 'Skill forecast data 2023' (annual growth rate of sector's employment share, 2022-2035), for the digital transformation-related indicators: own elaboration on Eurostat data (share of enterprises that employ ICT specialists, Eurostat code: lfsa_egais) and on EUKLEMS & INTANProd data (digital capital intensity).
Note: In the first column of the table, the letter preceding the sectors is the code of the NACE Rev.2 classification. In the last two columns of the table, the two proxy indicators used for the digital transformation are: i) the share of enterprises that employ ICT specialists (Eurostat code: lfsa_egais) and ii) the digital capital intensity (EUKLEMS & INTANProd data, average 2014-2017) with rank n°1 corresponding to the most digitally intense sector.

Figure 1 below complements Table 1 by examining the potential relationship between the sectors' degree of digital transformation and the projected annual growth rates of the sectors' employment shares in the economy.

In **Figure 1**, we present a scatterplot to shed light on the relationship between the proxy of digital transformation used (percentage of enterprises that employ ICT specialists) and the projected annual growth rate of a sector's employment share between 2022-2035. The correlation is positive (0.42), but not statistically significant (it is 0.62 and statistically significant for the EU27). **The lack of statistically significant correlation implies that in Poland, an association, at the sectoral level, between the percentage of enterprises that employ ICT specialists and the projected annual growth rate of a sector's employment share cannot be inferred.**

Figure 1 – PL. Relationship between the percentage of enterprises that employ ICT specialists (in 2022) and the projected annual growth rate of sector's employment share (2022-2035).

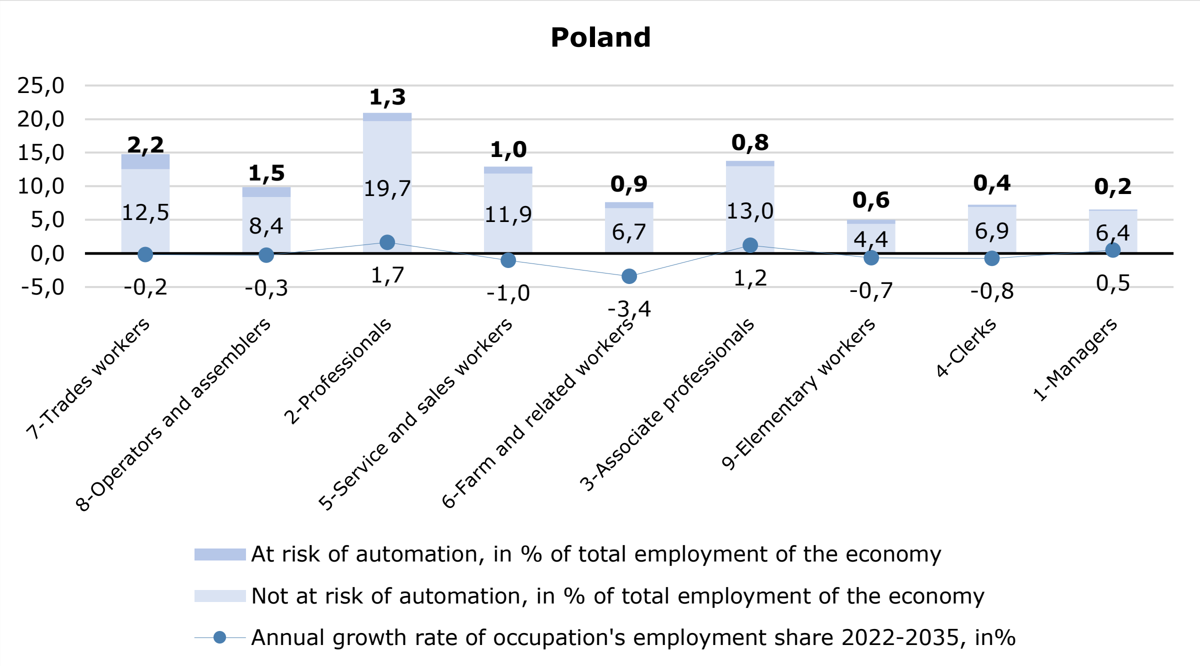


Source: Own elaboration on Eurostat and Cedefop 'Skill forecast 2023' data.

PL 1.2 Occupational composition at ISCO-08 1 digit and risk of automation (current and forward-looking perspectives)

Different occupations are subject to differing levels of automation risk. Cedefop developed[567] a "risk of automation" index by occupation at the EU27 level, most recently updated for 2022[568]. We apply this indicator at the Member State level, with the assumption that the risk of automation for a given occupation is constant across Member States[569]. As such, the variation, across Member States, in the overall susceptibility of a Member State's workforce to automation (overall risk across all occupations in that Member State) will be due to the employment composition effect, meaning that while the automation risk for a given occupation stays constant across Member States, the overall automation risk of a Member State will naturally be greater for those with more employment in occupations that have a higher automation risk.

Figure 2 – PL. Employment shares of occupations (at ISCO-08 1 digit level) - split into sub shares 'not at risk' and 'at risk' of automation (2022) - and projected annual growth rate



Source: Own elaboration on Cedefop data (risk of automation calculated by Cedefop at EU27 level by ISCO-08 1 digit level for 2022) applied to Eurostat data (share of employment by occupation, lfsa_egais, 2022).
Note: The numbers preceding the occupations are the ISCO-08 codes. Occupations are ranked from the highest to the lowest share of workers that present a risk of automation. The vertical sum of the two components (darker blue and lighter blue) gives back the total employment share by occupation (in % of total employment in the Member State). The ISCO nomenclature used in the text and the figure is the Cedefop one. For examples of specific occupations see: https://esco.ec.europa.eu/en/classification/occupation_main.

As can be seen in **Figure 2**, in Poland, the occupation with the largest employment sub-share (in % of total employment in the economy) 'at risk of automation' is Trades workers, with an employment sub-share of workers 'at risk of automation'

[567] Based on the methodology in Pouliakas, K. (2018) "The risk of automation in EU labour markets: a skill-requirements approach", in Economy, Employment and Skills: European and global perspectives in an age of uncertainty, Fondazione Giacomo Brodolini Quaderni Series, also IZA DP 11829.
[568] As retrieved at https://www.cedefop.europa.eu/en/tools/skills-intelligence/automation-risk-occupations#1
[569] While this assumption may be considered strong, Cedefop data are the only ones available that are at the same time, up to date and available for all the occupations at the ISCO-08 level.

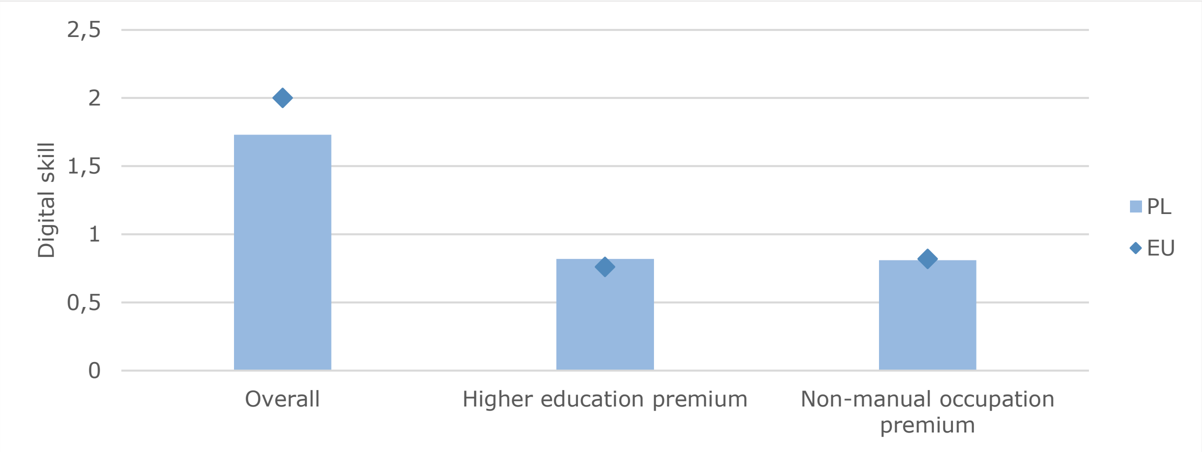
representing 2.2% of total employment in the country (vs 1.3% for the EU27). The occupation with the second-largest employment sub-share of workers 'at risk of automation' is Operators and assemblers, with an employment sub-share of workers 'at risk' of 1.5% of total employment in Poland (vs 1.1% for the EU27). Ranking third are Professionals, with a share of workers 'at risk' of 1.3% in total employment in Poland (vs 1.3% for the EU27). **Among these three occupations, only the first one is also the most affected across the EU27[570].**

For **ICT professionals (ISCO 25)**[571], the 2022 employment share is 2.0% in Poland (vs 2.3% in the EU27) and its composition (as regards the risk of automation) is as follows: an employment sub-share of 0.1% (vs 0.1% in the EU27) is 'at risk of automation', whereas the remaining employment sub-share of 1.9% (vs 2.2% at EU27 level) is 'not at risk of automation'. The projected annual growth rate (2022-2035) of the employment share of ICT professionals is 3.0% in Poland (vs 1.9% in EU27).

PL 2. Key policy dimensions for a socially fair digital transformation

PL 2.1 Digital skills

Figure 3 – Estimated Digital Skills in PL and the EU (2019)



Source: Authors' own estimation based on Eurostat ICT survey
Note: Higher education premium refers to the difference in digital skills between individuals with tertiary and lower than tertiary education. Non-manual occupation premium refers to the difference in digital skills between individuals in manual and non-manual occupations.

A high level of digital skills in the population is an important prerequisite for facilitating a successful and socially fair digital transformation. However, **in terms of digital skills, Poland is lagging behind the rest of the EU**. In the study's own estimated index of digital skills[572] (Figure 3, bar "Overall"), it ranks 22nd among the EU27, while in the DESI Index[573] for Human Capital (Figure 5, section "Other dimensions") it ranks 24th. Divides in digital skill between individuals in

570 The most affected in the EU27 are Trades workers, Professionals, and Service and sales workers.
571 Eurostat code: lfsa_egai2d.
572 The construction of the digital skill index is described in detail in the introductory section.
573 European Commission (2022). Digital Economy and Society Index. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi

non-manual and in manual occupations are in line with the EU rate ("Non-manual occupation premium" in Figure 3), while those between individuals with different levels of education is higher than the EU rate ("Higher education premium" in Figure 3). On both indicators Poland ranks 17th in the EU27. Overall, significant investment in digital skills, particularly for disadvantaged groups, is, therefore, an important policy priority in the context of the digital transformation.

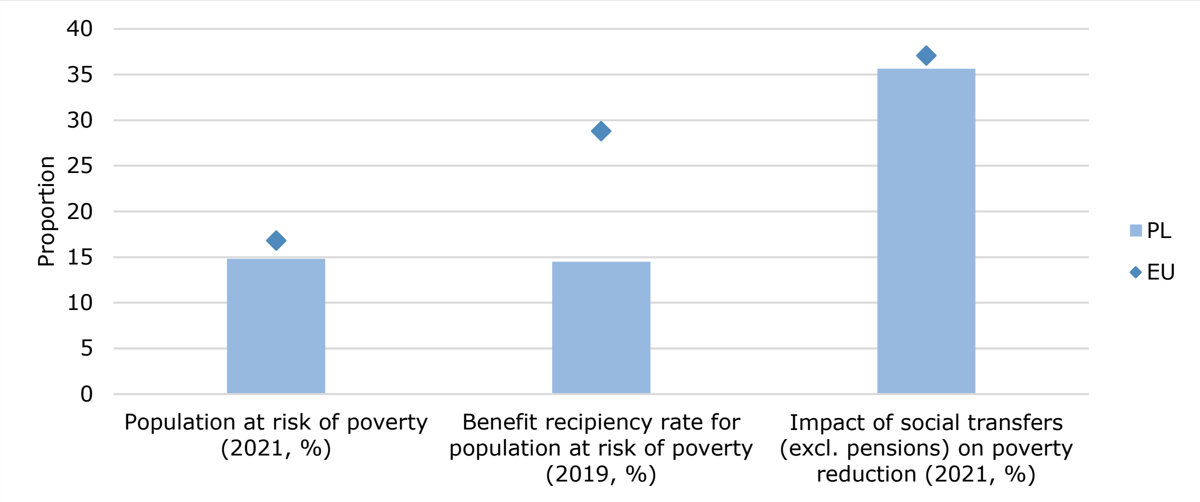
Poland has a dedicated strategy for the digital transformation[574], focusing on digitalization of public administration, development of e-services and increasing the level of digital skills. In addition, a Polish strategy for digital skills development has been launched under the Digital Competence Development Programme 2020-2030,which was adopted in February 2023.[575] Within the strategic pillar on digital skills for the labour force, Poland commits to fostering skills development across all sectors, particularly for SMEs. Digital skills investment is also foreseen through multiple initiatives as part of the Polish NRRP, where 22.8% of digital expenditure is allocated towards human capital. For instance, this includes an investment to train at least 323,000 people in basic digital skills, including citizens in need, public officials, people excluded or at risk of exclusion and educators and teachers[576].

PL 2.2 Social protection and social policy

Countries with more encompassing social protection systems may be better equipped to protect workers and citizens from the potential effects of the digital transformation on employment. **Key indicators on social protection (Figure 4) paint a mixed picture for Poland**. The rate of the population at risk of poverty after social transfers[577] (14.8%) is below the EU27 rate. Yet at the same time, other indicators point to a limited effectiveness of the social protection system in mitigating poverty. The impact of social transfers on poverty reduction[578] (35.7%) is below the EU rate and, significantly, the benefit recipiency rate for the population at risk of poverty before social transfers[579] is among the lowest in the EU (14.5%). On the specific issue of platform work, one of the forms of work significantly shaped by the digital transformation of the labour market, there has also been only limited discussion on the regulation of employment status, which has significant implications for access to social protection[580].

[574] The Integrated State Informatization Programme 2014-2022 (Program Zintegrowanej Informatyzacji Państwa), prolonged until 31 December 2024.
[575] For more information, see https://www.gov.pl/web/cyfryzacja/kompetencje-cyfrowe
[576] Council of the European Union (2022). Annex to the Proposal for a Council Implementing Decision on the approval of the recovery and resilience plan for Poland. Available at : https://data.consilium.europa.eu/doc/document/ST-9728-2022-ADD-1/en/pdf
[577] Eurostat (2023). TPS00184: At-risk-of-poverty rate after social transfers by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/tps00184/default/table?lang=en
[578] Eurostat (2023). TESPM050:Impact of social transfers (excluding pensions) on poverty reduction by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/TESPM050/bookmark/table?lang=en&bookmarkId=b001ae62-ce34-4b49-9741-28a3ef99477f
[579] Eurostat indicator as re-elaborated by JRC (2022) "Monitoring the effective coverage and adequacy of social protection in the EU".
[580] PPMI (2021). Study to support the impact assessment on improving working conditions in platform work. Available at: https://ec.europa.eu/social/main.jsp?catId=738&furtherPubs=yes&langId=en&pubId=8428

Figure 4 – Social Protection in PL and the EU



Source: Eurostat (2023) and JRC (2022)

The Polish national implementation plan for the Recommendation on access to social protection[581] mentions some planned measures to expand the formal coverage of social protection, but none to address effective coverage, adequacy or transparency, with gaps in access to social protection expected to remain after implementation of the measures[582]. Specific measures on platform work are not included. Within the Polish NRRP, a reform is included to increase social security of certain workers, making all civil law work contracts subject to social security contributions[583]. The broader social spending within the NRRP focuses mainly on health and long-term care (46.6% of social expenditure), as well as education and childcare (33.2% of social expenditure).

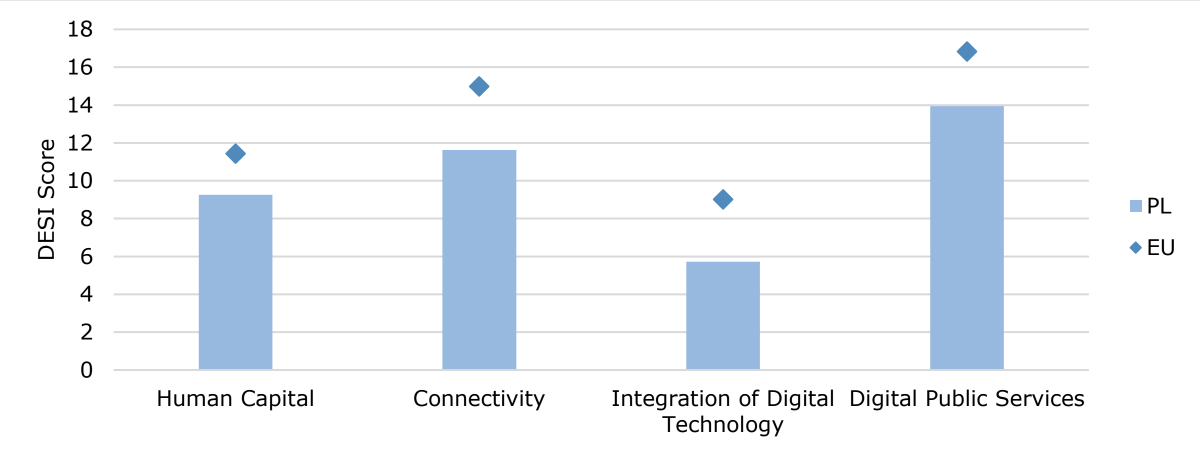
PL 3. Other dimensions relevant to the digital transformation

Beyond digital skills and social protection, other context factors can play a significant role in supporting the digital transformation. These support factors include (i) the level of digitalisation of businesses (ii) digitalisation of infrastructure and public services. **Poland is lagging behind the rest of the EU when it comes to digitalisation of businesses**. The DESI Index (Figure 5) for the level of integration of technologies in firms ranks Poland 24th in the EU27. Other data on the update of digital technologies by firms confirm this picture. Robot density[584] in both manufacturing and the total economy is significantly lower than the EU average[585], as are growth rates over the past decade. This is also the case for levels of and growth in digital capital intensity[586] in firms. Hence, investment in

[581] European Commission (2023). Access to social protection. Available at: https://ec.europa.eu/social/main.jsp?catId=1312&langId=en=en
[582] European Commission (2023). Report from the Commission to the Council on the implementation of the Council Recommendation on access to social protection for workers and the self-employed. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023DC0043&qid=16764733477492
[583] Council of the European Union (2022). Annex to the Proposal for a Council Implementing Decision on the approval of the recovery and resilience plan for Poland. Available at : https://data.consilium.europa.eu/doc/document/ST-9728-2022-ADD-1/en/pdf
[584] As described in the Annex, based on data from the International Federation of Robotics (2010-2019). Data is not available for Cyprus, Greece, Luxembourg and Slovenia.
[585] For Member States with available data
[586] As described in the Annex, based on data from EU-KLEMS (2008-2018). Data is not available for Cyprus, Croatia, Ireland and Romania.

the digitalisation of businesses is a significant policy concern for Poland. The digital transformation of businesses should be stepped up through incentives to invest, dedicated support and encouragement, the promotion of female digital entrepreneurship and encouraging capacity building among Polish enterprises[587]. Within the Polish NRRP, only a marginal share of digital expenditure is allocated to digitalisation of businesses (6.1%).

Figure 5 – DESI Index for PL and the EU (2022)



Source: European Commission (2022)

On the digitalisation of infrastructure and of public services, Poland is equally behind the rest of the EU. Within the DESI Index for connectivity and digital public services, the country respectively ranks 25th and 22nd in the EU27. Substantial shares of digital expenditure within the Polish NRRP are allocated to connectivity (32%) and digital public services (32.8%). Investments in connectivity are primarily targeted at the development of very high-capacity networks, including fibre and 5G[588], while digital public service measures include a number of actions for the digitalisation of public administration[589].

[587] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance

[588] European Commission (2023); Recovery and Resilience Scoreboard Thematic Analyses. Connectivity. https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_connectivity.pdf

[589] https://commission.europa.eu/business-economy-euro/economic-recovery/recovery-and-resilience-facility/recovery-and-resilience-plan-poland_en#:~:text=The%20plan%20will%20foster%20economic,to%20105%2C000%20citizens%20into%20jobs.

22. PORTUGAL: elements of a socially fair digital transformation

Key Points

Labour market: Currently, the sector with the largest employment share in the economy – the Manufacturing sector - ranks sixth amongst the sectors in terms of the sectors' degree of digital transformation (based on the current percentage of enterprises that employ ICT specialists in a sector). The Manufacturing sector's employment share in the economy is projected to grow further in the decade to come (slightly more than EU27 trends). ICT services, Energy supply services and Professional services are the three sectors with the highest current degree of digital transformation, and their employment shares are projected to grow more than EU27 trends in the coming decade. Regarding the risk of automation of occupations, the type of occupation that is most vulnerable is Trades workers.

Digital skills: Levels of digital skills in Portugal align with the EU level, but digital divides between socio-economic groups are very pronounced.

Social protection: The Portuguese social protection system demonstrates several shortcomings, with a high rate of the population at risk of poverty. Regulatory action on platform work is planned as part of the Portuguese NRRP.

PT 1. The labour market and the digital transformation

PT 1.1 Sectoral composition (current and forward-looking perspectives)

In Portugal ("PT"), in 2022, the sectors with the largest employment shares in the economy were: Manufacturing (17.0% vs 16.0% at the EU27 level), Wholesale and retail trade (14.5% vs 13.6% at the EU27 level), and Health and social care (10.4% vs 11.0% at the EU27 level). For the period 2022-2035, Cedefop data projects[590] the annual growth rate of a sector's employment share. For Portugal's Manufacturing sector, the annual growth rate is 0.2% (-0.2% for the EU27). For the Wholesale and retail trade sector, projected annual growth is 0.3% (0.0% for the EU27), while it is 0.1% for the Health and Social care sector (0.6% for the EU27).

[590] Own elaboration on Cedefop 'Skill forecast 2023' data.

Table 1 shows each sector's employment share in the economy in 2022, the projected annual growth rate (2022-2035) of its employment share, as well as its resulting employment share in the economy by 2035. Along with these elements relating to employment, Table 1 also presents the degree of "digital transformation" of each sector. Hence, Table 1 enables a comparison between a sector's degree of digital transformation, its employment share and its employment share's prospects. The aforementioned degree of digital transformation is proxied in Table 1, for each sector, by the percentage of enterprises in the sector that employ ICT specialists. of the considered sector. Table 1 presents the ranking of each sector according to this proxy (with rank n°1 corresponding to the most digitised sector). The three sectors with the highest degree of digital transformation in Portugal, in order, are: ICT services (employment share: 4.0% in PT vs 3.7% in the EU27), Energy supply services (0.4% vs 0.7%) and Professional services (5.2% vs 5.7%). These sectors' employment shares have a projected annual growth rate (2022-2035) of 1.9% for ICT services (vs 0.8% for the EU27), 1.2% for Energy supply services (vs 0.1% for the EU27), and 1.2% for Professional services (vs -0.6% for the EU27) in Portugal.

As can be seen from Table 1, it is worth noting that two of the top three sectors in terms of degree of digital transformation – ICT services and Professional services – are also among the top three sectors in terms of the annual growth rate of employment share in the coming decade in Portugal. Furthermore, in terms of employment share (in 2022), the top two sectors – Manufacturing and Wholesale and retail trade - rank sixth and seventh, on the only proxy indicator of the digital transformation available (% of enterprises that employ ICT specialists).

Table 1 – PT. Sector's share of employment, annual growth rate, and ranking of "digital transformation" (the sectors are ranked according to the ranking in the "proxy 1" column of the table).

Sectors	Sector's employment share in 2022 (%)		Projected annual growth rate of the sector's employment share (2022 - 2035, %)		Projected sector's employment share in 2035 (%)		Proxy 1 for digital transformation (ranking)	Proxy 2 for digital transformation (ranking)
	PT	**EU**	**PT**	**EU**	**PT**	**EU**	**% enterprises that employ ICT specialists**	**Digital capital intensity**
J - ICT services	4.0	3.7	1.9	0.8	5.2	4.2	1	n.a.
D - Energy supply services	0.4	0.7	1.2	0.1	0.5	0.8	2	n.a.
M - Professional services	5.2	5.7	1.2	0.6	6.1	6.3	3	n.a.
N - Administrative services	3.4	4.1	0.6	0.0	3.7	4.1	4	n.a.
E- Water and waste treatment	0.8	0.8	1.2	-0.1	0.9	0.8	5	n.a.
C - Manufacturing	17.0	16.0	0.2	-0.2	17.4	15.6	6	n.a.
G - Wholesale & retail trade	14.5	13.6	0.3	0.0	15.1	13.6	7	n.a.
H - Transport & storage	4.6	5.3	-0.1	-0.1	4.6	5.3	8	n.a.
I - Accommodation & food	5.8	4.5	0.2	0.6	5.9	4.9	9	n.a.
F - Construction	6.4	6.8	-1.8	-0.3	5.0	6.5	10	n.a.
A - Agriculture, forestry & fishing	2.4	3.5	-1.9	-3.1	1.9	2.3	n.a.	n.a.
B - Mining & quarrying	0.2	0.3	0.8	-1.7	0.2	0.2	n.a.	n.a.

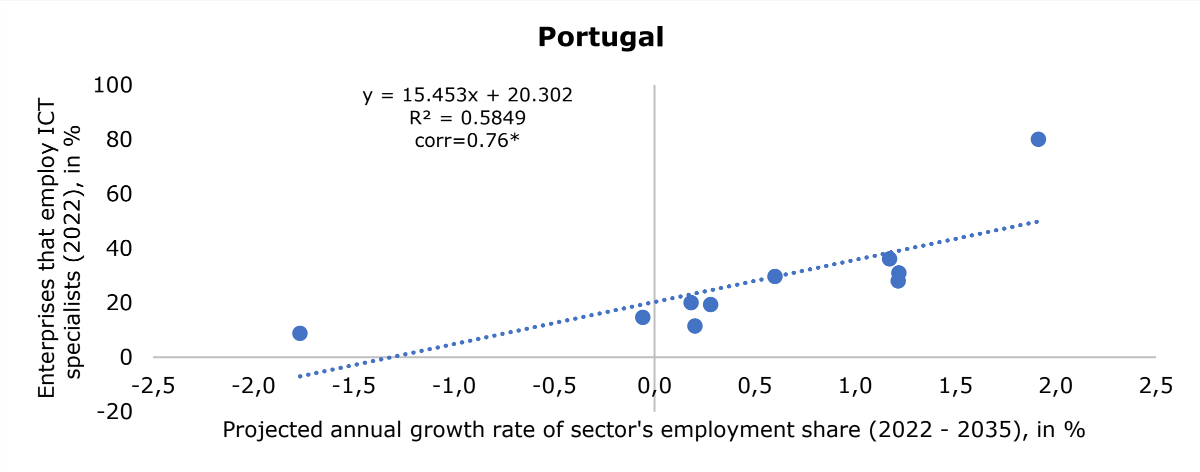
K - Finance & insurance	2.1	2.8	0.2	0.2	2.2	2.8	n.a.	n.a.
L - Real Estate	1.0	0.9	1.2	0.9	1.2	1.0	n.a.	n.a.
O - Public sector & defence	7.0	7.1	-0.3	-0.1	6.7	7.0	n.a.	n.a.
P - Education	9.1	7.4	-0.3	0.3	8.7	7.7	n.a.	n.a.
Q - Health & social care	10.4	11.0	0.1	0.6	10.5	11.9	n.a.	n.a.
R - Arts & recreation and other services	1.6	1.7	1.4	0.3	1.9	1.7	n.a.	n.a.
S - Other service activities	2.3	2.6	0.5	0.0	2.4	2.6	n.a.	n.a.
T - Activities of households as employers	1.7	0.9	0.7	-0.3	1.9	0.9	n.a.	n.a.
U - Activities of extraterritorial org.	n.a.	0.1	n.a.	n.a.	n.a.	0.1	n.a.	n.a.

Source: For the employment-related indicators own elaboration on Eurostat data (share of employment, 2022 calculated based on lfsa_egan) and on Cedefop 'Skill forecast data 2023' (annual growth rate of sector's employment share, 2022-2035), for the digital transformation-related indicators: own elaboration on Eurostat data (share of enterprises that employ ICT specialists, Eurostat code: lfsa_egais) and on EUKLEMS & INTANProd data (digital capital intensity).
Note: In the first column of the table, the letter preceding the sectors is the code of the NACE Rev.2 classification. In the last two columns of the table, the two proxy indicators used for the digital transformation are: i) the share of enterprises that employ ICT specialists (Eurostat code: lfsa_egais) and ii) the digital capital intensity (EUKLEMS & INTANProd data, average 2014-2017) with rank n°1 corresponding to the most digitally intense sector.

To complement Table 1, Figure 1 below examines whether there may be a relationship between the sectors' degree of digital transformation and their projected annual growth rates.

In **Figure 1**, we present a scatterplot to shed light on the relationship between the proxy of the digital transformation used (percentage of enterprises that employ ICT specialists) and the projected annual growth rate of a sector's employment share between 2022-2035. The correlation is positive, and statistically significant in Portugal, with a value of 0.76 (it is 0.62 and statistically significant for the EU27). Among the ten Member States with a significant correlation, Portugal ranks 3rd in terms of highest correlation. The statistically significant and positive correlation could suggest that **the employment shares of those sectors with a higher 'percentage of enterprises that employ ICT specialists' are more likely to grow (over 2022-2035) than other sectors. The relationship is very high and higher than the one at the EU27 level.** Nevertheless, this correlation does not imply causal links.

Figure 1 – PT. Relationship between the percentage of enterprises that employ ICT specialists (in 2022) and the projected annual growth rate of sector's employment share (2022-2035).



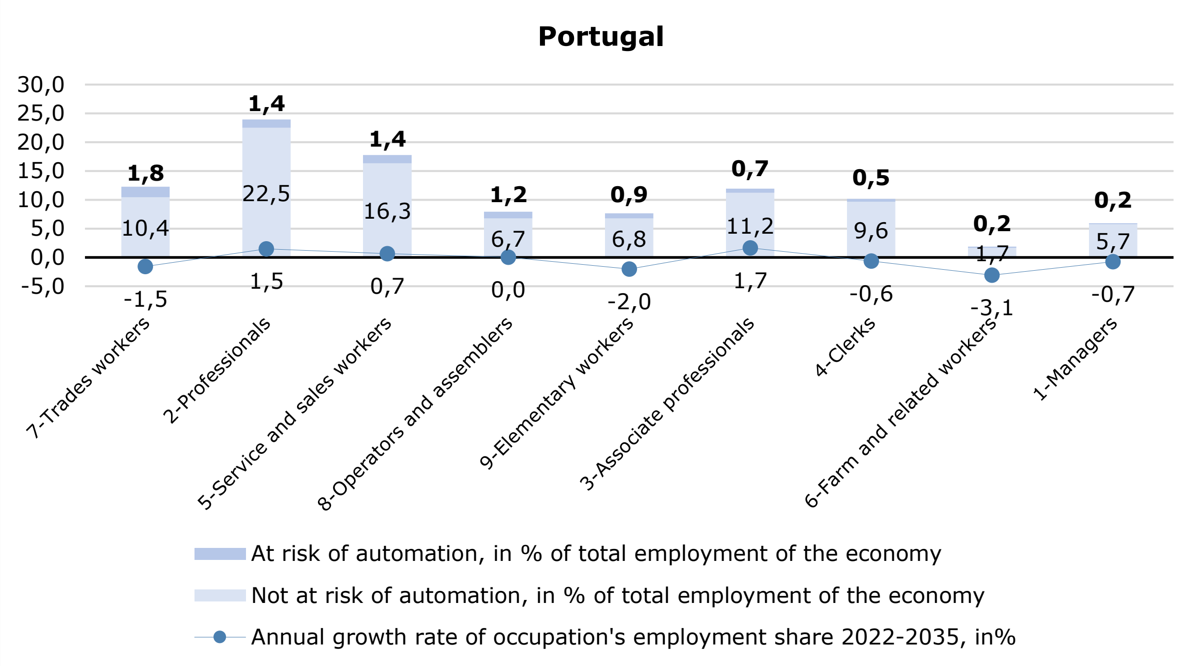
Source: Own elaboration on Eurostat and Cedefop 'Skill forecast 2023' data.

PT 1.2 Occupational composition at ISCO-08 1 digit and risk of automation (current and forward-looking perspectives)

Different occupations are subject to differing levels of automation risk. Cedefop developed[591] a "risk of automation" index by occupation at the EU27 level, with the most recent data available for 2022[592]. We apply this indicator at the Member State level, with the assumption that the risk of automation for a given occupation is constant across Member States[593]. As such, the variation across Member States in the overall susceptibility of a Member State's workforce (overall risk across all occupations in that Member State) will be due to the employment composition effect. That is, while the automation risk for a given occupation stays constant across Member States, the overall automation risk of a Member State will naturally be greater for those Member States having more employment in occupations with a higher automation risk.

[591] Based on the methodology in Pouliakas, K. (2018) "The risk of automation in EU labour markets: a skill-requirements approach", in Economy, Employment and Skills: European and global perspectives in an age of uncertainty, Fondazione Giacomo Brodolini Quaderni Series, also IZA DP 11829.
[592] As retrieved at https://www.cedefop.europa.eu/en/tools/skills-intelligence/automation-risk-occupations#1
[593] While this assumption may be considered strong, Cedefop data are the only ones available that are at the same time, up to date and available for all the occupations at the ISCO-08 level.

Figure 2 – PT. Employment shares of occupations (at ISCO-08 1 digit level) - split into sub shares 'not at risk' and 'at risk' of automation (2022) - and projected annual growth rate



Source: Own elaboration on Cedefop data (risk of automation calculated by Cedefop at EU27 level by ISCO-08 1 digit level for 2022) applied to Eurostat data (share of employment by occupation, lfsa_egais, 2022).
Note: The numbers preceding the occupations are the ISCO-08 codes. Occupations are ranked from the highest to the lowest share of workers that present a risk of automation. The vertical sum of the two components (darker blue and lighter blue) gives back the total employment share by occupation (in % of total employment in the Member State). The ISCO nomenclature used in the text and the figure is the Cedefop one. For examples of specific occupations see: https://esco.ec.europa.eu/en/classification/occupation_main.

As can be seen in **Figure 2**, in Portugal, the occupation with the largest employment sub-share (in % of total employment in the economy) 'at risk of automation' is Trades workers, with an employment sub-share of workers 'at risk of automation' representing 1.8% of total employment in the country (vs 1.3% for the EU27). The second-ranked occupation regarding the employment sub-share of workers 'at risk of automation' is Professionals, with an employment sub-share of workers 'at risk' of 1.4% of total employment in Portugal (vs 1.3% for the EU27). Ranking third are Service and sales workers, with a share of workers 'at risk' of 1.4% in total employment in Portugal (vs 1.3% for the EU27). **These three occupations are also the most affected across the EU27.**

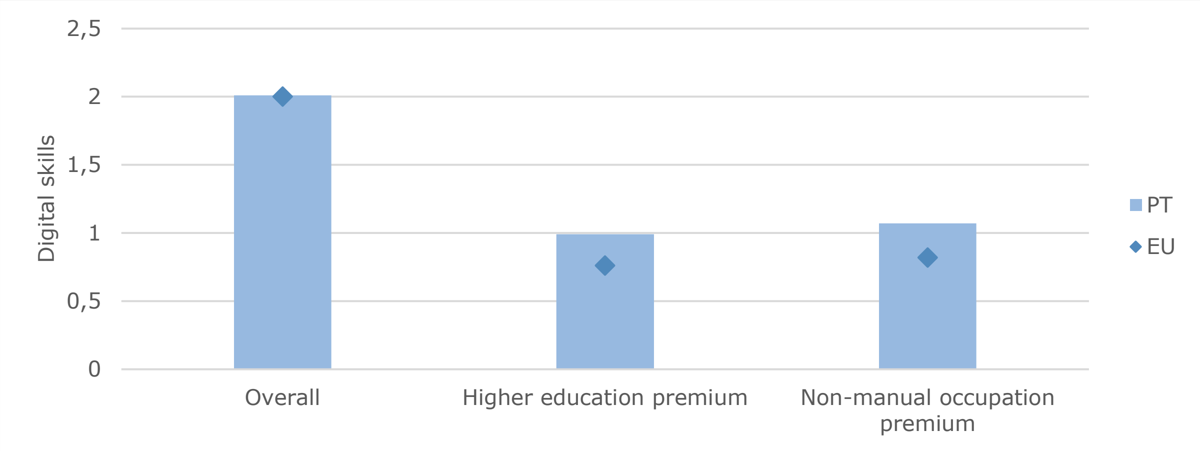
For **ICT professionals (ISCO 25)**[594], the 2022 employment share is 2.5% in Portugal (vs 2.3% in the EU27) and its composition (as regards the risk of automation) is as follows: an employment sub-share of 0.1% (vs 0.1% in the EU27) is 'at risk of automation', whereas the remaining employment sub-share of 2.3% (vs 2.2% at EU27 level) is 'not at risk of automation'. The projected annual growth rate 2022-2035 of the employment share of ICT professionals is 4.0% in Portugal (vs 1.9% in EU27).

[594] Eurostat code: lfsa_egai2d.

PT 2. Key policy dimensions for a socially fair digital transformation

PT 2.1 Digital skills

Figure 3 – Estimated Digital Skills in PT and the EU (2019)



Source: Authors' own estimation based on Eurostat ICT survey
Note: Higher education premium refers to the difference in digital skills between individuals with tertiary and lower than tertiary education. Non-manual occupation premium refers to the difference in digital skills between individuals in manual and non-manual occupations.

One of the important preconditions for facilitating a successful and socially fair digital transformation is a high level of digital skills within the population. The level of digital skills of the population in Portugal is in line with the EU level. In the study's own estimated index of digital skills[595] (Figure 3, bar "Overall"), the country ranks 10th in the EU27, with a level of digital skills just above the EU27 level. According to the DESI Index[596] (Figure 5, section "Other dimensions") for Human Capital, Portugal is ranked 14th among EU member states. It should be noted, however, that **digital divides between socio-economic groups are very pronounced**. Both the differences in digital skills between individuals with tertiary and lower education ("Higher education premium" in Figure 3), and between individuals in manual and non-manual occupations ("Non-manual occupation premium" in Figure 3), rank as the third-largest in Europe. These pronounced inequalities in digital skills are a salient concern when it comes to managing the digital transformation in a socially fair way.

The Portuguese strategy regarding the digital transformation is presented in the Portuguese Action Plan for the Digital Transition[597]. The first main pillar of the plan, capacity building and digital inclusion, focuses on digital skills, with policy initiatives on digital education, professional training and reskilling, and digital inclusion and literacy[598]. Skills development is facilitated through the skills

[595] The construction of the digital skill index is described in detail in the introductory section.
[596] European Commission (2022). Digital Economy and Society Index. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi
[597] For more information, see https://portugaldigital.gov.pt/wp-content/uploads/2022/01/Portugal_Action_Plan_for_Digital_Transition.pdf
[598] For more information, see https://digital-skills-jobs.europa.eu/en/actions/national-initiatives/national-strategies/portugal-action-plan-digital-transition

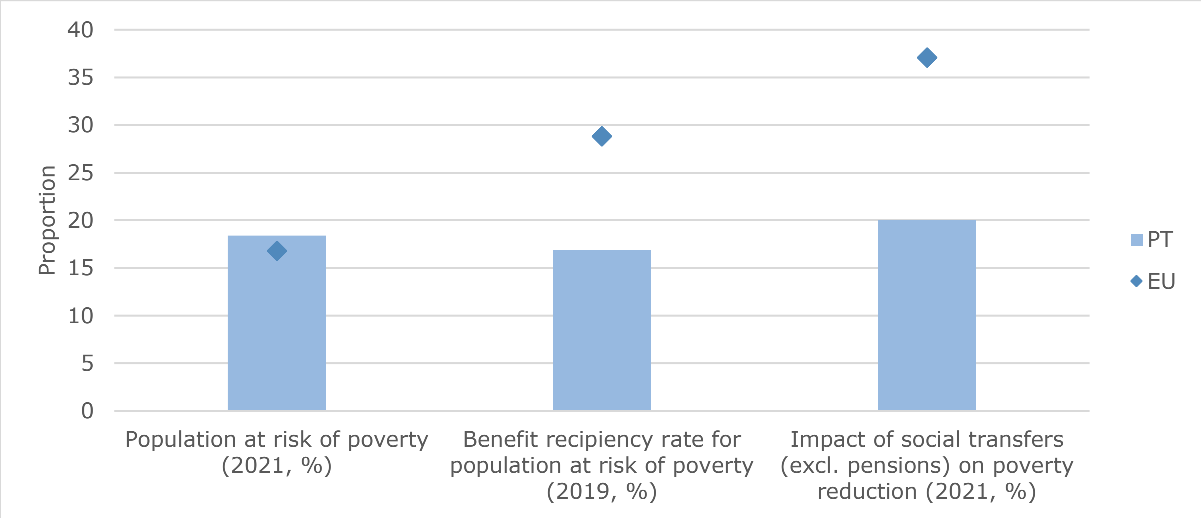
strategy INCoDe.2030, which identifies measures and targets to be reached in 2025 and 2030[599]. Further investment in digital skills is foreseen as part of the Portuguese NRRP, where 37.1% of the planned digital expenditure is aimed at enhancing human capital. The NRRP focuses on a systemic approach to increase digital skills by targeting different segments of the population, with a variety of training initiatives for civil servants, students, teachers and the workforce[600]. For instance, the Portuguese Digital Academy aims to train 800,000 employees using personalised training that matches employees' digital skill level.

PT 2.2 Social protection and social policy

While digital skills are one key element for ensuring a socially fair digital transformation, comprehensive social protection systems are also needed to protect workers and citizens against potential adverse impacts of digitalisation on employment. In this regard, however, **Portugal presents significant shortcomings** (Figure 4). The rate of the population at risk of poverty after social transfers[601] (18.4%) is significantly higher than the EU27 rate, ranking as the 10th-highest in the EU. Conversely, both the benefit recipiency rate for the population at risk of poverty before social transfers[602] (16.9%) and the effect of social transfers on poverty reduction rate[603] (20.0%) rank among the lowest in Europe. Overall, therefore, the Portuguese social protection demonstrates limited effectiveness in mitigating against poverty.

[599] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[600] European Commission (2022); Recovery and Resilience Scoreboard Thematic Analyses. Digital Skills. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_digital_skills.pdf
[601] Eurostat (2023). TPS00184: At-risk-of-poverty rate after social transfers by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/tps00184/default/table?lang=en
[602] Eurostat indicator as re-elaborated by JRC (2022) "Monitoring the effective coverage and adequacy of social protection in the EU".
[603] Eurostat (2023). TESPM050:Impact of social transfers (excluding pensions) on poverty reduction by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/TESPM050/bookmark/table?lang=en&bookmarkId=b001ae62-ce34-4b49-9741-28a3ef99477f

Figure 4 – Social Protection in PT and the EU



Source: Eurostat (2023) and JRC (2022)

In its national implementation plan for the Recommendation on access to social protection[604], the Portuguese governments sets out a range of measures that have been implemented to increase the formal and effective coverage as well as adequacy and transparency of social protection, though not all gaps in access to social protection are mentioned[605]. The NRRP for Portugal also includes measures relevant to social protection, such as the publication of a Green Book on the future of work and a planned legislative act to regulate platform work[606]. A large share of social expenditure within the Portuguese NRRP is in fact allocated to social policies (48.2%), with the rest split between employment and skills, education and childcare and health and long-term care.

PT 3. Other dimensions relevant to the digital transformation

A socially fair digital transformation also relies on a number of broader contextual support factors. One of these is the level of **digitalisation of businesses**. According to the DESI Index, Portugal ranks in the mid-field of Member States in this regard (12th in the EU27). Focusing on specific categories of technologies, some shortcomings can be identified. Levels of and growth in both robot density[607] and digital capital intensity[608] are substantially lower than the EU average[609]. Hence, **digitalisation of businesses should be further improved in Portugal** . The digitalisation of businesses is a central focus of the Portuguese Action Plan

[604] European Commission (2023). Access to social protection. Available at: https://ec.europa.eu/social/main.jsp?catId=1312&langId=en=en

[605] European Commission (2023). Report from the Commission to the Council on the implementation of the Council Recommendation on access to social protection for workers and the self-employed. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023DC0043&qid=16764733477492

[606] Council of the European Union (2021). Revised Annex to the Council Implementing Decision on the approval of the recovery and resilience plan for Portugal. Available at/ https://data.consilium.europa.eu/doc/document/ST-10149-2021-ADD-1-REV-1/en/pdf

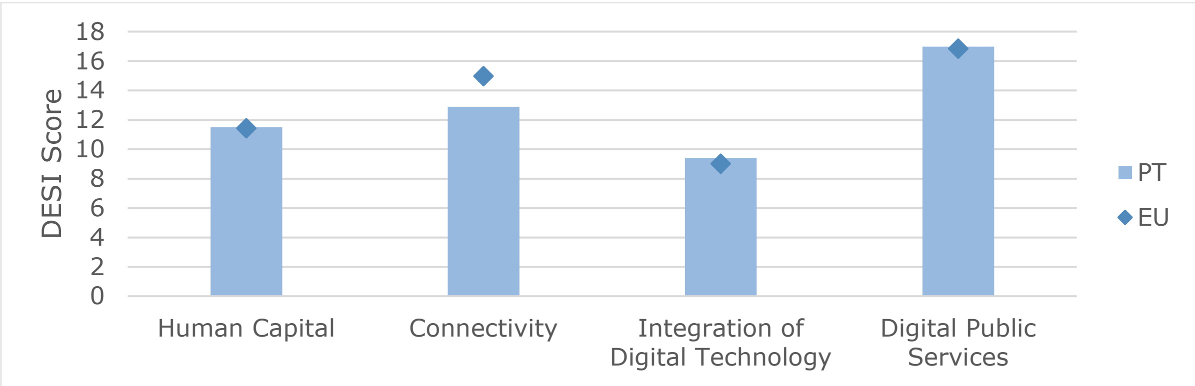
[607] As described in the Annex, based on data from the International Federation of Robotics (2010-2019). Data is not available for Cyprus, Greece, Luxembourg and Slovenia.

[608] As described in the Annex, based on data from EU-KLEMS (2008-2018). Data is not available for Cyprus, Croatia, Ireland and Romania.

[609] For Member States with available data

for the Digital Transformation and numerous policy measures to encourage technology adoption have been advanced in recent years, but significant gaps in ICT adoption remain, particularly among SMEs, where further awareness-raising and communication efforts may be helpful[610]. Within the Portuguese NRRP, 17.2% of the planned digital expenditure is allocated to digitalisation of businesses. This includes an investment of over EUR650 million to support the digitalisation of enterprises through actions on skills, entrepreneurship, internationalisation, support in adopting digital technologies and support for start-ups[611].

Figure 5 – DESI Index for PT and the EU (2022)



Source: European Commission (2022)

As regards digital infrastructure and digital public services, results are mixed. On digital public services, Portugal performs in line with the EU average, ranking 14th in the EU27. Connectivity levels are less advanced, with Portugal ranking (18th). However, on several dimensions, including roll-out of fixed VHCNs and take up of ultra high-speed connections, Portugal is a top performer[612]. Only a very marginal part of the planned digital expenditure within the Portuguese NRRP is dedicated to connectivity (0.27%), while a substantial amount of is allocated to digital public services (43.9%). A variety of measures focus on the digitalisation of public administration, including the use of novel technologies such as cloud[613]. However, investment in digital skills is crucial to ensure that citizens can actually make use of digitized public services[614].

[610] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[611] European Commission (2022): Recovery and Resilience Scoreboard Thematic Analysis. SME Support. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/3_SME.pdf
[612] European Commission (2023). Countries' performance in digitisation. Available at: European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[613] European Commission (2021); Recovery and Resilience Scoreboard Thematic Analyses. Digital public services. Available at :https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/2_Digital.pdf
[614] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance

23. ROMANIA: elements of a socially fair digital transformation

Key Points

Labour market: Currently, the Manufacturing sector has the largest employment share in the economy and ranks sixth amongst the sectors in terms of the sectors' degree of digital transformation (based on the current percentage of enterprises that employ ICT specialists in a sector). The Manufacturing sector's employment share in the economy is projected to grow further in the decade to come (slightly more than EU27 trends). ICT services, Energy supply services and Professional services are currently the three sectors with the highest degree of digital transformation currently, and their employment shares are projected to grow more than the corresponding EU27 trends in the coming decade. Regarding the risk of automation of occupations, the most vulnerable occupation is Trades workers.

Digital skills: Romania has one of the lowest levels of digital skills in the EU. Though gaps in digital skill levels between socio-economic groups are small, this should be seen within the context of the overall very low level of digital skills.

Social protection: The Romanian social protection system exhibits shortcomings, and Romania has one of the highest rates of the population at risk of poverty in the EU. Policy measures to improve the access of platform workers to social security are planned.

RO 1. The labour market and the digital transformation

RO 1.1 Sectoral composition (current and forward-looking perspectives)

In Romania ("RO"), in 2022, the sectors with the largest employment shares in the economy were: Manufacturing (19.9% vs 16.0% at the EU27 level), Wholesale and retail trade (17.8% vs 13.6% at the EU27 level), and Agriculture, forestry and fishing (10.8% vs 3.5% at the EU27 level). Cedefop data projects[615] the annual growth rate of a sector's employment share for the period 2022-2035. For Romania's Manufacturing sector, the annual growth rate is 1.2% (-0.2% for the EU27), for the Wholesale and retail trade sector it is 1.3% (0.0% for the EU27), and for the Agriculture, forestry and fishing sector, the annual growth rate is -4.4% (-3.1% for the EU27).

[615] Own elaboration on Cedefop 'Skill forecast 2023' data.

Table 1 shows, for each sector, the employment share in the economy in 2022, the projected annual growth rate (2022-2035) of its employment share, as well as its resulting employment share in the economy by 2035. Along with these elements relating to employment, Table 1 also presents the degree of "digital transformation" of each sector. The goal of Table 1 is thus to enable seeing how the sectors' degree of digital transformation compares to their employment share and their employment shares' prospects. The aforementioned degree of digital transformation is proxied in Table 1, for each sector, by the percentage of enterprises that employ ICT specialists. Table 1 presents the ranking of each sector according to this proxy (with rank n°1 corresponding to the most digitised sector). The three sectors with the highest degree of digital transformation in Romania, in order, are: ICT services (employment share: 2.6% in RO vs 3.7% in the EU27), Professional services (2.8% vs 5.7%) and Energy supply services (1.1% vs 0.7%). In Romania, these sectors' employment shares have a projected annual growth rate (2022-2035) of 2.8% for ICT services (vs 0.8% for the EU27), 5.0% for Professional services (vs 0.6% for the EU27), and -0.5% for Energy supply services (vs 0.1% for the EU27).

As can be seen from Table 1, notably, two of the top three sectors in terms of digital transformation – ICT services and Professional services – are also among the top three sectors in terms of the annual growth rate of employment share in the decade to come in Romania. As can be seen from Table 1, notably, two of the top three sectors in terms of the degree of digital transformation – ICT services and Professional services – are also among the top three sectors in terms of the annual growth rate of employment share in the decade to come in Romania. Furthermore, in terms of employment share (in 2022), the first and the second sectors – Manufacturing and Wholesale and retail trade - rank sixth and ninth, on the only proxy indicator of digital transformation available (% of enterprises that employ ICT specialists).Furthermore, the first and second sectors in terms of employment share – Manufacturing and Wholesale and retail trade - rank sixth and ninth, on the only proxy indicator of the digital transformation available (% of enterprises that employ ICT specialists).

Table 1 – RO. Sector's share of employment, annual growth rate, and ranking of "digital transformation" (the sectors are ranked according to the ranking in the last column of the table).

Sectors	Sector's employment share in 2022 (%)		Projected annual growth rate of the sector's employment share (2022 - 2035, %)		Projected sector's employment share in 2035 (%)		Proxy 1 for digital transformation (ranking)	Proxy 2 for digital transformation (ranking)
	RO	**EU**	**RO**	**EU**	**RO**	**EU**	**% enterprises that employ ICT specialists**	**Digital capital intensity**
J - ICT services	2.6	3.7	2.8	0.8	3.8	4.2	1	n.a.
M - Professional services	2.8	5.7	5.0	0.6	5.6	6.3	2	n.a.
D - Energy supply services	1.1	0.7	-0.5	0.1	1.0	0.8	3	n.a.
E- Water and waste treatment	1.5	0.8	0.8	-0.1	1.7	0.8	4	n.a.
N - Administrative services	2.7	4.1	-0.3	0.0	2.7	4.1	5	n.a.
C - Manufacturing	19.9	16.0	1.2	-0.2	23.6	15.6	6	n.a.
I - Accommodation & food	2.5	4.5	2.2	0.6	3.3	4.9	7	n.a.
H - Transport & storage	7.2	5.3	0.9	-0.1	8.1	5.3	8	n.a.

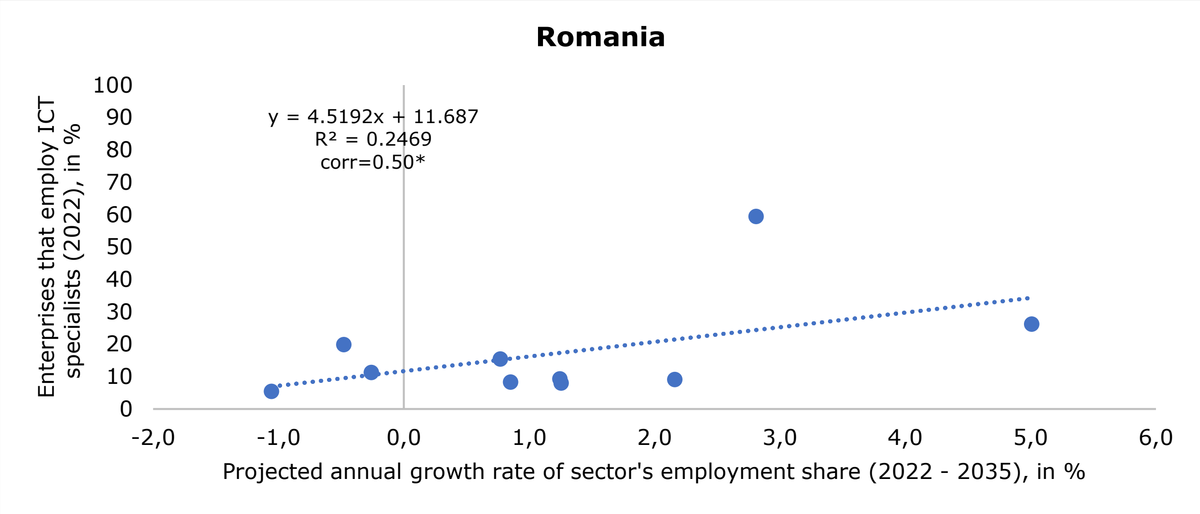
G - Wholesale & retail trade	17.8	13.6	1.3	0.0	21.2	13.6	9	n.a.
F - Construction	9.9	6.8	-1.1	-0.3	8.5	6.5	10	n.a.
A - Agriculture, forestry & fishing	10.8	3.5	-4.4	-3.1	5.7	2.3	n.a.	n.a.
B - Mining & quarrying	0.7	0.3	-2.4	-1.7	0.5	0.2	n.a.	n.a.
K - Finance & insurance	1.5	2.8	2.9	0.2	2.2	2.8	n.a.	n.a.
L - Real Estate	0.3	0.9	3.5	0.9	0.5	1.0	n.a.	n.a.
O - Public sector & defence	5.4	7.1	1.3	-0.1	6.5	7.0	n.a.	n.a.
P - Education	4.8	7.4	0.9	0.3	5.4	7.7	n.a.	n.a.
Q - Health & social care	5.8	11.0	1.3	0.6	6.9	11.9	n.a.	n.a.
R - Arts & recreation and other services	0.9	1.7	0.1	0.3	0.9	1.7	n.a.	n.a.
S - Other service activities	1.6	2.6	0.9	0.0	1.9	2.6	n.a.	n.a.
T - Activities of households as employers	0.3	0.9	n.a.	-0.3	n.a.	0.9	n.a.	n.a.
U - Activities of extraterritorial org.	n.a.	0.1	n.a.	n.a.	n.a.	0.1	n.a.	n.a.

Source: For the employment-related indicators own elaboration on Eurostat data (share of employment, 2022 calculated based on lfsa_egan) and on Cedefop 'Skill forecast data 2023' (annual growth rate of sector's employment share, 2022-2035), for the digital transformation-related indicators: own elaboration on Eurostat data (share of enterprises that employ ICT specialists, Eurostat code: lfsa_egais) and on EUKLEMS & INTANProd data (digital capital intensity).
Note: In the first column of the table, the letter preceding the sectors is the code of the NACE Rev.2 classification. In the last two columns of the table, the two proxy indicators used for the digital transformation are: i) the share of enterprises that employ ICT specialists (Eurostat code: lfsa_egais) and ii) the digital capital intensity (EUKLEMS & INTANProd data, average 2014-2017) with rank n°1 corresponding to the most digitally intense sector.

In complement to Table 1, Figure 1 below shows to what extent there may be a relationship between the ranking of the sectors in terms of digital transformation and the projected annual growth rates of the sectors' employment shares in the economy.

In **Figure 1**, we present a scatterplot to shed light on the relationship between the only proxy of digital transformation used (percentage of enterprises that employ ICT specialists) and the projected annual growth rate of a sector's employment share between 2022-2035. The correlation is positive and statistically significant in Romania, with a value of 0.50 (it is 0.62 and statistically significant for the EU27). Among the ten Member States with a significant correlation, Romania ranks 8th in terms of the highest correlation. The positive correlation could suggest that **the employment shares of those sectors with a higher 'percentage of enterprises that employ ICT specialists' are more likely to grow (over 2022-2035) than those of other sectors. The relationship is strong, but weaker than the one at the EU27 level. Nevertheless, this correlation does not imply causal links.**

Figure 1 – RO. Relationship between the percentage of enterprises that employ ICT specialists (in 2022) and the projected annual growth rate of sector's employment share (2022-2035).



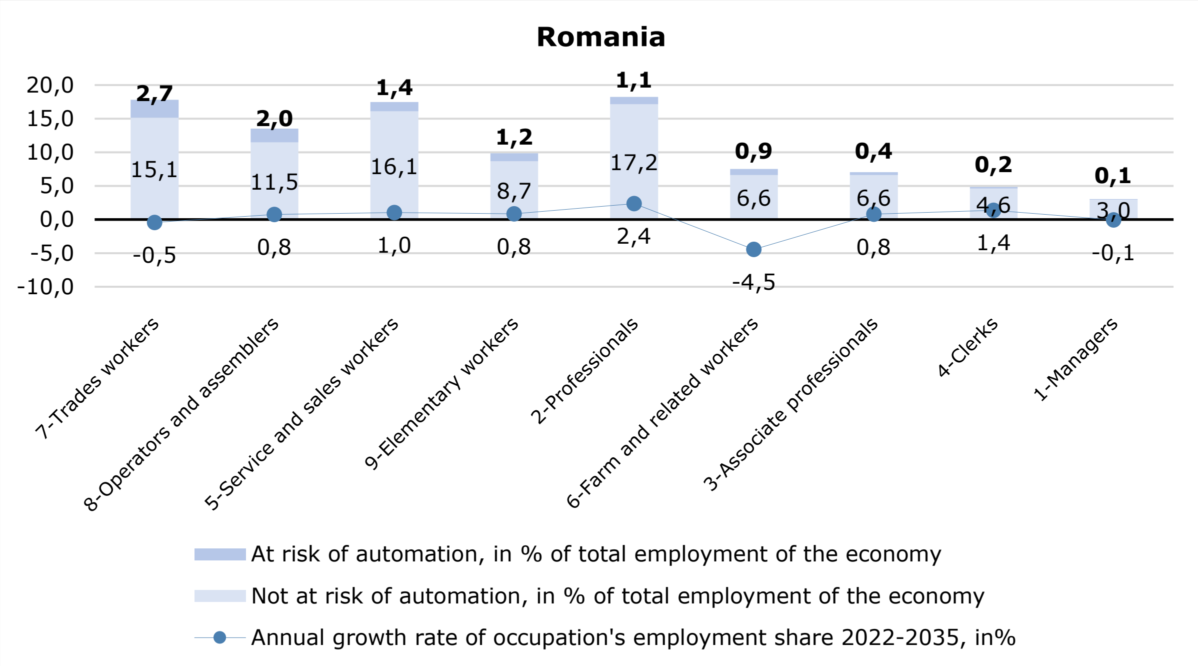
Source: Own elaboration on Eurostat and Cedefop 'Skill forecast 2023' data.

RO 1.2 Occupational composition at ISCO-08 1 digit and risk of automation (current and forward-looking perspectives)

Different occupations are subject to differing levels of automation risk. Cedefop developed[616] a 'risk of automation' index by occupation at the EU27 level, most recently updated for 2022[617]. We apply this indicator at the Member State level, with the assumption that the risk of automation for a given occupation is constant across Member States[618]. As such, the variation observed across Member States in the overall susceptibility of the Member State's workforce to automation (overall risk across all occupations in that Member State) will be due to the employment composition effect. This means that while the automation risk for a given occupation stays constant across Member States, the overall automation risk of a Member State will naturally be greater for those Member States having more employment in occupations that have a higher automation risk.

[616] Based on the methodology in Pouliakas, K. (2018) "The risk of automation in EU labour markets: a skill-requirements approach", in Economy, Employment and Skills: European and global perspectives in an age of uncertainty, Fondazione Giacomo Brodolini Quaderni Series, also IZA DP 11829.
[617] As retrieved at https://www.cedefop.europa.eu/en/tools/skills-intelligence/automation-risk-occupations#1
[618] While this assumption may be considered strong, Cedefop data are the only ones available that are at the same time, up to date and available for all the occupations at the ISCO-08 level.

Figure 2 – RO. Employment shares of occupations (at ISCO-08 1 digit level) - split into sub shares 'not at risk' and 'at risk' of automation (2022) - and projected annual growth rate



Source: Own elaboration on Cedefop data (risk of automation calculated by Cedefop at EU27 level by ISCO-08 1 digit level for 2022) applied to Eurostat data (share of employment by occupation, lfsa_egais, 2022).
Note: The numbers preceding the occupations are the ISCO-08 codes. Occupations are ranked from the highest to the lowest share of workers that present a risk of automation. The vertical sum of the two components (darker blue and lighter blue) gives back the total employment share by occupation (in % of total employment in the Member State). The ISCO nomenclature used in the text and the figure is the Cedefop one. For examples of specific occupations see: https://esco.ec.europa.eu/en/classification/occupation_main.

As can be seen in **Figure 2**, in Romania, the occupation with the largest employment sub-share (in % of total employment in the economy) 'at risk of automation' is Trades workers, with an employment sub-share of workers 'at risk of automation' representing 2.7% of total employment in the country (vs 1.3% for the EU27). The second-ranked occupation regarding the employment sub-share of workers 'at risk of automation' are Operators and assemblers, where the employment sub-share of workers 'at risk' represents 2.0% of total employment in Romania (vs 1.1% for the EU27). The third-ranked occupation is Service and sales workers, with a share of workers 'at risk' of 1.4% in total employment in Romania (vs 1.3% for the EU27). **Among these three occupations, the first and the third ones are also the most affected across the EU27[619].**

For ICT **professionals (ISCO 25)**[620], the 2022 employment share is 1.4% in Romania (vs 2.3% in the EU27) and its composition (as regards the risk of automation) is as follows: an employment sub-share of 0.1% (vs 0.1% in the EU27) is 'at risk of automation', whereas the remaining employment sub-share of 1.3% (vs 2.2% at EU27 level) is 'not at risk of automation'. The projected annual growth rate 2022-2035 of the employment share of ICT professionals is 3.2% in Romania (vs 1.9% in EU27).

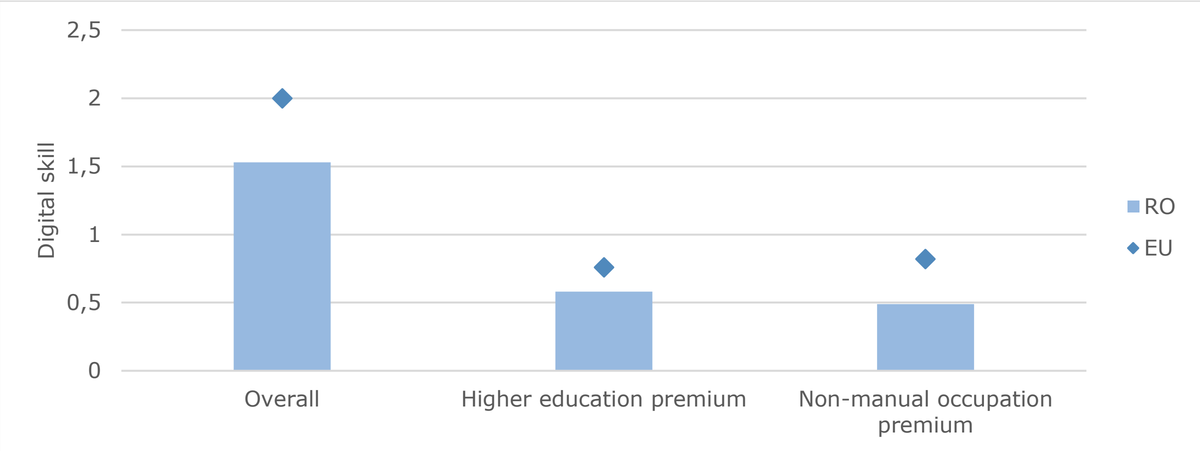
[619] The most affected in the EU27 are Trades workers, Professionals, and Service and sales workers.
[620] Eurostat code: lfsa_egai2d.

RO 2. Key policy dimensions for a socially fair digital transformation

RO 2.1 Digital skills

Digital skills are a key prerequisite to a successful and socially fair digital transformation. **Yet with regard to the level of digital skills in the population, Romania is lagging significantly behind the rest of the EU**. According to the study's own estimated index of digital skills (Figure 3, bar "Overall"), the average level of digital skills in Romania is the second lowest in Europe. In the DESI Index (Figure 5, section "Other dimensions") for Human Capital, Romania ranks last among EU Member States. Digital divides between different socio-economic groups in Romania are in fact not very pronounced, ranking among the lowest in the EU (fourth in the EU27 with regard to the higher education premium and second with regard to the non-manual occupation premium; see Figure 3). However, this is not very meaningful given the overall very low level of digital skills in Romania. Investment in improving the digital skills of the Romanian population is therefore of key importance in the context of the digital transformation. However, Romania does not yet have a national digital skills strategy[621].

Figure 3 – Estimated Digital Skills in RO and the EU (2019)



Source: Authors' own estimation based on Eurostat ICT survey
Note: Higher education premium refers to the difference in digital skills between individuals with tertiary and lower than tertiary education. Non-manual occupation premium refers to the difference in digital skills between individuals in manual and non-manual occupations.

The Romanian NRRP contains significant measures on digital skills development, with 21% of the planned digital expenditure allocated towards human capital. This includes a range of digital skill development measures targeted at different population groups, including, among others, training for civil servants, measures to develop cybersecurity skills and measures to digitise education systems[622]. The

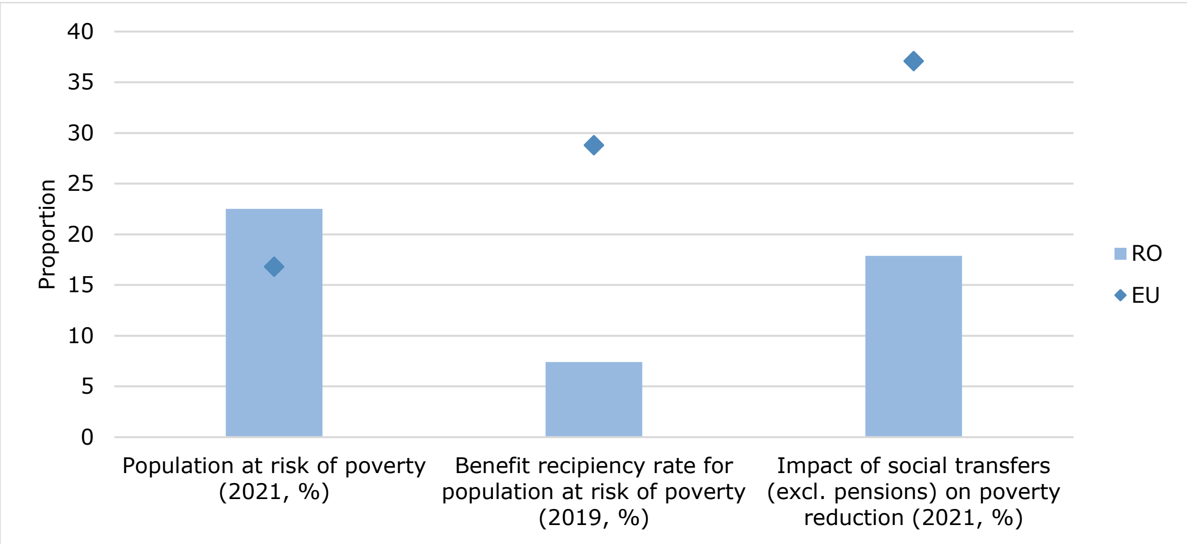
[621] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[622] European Commission (2022); Recovery and Resilience Scoreboard Thematic Analyses. Digital Skills. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_digital_skills.pdf

NRRP also includes some cross-cutting measures, such as a framework for the digitalisation of education[623].

RO 2.2 Social protection and social policy

Alongside digital skill development, countries with more encompassing social protection systems may be better positioned to cushion a possible negative labour market impact of the digital transformation on people. As shown by key indicators summarized in Figure 4, **the Romanian social protection system suffers from significant shortcomings in this regard**. The rate of the population at risk of poverty after social transfers[624] (22.5%) is the second highest in the EU27. The benefit recipiency rate for the population at risk of poverty before social transfers[625] (7.4%) is the lowest in the EU, while the impact of social transfers on poverty reduction[626] (17.9%) is the second lowest. Finally, the employment status of platform workers, with associated social protection implications, has only been discussed to a limited extent so far[627].

Figure 4 – Social Protection in RO and the EU



Source: Eurostat (2023) and JRC (2022)

The Romanian national implementation plan[628] for the Recommendation on access to social protection sets out some planned measures to improve formal coverage of social protection, but none that would affect effective coverage, adequacy or

[623] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[624] Eurostat (2023). TPS00184: At-risk-of-poverty rate after social transfers by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/tps00184/default/table?lang=en
[625] Eurostat indicator as re-elaborated by JRC (2022) "Monitoring the effective coverage and adequacy of social protection in the EU".
[626] Eurostat (2023). TESPM050:Impact of social transfers (excluding pensions) on poverty reduction by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/TESPM050/bookmark/table?lang=en&bookmarkId=b001ae62-ce34-4b49-9741-28a3ef99477f
[627] PPMI (2021). Study to support the impact assessment on improving working conditions in platform work. Available at: https://ec.europa.eu/social/main.jsp?catId=738&furtherPubs=yes&langId=en&pubId=8428
[628] European Commission (2023). Access to social protection. Available at: https://ec.europa.eu/social/main.jsp?catId=1312&langId=en=en

transparency[629]. A measure to improve the access to social protection of platform workers is also included. The Romanian NRRP contains several reforms of the social protection system, including a reform on the implementation of the minimum income scheme and of the public pension system[630]. Social spending within the NRRP is largely focused on education and childcare (48.8%) as well as health and long term care (39.8%).

RO 3. Other dimensions relevant to the digital transformation

Further contextual factors play an important role in the digital transformation, such as (i) the digitalisation of businesses and (ii) digital infrastructure and digital public services.

The level of digitalisation of businesses in Romania is low. The DESI Index (Figure 5) indicates that **in terms of integration of digital technologies in companies, Romania ranks last among EU Member States**. Data on robot density[631] in firms also shows that Romania is lagging behind other EU countries with regard to the level of robot density in both manufacturing and the overall economy. However, more encouragingly, growth in robot density between 2010 and 2019 has been above the EU average[632]. Overall, structural issues related to the level of digital education, managers' understanding of digital tools in business and the level of digital public services (see below) impede the digitalisation of businesses in Romania[633]. The Romanian government sets out measures for the digitalisation of businesses in the 2021-2027 government strategy to develop the SME sector, which includes, for instance, the development of a Digital Innovation Hub network[634]. Within the Romanian NRRP, 6.3% of the planned digital expenditure is dedicated to digitalisation of businesses. The plan also includes a set of measures to advance the green and digital transition of SMEs, including state aid schemes and other financial instruments[635].

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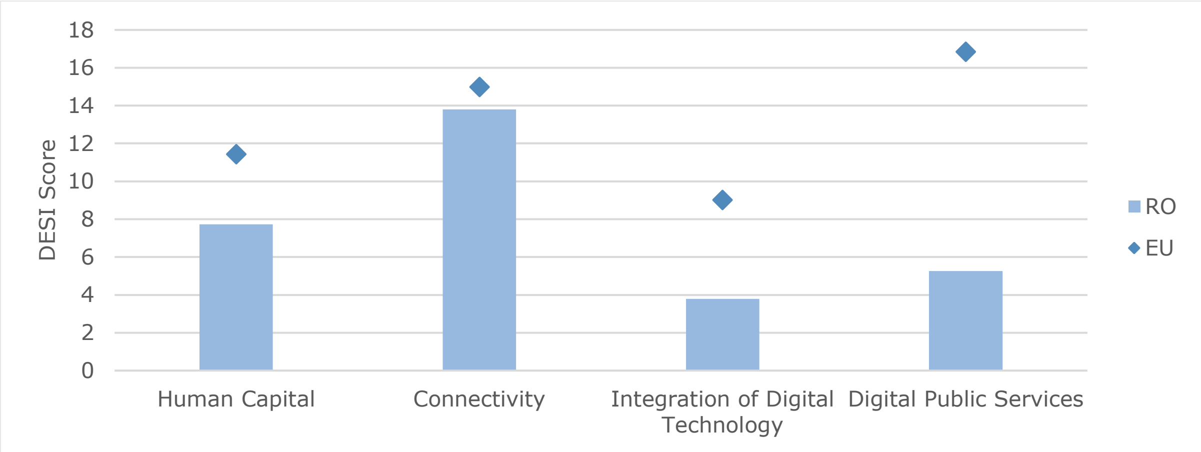
[629] European Commission (2023). Report from the Commission to the Council on the implementation of the Council Recommendation on access to social protection for workers and the self-employed. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023DC0043&qid=16764733477492
[630] European Commission (2022). Recovery and Resilience Scoreboard Thematic Analyses. Social protection. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_social_protection.pdf
[631] As described in the Annex, based on data from the International Federation of Robotics (2010-2019). Data is not available for Cyprus, Greece, Luxembourg and Slovenia.
[632] For Member States with available data
[633] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[634] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[635] European Commission (2022): Recovery and Resilience Scoreboard Thematic Analysis. SME Support. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/3_SME.pdf

Figure 5 – DESI Index for RO and the EU (2022)



Source: European Commission (2022)

In addition to the digitalisation of businesses, digital infrastructure and digital public services are important structural factors supporting the digital transformation. With regard to connectivity, the DESI Index shows that Romania performs better than in other areas of digitalisation, though the country still ranks below the EU average (15th in the EU27). While there has been substantial progress in recent years, challenges can be identified with regard to take-up of fixed broadband, which can be related to demographic factors, but also the low level of digital skills in the population[636]. On digital public services, significant shortcomings can be identified, with Romania ranking last among EU Member States. In 2021, the Romanian government adopted the e-government public policy for 2021-2030, which is meant to establish a framework for e-government and tools[637]. Substantial investment in digital public services is also foreseen as part of the Romanian NRRP, where 50.7% of planned digital expenditure is allocated to this area (planned spending on connectivity amounts to only 1.6%). The plan includes a number of measures, such as a key reform on the development of the government cloud and various other reforms linked to the digitalisation of public administration and services[638].

[636] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[637] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[638] European Commission (2021); Recovery and Resilience Scoreboard Thematic Analyses. Digital public services. Available at :https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/2_Digital.pdf

24. SLOVENIA: elements of a socially fair digital transformation

Key Points

Labour market: The Manufacturing sector currently has the largest employment share in the economy and ranks fifth amongst the sectors in terms of the degree of digital transformation (based on the current percentage of enterprises that employ ICT specialists in a sector). The sector's employment share in the economy is projected to grow further in the decade to come (more than EU27 trends). ICT services, Energy supply services and Professional services are the three sectors with the highest degree of digital transformation currently, and their employment shares are projected to grow, in the decade to come, much more than in the EU27. Regarding the risk of automation of occupations, Trades workers are most vulnerable.

Digital skills: Digital skill levels in Slovenia are slightly below the EU level: With regard to divides in digital skill levels within the population, Slovenia also performs in the lower mid-range of EU countries.

Social protection: Slovenia has a well-developed social protection system and one of the lowest rates of the population at risk of poverty in the EU. However, policy action on the regulation of platform work has been limited so far.

SI 1. The labour market and the digital transformation

SI 1.1 Sectoral composition (current and forward-looking perspectives)

In Slovenia ("SI"), in 2022, the sectors with the largest employment shares in the economy were: Manufacturing (22.2% vs 16.0% at the EU27 level), Wholesale and retail trade (11.6% vs 13.6% at the EU27 level), and Education (9.9% vs 7.4% at the EU27 level). Cedefop data projects the annual growth rate of a sector's employment share for the period 2022-2035. For Slovenia's Manufacturing sector, the annual growth rate is 0.7% (-0.2% for the EU27), while it is 0.3% for the Wholesale and retail trade sector (0.0% for the EU27), and -3.4% for the Education sector (0.3% for the EU27).

Table 1 presents, for each sector, the employment share in the economy in 2022, the projected annual growth rate (2022-2035) of its employment share, as well as its resulting employment share in the economy by 2035. Along with these elements relating to employment, Table 1 also presents the degree of "digital transformation" of each sector. The goal of Table 1 is thus to compare the sectors' degree of digital transformation with their current employment shares or with their employment shares' prospects. The aforementioned degree of digital transformation is proxied in Table 1, for each sector, by two indicators: i) the percentage of enterprises that employ ICT specialists in the sector and ii) the sector's level of digital capital intensity[639]. Table 1 presents the ranking of each sector according to these two proxy indicators (with rank n°1 corresponding to the most digitised sector). According to the first indicator, the three sectors with the highest degree of digital transformation in Slovenia are: ICT services (employment share: 3.7% in SI vs 3.7% in the EU27), Energy supply services (0.9% vs 0.7%) and Professional services (6.9% vs 5.7%). According to the second indicator (digital capital intensity), the three sectors with the highest degree of digital transformation are: ICT services (employment share: 3.7% in SI vs 3.7% in the EU27), Professional services (6.9% vs 5.7%) and Arts and recreation and other services (2.2% vs 1.7%). For 2022-2035, these sectors' employment shares have a projected annual growth rate of 3.6% for ICT services (vs 0.8% for the EU27), 2.5% for Energy supply services (vs 0.1% for the EU27), 1.5% for Professional services (vs 0.6% for the EU27), and -0.4% for Arts and recreation services (0.3% for the EU27) in Slovenia.

As can be seen from Table 1, in Slovenia, three of the top four sectors in terms of the degree of digital transformation – ICT services, Energy supply and Professional services – are also among the top four sectors in terms of the annual growth rate of employment share in the coming decade. Furthermore, in terms of employment share (in 2022), the first and second sectors – Manufacturing and Wholesale and retail trade - rank fifth and sixth, according to one of the two proxy indicators of the digital transformation (% of enterprises that employ ICT specialists).

Table 1 – SI. Sector's share of employment, annual growth rate, and ranking of "digital transformation" (the sectors are ranked according to the ranking in the last column of the table).

Sectors	Sector's employment share in 2022 (%)		Projected annual growth rate of the sector's employment share (2022 - 2035, %)		Projected sector's employment share in 2035 (%)		Proxy 1 for digital transformation (ranking)	Proxy 2 for digital transformation (ranking)
	SI	**EU**	**SI**	**EU**	**SI**	**EU**	**% enterprises that employ ICT specialists**	**Digital capital intensity**
J - ICT services	3.7	3.7	3.6	0.8	6.1	4.2	1	1
M - Professional services	6.9	5.7	1.5	0.6	8.5	6.3	3	2
R - Arts & recreation and other services	2.2	1.7	-0.4	0.3	2.1	1.7	n.a.	3
F - Construction	5.7	6.8	-1.9	-0.3	4.4	6.5	10	4
B - Mining & quarrying	0.2	0.3	1.5	-1.7	0.3	0.2	n.a.	5
N - Administrative services	3.3	4.1	0.1	0.0	3.3	4.1	7	6
Q - Health & social care	8.2	11.0	1.0	0.6	9.4	11.9	n.a.	7
C - Manufacturing	22.2	16.0	0.7	-0.2	24.3	15.6	5	8

[639] 'Digital capital intensity' is an index – built in the context of this study – that looks at the ratio between the stock of capital the firms have in software and databases and the overall stock of capital excluding non-residential buildings. Its construction is based on the integrated EUKLEMS & INTANProd database, run by the Luiss Lab of European Economics at Luiss University in Rome, Italy. For more in-depth information on the source, and the availability of the indicator for Member States/sectors, please refer to the Annex.

O - Public sector & defence	6.2	7.1	-1.0	-0.1	5.4	7.0	n.a.	9
A - Agriculture, forestry & fishing	3.6	3.5	-2.6	-3.1	2.5	2.3	n.a.	10
K - Finance & insurance	2.3	2.8	2.0	0.2	3.1	2.8	n.a.	11
G - Wholesale & retail trade	11.6	13.6	0.3	0.0	12.2	13.6	6	12
D - Energy supply services	0.9	0.7	2.5	0.1	1.2	0.8	2	13
H - Transport & storage	4.7	5.3	0.9	-0.1	5.4	5.3	8	14
E- Water and waste treatment	1.4	0.8	1.1	-0.1	1.6	0.8	4	15
I - Accommodation & food	4.0	4.5	0.5	0.6	4.3	4.9	9	n.a.
L - Real Estate	0.5	0.9	0.2	0.9	0.5	1.0	n.a.	n.a.
P - Education	9.9	7.4	-3.4	0.3	6.1	7.7	n.a.	n.a.
S - Other service activities	2.0	2.6	-0.6	0.0	1.9	2.6	n.a.	n.a.
T - Activities of households as employers	n.a.	0.9	1.2	-0.3	n.a.	0.9	n.a.	n.a.
U - Activities of extraterritorial org.	n.a.	0.1	n.a.	n.a.	n.a.	0.1	n.a.	n.a.

Source: For the employment-related indicators own elaboration on Eurostat data (share of employment, 2022 calculated based on lfsa_egan) and on Cedefop 'Skill forecast data 2023' (annual growth rate of sector's employment share, 2022-2035), for the digital transformation-related indicators: own elaboration on Eurostat data (share of enterprises that employ ICT specialists, Eurostat code: lfsa_egais) and on EUKLEMS & INTANProd data (digital capital intensity).

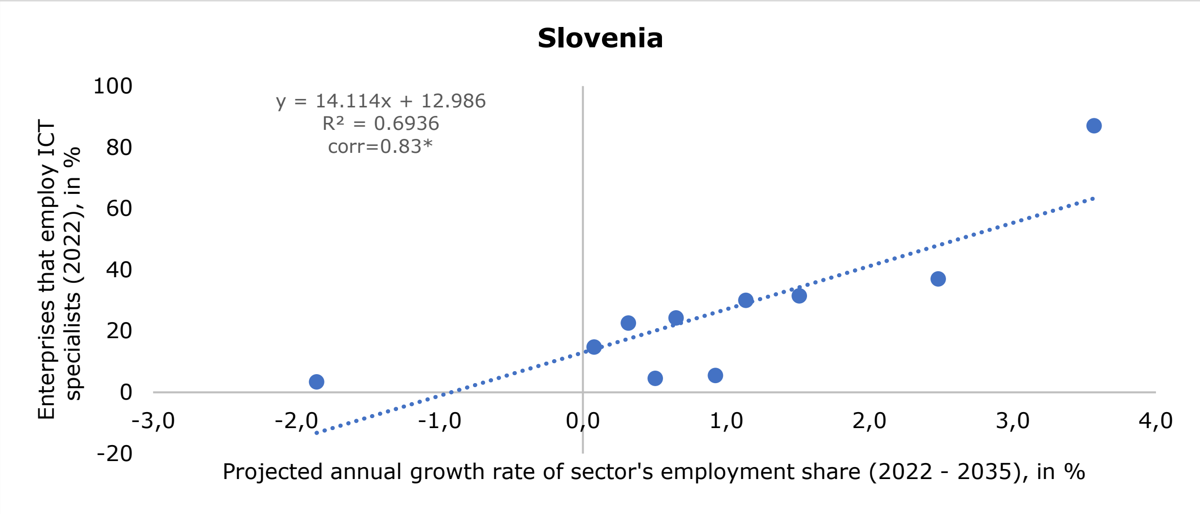
Note: In the first column of the table, the letter preceding the sectors is the code of the NACE Rev.2 classification. In the last two columns of the table, the two proxy indicators used for digital transformation are: i) the share of enterprises that employ ICT specialists (Eurostat code: lfsa_egais) and ii) the digital capital intensity (EUKLEMS & INTANProd data, average 2014-2017) with rank n°1 corresponding to the most digitally intense sector.

In addition to Table 1, Figures 1a and 1b below analyse to what extent there may be a relationship between the projected annual growth rates of the sectors' employment shares in the economy and their degree of digital transformation[640].

In **Figure 1a**, we present a scatterplot to shed light on the relationship between the first proxy of digital transformation used (percentage of enterprises that employ ICT specialists) and the projected annual growth rate of a sector's employment share between 2022-2035. The correlation is positive, and statistically significant in Slovenia, with a value of 0.83 (it is 0.62 and statistically significant for the EU27). Among the ten Member States with a significant correlation, Slovenia ranks 2nd in terms of the strongest correlation. The positive correlation could suggest that **the employment shares of those sectors with a higher 'percentage of enterprises that employ ICT specialists' are more likely to grow (over 2022-2035) than those of other sectors. The relationship is very strong, and stronger than the relationship observed at EU27 level. Nevertheless, this correlation does not imply causal links.**

[640] With the caveat that the correlation coefficients presented in Figure 1a and Figure 1b cannot be directly compared, as they pertain to a combination of sectors that varies across different Member States.

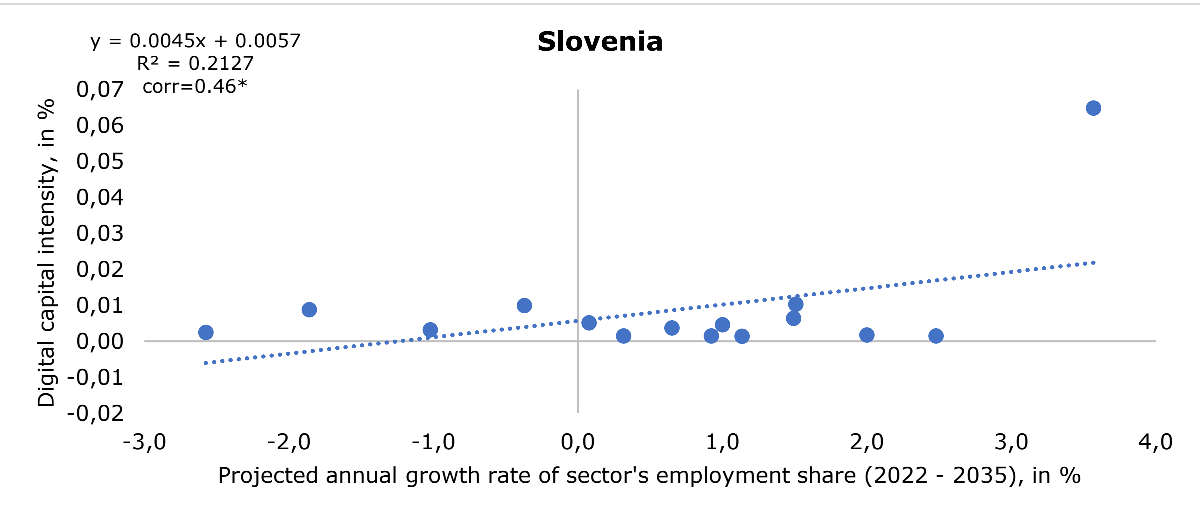
Figure 1a – SI. Relationship between the percentage of enterprises that employ ICT specialists (in 2022) and the projected annual growth rate of sector's employment share (2022-2035).



Source: Own elaboration on Eurostat and Cedefop 'Skill forecast 2023' data.

Figure 1b shows the correlation between the second digital transformation proxy ('digital capital intensity') and the projected annual growth rate of a sector's employment share (2022-2035). The correlation coefficient exhibits a value of 0.46 and is statistically significant in Slovenia. Among the 16 Member States for whom 'digital capital intensity' can be computed (7 of which present a positive and significant correlation), Slovenia ranks second. In this case, **the statistically significant and positive correlation could suggest that, in Slovenia, the employment shares of those sectors with a higher 'digital capital intensity' are more likely to a grow (over 2022-2035) than those of other sectors. However, the relationship is only moderate** and at the average level of the seven Member States where a positive correlation was observed. As before, this correlation does not imply causal links.

Figure 1b – SI. Relationship between 'digital capital intensity' and the projected annual growth rate of sector's employment share (2022-2035).

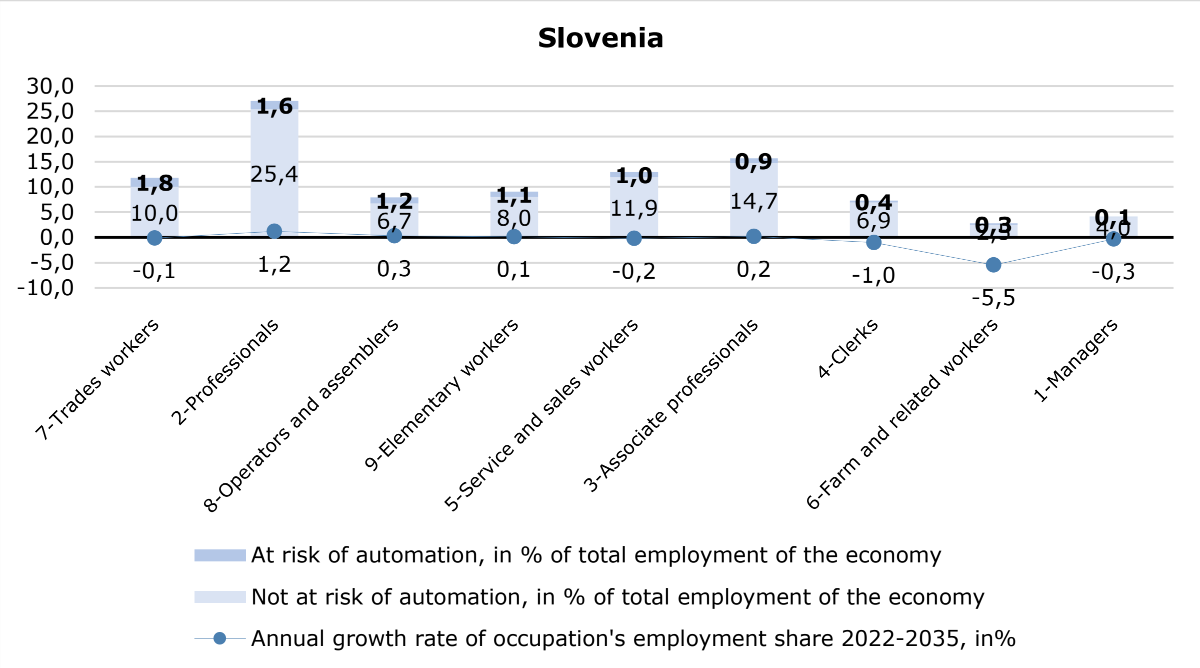


Source: Own elaboration on EUKLEMS & INTANProd, and Cedefop 'Skill forecast 2023' data.

SI 1.2 Occupational composition at ISCO-08 1 digit and risk of automation (current and forward-looking perspectives)

Different occupations are subject to differing levels of automation risk. Cedefop developed[641] a "risk of automation" index by occupation at the EU27 level, with the most recent data available for 2022[642]. We apply this indicator at the Member State level, with the assumption that the risk of automation for a given occupation is constant across Member States[643]. As such, Member State variation in the overall susceptibility of the workforce to automation (overall risk across all occupations in that Member State) will be due to the employment composition effect. That is, while the automation risk for a given occupation stays constant across Member States, the overall automation risk of a Member State will naturally be greater for those with more employment in occupations that have a higher automation risk.

Figure 2 – SI. Employment shares of occupations (at ISCO-08 1 digit level) - split into sub shares 'not at risk' and 'at risk' of automation (2022) - and projected annual growth rate



Source: Own elaboration on Cedefop data (risk of automation calculated by Cedefop at EU27 level by ISCO-08 1 digit level for 2022) applied to Eurostat data (share of employment by occupation, lfsa_egais, 2022).
Note: The numbers preceding the occupations are the ISCO-08 codes. Occupations are ranked from the highest to the lowest share of workers that present a risk of automation. The vertical sum of the two components (darker blue and lighter blue) gives back the total employment share by occupation (in % of total employment in the Member State). The ISCO nomenclature used in the text and the figure is the Cedefop one. For examples of specific occupations see: https://esco.ec.europa.eu/en/classification/occupation_main.

As can be seen in **Figure 2**, in Slovenia, the occupation with the largest employment sub-share (in % of total employment in the economy) 'at risk of

[641] Based on the methodology in Pouliakas, K. (2018) "The risk of automation in EU labour markets: a skill-requirements approach", in Economy, Employment and Skills: European and global perspectives in an age of uncertainty, Fondazione Giacomo Brodolini Quaderni Series, also IZA DP 11829.
[642] As retrieved at https://www.cedefop.europa.eu/en/tools/skills-intelligence/automation-risk-occupations#1
[643] While this assumption may be considered strong, Cedefop data are the only ones available that are at the same time, up to date and available for all the occupations at the ISCO-08 level.

automation' is Trades workers, with an employment sub-share of workers 'at risk of automation' representing 1.8% of total employment in the country (vs 1.3% for the EU27). The second-ranked occupation regarding the employment sub-share of workers 'at risk of automation' are Professionals, with an employment sub-share of workers 'at risk' of 1.6% of total employment in Slovenia (vs 1.3% for the EU27). Ranking third are Operators and assemblers, with a share of workers 'at risk' of 1.2% in total employment in Slovenia (vs 1.1% for the EU27). **Among these three occupations, the first and second ones are also the most affected across the EU27[644].**

For **ICT professionals (ISCO 25)**[645], the 2022 employment share is 2.5% in Slovenia (vs 2.3% in the EU27) and its composition (as regards the risk of automation) is as follows: an employment sub-share of 0.1% (vs 0.1% in the EU27) is 'at risk of automation', whereas the remaining employment sub-share of 2.4% (vs 2.2% at EU27 level) is 'not at risk of automation'. The projected annual growth rate 2022-2035 of the employment share of ICT professionals is 2.7% in Slovenia (vs 1.9% in EU27).

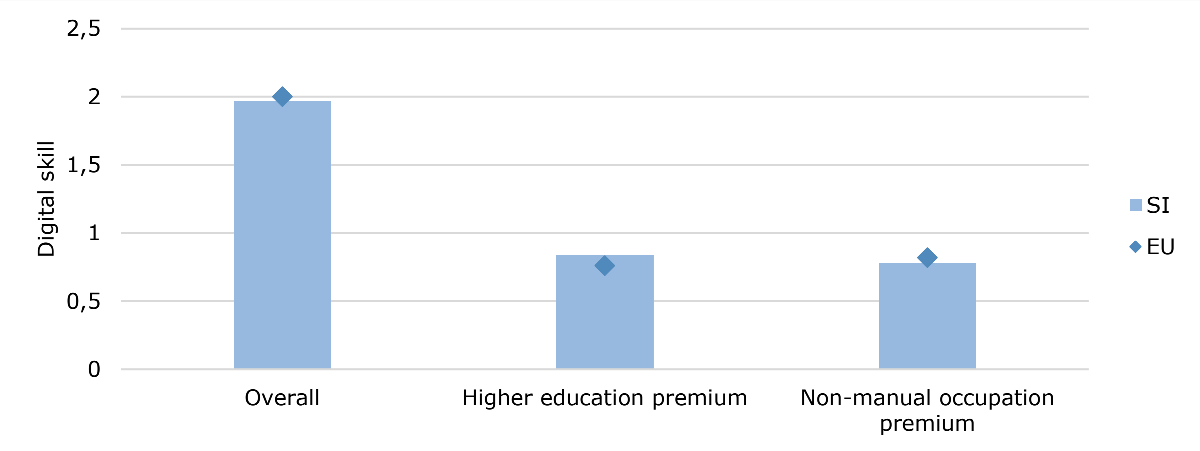
SI 2. Key policy dimensions for a socially fair digital transformation

SI 2.1 Digital skills

One of the key factors to manage the digital transformation in a socially fair way is a high level of digital skills in the population. **In this regard, Slovenia performs somewhat below the EU average**. According to the study's estimated index of digital skills[646] (Figure 3, bar "Overall"), Slovenia has the 14th highest level of overall skills in the population among EU Member States, while in the DESI Index for Human Capital[647] (Figure 5, section "Other dimensions"), the country ranks at the 17thposition. With regard to digital divides in the population, the picture is also relatively negative. With regard to the digital skills premium for individuals with a tertiary education degree ("Higher education premium" in Figure 3), Slovenia ranks 18th in the EU27, while on the premium for individuals in non-manual occupations ("Non-manual occupation premium" in Figure 3), the country ranks 13th.

[644] The most affected in the EU27 are Trades workers, Professionals, and Service and sales workers.
[645] Eurostat code: lfsa_egai2d.
[646] The construction of the digital skill index is described in detail in the introductory section.
[647] European Commission (2022). Digital Economy and Society Index. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi

Figure 3 – Estimated Digital Skills in SI and the EU (2019)



Source: Authors' own estimation based on Eurostat ICT survey
Note: Higher education premium refers to the difference in digital skills between individuals with tertiary and lower than tertiary education. Non-manual occupation premium refers to the difference in digital skills between individuals in manual and non-manual occupations.

In this context, **further investment in the digital skills of the population, particularly those of vulnerable groups, is of key policy importance**. The Digital Slovenia 2030 Strategy sets out the overarching policy framework for digitalisation of the economy, with competencies and digital inclusion designated as one of four pillars[648]. In 2022, Slovenia published the Strategy for the digital transformation of the economy[649] as part of the measures contained within its NRRP. Under the digital skills and competences pillar of its NRRP, several major targets are defined, including investment in digital skills and competences, the development of lifelong learning systems to increase digital literacy and competences, and strengthening the skills of ICT personnel[650]. The strategy is complemented by human capital investment as part of the NRRP, which amounts to 10.4% of the NRRP planned digital expenditure. Investment in digital skills within the plan focuses on public employees such as civil servants and teachers, as well as general digital skills in the population[651]. To further improve human capital in the realm of digital skills, greater awareness-raising and stronger learning incentives could be useful policy actions[652].

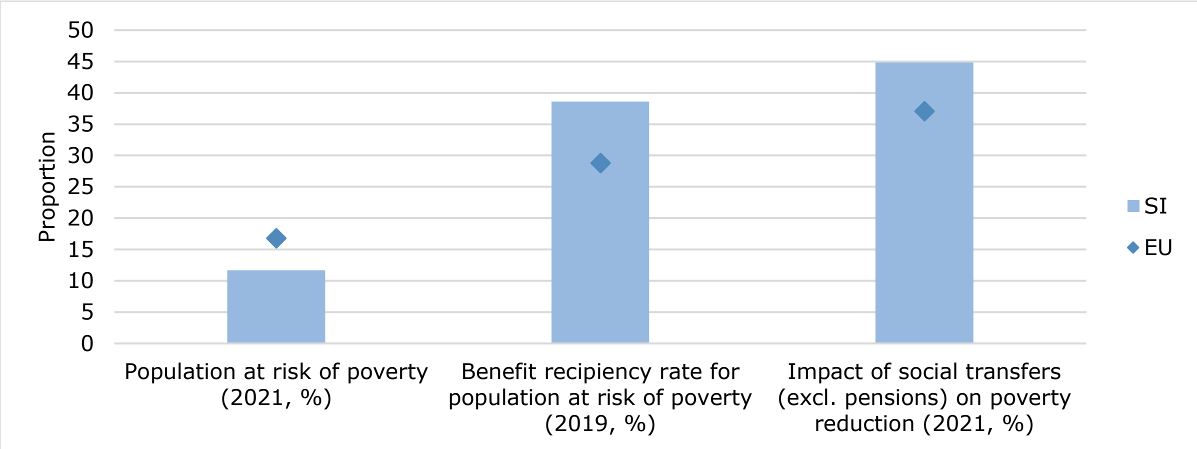
SI 2.2 Social protection and social policy

To mitigate the potential adverse impacts of the digital transformation on the labour market, social protection systems are of key importance. Figure 4 presents key indicators on social protection in Slovenia, which shows that **the social protection system in Slovenia performs well compared to the EU average**.

[648] For more information, see https://nio.gov.si/nio/asset/strategija+digitalna+slovenija+2030?lang=en
[649] For more information, see https://www.gov.si/assets/ministrstva/MGRT/Dokumenti/DIPT/StrategijaDTG.pdf
[650] For more information, see https://digital-skills-jobs.europa.eu/en/actions/national-initiatives/national-strategies/slovenia-strategy-digital-transformation-economy
[651] European Commission (2022); Recovery and Resilience Scoreboard Thematic Analyses. Digital Skills. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_digital_skills.pdf
[652] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance

The rate of the population at risk of poverty after social transfers[653] (11.7%) is the third lowest among EU member states. Data also shows that both the benefit recipiency rate for the population at risk of poverty[654] before social transfers (38.6%) and the impact of social transfers on poverty reduction[655] (45.5%) are high (respectively the sixth- and eighth highest in Europe). However, when it comes to the regulation of the employment status of platform workers, one of the groups whose work is strongly shaped by digitalisation, there has overall been relatively limited discussion in Slovenia.

Figure 4: Social Protection in SI and the EU



Source: Eurostat (2023) and JRC (2022)

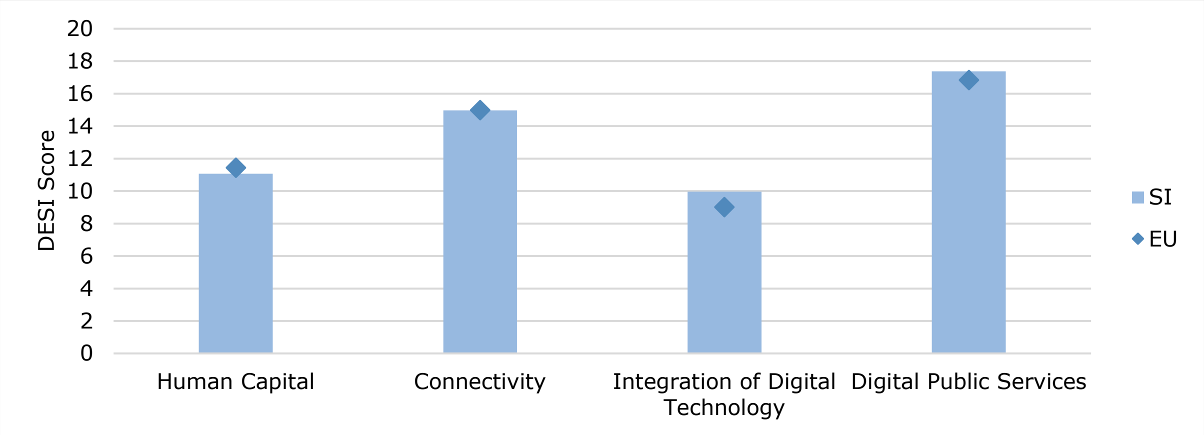
The Slovenian national implementation plan for the Recommendation on access to social protection sets out planned measures to improve the effective coverage of social protection in Slovenia, though not formal coverage or adequacy[656]. It also discusses the development of measures to improve the situation of platform workers specifically. The remaining gaps in access to social protection in the country are not expected to be closed by these measures[657]. In addition, several measures related to the social protection system were introduced as part of the Slovenian NRRP, including reforms to improve the adequacy of unemployment and pension benefits[658]. In terms of social expenditure, the measures in the NRRP largely focus on education and childcare (44.8%) and health and long-term care (39.5%).

[653] Eurostat (2023). TPS00184: At-risk-of-poverty rate after social transfers by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/tps00184/default/table?lang=en
[654] Eurostat indicator as re-elaborated by JRC (2022) "Monitoring the effective coverage and adequacy of social protection in the EU".
[655] Eurostat (2023). TESPM050:Impact of social transfers (excluding pensions) on poverty reduction by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/TESPM050/bookmark/table?lang=en&bookmarkId=b001ae62-ce34-4b49-9741-28a3ef99477f
[656] PPMI (2021). Study to support the impact assessment on improving working conditions in platform work. Available at: https://ec.europa.eu/social/main.jsp?catId=738&furtherPubs=yes&langId=en&pubId=8428
[657] European Commission (2023). Report from the Commission to the Council on the implementation of the Council Recommendation on access to social protection for workers and the self-employed. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023DC0043&qid=16764733477492
[658] European Commission (2022). Recovery and Resilience Scoreboard Thematic Analyses. Social protection. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_social_protection.pdf

SI 3. Other dimensions relevant to the digital transformation

Beyond digital skills and social protection, broader supporting factors can play a significant role in supporting the digital transformation. These include (i) the level of digitalisation in firms and (ii) the level of digital infrastructure and of digital public services. With regard to the digitalisation of firms, the DESI Index (Figure 5) shows that Slovenia performs better than the EU average, ranking ninth among EU Member States in terms of the level of integration of digital technology in firms. However, concerningly, digital capital intensity[659] in firms is lower than the EU average[660] and, in contrast to the general EU trend, has not increased between 2008 and 2018. Further policies for digitalisation of businesses are set out within the Digital Slovenia strategy, where digitalisation of businesses is one of four key pillars, and the Strategy on the digital transformation of the economy 2021-2030[661]. Moreover, 8.4% of the planned digital expenditure in the Slovenian NRRP is targeted at the digitalisation of businesses. This includes investments for the development of tailored digital strategies for the digitalisation of businesses[662].

Figure 5 – DESI Index for SI and the EU (2022)



Source: European Commission (2022)

Turning to digital infrastructure and public services, Slovenia performs slightly better than the EU average. According to the DESI Index on connectivity, it ranks 10th in the EU27, and on digital public services, it ranks 13th. In the Digital Slovenia Strategy, both digital infrastructure and digital public services are key areas of focus[663]. While only a relatively small share of the planned digital expenditure in the Slovenian NRRP is targeted at connectivity (5.2%), a major share focuses on digital public services, with 61.4% of planned digital expenditure allocated to this issue. On connectivity, though expenditure is relatively small, the NRRP includes the adoption of a broadband plan and a national

[659] As described in the Annex, based on data from EU-KLEMS (2008-2018). Data is not available for Cyprus, Croatia, Ireland and Romania.
[660] For Member States with available data
[661] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[662] European Commission (2022): Recovery and Resilience Scoreboard Thematic Analysis. SME Support. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/3_SME.pdf
[663] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance

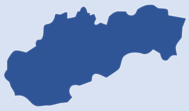
plan for the construction of 5G[664]. The measures on digital public services focus on the digitalisation of administration in a comprehensive manner through a package of reforms and investments in ICT infrastructure for e-government, the data economy and other factors[665].

[664] European Commission (2023); Recovery and Resilience Scoreboard Thematic Analyses. Connectivity. https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_connectivity.pdf

[665] European Commission (2021); Recovery and Resilience Scoreboard Thematic Analyses. Digital public services. Available at :https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/2_Digital.pdf

25. SLOVAKIA: elements of a socially fair digital transformation

Key Points



Labour market: Currently, the sector with the largest employment share in the economy – the Manufacturing sector - ranks fifth amongst the sectors in terms of the degree of digital transformation (based on the current percentage of enterprises that employ ICT specialists in a sector). The Manufacturing sector's employment share in the economy is projected to grow further in the decade to come (slightly more than EU27 trends). ICT services, Energy supply services and Professional services are the three sectors with the highest current degree of digital transformation, and their employment shares are projected to grow more than the corresponding EU27 trends in the coming decade. Regarding the risk of automation of occupations, the most vulnerable type of occupation is Trades workers.

Digital skills: Slovakia is lagging behind the EU level with respect to the overall level of digital skills. Divides in digital skills between different educational and occupational groups are relatively small but should be considered in the context of the overall low level of digital skills in the population.

Social protection: The Slovakian social protection system is fairly well developed, with a very low rate of the population at risk of poverty. However, policy action on the regulation of platform work has been limited so far.

SK 1. The labour market and the digital transformation

SK 1.1 Sectoral composition (current and forward-looking perspectives)

In Slovakia ("SK"), in 2022, the sectors with the largest employment shares in the economy were: Manufacturing (24.2% vs 16.0% at the EU27 level), Wholesale and retail trade (12.1% vs 13.6% at the EU27 level), and Construction (9.9% vs 6.8% at the EU27 level). For the period 2022-2035, Cedefop data projects[666] the annual growth rate of a sector's employment share. For Slovakia's Manufacturing sector, the annual growth rate is 0.2% (-0.2% for the EU27). For the Wholesale and retail trade sector it is -0.7% (0.0% for the EU27), while it is -0.4% for the Health and social care sector (-0.3% for the EU27).

[666] Own elaboration on Cedefop 'Skill forecast 2023' data.

Table 1 shows each sector's employment share in the economy in 2022, the projected annual growth rate (2022-2035) of its employment share, as well as its resulting employment share in the economy by 2035. Along with these elements relating to employment, Table 1 also presents the degree of "digital transformation" of each sector. Table 1 thus enables a comparison between a sector's degree of digital transformation, its current employment share, and growth therein. The aforementioned degree of digital transformation is proxied in Table 1, for each sector, by two indicators: i) the percentage of enterprises that employ ICT specialists in the sector and ii) the digital capital intensity[667] of the sector. Table 1 presents the ranking of each sector according to these two proxy indicators (with rank n°1 corresponding to the most digitised sector). According to the first indicator, the three sectors with the highest degree of digital transformation in Slovakia are: ICT services (employment share: 4.2% in SK vs 3.7% in the EU27), Energy supply services (1.0% vs 0.7%) and Professional services (3.6% vs 5.7%). According to the second indicator (digital capital intensity), the three sectors with the highest degree of digital transformation are: Accommodation and food (employment share: 3.5% in SK vs 4.5% in the EU27), ICT services (4.2% vs 3.7%) and Health and social care (7.3% vs 11.0%). In Slovakia, these sectors' employment shares have a projected annual growth rate (2022-2035) of 1.0% for ICT services (vs 0.8% for the EU27), 1.9% for Energy supply services (vs 0.1% for the EU27), 0.4% for Professional services (vs 0.6% for the EU27), 0.8% for Accomodation and food (0.6% for the EU27), and 0.2% for Health and social care (vs 0.6% for the EU27).

As can be seen from Table 1, two of the top four sectors in terms of the degree of digital transformation – ICT services and Energy supply services – are also among the top four sectors with regard to the annual growth rate of employment share in the coming decade in Slovakia. Furthermore, in terms of employment share (in 2022), the first and second sectors – Manufacturing and Wholesale and retail trade - rank fourth and sixth, according to one of the two proxy indicators of the digital transformation (% of enterprises that employ ICT specialists).

Table 1 – SK. Sector's share of employment, annual growth rate, and ranking of "digital transformation" (the sectors are ranked according to the ranking in the last column of the table).

Sectors	Sector's employment share in 2022 (%)		Projected annual growth rate of the sector's employment share (2022 - 2035, %)		Projected sector's employment share in 2035 (%)		Proxy 1 for digital transformation (ranking)	Proxy 2 for digital transformation (ranking)
	SI	**EU**	**SI**	**EU**	**SI**	**EU**	**% enterprises that employ ICT specialists**	**Digital capital intensity**
I - Accommodation & food	3.5	4.5	0.8	0.6	3.9	4.9	10	1
J - ICT services	4.2	3.7	1.0	0.8	4.8	4.2	1	2
Q - Health & social care	7.3	11.0	0.2	0.6	7.6	11.9	n.a.	3
P - Education	8.4	7.4	-0.1	0.3	8.3	7.7	n.a.	4
D - Energy supply services	1.0	0.7	1.9	0.1	1.4	0.8	2	5

[667] 'Digital capital intensity' is an index – built in the context of this study – that looks at the ratio between the stock of capital the firms have in software and databases and the overall stock of capital excluding non-residential buildings. Its construction is based on the integrated EUKLEMS & INTANProd database, run by the Luiss Lab of European Economics at Luiss University in Rome, Italy. For more in-depth information on the source, and the availability of the indicator for Member States/sectors, please refer to the Annex.

M - Professional services	3.6	5.7	0.4	0.6	3.8	6.3	3	6
G - Wholesale & retail trade	12.1	13.6	-0.7	0.0	10.9	13.6	6	7
B - Mining & quarrying	0.3	0.3	-3.2	-1.7	0.2	0.2	n.a.	8
N - Administrative services	1.9	4.1	1.2	0.0	2.2	4.1	8	9
E- Water and waste treatment	0.9	0.8	-0.3	-0.1	0.8	0.8	5	10
R - Arts & recreation and other services	1.3	1.7	-0.5	0.3	1.2	1.7	n.a.	11
O - Public sector & defence	8.1	7.1	-0.3	-0.1	7.8	7.0	n.a.	12
F - Construction	9.9	6.8	-0.4	-0.3	9.4	6.5	9	13
K - Finance & insurance	2.4	2.8	-0.6	0.2	2.2	2.8	n.a.	14
A - Agriculture, forestry & fishing	2.5	3.5	0.0	-3.1	2.5	2.3	n.a.	15
C - Manufacturing	24.2	16.0	0.2	-0.2	24.9	15.6	4	16
H - Transport & storage	6.2	5.3	-0.2	-0.1	6.0	5.3	7	17
L - Real Estate	0.7	0.9	-0.4	0.9	0.7	1.0	n.a.	n.a.
S - Other service activities	1.4	2.6	-0.1	0.0	1.4	2.6	n.a.	n.a.
T - Activities of households as employers	n.a.	0.9	n.a.	-0.3	n.a.	0.9	n.a.	n.a.
U - Activities of extraterritorial org.	n.a.	0.1	n.a.	n.a.	n.a.	0.1	n.a.	n.a.

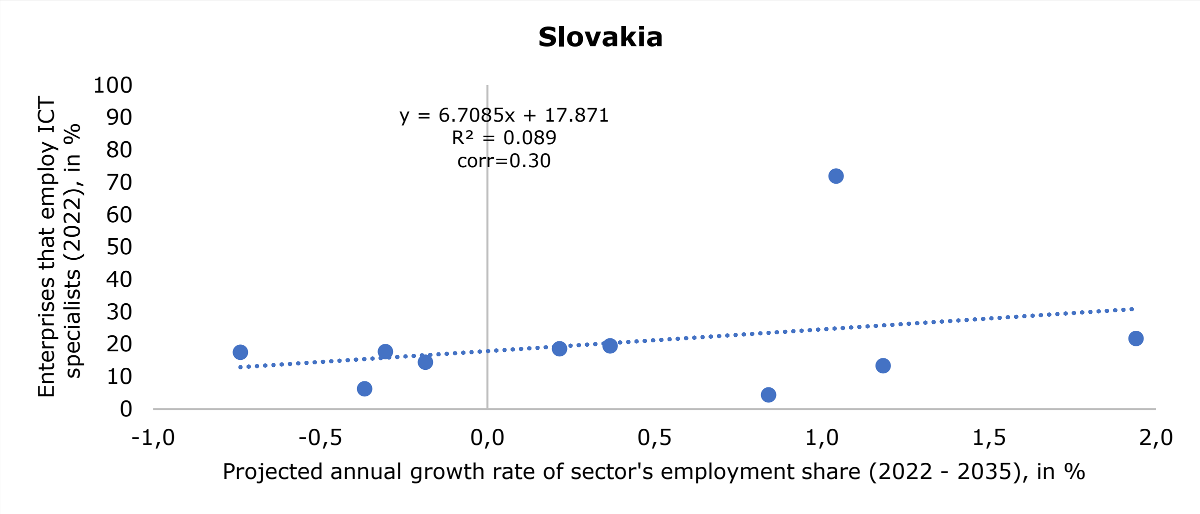
Source: For the employment-related indicators own elaboration on Eurostat data (share of employment, 2022 calculated based on lfsa_egan) and on Cedefop 'Skill forecast data 2023' (annual growth rate of sector's employment share, 2022-2035), for the digital transformation-related indicators: own elaboration on Eurostat data (share of enterprises that employ ICT specialists, Eurostat code: lfsa_egais) and on EUKLEMS & INTANProd data (digital capital intensity).
Note: In the first column of the table, the letter preceding the sectors is the code of the NACE Rev.2 classification. In the last two columns of the table, the two proxy indicators used for digital transformation are: i) the share of enterprises that employ ICT specialists (Eurostat code: lfsa_egais) and ii) the digital capital intensity (EUKLEMS & INTANProd data, average 2014-2017) with rank n°1 corresponding to the most digitally intense sector.

To complement Table 1, Figures 1a and 1b below examine the extent to which there may be a relationship between the projected annual growth rates of the sectors' employment shares in the economy and their degree of digital transformation[668].

In **Figure 1a**, we present a scatterplot to shed light on the relationship between the first proxy of the digital transformation used (percentage of enterprises that employ ICT specialists) and the projected annual growth rate of a sector's employment share between 2022-2035. The correlation is positive at 0.30, but not statistically significant (it is 0.62 and statistically significant for the EU27). **The lack of statistically signifiant correlation implies that an association, at the sectoral level, between the percentage of enterprises that employ ICT specialists and the projected annual growth rate of a sector's employment share cannot be inferred in Slovakia.**

[668] With the caveat that the correlation coefficients presented in Figure 1a and Figure 1b cannot be directly compared, as they pertain to a combination of sectors that varies across different Member States.

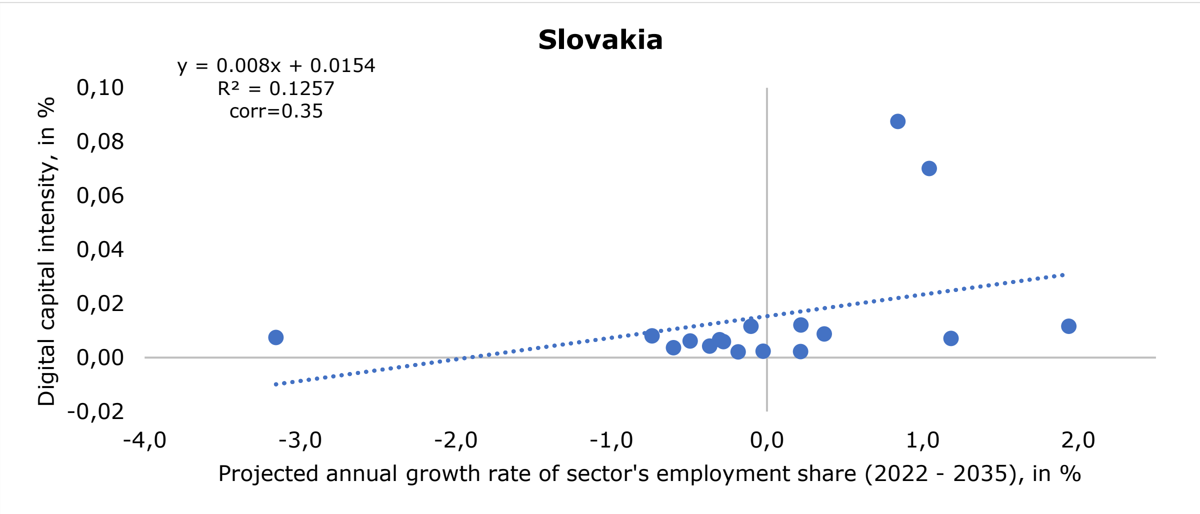
Figure 1a – SK. Relationship between the percentage of enterprises that employ ICT specialists (in 2022) and the projected annual growth rate of sector's employment share (2022-2035).



Source: Own elaboration on Eurostat and Cedefop 'Skill forecast 2023' data.

Figure 1b shows the correlation between the second digital transformation proxy ('digital capital intensity') and the projected annual growth rate of a sector's employment share between 2022-2035. The correlation coefficient exhibits a value of 0.35 and is not statistically significant in Slovakia. As before, **the lack of statistically significant correlation implies that in Slovakia a sectoral-level association between the 'digital capital intensity' and the projected annual growth rate of a sector's employment share cannot be inferred.**

Figure 1b – SK. Relationship between 'digital capital intensity' and the projected annual growth rate of sector's employment share (2022-2035).

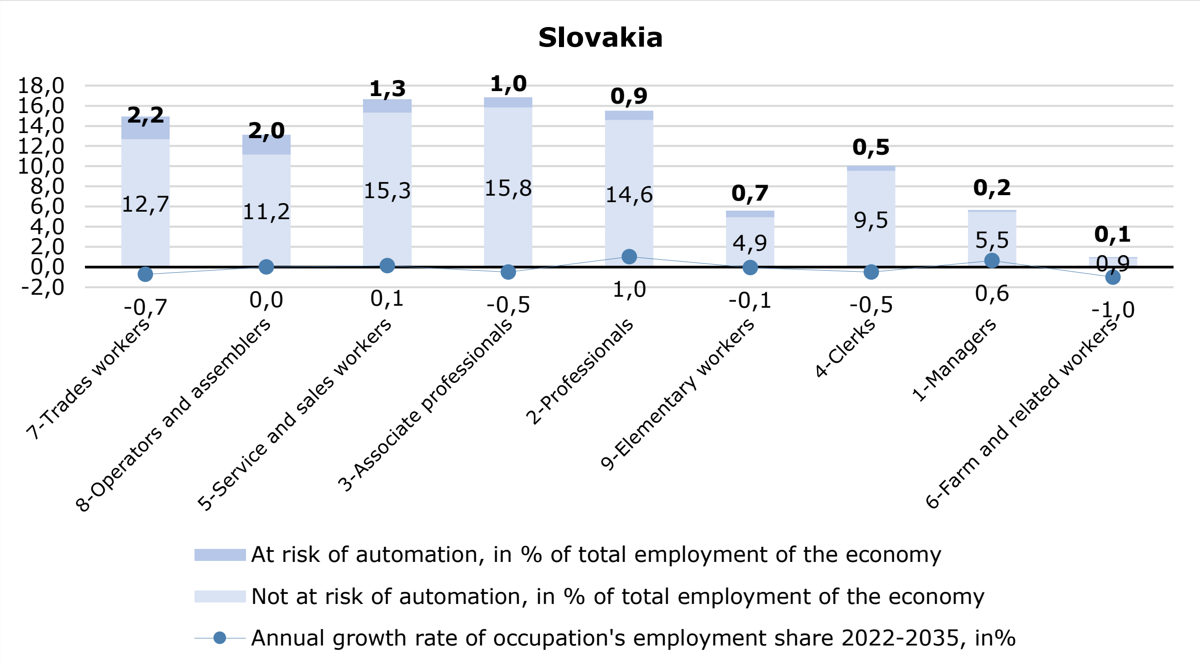


Source: Own elaboration on EUKLEMS & INTANprod, and Cedefop 'Skill forecast 2023' data.

SK 1.2 Occupational composition at ISCO-08 1 digit and risk of automation (current and forward-looking perspectives)

Different occupations are subject to differing levels of automation risk. Cedefop developed[669] a "risk of automation" index by occupation at the EU27 level, most recently updated for 2022[670]. We apply this indicator at the Member State level, with the assumption that the risk of automation for a given occupation is constant across Member States[671]. As such, variation across Member States in the overall susceptibility of the workforce to automation (overall risk across all occupations in that Member State) will be due to the employment composition effect. That is, while the automation risk for a given occupation stays constant across Member States, the overall automation risk of a Member State will naturally be greater for those Member States having more employment in occupations with a higher automation risk.

Figure 2 – SK. Employment shares of occupations (at ISCO-08 1 digit level) - split into sub shares 'not at risk' and 'at risk' of automation (2022) - and projected annual growth rate



Source: Own elaboration on Cedefop data (risk of automation calculated by Cedefop at EU27 level by ISCO-08 1 digit level for 2022) applied to Eurostat data (share of employment by occupation, lfsa_egais, 2022).
Note: The numbers preceding the occupations are the ISCO-08 codes. Occupations are ranked from the highest to the lowest share of workers that present a risk of automation. The vertical sum of the two components (darker blue and lighter blue) gives back the total employment share by occupation (in % of total employment in the Member State). The ISCO nomenclature used in the text and the figure is the Cedefop one. For examples of specific occupations see: https://esco.ec.europa.eu/en/classification/occupation_main.

[669] Based on the methodology in Pouliakas, K. (2018) "The risk of automation in EU labour markets: a skill-requirements approach", in Economy, Employment and Skills: European and global perspectives in an age of uncertainty, Fondazione Giacomo Brodolini Quaderni Series, also IZA DP 11829.
[670] As retrieved at https://www.cedefop.europa.eu/en/tools/skills-intelligence/automation-risk-occupations#1
[671] While this assumption may be considered strong, Cedefop data are the only ones available that are at the same time, up to date and available for all the occupations at the ISCO-08 level.

As can be seen in **Figure 2**, in Slovakia, the occupation with the largest employment sub-share (in % of total employment in the economy) 'at risk of automation' is Trades workers, with an employment sub-share of workers 'at risk of automation' representing 2.2% of total employment in the country (vs 1.3% for the EU27). Ranking second regarding the employment sub-share of workers 'at risk of automation' are Operators and assemblers, with an employment sub-share of workers 'at risk' of 2.0% of total employment in Slovakia (vs 1.1% for the EU27). The third-ranked occupation is Service and sales workers, with a share of workers 'at risk' of 1.3% in total employment in Slovakia (vs 1.3% for the EU27). **Among these three occupations, the first and the third ones are also the most affected across the EU27[672].**

For **ICT professionals (ISCO 25)**[673], the 2022 employment share is 1.9% in Slovakia (vs 2.3% in the EU27) and its composition (as regards the risk of automation) is as follows: an employment sub-share of 0.1% (vs 0.1% in the EU27) is 'at risk of automation', whereas the remaining employment sub-share of 1.8% (vs 2.2% at EU27 level) is 'not at risk of automation'. The projected annual growth rate 2022-2035 of the employment share of ICT professionals is 2.4% in Slovakia (vs 1.9% in EU27).

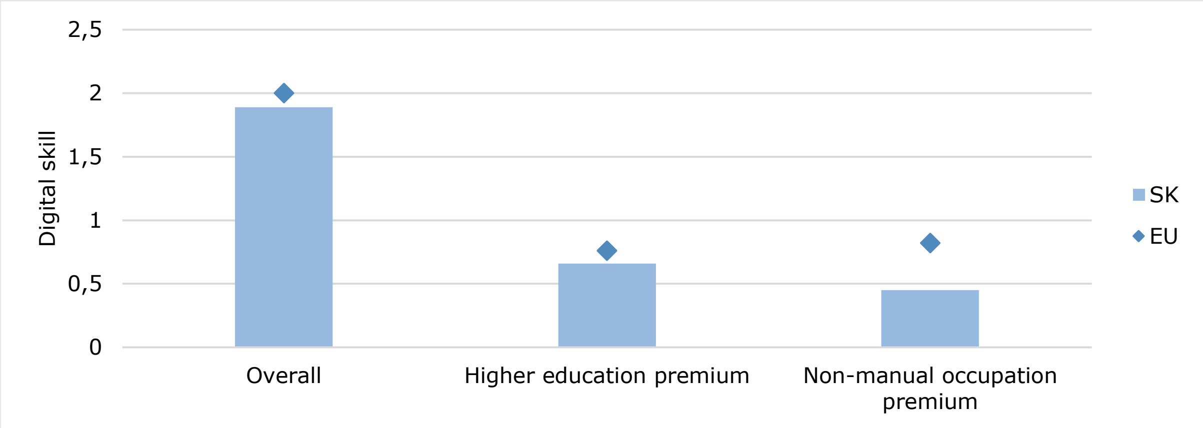
SK 2. Key policy dimensions for a socially fair digital transformation

SK 2.1 Digital skills

One key policy dimension influencing the extent to which the digital transformation is socially fair is the level of digital skills within the population. Overall, the level of digital skills in Slovakia is low relative to the EU level. In the study's own estimated index of digital skills[674] (Figure 3, bar "Overall"), Slovakia ranks 21st in the EU27. Similarly, in the DESI Index[675] for Human Capital (Figure 5, "Other dimensions"), the country ranks 19th [676]. The picture is more positive when looking at digital divides between socio-economic groups. The digital skill premium for individuals with a tertiary education degree ("Higher education premium" in Figure 3) is relatively low, Slovakia ranking ninth in the EU27, while the premium for individuals in non-manual occupations is the smallest in the EU27 ("Non-manual occupation premium" in Figure 3). Nevertheless, **given the relatively low overall level of digital skills in the population, further investment in digital skills is of key policy importance within the Slovakian context**.

[672] The most affected in the EU27 are Trades workers, Professionals, and Service and sales workers.
[673] Eurostat code: lfsa_egai2d.
[674] The construction of the digital skill index is described in detail in the introductory section.
[675] European Commission (2022). Digital Economy and Society Index. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi
[676] Generally, the Education and Training Monitor 2022 (European Commission, 2022) highlighted that Slovakia has a skill mismatch rate of 35%, one of the highest among OECD countries. Addressing skills mismatches and making further investments in adult learning can help Slovakia's labour productivity catch up with the EU average and get ready for the waves of automation expected to affect largely the Slovak economy.

Figure 3 – Estimated Digital Skills in SK and the EU (2019)



Source: Authors' own estimation based on Eurostat ICT survey
Note: Higher education premium refers to the difference in digital skills between individuals with tertiary and lower than tertiary education. Non-manual occupation premium refers to the difference in digital skills between individuals in manual and non-manual occupations.

Digital policy priorities for Slovakia are defined within the 2030 Strategy for the Digital Transformation of Slovakia[677]. On digital skills, several priorities are defined, including, among others, educational programmes for skills development for the workforce, the update of employees' skills in the context of automation, as well as investment in advanced digital skills[678]. This is complemented by several other national strategic documents, such as the Programme of digitalisation of education for 2030[679]. Within the NRRP for Slovakia, 21.9% of planned digital expenditure is allocated to human capital. The NRRP includes an educational reform to improve digital skills education as well as the development of a national digital skills strategy for adults. The expenditure in the plan is focused on improving the digital skills of the elderly and vulnerable groups, as well as investing in IT and cybersecurity skills[680] [681].

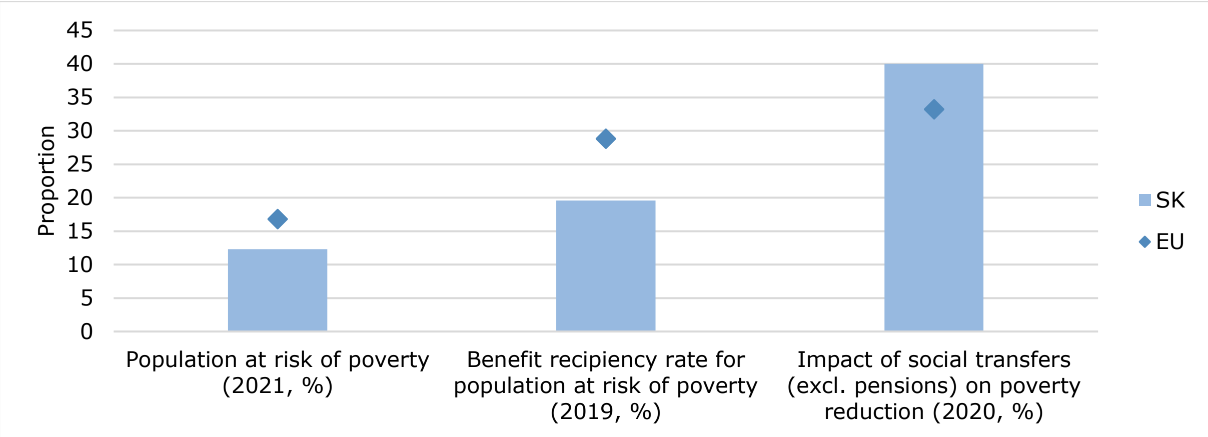
SK 2.2 Social protection and social policy

While digital skills are a key prerequisite for a successful digital transformation, social protection systems also play an important role in mitigating the potential adverse impact of digitalisation on the labour market. Figure 4 shows some key

[677] For more information, see https://www.mirri.gov.sk/wp-content/uploads/2019/10/SDT-English-Version-FINAL.pdf
[678] For more information, see https://digital-skills-jobs.europa.eu/en/actions/national-initiatives/national-strategies/slovakia-2030-digital-transformation-strategy
[679] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[680] European Commission (2022); Recovery and Resilience Scoreboard Thematic Analyses. Digital Skills. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_digital_skills.pdf
[681] One particular project (funded by the European Social Fund) can be mentioned here as a good practice: The project called "IT Academy-Education for the 21st century" offered education and mentoring to 33 000 pupils from primary and secondary schools, 313 primary schools, 251 secondary schools, 3 000 students form Universities, 2 100 pedagogical and professional employees and 20 university teachers. The aim of the project was to create a model of education and training of young people for the current and prospective needs of the knowledge society and the labour market with a focus on informatics and ICT.

indicators on social protection in Slovakia. The rate of the population at risk of poverty after social transfers[682] (12.3%) is considerably lower than the EU rate (fifth lowest in the EU27). Slovakia also performs well when it comes to the impact of social transfers on poverty reduction[683] (40%). However, on the benefit recipiency rate for the population at risk of poverty before social transfers[684] (19.6%), Slovakia is lagging behind the rest of the EU. On the regulation of the employment status of platform workers, there has only been a limited amount of discussion so far[685]. Hence, **while there is a positive picture overall for social protection systems in Slovakia, there are also some areas for improvement**.

Figure 4 – Social Protection in SK and the EU



Source: Eurostat (2023) and JRC (2022)

The Slovak national implementation plan for the Recommendation on access to social protection[686] does not present any further measures to improve coverage, adequacy or transparency of social protection, nor does it include specific measures for platform workers. The Slovak NRRP also does not include measures specifically focused on social protection. Looking at social expenditure within the NRRP more broadly, the focus is mainly on health and long term care (55.3%) as well as education and childcare (41.2%). As well, Slovakia has been grappling with the problem of "bogus self-employment"[687].

[682] Eurostat (2023). TPS00184: At-risk-of-poverty rate after social transfers by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/tps00184/default/table?lang=en

[683] Eurostat (2023). TESPM050: Impact of social transfers (excluding pensions) on poverty reduction by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/TESPM050/bookmark/table?lang=en&bookmarkId=b001ae62-ce34-4b49-9741-28a3ef99477f

[684] Eurostat indicator as re-elaborated by JRC (2022) "Monitoring the effective coverage and adequacy of social protection in the EU".

[685] PPMI (2021). Study to support the impact assessment on improving working conditions in platform work. Available at: https://ec.europa.eu/social/main.jsp?catId=738&furtherPubs=yes&langId=en&pubId=8428

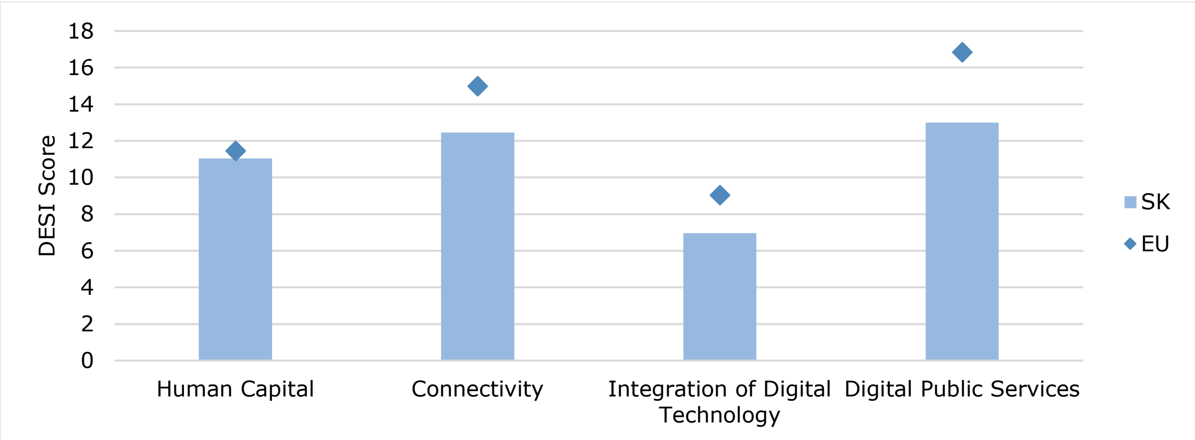
[686] European Commission (2023). Access to social protection. Available at: https://ec.europa.eu/social/main.jsp?catId=1312&langId=en=en

[687] According to Eurostat and the OECD, the count of fictitious self-employed persons in Slovakia has risen from 84 000 to nearly 110 000 in the past decade. As self-employed persons have an opt-out option from social contribution schemes and pay 6 times less tax and social contributions for the first year of activity and 2.3 times less for subsequent years than other workers, the state social security budget is deprived of significant sources of revenues.

SK 3. Other dimensions relevant to the digital transformation

Further contextual dimensions may influence the extent to which the digital transformation is socially fair. The first of these is the digitalisation of businesses. However, Slovakia is lagging behind other EU countries in this regard. According to the DESI Index (Figure 5), the level of integration of digital technology in firms in Slovakia ranks as 21st in the EU27. Other indicators also confirm that there is a **relatively low uptake of digital technologies in Slovak firms**. Levels of digital capital intensity[688] in Slovakia are lower than the EU average[689] and, significantly, have declined between 2008 and 2018, while there has been positive growth on average at the EU level. However, looking at robotics, Slovakia is comparatively more advanced than the EU average. Robot density[690] in both manufacturing and the overall economy is higher than the EU average[691], and growth has been positive between 2009 and 2019, though lower than the average EU rate. To further increase the digitalisation of enterprises, Slovakia has put forward a 2030 strategy for the digital transformation of the country, which supports the integration of technologies such as cloud and AI in enterprises[692]. Within the Slovak NRRP, a relatively small share of digital expenditure (6.8%) is allocated towards the digitalisation of businesses. A number of measures are targeted at the digitalisation of SMEs, for instance through Digital Innovation Hubs and vouchers for innovation, digitalisation of processes and services, and patents[693]. Barriers to the uptake of digital technologies remain in the form of administrative burden and low awareness of financing possibilities and financial instruments, which should be incorporated in future strategic documents[694].

Figure 5 – DESI Index for SK and the EU (2022)



[688] As described in the Annex, based on data from EU-KLEMS (2008-2018). Data is not available for Cyprus, Croatia, Ireland and Romania.
[689] For Member States with available data.
[690] As described in the Annex, based on data from the International Federation of Robotics (2010-2019). Data is not available for Cyprus, Greece, Luxembourg and Slovenia.
[691] For Member States with available data
[692] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[693] European Commission (2022): Recovery and Resilience Scoreboard Thematic Analysis. SME Support. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/3_SME.pdf
[694] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance

Source: European Commission (2022)

On digital infrastructure and digital public services, Slovakia is equally performing worse than the EU average. According to the DESI Index, connectivity levels in Slovakia rank 21st in the EU27, while levels of digital public services rank 24th. Even though there have been considerable improvements in connectivity in recent years, awareness-raising among end users and accelerated deployment of 5G networks will remain crucial to further improvement[695]. Slovakia also approved a new National Concept of Informatization of the Public Administration for the years 2021-2026 in 2021, outlining a vision for more reliable and user-friendly digital public services[696]. As part of the Slovak NRRP, investment in connectivity is not foreseen. However, a major share of the digital expenditure planned in the NRRP is allocated to digital public services (52.7%), with a number of measures to advance digitalisation in public administration, such as the roll-out of information systems in the judiciary, healthcare, policy and rescue systems[697].

[695] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[696] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[697] European Commission (2021); Recovery and Resilience Scoreboard Thematic Analyses. Digital public services. Available at :https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/2_Digital.pdf

26. SWEDEN: elements of a socially fair digital transformation

Key Points

Labour market: Currently, the sector with the third largest employment share in the economy - which is the Wholesale and retail trade sector - ranks fourth amongst the sectors in terms of a sector's degree of digital intensity (based on the current digital capital intensity in a sector)[698]. The Wholesale and retail trade sector's employment share in the economy is not projected to grow further in the decade to come (even less than the EU27 trends). ICT services, Professional services and Energy supply services are currently the three sectors with the highest degree of digital transformation, and their employment shares, except for Energy supply services, are projected to grow much more than the corresponding EU27 trends in the coming decade. Regarding the risk of automation of occupations, the most vulnerable occupation is Trades workers.

Digital skills: Sweden is a leader in digital skills in the EU. Overall levels of digital skills in the population are among the highest in Europe, and digital divides between socio-economic groups are small.

Social protection: Sweden has a comprehensive social protection system and a rate of the population at risk of poverty below the EU level. Regulatory action on the employment status of platform workers has been limited so far, though there are some examples

[698] The ranking based on digital capital intensity is used in the key points only when the sector with the largest employment share is not rankable according to the percentage of enterprises that employ ICT specialists. In this case, the ranking for the first largest employment share in the economy was not available.

of collective bargaining agreements between trade unions and digital labour platforms.

SE 1. The labour market and the digital transformation

SE 1.1 Sectoral composition (current and forward-looking perspectives)

In Sweden ("SE"), in 2022, the sectors with the largest employment shares in the economy were: Health and social care (14.5% vs 11.0% at the EU27 level), Education (11.1% vs 7.4% at the EU27 level), and Wholesale and retail trade (10.3% vs 13.6% at the EU27 level). Cedefop data projects[699] the annual growth rate of a sector's employment share for the period 2022-2035. For Sweden's Health and social care sector, the annual growth rate is 0.5% (0.6% for the EU27), while it is 0.5% for the Education sector (0.3% for the EU27), and -0.4% for the Wholesale and retail trade sector (0.0% for the EU27).

Table 1 shows each sector's employment share in the economy in 2022, the projected annual growth rate (2022-2035) of its employment share, as well as its resulting employment share in the economy by 2035. Along with these elements relating to employment, Table 1 also presents the degree of "digital transformation" of each sector. The goal of Table 1 is thus to enable a comparison between the sectors' degree of digital transformation, their employment shares and projected growth in these shares. The aforementioned degree of digital transformation is proxied in Table 1, for each sector, by the percentage of enterprises that employ ICT specialists of the considered sector. Table 1 presents the ranking of each sector according to this proxy (with rank n°1 corresponding to the most digitised sector). The three sectors with the highest degree of digital transformation in Sweden are: ICT services (employment share: 6.1% in SE vs 3.7% in the EU27), Energy supply services (0.7%, as in the EU27) and Professional services (9.9% vs 5.7%). In Sweden, these sectors' employment shares have a projected annual growth rate (2022-2035) of 0.4% for ICT services (vs 0.8% for the EU27), -0.9% for Energy supply services (vs 0.1% for the EU27), and -0.4% for Professional services (vs -0.6% for the EU27).

As can be seen from Table 1, notably, none of the top five sectors in terms of the degree of digital transformation are among the top five sectors with regard to the annual growth rate of employment share in the coming decade. Table 1 also shows that, in terms of employment share (in 2022), the third and fourth sectors[700] – Wholesale and retail trade and professional services - rank fourth and third, according to the proxy indicator of the degree of digital transformation (% of enterprises that employ ICT specialists).

Table 1 – SE. Sector's share of employment, annual growth rate, and ranking of "digital transformation" (the sectors are ranked according to the ranking in the last column of the table).

Sectors	Sector's employment share in 2022 (%)	Projected annual growth rate of the sector's	Projected sector's employment	Proxy 1 for digital transformation (ranking)	Proxy 2 for digital transformation (ranking)

[699] Own elaboration on Cedefop 'Skill forecast 2023' data.
[700] The first and the second sectors in terms of employment share (in 2022) - Health and social care and Education - were not rankable with either of the proxy indicators for digital transformation.

			employment share (2022 - 2035, %)		share in 2035 (%)			
	SE	**EU**	**SE**	**EU**	**SE**	**EU**	**% enterprises that employ ICT specialists**	**Digital capital intensity**
J - ICT services	6.1	3.7	0.4	0.8	6.5	4.2	1	n.a.
D - Energy supply services	0.7	0.7	-0.9	0.1	0.6	0.8	2	n.a.
M - Professional services	9.9	5.7	-0.4	0.6	9.4	6.3	3	n.a.
G - Wholesale & retail trade	10.3	13.6	-0.4	0.0	9.8	13.6	4	n.a.
C - Manufacturing	9.7	16.0	-0.3	-0.2	9.2	15.6	5	n.a.
E- Water and waste treatment	0.5	0.8	0.9	-0.1	0.5	0.8	6	n.a.
N - Administrative services	4.7	4.1	-1.2	0.0	4.0	4.1	7	n.a.
H - Transport & storage	3.8	5.3	-0.3	-0.1	3.7	5.3	8	n.a.
F - Construction	6.4	6.8	-0.7	-0.3	5.8	6.5	9	n.a.
I - Accommodation & food	3.1	4.5	1.0	0.6	3.6	4.9	10	n.a.
A - Agriculture, forestry & fishing	1.4	3.5	-1.7	-3.1	1.1	2.3	n.a.	n.a.
B - Mining & quarrying	0.2	0.3	-0.4	-1.7	0.2	0.2	n.a.	n.a.
K - Finance & insurance	2.4	2.8	1.0	0.2	2.7	2.8	n.a.	n.a.
L - Real Estate	1.7	0.9	-0.1	0.9	1.6	1.0	n.a.	n.a.
O - Public sector & defence	8.2	7.1	0.5	-0.1	8.8	7.0	n.a.	n.a.
P - Education	11.1	7.4	0.5	0.3	12.0	7.7	n.a.	n.a.
Q - Health & social care	14.5	11.0	0.5	0.6	15.6	11.9	n.a.	n.a.
R - Arts & recreation and other services	2.2	1.7	0.2	0.3	2.3	1.7	n.a.	n.a.
S - Other service activities	2.4	2.6	1.1	0.0	2.8	2.6	n.a.	n.a.
T - Activities of households as employers	n.a.	0.9	0.5	-0.3	n.a.	0.9	n.a.	n.a.
U - Activities of extraterritorial org.	n.a.	0.1	n.a.	n.a.	n.a.	0.1	n.a.	n.a.

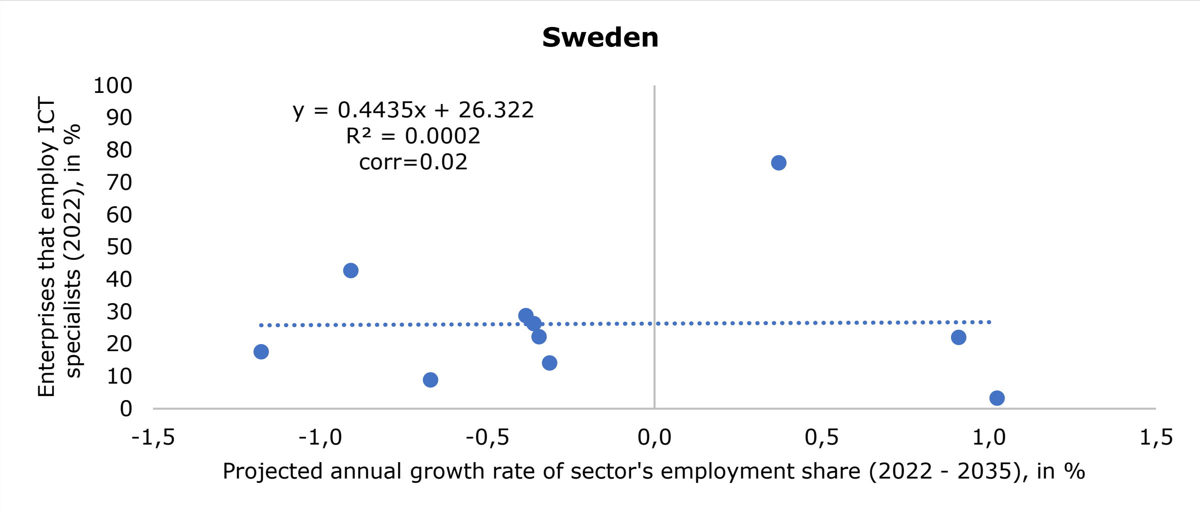
Source: For the employment-related indicators own elaboration on Eurostat data (share of employment, 2022 calculated based on lfsa_egan) and on Cedefop 'Skill forecast data 2023' (annual growth rate of sector's employment share, 2022-2035), for the digital transformation-related indicators: own elaboration on Eurostat data (share of enterprises that employ ICT specialists, Eurostat code: lfsa_egais) and on EUKLEMS & INTANProd data (digital capital intensity).
Note: In the first column of the table, the letter preceding the sectors is the code of the NACE Rev.2 classification. In the last two columns of the table, the two proxy indicators used for digital transformation are: i) the share of enterprises that employ ICT specialists (Eurostat code: lfsa_egais) and ii) the digital capital intensity (EUKLEMS & INTANProd data, average 2014-2017) with rank n°1 corresponding to the most digitally intense sector.

To complement Table 1, Figure 1 below examines the potential relationship between the sectors' degree of digital transformation and the projected annual growth rates in their employment shares.

In **Figure 1**, we present a scatterplot to shed light on a potential relationship between the proxy of the digital transformation used (percentage of enterprises that employ ICT specialists) and the projected annual growth rate of a sector's employment share between 2022-2035. The correlation is positive (0.02), but weak and not statistically significant (it is 0.62 and statistically significant for the EU27). **The lack of correlation implies that a sectoral-level association the percentage of enterprises that employ ICT specialists and the projected**

annual growth rate of a sector's employment share cannot be inferred in Sweden.

Figure 1 – SE. Relationship between the percentage of enterprises that employ ICT specialists (in 2022) and the projected annual growth rate of sector's employment share (2022-2035).



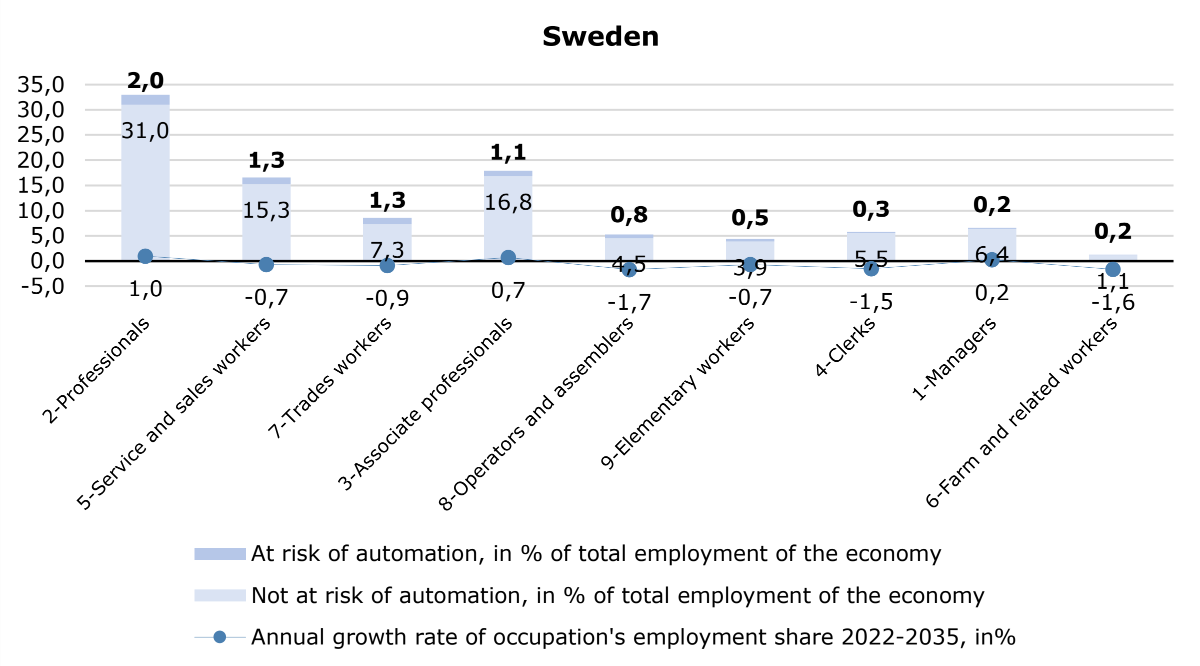
Source: Own elaboration on Eurostat and Cedefop 'Skill forecast 2023' data.

SE 1.2 Occupational composition at ISCO-08 1 digit and risk of automation (current and forward-looking perspectives)

Different occupations are subject to differing levels of automation risk. Cedefop developed[701] a "risk of automation" index by occupation at the EU27 level, most recently updated for 2022[702]. We apply this indicator at the Member State level, with the assumption that the risk of automation for a given occupation is constant across Member States[703]. As such, variation across Member States in the overall susceptibility of the workforce to automation (overall risk across all occupations in that Member State) will be due to the employment composition effect, meaning that while the automation risk for a given occupation stays constant across Member States, the overall automation risk of a Member State will naturally be greater for those Member States with more employment in occupations that have a higher automation risk.

[701] Based on the methodology in Pouliakas, K. (2018) "The risk of automation in EU labour markets: a skill-requirements approach", in Economy, Employment and Skills: European and global perspectives in an age of uncertainty, Fondazione Giacomo Brodolini Quaderni Series, also IZA DP 11829.
[702] As retrieved at https://www.cedefop.europa.eu/en/tools/skills-intelligence/automation-risk-occupations#1
[703] While this assumption may be considered strong, Cedefop data are the only ones available that are at the same time, up to date and available for all the occupations at the ISCO-08 level.

Figure 2 – SE. Employment shares of occupations (at ISCO-08 1 digit level) - split into sub shares 'not at risk' and 'at risk' of automation (2022) - and projected annual growth rate



Source: Own elaboration on Cedefop data (risk of automation calculated by Cedefop at EU27 level by ISCO-08 1 digit level for 2022) applied to Eurostat data (share of employment by occupation, lfsa_egais, 2022).
Note: The numbers preceding the occupations are the ISCO-08 codes. Occupations are ranked from the highest to the lowest share of workers that present a risk of automation. The vertical sum of the two components (darker blue and lighter blue) gives back the total employment share by occupation (in % of total employment in the Member State). The ISCO nomenclature used in the text and the figure is the Cedefop one. For examples of specific occupations see: https://esco.ec.europa.eu/en/classification/occupation_main.

As shown in **Figure 2**, in Sweden, the occupation with the largest employment sub-share (in % of total employment in the economy) 'at risk of automation' is Professionals, with an employment sub-share of workers 'at risk of automation' representing 2.0% of total employment in the country (vs 1.3% for the EU27). Ranking second regarding the employment sub-share of workers 'at risk of automation' are Service and sales workers, with an employment sub-share of workers 'at risk' of 1.3% of total employment in Sweden (vs 1.3% for the EU27). The third-ranked occupation is Trades workers, with a share of workers 'at risk' of 1.3% in total employment in Sweden (vs 1.3% for the EU27). **These three occupations are not the most affected across the EU27[704].**

For **ICT professionals (ISCO 25)**[705], the 2022 employment share is 5.6% in Sweden (vs 2.3% in the EU27) and its composition (as regards the risk of automation) is as follows: an employment sub-share of 0.3% (vs 0.1% in the EU27) is 'at risk of automation', whereas the remaining employment sub-share of 5.3% (vs 2.2% at EU27 level) is 'not at risk of automation'. The projected annual growth rate 2022-2035 of the employment share of ICT professionals is 0.7% in Sweden (vs 1.9% in EU27).

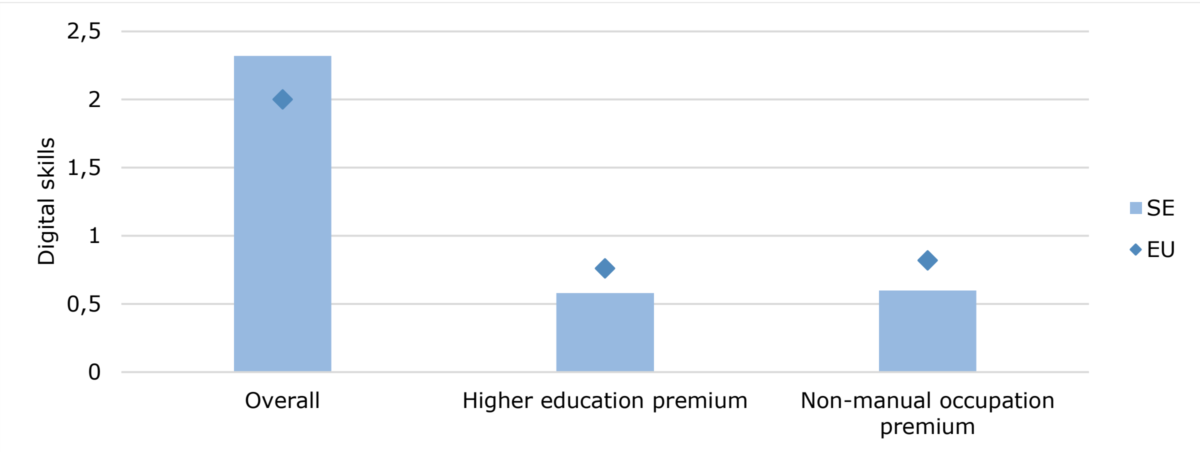
[704] The most affected in the EU27 are Trades workers, Professionals, and Service and sales workers.
[705] Eurostat code: lfsa_egai2d.

SE 2. Key policy dimensions for a socially fair digital transformation

SE 2.1 Digital skills

To ensure a socially fair digital transformation, a high level of digital skills within the population is an important prerequisite. **Sweden has one of the highest levels of digital skills in the EU**. The study's own estimated index of digital skills[706] (Figure 3, bar "Overall") ranks the level of digital skills in Sweden as the fourth highest in the EU. In the DESI Index for Human Capital[707] (Figure 5, section "Other dimensions"), Sweden equally ranks fourth among EU member states. Moreover, **digital divides between different socio-economic groups are among the lowest in the EU**. Differences between individuals with tertiary and lower than tertiary education ("Higher education premium" in Figure 3) as well as between individuals in manual and non-manual occupations ("Non-manual occupation premium" in Figure 3) are the fourth- and fifth lowest among EU Member States, respectively. The high overall level of digital skills and the relatively low level of inequality in digital skills are a significant potential asset for Sweden when it comes to managing the digital transformation in a socially fair way.

Figure 3 – Estimated Digital Skills in SE and the EU (2019)



Source: Authors' own estimation based on Eurostat ICT survey
Note: Higher education premium refers to the difference in digital skills between individuals with tertiary and lower than tertiary education. Non-manual occupation premium refers to the difference in digital skills between individuals in manual and non-manual occupations.

Skills are a key element of Swedish policy strategies on digitalisation, such as the overarching Swedish Digitisation strategy as well as the National Approach to AI and the Data Strategy[708]. A new national digitalisation strategy for the school system is currently being discussed[709]. Within the planned digital expenditure in

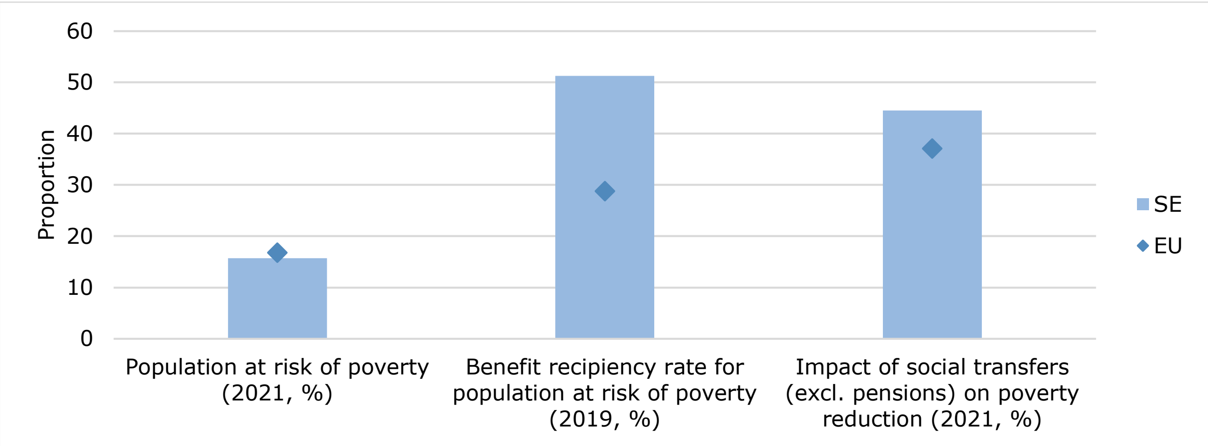
[706] The construction of the digital skill index is described in detail in the introductory section.
[707] European Commission (2022). Digital Economy and Society Index. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi
[708] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[709] For more information, see https://www.regeringen.se/pressmeddelanden/2023/03/forslag-pa-nationell-digitaliseringsstrategi-skickas-pa-remiss/

the Swedish NRRP, a large share of funding is allocated to human capital development (43.1%). The NRRP funding will be used to finance places in vocational training with a focus on data/IT or in other fields that are key for the digital transformation, as well as investment in education for digital skills[710].

SE 2.2 Social protection and social policy

Countries with more developed social protection systems may be in a better position to mitigate the potential impact of the digital transformation on the labour market. Figure 4 presents key indicators on social protection in Sweden relative to the rest of the EU. Overall, **Sweden is well positioned relative to other countries with regard to social protection**. The rate of the population at risk of poverty after social transfers[711] (15.7%), is somewhat lower than the EU27 rate, placing 14th in the EU27. Concerning the impact of social transfers on poverty reduction[712] (44.5%) and, particularly, the benefit recipiency rate for the population at risk of poverty before social transfers[713] (51.3%), Sweden is among the best-performing countries in the EU. When it comes to the regulation of the employment status of platform workers, one of the groups whose work is strongly shaped by digitalisation, there has overall been relatively limited discussion[714]. However, there are some examples of collective bargaining agreements between select digital labour platforms and trade unions[715].

Figure 4 – Social Protection in SE and the EU



Source: Eurostat (2023) and JRC (2022)

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[710] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance

[711] Eurostat (2023). TPS00184: At-risk-of-poverty rate after social transfers by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/tps00184/default/table?lang=en

[712] Eurostat (2023). TESPM050:Impact of social transfers (excluding pensions) on poverty reduction by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/TESPM050/bookmark/table?lang=en&bookmarkId=b001ae62-ce34-4b49-9741-28a3ef99477f

[713] Eurostat indicator as re-elaborated by JRC (2022) "Monitoring the effective coverage and adequacy of social protection in the EU".

[714] PPMI (2021). Study to support the impact assessment on improving working conditions in platform work. Available at: https://ec.europa.eu/social/main.jsp?catId=738&furtherPubs=yes&langId=en&pubId=8428

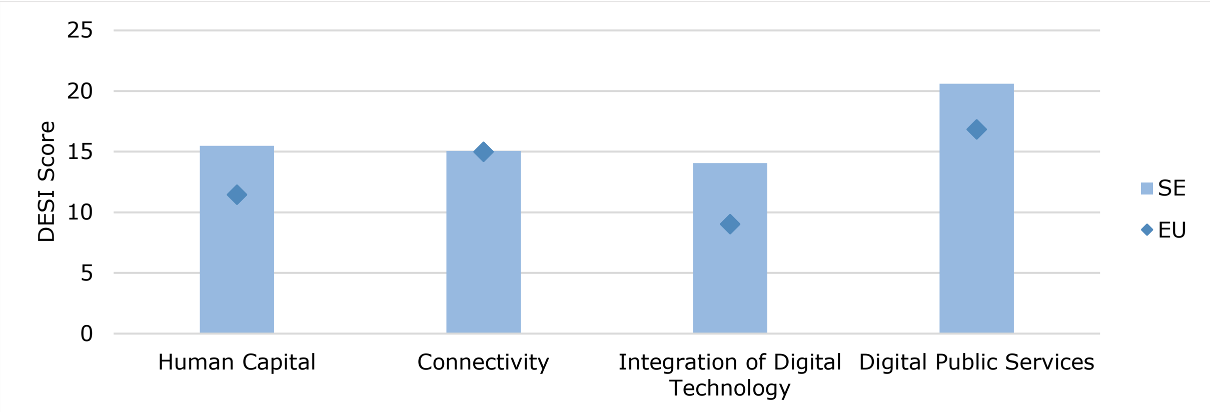
[715] See, for instance, Selberg (2023). Autonomous regulation of work in the gig economy. The first collective bargaining agreement for riders in Sweden. Available at. https://journals.sagepub.com/doi/10.1177/20319525231178980?icid=int.sj-full-text.similar-articles.9

The Swedish national implementation plan for the Recommendation on access to social protection[716] does not set out measures to improve the coverage, adequacy or transparency of social protection. However, given the existing coverage of the Swedish social protection system, there are only limited gaps in access to be addressed[717]. Platform workers are not specifically addressed in the plan. The Swedish NRRP does not include measures specifically focused on social protection, though there is social expenditure in a variety of categories, with the largest share dedicated to employment and skills (43.4%).

SE 3. Other dimensions relevant to the digital transformation

In addition to the two key policy dimensions digital skills and social protection, other dimensions are important contextual factors which may help or hinder in mitigating the impact of the digital transformation. The first contextual dimension that should be considered is the level of digitalisation in firms. **Sweden is a leader in the EU in this regard**. According to the DESI Index (Figure 5), **the level of integration of digital technologies in firms in Sweden is the third highest in the EU27**.

Figure 5 – DESI Index for SE and the EU



Source: European Commission (2022)

Other indicators confirm that Sweden is a leader in digitalisation of businesses. Levels of robot density[718] in the overall economy and the manufacturing sector, as well as digital capital intensity[719], are significantly higher than the EU average[720]. Growth in these two factors over the past decade has been relatively lower than the EU average, though this may partially be due to the existing relatively high stock. Swedish policy on digitalisation of businesses focuses mainly on facilitating public-private partnerships to facilitate research, development and

[716] European Commission (2023). Access to social protection. Available at: https://ec.europa.eu/social/main.jsp?catId=1312&langId=en=en
European Commission (2023).
Report from the Commission to the Council on the implementation of the Council Recommendation on access to social protection for workers and the self-employed. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023DC0043&qid=16764733477492
[718] As described in the Annex, based on data from the International Federation of Robotics (2010-2019). Data is not available for Cyprus, Greece, Luxembourg and Slovenia.
[719] As described in the Annex, based on data from EU-KLEMS (2008-2018). Data is not available for Cyprus, Croatia, Ireland and Romania.
[720] For Member States with available data

transfer of knowledge[721]. Both the National Approach to AI and the Data Strategy also put strong emphasis on the digitalisation of businesses[722]. Within the Swedish NRRP, investment in the digitalisation of businesses is not foreseen.

A second significant contextual factor to consider is digital infrastructure and digital public services. The level of digital public services in Sweden is the ninth highest in Europe, according to the DESI Index, as is the level of connectivity, though Sweden has fallen back relative to other EU countries in this dimension in the last years[723]. The Swedish NRRP allocates a major share of the planned digital expenditure towards connectivity (48.5%), while spending on digital public services constitutes only a marginal share (8.4%). Investment on connectivity will be used to support the expansion of broadband, particularly in sparsely populated areas[724], while measures on digital public services focus on the establishment of an administration-wide digital infrastructure.

[721] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[722] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[723] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance
[724] European Commission (2023); Recovery and Resilience Scoreboard Thematic Analyses. Connectivity. https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_connectivity.pdf

27. FINLAND: elements of a socially fair digital transformation

Key Points

Labour market: Currently, the Health and social care sector, which makes up the largest employment share in the Finnish economy, has the ninth highest sectoral degree of digital transformation (based on current digital capital intensity)[725]. The Health and social care sector is expected to slightly decrease in employment share in the economy over the next decade (contrary to EU27-level trends). ICT services, Energy supply services and Professional services are the three sectors with the highest degree of digital transformation currently, and their employment shares are projected to grow in the decade to come, slightly more than in the EU27. Workers in Professional occupations in Finland are most vulnerable to the risk of automation of their profession.

Digital skills: Finland has one of the highest levels of digital skills in the EU. Moreover, inequality in digital skill levels between different socio-economic groups is very low compared to other countries.

Social protection: Finland has a very well-developed social protection system and one of the lowest rates of the population at risk of poverty in the EU. However, there has been limited discussion on regulating the employment status of platform workers.

FI 1. The labour market and the digital transformation

FI 1.1 Sectoral composition (current and forward-looking perspectives)

In Finland ("FI"), in 2022, the sectors with the largest employment shares in the economy were: Health and social care (15.9% vs 11.0% at the EU27 level), Manufacturing (13.0% vs 16.0% at the EU27 level), and Wholesale and retail trade (11.1% vs 13.6% at EU27 level). For the period 2022-2035, CEDEFOP data projects the annual growth rate of a sector's employment share. For Finland's Health and social care sector, the annual growth rate is -0.6% (0.6% for the EU27), for the Manufacturing sector it is 0.2% (-0.2% for the EU27), and for the Wholesale and retail trade sector it is -0.4% (0.0% for the EU27).

[725] The ranking based on digital capital intensity is used in the key points only when the sector with the largest employment share is not rankable according to the percentage of enterprises that employ ICT specialists.

Table 1 presents each sector's employment share in 2022, the projected annual growth rates (2022-2035) of its employment share, and its resulting employment share in the economy by 2035. Along with these elements relating to employment, Table 1 also presents the degree of "digital transformation" of each sector. Table 1 thus enables comparison between the digital transformation of a sector and its employment share or its employment share's prospects. The degree of digital transformation is proxied for each sector in Table 1 using two indicators: i) the percentage of enterprises in the sector that employ ICT specialists and ii) the digital capital intensity[726] of the sector. Table 1 presents the ranking of each sector according to these two proxy indicators (with rank n°1 corresponding to the most digitised sector). According to the first indicator, the three sectors with the highest degree of digital transformation in Finland, in order, are ICT services (sector's employment share: 5.3% in FI vs 3.7% in the EU27), Energy supply services (0.6% vs 0.7%), and Professional services (7.3% vs 5.7%). According to the second indicator (digital capital intensity), the three sectors with the highest degree of digital transformation, in order, are ICT services (sector's employment share: 5.3% in FI vs 3.7% in the EU27), Wholesale and retail trade (11.1% vs 13.6%), and Professional services (7.3% vs 5.7%). These sectors' employment shares have a projected annual growth rate for 2022-2035 in Finland of 1.1% for ICT services (vs 0.8% for the EU27), 1.0% for Energy supply services (vs 0.1% for the EU27), 1.0% for Professional services (vs 0.6% for the EU27) and -0.4% for Wholesale and retail trade (vs 0.0% for the EU 27).

It is important to note that two of the four sectors with the highest degree of digital transformation – ICT services and Professional services – are also among the four sectors with the highest projected annual growth rate of employment share over the next decade in Finland[727]. Furthermore, the second and third largest sectors, by employment share[728] – Manufacturing and Wholesale and retail trade - rank fourth and sixth on the first proxy of digital transformation (% of enterprises that employ ICT specialists). Wholesale and retail trade sector also ranks second with the second proxy indicator for digital transformation (digital capital intensity).

Table 1 – FI. Sector's share of employment, annual growth rate, and ranking of "digital transformation" (the sectors are ranked according to the ranking in the last column of the table).

Sectors	Sector's employment share in 2022 (%)		Projected annual growth rate of the sector's employment share (2022 - 2035, %)		Projected sector's employment share in 2035 (%)		Proxy 1 for digital transformation (ranking)	Proxy 2 for digital transformation (ranking)
	FI	**EU**	**FI**	**EU**	**FI**	**EU**	**% enterprises that employ ICT specialists**	**Digital capital intensity**
J - ICT services	5.3	3.7	1.1	0.8	6.2	4.2	1	1

[726] 'Digital capital intensity' is an index – built in the context of this study – that looks at the ratio between the stock of capital the firms have in software and databases and the overall stock of capital excluding non-residential buildings. Its construction is based on the integrated EUKLEMS & INTANProd database, run by the Luiss Lab of European Economics at Luiss University in Rome, Italy. For more in-depth information on the source, and the availability of the indicator for Member States/sectors, please refer to the Annex.
[727] This is true for both the rankings based on the proxy indicators for digital transformation ('percentage of enterprises with ICT specialists' and 'digital capital intensity').
[728] The first sector in terms of employment share (in 2022) - Health and social care - was not rankable on one of the two proxies of digital transformation (% of enterprises that employ ICT specialists). It ranks ninth with the second proxy indicator for digital transformation (digital capital intensity).

G - Wholesale & retail trade	11.1	13.6	-0.4	0.0	10.6	13.6	6	2
M - Professional services	7.3	5.7	1.0	0.6	8.4	6.3	3	3
N - Administrative services	5.4	4.1	0.5	0.0	5.8	4.1	5	4
C - Manufacturing	13.0	16.0	0.2	-0.2	13.3	15.6	4	5
F - Construction	7.0	6.8	0.7	-0.3	7.8	6.5	8	6
H - Transport & storage	5.2	5.3	1.0	-0.1	6.0	5.3	7	7
Q - Health & social care	15.9	11.0	-0.6	0.6	14.7	11.9	n.a.	8
D - Energy supply services	0.6	0.7	1.0	0.1	0.7	0.8	2	9
O - Public sector & defence	4.8	7.1	-1.6	-0.1	3.8	7.0	n.a.	10
R - Arts & recreation and other services	2.4	1.7	0.7	0.3	2.7	1.7	n.a.	11
P - Education	7.1	7.4	-1.6	0.3	5.7	7.7	n.a.	12
E- Water and waste treatment	0.6	0.8	0.9	-0.1	0.7	0.8	n.a.	13
B - Mining & quarrying	0.2	0.3	-2.6	-1.7	0.2	0.2	n.a.	14
I - Accommodation & food	3.9	4.5	1.4	0.6	4.7	4.9	9	n.a.
A - Agriculture, forestry & fishing	3.1	3.5	-0.9	-3.1	2.8	2.3	n.a.	n.a.
S - Other service activities	3.1	2.6	0.6	0.0	3.4	2.6	n.a.	n.a.
K - Finance & insurance	1.9	2.8	0.6	0.2	2.0	2.8	n.a.	n.a.
L - Real Estate	1.1	0.9	-0.2	0.9	1.0	1.0	n.a.	n.a.
T - Activities of households as employers	0.3	0.9	0.5	-0.3	0.3	0.9	n.a.	n.a.
U - Activities of extraterritorial org.	n.a.	0.1	n.a.	n.a.	n.a.	0.1	n.a.	n.a.

Source: For the employment-related indicators own elaboration on Eurostat data (share of employment, 2022 calculated based on lfsa_egan) and on Cedefop 'Skill forecast data 2023' (annual growth rate of sector's employment share, 2022-2035), for the digital transformation-related indicators: own elaboration on Eurostat data (share of enterprises that employ ICT specialists, Eurostat code: lfsa_egais) and on EUKLEMS & INTANProd data (digital capital intensity).
Note: In the first column of the table, the letter preceding the sectors is the code of the NACE Rev.2 classification. In the last two columns of the table, the two proxy indicators used for digital transformation are: i) the share of enterprises that employ ICT specialists (Eurostat code: lfsa_egais) and ii) the digital capital intensity (EUKLEMS & INTANProd data, average 2014-2017) with rank n°1 corresponding to the most digitally intense sector.

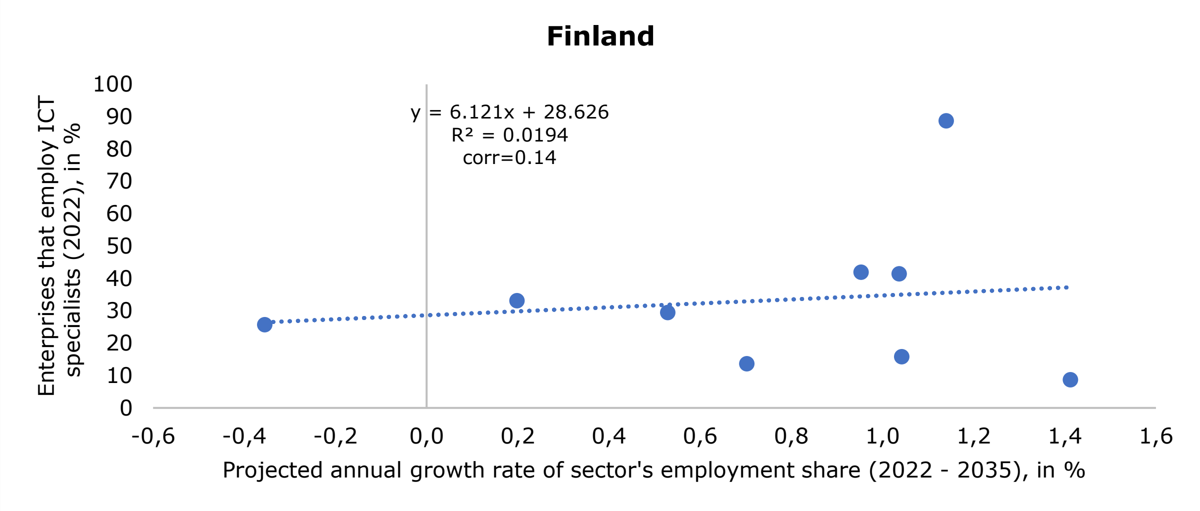
Figures 1a and 1b (below) complement Table 1, further enabling a comparison between the projected annual growth rates of the sectors' employment shares in the economy and their digital transformation[729].

In **Figure 1a**, we present a scatterplot to explore this relationship between the first proxy of digital transformation used (percentage of enterprises that employ ICT specialists) and the projected annual growth rate of a sector's employment share between 2022-2035. The correlation is positive - 0.14 - but not statistically significant (it is 0.62 and statistically significant for the EU27). **The statistically insignificant correlation implies that an association between the percentage of enterprises in a sector that employ ICT specialists, and that**

[729] With the caveat that the correlation coefficients presented in Figure 1a and Figure 1b cannot be directly compared, as they pertain to a combination of sectors that varies across different Member States.

sector's projected annual employment share growth rate cannot be inferred at the sectoral level in Finland.

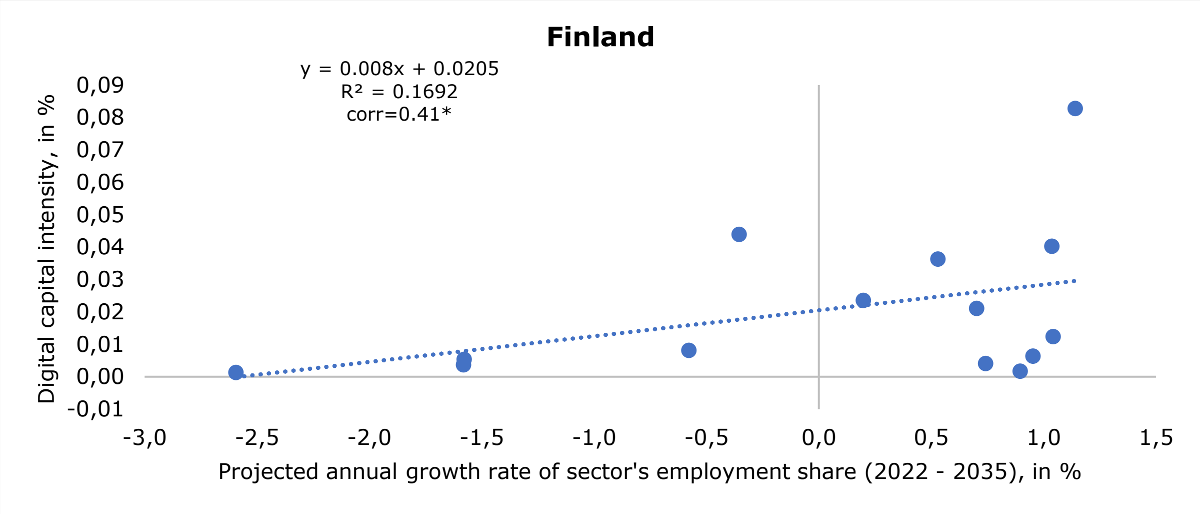
Figure 1a – FI. Relationship between the percentage of enterprises that employ ICT specialists (in 2022) and the projected annual growth rate of sector's employment share (2022-2035).



Source: Own elaboration on Eurostat and Cedefop 'Skill forecast 2023' data.

Figure 1b shows the correlation between the *second* digital transformation proxy ('digital capital intensity') and the projected annual growth rate of a sector's employment share between 2022 and 2035. The correlation coefficient is 0.41 and is statistically significant in Finland. Among the 16 Member States for which the 'digital capital intensity' can be computed (7 of which present a positive and significant correlation), Finland ranks seventh. In this case, **the positive correlation could suggest that, in Finland, the employment shares of those sectors with a higher 'digital capital intensity' are more likely to experience a higher rate of growth (over 2022-2035) than other sectors.** However, the relationship is only moderately strong and below the average of the seven Member States presenting a positive and significant correlation. However, this correlation does not imply causal links.

Figure 1b – FI. Relationship between 'digital capital intensity' and the projected annual growth rate of sector's employment share (2022-2035).



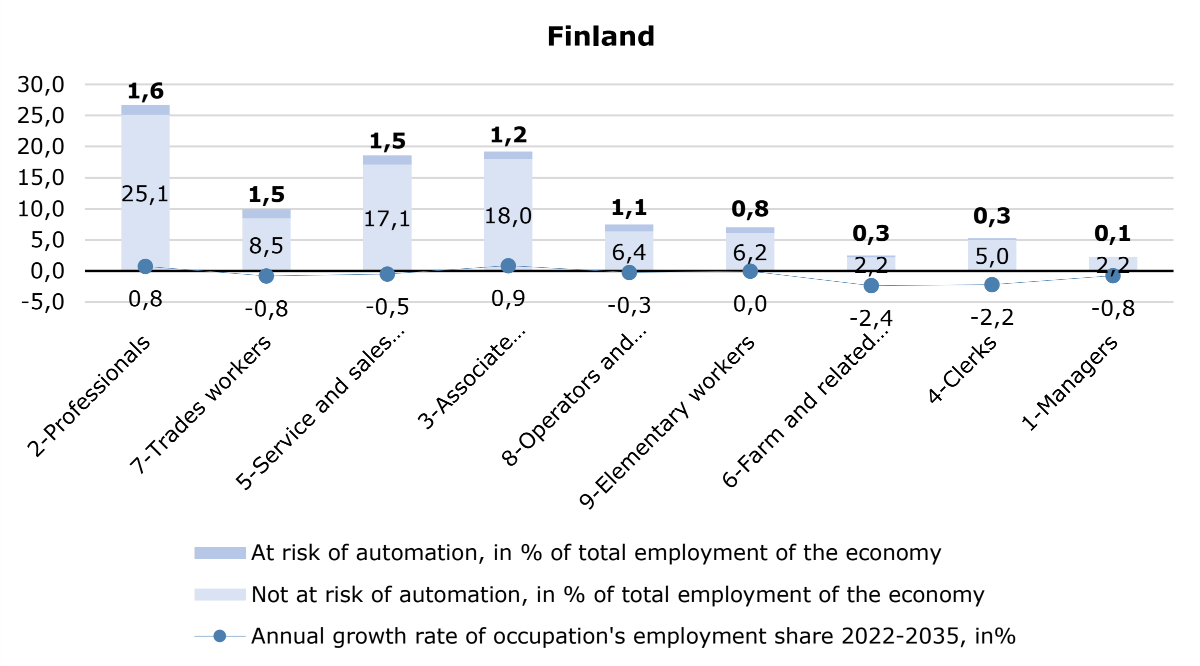
Source: Own elaboration on EUKLEMS & INTANProd, and Cedefop 'Skill forecast 2023' data.

FI 1.2 Occupational composition at ISCO-08 1 digit and risk of automation (current and forward-looking perspectives)

Different types of occupations are subject to differing levels of automation risk. CEDEFOP developed[730] a "risk of automation" index by occupation at the EU27 level, with the most recent data available for 2022[731]. We apply this indicator at the Member State level, with the assumption that the risk of automation for a given occupation is constant across Member States[732]. As such, variation across Member States in the overall susceptibility of a Member State's workforce to automation (overall risk across all occupations in that Member State) will be due to the employment composition effect. This means that while the automation risk for a given occupation stays constant across Member States, the overall automation risk of a Member State will naturally be greater for those Member States having more employment in occupations that have a higher automation risk.

[730] Based on the methodology in Pouliakas, K. (2018) "The risk of automation in EU labour markets: a skill-requirements approach", in Economy, Employment and Skills: European and global perspectives in an age of uncertainty, Fondazione Giacomo Brodolini Quaderni Series, also IZA DP 11829.
[731] As retrieved at https://www.cedefop.europa.eu/en/tools/skills-intelligence/automation-risk-occupations#1
[732] While this assumption may be considered strong, Cedefop data are the only ones available that are at the same time, up to date and available for all the occupations at the ISCO-08 level.

Figure 2 – FI. Employment shares of occupations (at ISCO-08 1 digit level) - split into sub shares 'not at risk' and 'at risk' of automation (2022) - and projected annual growth rate



Source: Own elaboration on Cedefop data (risk of automation calculated by Cedefop at EU27 level by ISCO-08 1 digit level for 2022) applied to Eurostat data (share of employment by occupation, lfsa_egais, 2022).
Note: The numbers preceding the occupations are the ISCO-08 codes. Occupations are ranked from the highest to the lowest share of workers that present a risk of automation. The vertical sum of the two components (darker blue and lighter blue) gives back the total employment share by occupation (in % of total employment in the Member State). The ISCO nomenclature used in the text and the figure is the Cedefop one. For examples of specific occupations see: https://esco.ec.europa.eu/en/classification/occupation_main.

As can be seen in **Figure 2**, in Finland, the occupation with the largest employment sub-share (in % of total employment in the economy) 'at risk of automation' is Professionals, with said sub-share representing 1.6% of total employment in the country (vs 1.3% for the EU27). Trades workers make up the second largest employment sub-share of workers 'at risk of automation', with an employment sub-share of workers 'at risk' of 1.5% of total employment in Finland (vs 1.3% for the EU27). Third are Service and sales workers, with a share of workers 'at risk' of 1.5% in total employment in Finland (vs 1.3% for the EU27). **Among these three occupations, only the third one is also the most affected across the EU27[733].**

For **ICT professionals (ISCO 25)**[734], the 2022 employment share is 4.3% in Finland (vs 2.3% in the EU27), of which an employment sub-share of 0.3% (vs 0.1% in the EU27) is 'at risk of automation'. The remaining employment sub-share of 4.0% (vs 2.2% at EU27 level) is 'not at risk of automation'. The projected annual growth rate 2022-2035 of the employment share of ICT professionals is 0.9% in Finland (vs 1.9% in EU27).

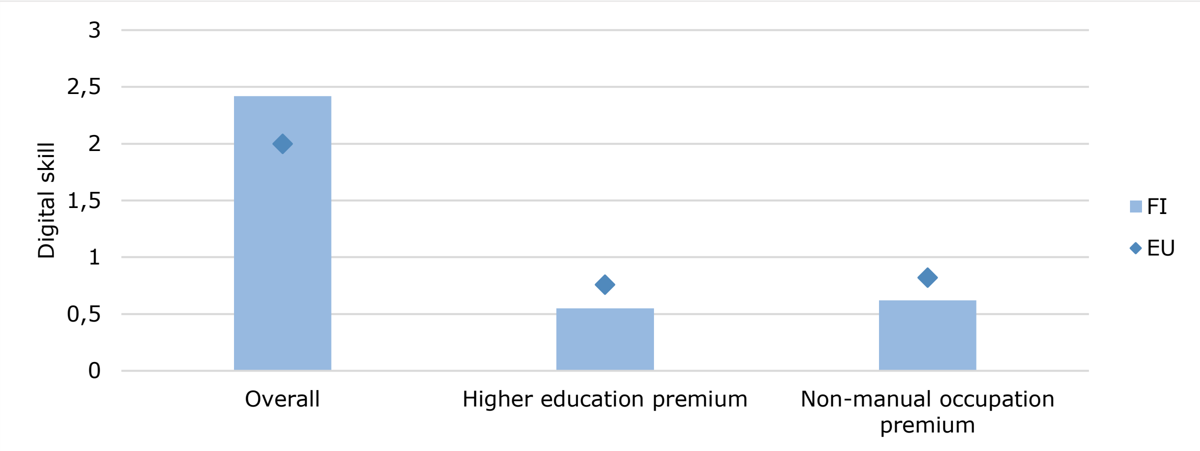
[733] The most affected in the EU27 are Trades workers, Professionals, and Service and sales workers.
[734] Eurostat code: lfsa_egai2d.

FI 2. Key policy dimensions for a socially fair digital transformation

FI 2.1 Digital skills

Digital skills are one of the key dimensions for ensuring a socially fair digital transformation. Finland has one of the highest levels of digital skills in the EU. The DESI index for human capital[735] (Figure 5 in section "Other dimensions") and the study's own estimated index of digital skills[736] (Figure 3, bar "Overall") rank Finland first and second among EU member states, respectively. Moreover, compared to the EU level, digital divides are also very low in Finland. While individuals with tertiary education and in non-manual occupations have higher levels of digital skills, both these gaps ("Higher education premium" and "Non-manual occupation premium" respectively in Figure 3) are among the lowest in Europe, ranking third and sixth among Member States, respectively. **The high overall level of digital skills and the relatively low inequality in such skills across the population constitute a significant strength for Finland with regard to a socially fair digital transformation.**

Figure 3 – Estimated Digital Skills in FI and the EU (2019)



Source: Authors' own estimation based on Eurostat ICT survey
Note: Higher education premium refers to the difference in digital skills between individuals with tertiary and lower than tertiary education. Non-manual occupation premium refers to the difference in digital skills between individuals in manual and non-manual occupations.

Looking to future development, in 2022, Finland adopted a national digital compass, in response to the EU Digital Compass, setting out a roadmap for managing the digital transformation, including objectives for a digitally skilled labour force and population[737]. The digital compass in Finland builds on previous policy strategies in the realm of digitalisation. For instance, in 2017, Finland launched the Artificial Intelligence Program[738], updated in 2020, which includes policies to strengthen lifelong learning and VET (Vocational Education and Training) to increase skills supply within the context of labour market disruption

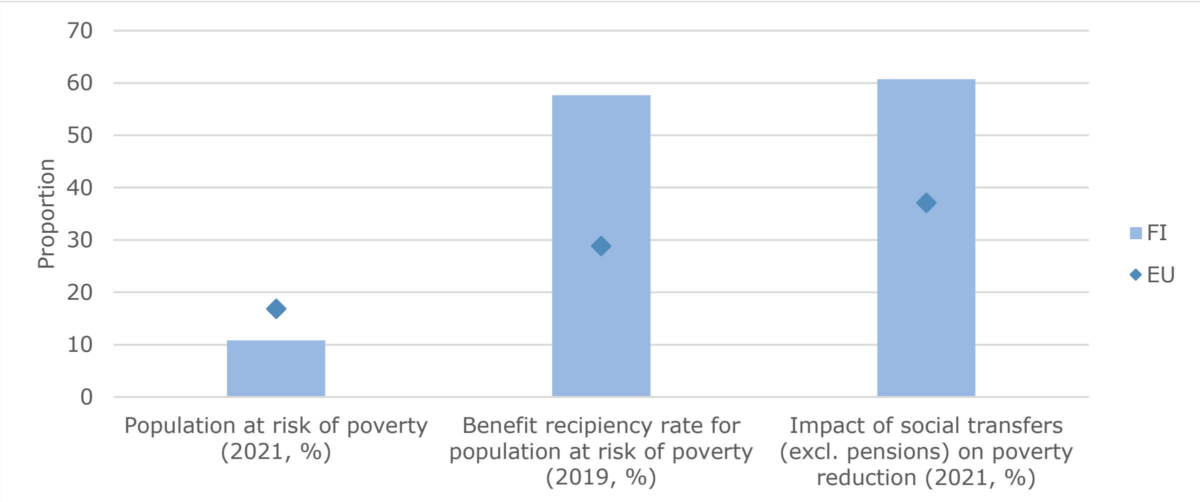
[735] European Commission (2022). Digital Economy and Society Index. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi
[736] The construction of the digital skill index is described in detail in the introductory section.
[737] For more information, see https://julkaisut.valtioneuvosto.fi/handle/10024/164472
[738] For more information, see https://vm.fi/en/national-artificial-intelligence-programme-auroraai

due to automation. Planned digital expenditure also plays a significant role within the NRRP for Finland (34.9%). Within the digital pillar, digital skills play only a marginal role, with 1% of digital expenditure devoted to human capital. However, this reflects the existing high stock of digital skills in Finland. Interestingly, in addition to measures aimed at increasing the general level of digital skills, the NRRP also contains an initiative to increase the cybersecurity skills of the population through a dedicated digital platform[739].

FI 2.2 Social protection and social policy

Countries with higher levels of social protection coverage and adequacy may be better equipped to address the potential employment and income effects of the digital transformation. Compared to the EU level, **Finland has high levels of social protection coverage and adequacy** (Figure 4). The rate of the population at risk of poverty[740] is the second lowest in the EU, at 10.8%. Both the benefit recipiency rate for the population at risk of poverty before social transfers[741] (60.7) and the impact of social transfers on poverty reduction[742] (57.7%) are also the second highest in the EU. However, as regards the regulation and social protection of people working through platforms, there has so far been only a relatively limited discussion of issues relating to the potential misclassification and regulation of employment status[743].

Figure 4 – Social Protection in FI and the EU



Source: Eurostat (2023) and JRC (2022)

[739] European Commission (2022); Recovery and Resilience Scoreboard Thematic Analyses. Digital Skills. Available at: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_digital_skills.pdf
[740] Eurostat (2023). TPS00184: At-risk-of-poverty rate after social transfers by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/tps00184/default/table?lang=en
[741] Eurostat indicator as re-elaborated by JRC (2022) "Monitoring the effective coverage and adequacy of social protection in the EU".
[742] Eurostat (2023). TESPM050:Impact of social transfers (excluding pensions) on poverty reduction by sex. Available at: https://ec.europa.eu/eurostat/databrowser/view/TESPM050/bookmark/table?lang=en&bookmarkId=b001ae62-ce34-4b49-9741-28a3ef99477f
[743] PPMI (2021). Study to support the impact assessment on improving working conditions in platform work. Available at: https://ec.europa.eu/social/main.jsp?catId=738&furtherPubs=yes&langId=en&pubId=8428

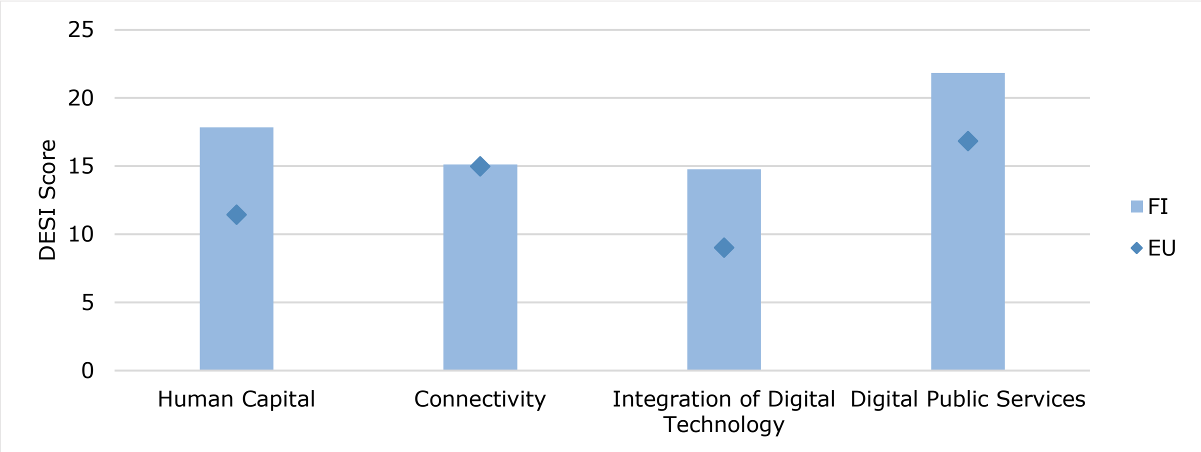
Looking at future social protection measures, the Finnish national implementation plan for the Recommendation on access to social protection contains planned measures to improve the adequacy of social protection. While coverage is not specifically addressed within the plan, coverage of social protection in Finland is already very advanced, so that there are limited gaps to be addressed based on European Commission monitoring[744]. However, measures specifically targeted at platforms workers are not included in the policy plans set out. Considering the planned social expenditure in the Finnish NRRP, the majority of this expenditure is allocated to spending on health and long-term care (58.8%). A substantial portion is also targeted at employment and skills (32%), while social policies play a marginal role (6.7%).

FI 3. Other dimensions relevant to the digital transformation

Broader contextual factors [745]are also significant for advancing a socially fair digital transformation. The first of these is the level of digital transformation in firms. **Overall, the digitalisation of firms is advanced in Finland.** According to the DESI index (Figure 5), Finland ranks first in the EU27 with regard to the integration of digital technologies in companies. Levels of robot density[746] in both the manufacturing sector as well as in the economy as a whole are also higher than the EU average[747]. However, it should be noted that in contrast to most other countries, where robot density is increasing, levels of robots in firms have decreased slightly in Finland between 2010 and 2019. Moreover, as regards digital capital intensity[748], overall levels in Finland are lower than the EU average[749], and between 2008 and 2018, the growth rate on this dimension in Finland was lower than the EU average growth rate. Finnish policy measures such as the Digital Progress Programme are designed to further advance digitalisation of businesses. Looking at the Finnish NRRP, out of the planned digital expenditure, 13.7% is targeted at digitalisation in firms. One of the measures included in the Finnish NRRP focuses specifically on business development for micro and small enterprises, with digital solutions being a key application criterion. In addition to this, the Artificial Intelligence Programme includes measures to support business development in the field of AI in Finland.

[744] European Commission (2023). Report from the Commission to the Council on the implementation of the Council Recommendation on access to social protection for workers and the self-employed. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023DC0043&qid=1676473347749
[745] For more information, see https://vm.fi/en/programme-for-the-promotion-of-digitalisation
[746] As described in the Annex, based on data from the International Federation of Robotics (2010-2019). Data is not available for Cyprus, Greece, Luxembourg and Slovenia.
[747] Average calculated for Member States for whom data was available.
[748] As described in the Annex, based on data from EU-KLEMS (2008-2018). Data is not available for Cyprus, Croatia, Ireland and Romania.
[749] Average calculated for Member States for whom data was available.

Figure 5 – DESI Index for FI and the EU (2022)



Source: European Commission (2022)

Looking at other infrastructural factors, compared to the rest of the EU, Finland has very high levels of connectivity and of digital public services. According to the DESI index (Figure 5), connectivity levels in Finland rank as the eighth highest in the EU27, while the country is in second place for digital public services. However, one issue to be highlighted is that Finland lags behind in the provision of Very High Capacity Network (VHCN) coverage, particularly in rural areas.[750] This issue is intended to be tackled in the national broadband plan and digital infrastructure strategy. Looking at planned digital expenditure within the Finnish NRRP, by far the largest share will be dedicated to digitalisation in the public sector (72.5%). Measures included under this dimension encompass, among others, policies to digitalize public administration and advance the digitalisation of public services for the public and businesses[751]. A reform of public employment services is also planned, for instance, by using digital innovations to develop personalised services for job-seekers. The share, within the NRRP planned digital expenditure, that is devoted to connectivity, is relatively low in comparison (6.9%), containing measures to increase quality and availability of high-speed connectivity networks. However, the NRRP does contain some additional measures to improve VHCN coverage in rural areas.

[750] European Commission (2023). Countries' performance in digitisation. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance

[751] European Commission (2021); Recovery and Resilience Scoreboard Thematic Analyses. Digital public services. Available at :https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/2_Digital.pdf

ANNEX I

Construction of the study's own estimated index of the level of digital skills in EU Member States

We construct an index to measure the level of digital skills within the population of EU Member States. To this end, we employ microdata from the **EU Survey on ICT usage in households and by individuals**, an annual survey conducted by Eurostat since 2002. This survey aims to collect and disseminate harmonized and comparable information on the use of ICT in households and by individuals.

We base our measure of individuals' level of digital skills on the official Eurostat digital skills indicator. The Eurostat indicator on "individuals' level of digital skills" is a composite indicator which aggregates a number of (sub-)indicators of digital skills to derive an indicator of digital skill, which can take 3 values: none; basic; above basic. Specifically, the composite indicator is defined as the percentage of individuals aged 16-74 performing selected activities in four specific areas: information, communication, problem-solving, software skills. Therefore, the indicator can be considered as a proxy of the digital competencies and skills of individuals" (Eurostat, 2021).[752] **Error! Reference source not found.**A1 summarizes the measures of digital skills contained within the indicator.

Table A1 – Summary of the four components of the Eurostat main composite indicator "individual's level of digital skills"

First component	Second component
Information skills*	Communication skills*
Copied or moved files or folders;	Sending/receiving emails;
Saved files on Internet storage space;	Participating in social networks;
Obtained information from public authorities/services' websites;	Telephoning/video calls over the internet;
Finding information about goods or services;	Uploading self-created content to any website to be shared.
Seeking health-related information.	
Third component	Fourth component
Problem solving skills	Software skills (for content manipulation)
List A - problem solving: -Transferring files between computers or other devices; - Installing software and applications (apps) - Changing settings of any software, including operational system or security programs.	List A: - Used word processing software; - Used spreadsheet software; - Used software to edit photos, videos or audio files.

[752] https://ec.europa.eu/eurostat/cache/metadata/en/tepsr_sp410_esmsip2.htm

List B - familiarity with online services: - Online purchases (in the last 12 months); - Selling online; - Using online learning resources; - Internet banking.	List B: - Created presentation or document integrating text, pictures, tables or charts; - Used advanced functions of spreadsheet to organise and analyse data (sorting, filtering, using formulas, creating charts); - Have written a code in a programming language.

Note: The four components are derived from the Digital Competence Framework. ([753])

Source: Extraction from Eurostat https://ec.europa.eu/eurostat/cache/metadata/en/tepsr_sp410_esmsip2.htm

Taking inspiration from the Eurostat methodology, we create a continuous measure of individuals' digital skills. Specifically, we employ the same variables that Eurostat uses in constructing a measure of an individual's digital skills, and convert these variables into a continuous measure. To this end, we first convert all measures of digital skills that form part of the Eurostat indicator into binary dummy variables. For each of the 22 digital skill variables, these dummy variables take on value 1 if individuals employ these skills, and 0 if they do not (e.g. the variable takes on the value 1 if individuals have copied or moved files or folders, and 0 if they have not). In the microdata, the full set of dummy variables is available for the years 2015, 2016, 2017 and 2019, so that we are able to measure time variation in digital skills.

In order to construct a continuous measure of digital skills based on the 22 dummy variables, we use an item response theory (IRT) model. IRT is a methodology for aggregating a number of items, such as our binary variables capturing various aspects of digital skill, in order to capture an underlying trait, in this case true digital skills (OECD, 2016) ([754]). IRT is widely established as a method for constructing measures of skill and ability. For instance, it is used by the OECD to construct measures of skills use in the Survey of Adult Skills (PIAAC) (Ibid.). Briefly, based on individuals' responses for each variable (or item) capturing a specific digital skill, the model used in this study estimates this item's difficulty (i.e. what should be the level of underlying true digital skills overall in the population for 50% of individuals to be able to perform this item) and discrimination (a slope parameter indicating how steeply the likelihood of an individual performing this item changes as true digital skills increase) (DeMars, 2010) ([755]). The implication is that the IRT models allows to attribute an estimated

[753] Here we refer to the definition given in the metadata (Eurostat 2021a): "Information skills: identify, locate, retrieve, store, organise and analyse digital information, judging its relevance and purpose."; "Communication skills communicate in digital environments, share resources through online tools, link with others and collaborate through digital tools, interact with and participate in communities and networks, cross-cultural awareness."; "Problem solving skills : identify digital needs and resources, make informed decisions as to which are the most appropriate digital tools according to the purpose or need, solve conceptual problems through digital means, creatively use technologies, solve technical problems, update one's own and others' competences."; "Create and edit new content (from word processing to images and video); integrate and re-elaborate previous knowledge and content; produce creative expressions, media outputs and programming; deal with and apply intellectual property rights and licences.". The Digital Competence Framework 2.0 is also available here https://ec.europa.eu/jrc/en/digcomp/digital-competence-framework.

[754] OECD (2016). The Survey of Adult Skills: Reader's Companion, Second Edition. Paris: OECD Publishing.

[755] DeMars, C. (2010). Item Response Theory. Oxford: Oxford University Press.

differentiated level of difficulty to each of the 22 digital skills items from the ICT survey, rather than simply assuming they have the same level of difficulty and averaging an individual's performance on each of them. This is important as the level of true digital skills associated with a given item is likely to vary between items (e.g. the level of underlying true digital skills associated with writing code in a programming language is likely higher than that associated with sending or receiving emails).

In a second step, the IRT model (i.e. the difficulty and discrimination parameters for each of the 22 digital skills items) is then used to predict a level of true digital skills for each individual within the microdata, based on the individual's responses to these 22 items measuring digital skills. This prediction was then rescaled so that the average level of true digital skills in the population has a mean level of 2 (for EU27 level) and standard deviation of 1 within the pooled sample of EU Member States.

For the purpose of the country fiche exercise, we calculate – based on the aforementioned methodology - the estimated level of digital skill in each member state and the EU27 for the most recent year available, 2019. Moreover, we also examine divides in digital skills between different socio-economic groups, which are an important measure of inequality. To examine divides in digital skills, we calculate measures of digital skill across subgroups and, subsequently, gaps in digital skill between them. Specifically, we examine **gaps in digital skills between individuals with tertiary and non-tertiary education, as well as in manual and non-manual occupations**. Higher gaps can be interpreted as indicative of greater inequality in digital skill across population groups.

Construction of the digital capital intensity index

We construct an index of the digital transformation that looks at the ratio between the stock of capital firms have in software and databases[756], and the overall stock of capital excluding non-residential buildings. The resulting measure can be interpreted as an indicator of digital capital intensity, at the country/industry level. For this, we use data from the new integrated EUKLEMS & INTANProd database, run by the Luiss Lab of European Economics at Luiss University in Rome, Italy. EUKLEMS includes information on gross output, gross value added, employment, number of hours worked, compensation of employees, as well as investment in capital stocks across both tangible and intangible assets for all the EU 27 Member States. EUKLEMS & INTANProd updates this widely-used EUKLEMS productivity database and extends it with new estimates of intangible investment coherent with INTAN-Invest (www.intaninvest.net). The dataset covers all EU countries for the period 1995-2019, and provides both measures of investment (flows) and stock of capital. We opt for looking at the capital stock, as this is less volatile and provides a better description of the extent of the ongoing digitalization process. More specifically, our index of digital capital intensity is defined as:

$$DigitalCapitalIntensity_{it} = \frac{K\_Soft\_Db_{it}}{({K_{Intang}}_{it} + {K_{TangNRes}}_{it})}$$

[756] See Carol Corrado & Charles Hulten & Daniel Sichel, 2009. "Intangible Capital And U.S. Economic Growth," Review of Income and Wealth, International Association for Research in Income and Wealth, vol. 55(3), pages 661-685, September.

where K_Soft_Db is the series on net capital stock in computer software and databases, K_{Intang} is total intangibles, and $K_{TangNRes}$ is total tangible assets excluding non-residential buildings. i refers to the industry and t to time.

Note that this index is subject to a few limitations, namely it cannot be computed for eleven Member States plus the EU27 which present only aggregated data. Furthermore, for the remaining Member States that present disaggregated data by sector, there is heterogeneity in data availability (see Table 3 here below for the availability of sectors). Finally, due to time inconsistencies in the availability of the necessary data, we take the average 2014-2017 to ensure the homogeneity of this variable. Table A2 shows the availability of the digital capital intensity index by country and sector. Avilability of the index at country level – used in the section on other dimensions relevant to the digital transformation is larger – and the index is for all EU countries except Cyprus, Croatia, Ireland and Romania.

Table A2 – Availability of EUKLEMS & INTANProd data by sector and by Member State for constructing the Digital Capital Intensity index.

MS/NACE Rev.2	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
BE	Y	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
BG	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
CZ	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
DK	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
DE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	N	N
EE	Y	Y	N	Y	Y	Y	N	N	Y	N	Y	Y	Y	Y	Y	Y	N	Y	Y	N	N
IE	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
EL	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
ES	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
FR	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
HR	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
IT	Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
CY	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
LV	Y	N	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
LT	Y	Y	N	Y	Y	Y	N	N	N	N	Y	Y	Y	Y	Y	N	Y	Y	Y	N	N
LU	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N	Y	Y	Y	Y	Y	N	N
HU	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
MT	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
NL	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
AT	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N	N
PL	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
PT	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
RO	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
SI	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	N	N
SK	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
FI	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
SE	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
EU27	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N

Note: according to the NACE Rev.2 activities classification the following applies A - Agriculture, forestry and fishing, B - Mining and quarrying, C – Manufacturing, D - Electricity, gas, steam and air conditioning supply, E - Water supply, sewerage, waste management and remediation activities, F – Construction, G - Wholesale and retail trade, H - Transportation and storage, I - Accomodation and food service activities, J - Information and communication, K - Financial and insurance activities, M - Professional, scientific and technical activities, N - Administrative and support service activities, O - Public administration and defence, compulsory social security, P – Education, Q - Human health and social work activities, R - Arts, entertainment and recreation, S - Other services activities, T - Activities of households as employers (undifferentiated goods), U - Activities of extraterritorial organisations and bodies.

Construction of the robot density measure

To capture uptake of robotics within countries, we compute an index that we refer to as **robot density**. The main data source of reference for this measure is the International Federation of Robotics (IFR) *Industrial and Service Robots* dataset. The IFR effectively collects data on installations of robotic equipment from robot manufacturers and cross-checks the result with statistics from national institutes of robotics to ensure high levels of reliability. It should be noted that, while the IFR represents the most reputable source of information on the global market for robots, it lacks distinction as to the quality of the installed equipment. This means that each robotic installation is counted as one, regardless of the quality level or the price it cost to acquire it.

The relevant variables used in building the index are the operational stock of robots and the corresponding number of employees in a given country-industry-year cell. The former is calculated by the IFR adding the new installations that occur each year to the available stock. Each robot is assumed to have an average service year of 12 years, with an immediate withdrawal from service afterwards, at which point it ceases to contribute to the operational stock figure.

Robot density is computed, straightforwardly, as

$$RobotDensity_{it} = \frac{OperationalStock_{it}}{Employees_{it}}$$

where *i* refers to the industry and *t* to time (the country index is omitted), and it can be read as the number of robots per thousands of employees.

In the country fiches, we include measures of robot density in both the total economy and in manufacturing (both for 2019), the sector where robots are most present, as well as growth therein in the ten most recent years available (2010-2019). The index is available for all EU countries except Cyprus, Greece, Luxembourg and Slovenia.

ANNEX II

Literature Review: a mapping and discussion of the various channels through which the digital transformation impacts labour market dynamics

To contextualize this study, a succinct yet comprehensive literature review is provided, which explores the channels through which the digital transformation impacts or may impact labour market dynamics and hence poverty and income inequality. In addition to the mapping of channels through which the digital transformation may impact poverty and income inequality, it also provides a brief description of the impact of the digital transformation on purchasing power and how these effects may differ along the income distribution.

The literature review is structured as follows. Section A.1 serves an introductory function and discusses seminal contributions. Section A.2 explores the labour demand channel. It investigates, inter alia, the pattern of job polarisation, the risk of automation and the potential role of robots. Section A.3 addresses labour supply. Section A.4 focuses on the functional distribution of labour and capital. Section A.5 looks at the role of platforms in the digital transformation, at how this business model has gained prominence in the recent past and at both the challenges and opportunities that this phenomenon could hold. Section A.6 concludes with some remarks on how the digital transformation may affect purchasing power and other measures of consumer welfare.

A.1. Seminal Contributions

This section reviews some of the earlier attempts to look at the impact of technology, specifically Information and Communication Technology (ICT), on labour market outcomes. While the study's primary interest lies in unpacking dynamics at the EU level, studies assessing the Anglo-Saxon world constitute key contributions to the literature and strongly informed and influenced subsequent scholarship. Indeed, as will be made clear in the following paragraphs, even research covering continental Europe makes extensive use of the "Skill-Biased" and "Routine-Biased Technological Change" frameworks, which were predominantly formalised with respect to the US and UK labour markets. These theories will be defined in the following paragraphs.

Technological progress has always been incorporated into economic theories as an engine for growth, and it was often attributed the status of a panacea. Throughout the last century the commonplace argument was that the economic pie would have grown bigger thanks to the introduction of these new innovations, and everyone would have benefitted from it. It was only in the 1970s that new observations on wage dynamics revealed that some people were actually worse off , pointing to a possible negative impact of digital technologies on labour market outcomes. Indeed, commentators noticed a surge in wage inequality, which was largely brought about by the rise of the relative wages of college-educated workers with respect to the rest of the population. Most of these commentators attributed this phenomenon to the technological innovations that were introduced at the time, launching the now famous theory of Skilled Biased Technological Change (hereafter, SBTC). The intuition behind this hypothesis is that new technologies are complementary to highly skilled workers, whereas they either substitute or are neutral with respect to low-skilled labour. Accordingly, individuals who join the labour market with a college degree will reap the productivity gains afforded by ICT usage in the form of an educational premia, whereas those with only secondary education will suffer degrading labour market outcomes since their productivity is not augmented by the new technologies. Thus, this mechanism predicts a monotonically increasing relationship between skill level and wages. On the one hand, for instance, managers (who generally come from the high end of the educational distribution) can overview and control highly fragmented global value chains leveraging ICT, greatly increasing efficiency and output. On the other hand, the prerogatives of brick layers, or of waiters, have not been significantly altered by ICT adoption, and the output per worker of these categories has remained stagnant.

What follows is an overview of the first scientific contributions to the topic. Bound and Johnson (1989) found that the observed increases in wage inequality were due to "a combination of skilled-labour-biased technical change and changes in unmeasured labour quality" (Bound and Johnson, 1989). Unfortunately, neither of these two changes were measured directly, but rather estimated as residuals of a production function. Acemoglu (2002) claims that it was precisely the rapid increase in the supply of educated workers that motivated the development and use of skill-biased technologies, framing the conversation into what he refers to as an "endogenous theory of technological progress" (Acemoglu, 2002). The reasoning goes that research and development (R&D) follows profit incentives, and the widespread availability of highly educated individuals maximises the market size for skill-biased innovations. Accordingly, the author stresses that technological development had been skill-biased since at least the 1940s; and the upsurge in wage inequality in the 1980s was caused by an acceleration, a discontinuity in the growth rate of demand for skills, possibly motivated by the widespread adoption of computer technology.

However, up to this point, researchers failed to address what computers did to make highly educated workers more desirable. Indeed, as pointed out by Autor et al. (2003), a panoply of quantitative studies reports a correlation between the adoption of computer-based technologies and increased use of college-educated labour and interpret it as evidence in favour of SBTC, but "this interpretation merely labels the correlation without explaining its cause" (Autor et al., 2003). Autor et al. investigated this question and argued that computer capital substitutes for workers in performing routine cognitive and manual tasks (e.g., clerical work, bookkeeping, assembling), because it is possible to specify an unambiguous set of procedures to automate these processes. On the other hand, computers complement workers performing non routine problem solving and complex communication tasks, in which highly educated individuals possess a comparative advantage. They constructed a model to predict demand shifts in the task content of occupations, emphasising the exogenous declining price in computer capital as the causal force driving changes in skill demand. They rely on a routinization index developed by exploiting detailed information on task content of occupations as derived from the Dictionary of Occupational Titles (DOT) and observed that industries who were extensive users of routine labour inputs made larger investments in computer capital to substitute for their routine workers, and simultaneously increased their labour input of non-routine tasks. This paper was pivotal, insofar as it refined the theory of SBTC into the more recent Routine-Biased Technological Change (RBTC) theory, namely the theory that has informed much of the debate on the risk of automation in more recent years. This theory seeks to make a link between the observed wage dynamics and the way new technologies are used at the firm level. It stresses how the increased educational premia earned by highly educated workers is the result of the improved efficiency with which they can carry out complex non-routine tasks leveraging computer equipment. The previous example of a manager overseeing the operations of a global value chain is still relevant. On the other hand, a segment of the labour force, namely the one engaged in both cognitive and manual repetitive tasks, finds itself competing directly against machines, which hold a comparative advantage in their own domain. Indeed, tasks that are easily codified and expressed in the form of an algorithm can increasingly be performed by computers, independently of the skill level they require.

In following work, Autor et al. (2006) exploited this rationalisation to make sense of a new trend in wage inequality that started in the 1990s, i.e., the upsurge in upper-tail inequality, which was defined as the difference in average wages between the 90th percentile and the 50th percentile of the income distribution (Autor, 2006). Goos and Manning (2007) formalised this insight in more nuanced terms in their seminal contribution "Lousy and Lovely Jobs: the rising polarisation of work in Britain", where they argue that routine occupations, which are the most sensible to automation, are not distributed uniformly across the wage spectrum. Indeed, these occupations include "precision jobs such as bookkeeping and craftsmanship which were never the least paid occupation in the labour market" (Goos and Manning, 2007), but rather occupied the middle of the income distribution. On the other hand, non-routine occupations include jobs featuring problem solving and abstract thinking (i.e., non-routine cognitive) which are usually well paid. Non-routine occupations also include some manual jobs that are associated with a lower level of skills, such as cleaners, shelf fillers or bar staff, and which are usally low paid. The latter should not be directly affected by technology, but rather indirectly through general equilibrium effects, whereby "employment will shift towards jobs in which productivity growth is low in order to keep the balance of output in different products" (Baumol, 1967). Thus, Goos and Manning observe a pattern of polarisation, with employment growth both at the top and bottom of the income distribution, and employment fall in middling jobs.

The study posits that the digital transformation can impact income dynamics through several channels. The seminal contributions highlighted above referred to the labour demand channel. This channel has been given much importance in the above review of seminal contributions because it has attracted a large amount of scholarly effort, both theoretical and empirical. The next section reviews more recent contributions related to this channel, with an eye to report mostly studies conducted within the European context.

A.2. Labour Demand

The theoretical mechanisms highlighted in the previous section form the framework for the discussion that follows. Indeed, the SBTC and RBTC theories are the hypotheses upon which research on how new technologies, including digital ones, are hinged. In the following section on labour demand, focus is placed on publications relevant to the European context.

Skill Upgrading and job polarisation in the European context

While in the US income inequality since the 1980s has increased significantly, European wage structures exhibited remarkable stability. Thus, most of the scholarly effort regarding Europe was directed at explaining such stability against the backdrop of the Anglo-Saxon experience. One of the first attempts to investigate the changing skill and wage structure at an international level was made by Machin and Van Reenen (1998): by using R&D intensity as a proxy for technological change, these authors found that innovation-driven skill upgrading, measured both as the headcount of relatively skilled workers and in terms of their relative wage share in total wage costs, was common to all the OECD countries considered (namely, UK, US, France, Germany, Denmark, Sweden, and Japan). However, while in the Anglo-Saxon countries this phenomenon manifested itself as higher wage premium for skilled workers and thus higher inequality, this was not the case in European countries. Acemoglu (2002) reviewed some of the most common explanations for why this may be the case. One of the most established arguments is that European wage-setting institutions, which are considerably stronger and more widespread than in the Anglo-Saxon world, caused labour markets to reach equilibrium "with a lower employment of unskilled workers compensating for their relatively higher wages" (Acemoglu, 2003). Indeed, it would appear that European economies accommodate the shift in the demand for skilled labour through higher unemployment rates rather than higher wage inequality. Another possible explanation put forward by the author is that more rigid labour markets provided greater incentives for firms to invest in technologies that are less skill-biased, and thus complement the workers whose wages are being artificially determined by collective bargaining. This was another consequence of endogenous technical change, as mentioned previously for the US case.

The polarisation hypothesis advanced by Goos and Manning (2007) was also explored in the European landscape. One of the most renowned contributions on this topic was given by Spitz-Oener (2006), who used a unique West Germany dataset on the task content of occupations to test the hypothesis of skill upgrading from 1979 to 1999. Her methodology was inspired by Autor et al. (2003), i.e., by the distinction between routine and non-routine tasks. First, Spitz-Oener (2006)observed that skill requirements indeed increased over the period, moving towards more analytical and interactive task requirements, and that this movement was more pronounced in rapidly computerising industries. Second, by studying the distribution of job growth/decline over the income distribution, she observes a hollowing out of the jobs concentrated between the 3rd and the 7th income decile, a pattern that is consistent with polarisation.

Croci-Angelini et al. (2009) dissected the phenomenon even further. These authors built a panel comprised of labour market as well as innovation indicators (the latter coming from the Community Innovation Survey) covering seven European economies. They made the case that it is the specific technologies adopted that influence the pattern of wage dispersion. Specifically, process innovations appeared to increase the productivity of lower income workers and thus resulted in wage compression, whereas the development of new products and markets was associated with widening wage differences within industries, as high-wage employees and managers benefitted the most from the returns of new innovations. It is to be noted that the former type of innovation (i.e. process innovation) is consistent with Acemoglu's theory of endogenous technical change, whereas the latter type of innovation (i.e. market and product innovation) supports the general conclusions on polarisation drawn by Goos and Manning (2007).

While the evidence collected so far does not unambiguously point to a pattern of polarisation in Europe, the original proponents of the theory defended it even in this context. In a series of papers written in concordance with Anna Salomons between 2009 and 2014, Goos and Manning refined and expanded the RBTC framework to a number of Western European countries. Specifically, these authors analysed 16 European countries over the period 1993-2010 and argued that both within- and between-industry shifts towards a reduced input of routine-intensive tasks were observed in these countries in this period, as well as an increased usage of non-routine analytical skills. Furthemore, they evaluated this finding against another commonly cited driver of job polarisation, that is, globalisation and the rise of off-shoring. Given that routine occupations such as assemblers, plant operators and office clerks are also fairly vulnerable to being outsourced to countries with lower labour costs, both technical change and outsourcing can be cited as forces driving job polarisation. However, the authors argued that the former element has been much more important (Goos, Manning, Solomons, 2009; Goos, Manning, Solomons, 2011; Goos, Manning, Solomons, 2014).

While the simplicity of the polarisation hypothesis makes it very appealing, Fernandez-Macias and Hurley (2016) provided a skeptical view of it. This view was largely motivated by the possible incongruity that seemingly lied in observing a virtually equal pattern in a context that exhibits significant diversity, especially at the level of heterogeneous wage setting institutions that are specifically targeted at regulating wages and occupational structures. Indeed, these authors mentioned several critiques of studies conducted on this topic, with the main one being the lack of consistency in the operationalisation of the concept of "routine-intensity". Accordingly, they developped their own indicator aiming to stick as accurately as possible with the theoretical definition and then ran an analysis of wage dynamics for 23 European countries over the period 1995-2007. Discordant with Goos, Manning and Salomons (2014), they did not find the phenomenon of polarisation to be pervasive. On the contrary, they observed that, while polarisation seemed to have occurred for some countries, "the most frequent development was in fact one of occupational upgrading", which was more in line with the traditional SBTC hypothesis (Fernandez-Macias and Hurley, 2016).

The emerging picture is one where technical change is indeed a strong force behind changes in the composition of labour demand. Many routine occupations are giving ground to automation technologies, and the people that used to perform them are forced to either upgrade or branch out into lower paid occupations. This phenomenon, however, is not necessarily pervasive across all Member States. The extent to which we observe polarisation or upgrading ultimately depends on a mix of institutional features (e.g., wage setting institutions, collective bargaining systems, employment protection legislation, etc.) and the economic incentives faced by firms, which may decide to invest more in process or product innovation depending on the available workforce.

Risk of automation

Transformations brought about by automation technology hold the potential to create widespread social unrest through the fear of job destructions. Developments in mobile robotics (757) are reshaping the manufacturing sector and the factory floor, while the development of artificial intelligence threatens a number of knowledge workers. In what follows, the study mentions a few innovations that could disrupt the current labour market: this list, while far from comprehensive, should provide tangibility to the issue considered, that is, the risk of automation.

For instnace, fully mechanised warehouses raise doubts as to the viability of the jobs that some human operators hold in the logistics sector. Another example of automation that has gained considerable pull in the public debate are self-driving vehicles. Although the process of creating safe and autonomous vehicles continues to cost more and take longer than prognosticators once believed (758), the prospect of it becoming commercially viable in the next decade may be reasonable, which could put a great number of professions at risk. Long-distance haul-tracking is particularly vulnerable to the development of self-driving technologies: while it is difficult to make precise estimates given the uncertainty that still surrounds the adoption of these innovations, some put the number of potential jobs impacted at 500,000 (in the US) (Mohan and Vaishnav, 2022).

The technological advancements mentioned above, to name just a few, motivate a rich stream of literature aimed at quantifying the risk of automation, defined as the probability of an occupation to be (partially) substituted by digital innovations in the next decade or two. One of the most prominent contributions to this stream was provided by Frey and Osborne (2017). These authors pioneered a methodology based on an understanding of *engineering bottlenecks*, that is, types of labour inputs that are still hard to automate. These include labour inputs into perception and manipulation, creative intelligence and social intelligence, realms in which humans are still considerably superior to machines. These authors relied on the O*NET database, which contained detailed information on the tasks usually performed in 903 occupations in the US labour market. The O*NET allowed the

(757) Mobile robotics refers to the field of robotics that focuses on the development and deployment of robots capable of autonomous or semi-autonomous movement in various environments. These robots are designed to operate in dynamic and unstructured spaces, such as homes, offices, hospitals, factories, outdoor areas, and even space exploration missions.
(758) Retrieved from: https://www.wired.com/story/uber-gives-up-self-driving-dream/

authors (and collaborators) to hand-label 70 occupations as either automatable or not depending on their task-content and the degree to which they rely on the labour inputs identified above as mostly human domain. These occupations formed the training dataset, which contains a binary label for whether the occupation is automatable, and several variables proxying for the engineering bottlenecks highlighted above. A probabilistic classification algorithm then exploited patterns existing in the training data to return the probability of a given occupation (other than the 70 occupations used for training the model) to be automated. The results were quite sensational: the authors estimate that as much as 47% of occupations in the US fall in the high-risk of automation category, which means that such occupations had a probability of automation higher than 0.7. It is important to note that the authors' approach was aimed at uncovering *potential* automation, as opposed to *actual* automation, which meant that considerations about the cost of labour, the cost of capital or of factors that may slowdown adoption of automation such as political activism or regulatory friction were not accounted for. Moreover, it should kept in mind that the authors referred to currently existing jobs whereas it is arguable that "as individual tasks are made obsolete by technology, this frees up time for workers to perform other tasks and particular job definitions will shift accordingly" (Bowles, 2014). (759)

While ground-breaking, the methodology used by Frey and Osborne (2017) came under attack after its publication. The strongest critique lied in the fact that automation usually aimed at automating specific tasks rather than whole occupations: indeed, occupations are made up of many different assignments, and shouldn't be treated as a homogeneous lump. In the words of Susskind (2020), it's not as if "lawyers do *lawyering* and doctors do *doctoring*". For instance, some tasks usually performed by legal professionals may be more easily accomplished by a computer, as testified for instance by the adoption of AI-driven solutions for document review and due diligence (760), whereas others, such as delivering a compelling argument in court, still need a human touch. This line of reasoning was adopted by Arntz et al. (2016). They relied on individual survey data as derived from the Programme for the International Assessment of Adult Competencies (PIAAC), which contained "micro-level indicators on socio-economic characteristics, skills, job-related information, job-tasks and competencies" (Arntz et al. 2016). The task-based approach was then implemented by estimating the relationship between the workers' tasks and the automatability indicator that is borrowed from Frey and Osborne (2017). The model developed by the authors then showed how the explanatory variables, which included both information on the task content as well as control variables about the workerssuch as age, gender, and education, influenced automatability. The results were deeply in contrast with the ones of Frey and Osborne (2017): only 9% of all workers in the US featured in the high-risk of substitution from automation category. Results from other OECD countries showed only moderate dispersion around the results for the US and were bound between those for South Korea (with only 6% of workers in the high-risk category) and those for Austria (14%). Germany stood close to Austria at 12%, followed by Spain at 11%, Italy at 9% and France at

(759) Retrieved from https://www.bruegel.org/blog-post/computerisation-european-jobs
(760) See for example: https://futurism.com/ai-contracts-lawyers-lawgeex

around 8%. The European countries at lowest risk seemed to be Belgium, Finland, and Estonia, which scored just above South Korea.

Nedelkoska and Quintini (2018) carried out a similar exercise, although they expanded the geographical scope of their analysis to include all the 32 countries that took part in the PIAAC survey. On top of providing an estimate for the share of workers at a high risk of substitution from automation (which they placed at 14% on average over countries), the authors provided an analysis of the characteristics of jobs that are at high risk of automation, and of the characteristics of the workers performing them. They found that the occupational groups at highest risk were those that did not require specific training (e.g., food preparation assistants) and those characterised by high degrees of interaction with machines (e.g., workers in the processing industry). Their key result was that we can generally observe a monotonic decrease in the risk of automation with higher skill levels, which supports the commonly cited argument for which the best policy response to the advance of automation technologies is to foster re-/up-skilling and lifelong education.

While all of the above-mentioned papers are reminiscent of Frey and Osborne (2017) insofar as they relied on the same training dataset (i.e., the 70 occupations hand-labelled as either fully or not at all automatable), Webbs (2020) developed an entirely novel methodology to determine automation exposure. His approach was based on the semantic overlap between the text descriptions of jobs and those of patents. The key idea was to "use the text of patents to identify what technology can do, then quantify the extent to which each occupation in the economy involves performing similar tasks" (Webbs, 2020). A key advantage of this approach was that, by focusing on specific families of patents (e.g. robotics), this author was able to grasp the risk of automation brought about by different technologies. Indeed, he applied his algorithm in turn to robots, software and AI patents. He found, perhaps unsurprisingly, that young, male individuals with less than high school education were the most exposed to robots. Middle-wage occupations were instead the most exposed to software technologies, as the theory of polarisation would predict. Finally, when focusing on the impact of AI, Webbs (2020) found that the most exposed occupations were concentrated in the top 90th percentile of the wage distribution. Exposure also seemed to increase with education, an outcome that is contrary to previous waves of innovation.

Finally, Kaltenberg and Foster-McGregor (2020) squared the circle by effectively linking the above discussion on the risk of automation with the main concern of our study: inequality. As many before them, they agreed that the increase in wage inequality that had characterised developed economies over the last decades had been driven by an upsurge in the relative wages granted to non-routine cognitive skills compared to routine ones. They argued that this secular change had two components: on the one hand, there was a wage effect due to changes in the relative wage returns to certain skills; on the other hand, there was a composition effect "which represents changes in the demand of tasks that may lead to some jobs disappearing, while other jobs growing" (Kaltenberg and Foster-McGregor, 2020). By applying an Oaxaca-Blinder decomposition they managed to show that the latter effect explained a larger part of automation-driven inequality. That was because jobs that were at a high risk of automation exhibited similar wage levels, whereas those that were relatively sheltered from new displacing technologies showed a much wider wage dispersion (e.g., highly paid corporate managers and poorly paid waiters are both protected). As people flew into these latter categories of occupations, inequality was bound to rise. These authors suggested that these income dynamics have been mostly affected by the recent upsurge in Machine Learning, Artificial Intelligence and Mobile Robotics.

While one should beware of dystopian scenarios that forecast a jobless future where machines have taken over human endeavours, it appears however that most studies in this field point to the possibility of a significant transformation, and it is very likely that automation will come to supplant at least some tasks in virtually every sector. At the levels of individuals, whether this will result in a worsening of labour market outcomes or not will depend to a great extent on educational levels and the level of routine intensity of the occupation. Unfortunately, these characteristics do not seem to be allocated randomly across the population. Indeed, amongst the jobs with automable tasks, those that feature the highest risks of automation are usually those jobs that don’t require specific skills or training (e.g., food preparation assistants), which are usually performed by workers at the lower end of the income distribution spectrum. Also, the manufacturing sector is projected to shrink, which explains why economies that rely on it intensely are more vulnerable to automation (Nedelkoska and Quintini, 2018). Workers in this latter domain may be forced to transition to other sectors of the economy. The higher their educational level the higher the probability of landing a better job in the process, but employees with poorer prospects of career development and limited transferability of skills – who also tend to be closer to the boundaries of poverty and social exclusion – may be forced into poorly-paid, low-level service occupations, with a consequent widening of the wage gap between the winners and losers of this demand shift.

Robots and employment

The first law of robotics, proposed and popularised by Isaac Asimov in 1942, states that "a robot may not injure a human being, or, through inaction, allow a human being to come to harm" (Asimov, 1942). Despite this reassuring canon, many European citizens somewhat fear the current trends in automation, with almost three people in four believing (in 2017) that more jobs will be destroyed by the use of robots and AI than the ones that will be created. [761] Frey and Osborne (2017) argued that automation capabilities are proceding along two parallel tracks, in the form of Machine Learning, which threatens knowledge workers (but not only), and Mobile Robotics, which might one day reach Elon Musk’s forecast according to which in the future “physical work will be a choice”. The latter track is a strongly salient form of automation, as our visual imagination makes it easier to picture a pneumatic arm taking over the prerogatives of human workers than to picture a software doing so. Yet evidence on the topic is anything but clear cut, both because it is difficult to grasp such phenomenon in all its complexity, and because it is hard to disentangle meaningful statistical relationships from the available data. The latter point is due to mainly three endogeneity concerns that affect the link between labour demand and robot adoption. Namely, we can

([761]) Retrieved from: https://digital-strategy.ec.europa.eu/en/news/attitudes-towards-impact-digitisation-and-automation-daily-life distinguish: (i) reverse causality (e.g., a particularly slack labour market may discourage firms from investing in robots and push them to opt for human workers instead); (ii) attenuation bias arising from measurement errors in the stock of robots; (iii) finally, there may be some selection bias affecting estimates, as the firms that decide to automate their workforce may be structurally different from the ones that do not (De Vries et al., 2020). We should also keep in mind that both labour demand and robot stock may be affected by transitory fluctuations associated with the business cycle (Carbonero et al., 2020). Accordingly, empirical analysis on this topic is usually conducted via the identification of some relevant instrument to predict robot adoption, and unfolds via Two Stage Least Squares (2SLS).

Graetz and Michaels (2018) focussed on 17 developed economies over the period 1993-2007, and constructed a "replaceability" index based on an understanding of the share of tasks that a robot was able to perform within a given industry. Their first concern was to investigate the impact of robots in terms of labour productivity and value added per hour of work, which they found to be positive, although suffering from diminishing marginal returns as "larger increases in robot density translated into increasingly small productivity gains" (Graetz and Michaels, 2018). When labour market outcomes were considered, the authors found no significant effect of robots on aggregate employment, although they uncovered a weakly monotonic negative relationship when low-skilled and medium-skilled workers are considered (Graetz and Michaels, 2018). The originality of this finding laid in the fact that robots, unlike ICT equipment, did not seem to be associated with a polarising effect. De Vries et al. (2020) made an interesting contribution insofar as they incorporated the recurring theme of task content in their study. Indeed, they relied on an occupational database built for previous research that allowed them to delineate occupations according to their level of routine vs non routine, and manual vs cognitive intensity. They found that country-industry pairs that experienced faster robot adoption saw larger reductions in the employment share of routine manual workers. However, this change was seemingly partially offset by an increase in the employment share of non-routine analytic workers.

This last point is at the core of the debate on whether technology will lead to a jobless future: economists have often envisioned compensation mechanisms that would re-balance labour demand in the long run even in the face of drastic technological progress. Such reinstatement effect was perhaps best formalised by Acemoglu and Restrepo (2018) in terms of the price-productivity and the scale-productivity effect. According to the former, employing robots in production leads to a compression in prices, which allows the industry to expand sales and take on more workers. The latter states that the lower aggregate prices obtained via mechanisation allow the local economy to expand, so that there may be spillover effects and adjacent industries may also increase their demand for labour. It is useful to mention that while we introduced these two concepts with reference to robots, they equally apply to all recent and past innovations. Indeed, much of the debate about the labour market impact of technology revolves around the identification, the validation or the demystification of these types of compensation mechanisms (Vivarelli, 2014). Unfortunately, though, there does not seem to be a clear convergence in this stream of literature, and results tend to be ambiguous and not entirely robust to different specifications. Furthermore, it is important to note that robotisation is only a subset of the overall automation technologies.

As a matter of fact, one could argue that Mobile Robotics, although growing, is still at an early stage of development. This implies that existing historical data may be too limited in scope to fully probe the issue. Accordingly, informed speculation, in the form of economic modelling, may be a stronger tool to delineate emerging trends. A telling contribution of this sort was provided by Berg, Buffie and Zanna (2018): the authors built an economic model where robots were assumed to be close substitutes for human workers. The results suggested that the increase in robotisation may substantially contribute to increases in inequality, and do so in different guises. The authors' model predicted that, in a first stage, a high degree of substitutability between workers and robots implies that the overall number of workers increases (i.e. human workers plus robots), which – willfully overlooking the complication posed by unemployment – would decrease real wages. However, the authors' model predicted that, in a second stage, returns to traditional capital will start to increase as robot stock increases (e.g. even a traditional warehouse is made more productive by a fleet of *robots*), and the two types of capital will grow together until the economy is dominated by them, at the expense of labour.

A.3. Labour Supply

From the above sections, it emerges that technological progress is transforming the labour market from the labour demand side. One stylised fact that we can draw at the present stage is that *some* workers are in a disadvantaged position to face this transformation, as their skillsets are projected to become less needed, irrelevant or outright obsolete in the near future.

Besides conducting a literature review on the digital transformation's impact on the labour demand channel, it is equally important to conduct a review on its impact on the labour supply channel. This is what is done in this section (note: it must be pointed out however that, to date, the labour supply aspect of the digital transformation has not been investigated as closely in the literature as the demand channel has).

Developed economies are already witnessing frictional technological unemployment in the apparent paradox of relatively high unemployment which is occurring at the same time as a general labour shortage (Autor, 2015). The concept of frictional technological unemployment refers to the situation in which work may still be available, even abundant, but out of reach for most of the population. It differs from the standard concept of frictional unemployment, which occurs whenever there are jobs vacancies available and individuals are actively seeking employment, in so far as the jobs vacancies advertised may be concentrated in occupations that require high levels of digital skills and training and this may bar jobseekers from candidating. For instance, while competences on artificial intelligence are in very high demand today, displaced factory line workers from any given manufacturing plant would need significant and very lenghty training in statistics, computer science and mathematics in order to take up jobs requiring such competences. This is relevant for poverty and inequality insofar as the very workers that are most likely to be overlooked by firms in their hiring strategies due to the scarce relevance of their competences also tend to be in the lower part of the income distribution, and they are also the least likely to receive on-the-job training.

Concerns of employers who fail to fill vacancies are flooding the public discourse, and such concerns are best investigated by the literature on skill mismatch, which is indeed a very broad term encompassing a variety of labour market frictions (McGuinness et al., 2018). In what follows, a brief review of the taxonomy of terms that this literature gave rise to is provided. Then, the channel(s) - through which a labour supply that fails to meet employers' demands can impact economic outcomes, at the micro as well as the aggregate level – are explored. Finally, a few ways - through which technology can be embraced and leveraged to cope with the very issues that it engenders – are looked at.

McGuinness et al. (2018) pointed out that the skill mismatch has manifested itself in several ways. Indeed, one can think of a "vertical mismatch", whereby workers are either over- or under-skilled for the position they fill. There can also be "skill gaps", where employers believe that employees lack the necessary skills to successfully do their job, which may translate into "skill shortages" if the gap eventually results in an unfilled vacancy. A situation of "horizontal mismatch" occurs when employees are employed in occupations outside of the realm of their formal education, which is quite typical of graduates in the field of humanities. Finally, a term that is particularly relevant in the context of fast-paced technological and organizational evolution is "skill obsolescence", typically affecting older workers whose skills are no longer tradeable on the labour market (McGuinness et al., 2018). One must also note how the measurement of these concepts is not a straightforward process. Some researchers rely on individual survey data, asking respondents directly whether their skills (or formal titles) are under-utilized in their current role, whether they are needed at all or if they lack the proper preparation to perform their duties. However, this approach may be biased insofar as employees may feel incentivized to inflate the skill requirements of their occupation (Brunello et al., 2019), and thus take the name of "subjective methods" (McGuiness et al., 2018). One could also interview firms instead of workers, which are believed to have a more accurate understanding of job requirements; but employers' complaints on the difficulty of finding suitable candidates could reflect their inability/reluctance to offer competitive pay rather than genuine skill mismatch. Another approach, which falls under the heading of "empirical methods", is the "realized matches" one, exploited for example by Quintini (2011). It is based on testing individuals on their cognitive skills and comparing the results with the median skill level in the occupation where they are employed: those who exceed the median can be deemed over-qualified, those that fare worse are likely under-qualified instead. Finally, one can compare the requirements on posted job vacancies with the composition of the unemployed workforce, which provides indicative evidence of skill gaps at the macro-level (McGuinness, 2018).

Regardless of the method used, however, the emerging picture at the EU-level is one of genuine hiring difficulties driven by an inadequate labour supply. The Talent Shortage Survey administered by Manpower, for example, highlights how 4 out of 10 employers struggle to fill vacancies (762). This situation is projected to worsen, as digital technologies displace workers and require more sophistication from the ones who manage to retain their positions. Indeed, the European Skills and Jobs Survey (ESJS) administered by Cedefop revealed that close to half of all

(762) Retrieved from: https://go.manpowergroup.com/talent-shortage

interviewed workers recently experienced changes in the technologies used at the workplace, or in the processes and methods employed (Cedefop, 2018). The survey also revealed that about 10% of jobs in the EU are at a high risk of technological skills obsolescence, with higher rates concentrated in Eastern Europe reflecting industrial composition and past low investments in ICT (Cedefop, 2018).

The channel through which the skills mismatch can impact inequality are not well-explored in the literature. However, one might still make two theoretical reasonable assumptions when it comes to such impact. First, workers who lack (or who lost) the necessary skills to be competitive in the labour market face higher risk of unemployment, and the resulting loss of labour income would push more individuals down the income distribution. Second, as highlighted by Nedelkoska and Quintini (2018), a key process through which workers can insulate themselves against skill obsolescence is re-training and up-skilling. Unfortunately, these authors also noticed how the workers who face a higher risk of skill obsolescence are also the ones in whom firms are less likely to invest. This is because firms' training budgets tend to be devoted in priority to high-skilled employees, which could result in a further widening of the wage wedge between low- and high-skilled individuals (Nedelkoska and Quintini, 2018).

Given the above, much of what has been written on the topic concerns policy recommendations to close the skill gap. Traditionally, policy responses that aim at easing the extent of the skill mismatch focus on the re-alignment between the capabilities constructed via formal education (provided both through educational institutions and through employer-sponsored on-the-job training) and the capabilities needed by firms. This can occur through the enhancing of formal education and Vocational Education Training (VET), improved career guidance systems and strengthening of national- and European-wide certification mechanisms to account for skills that are learned informally via on-the-job training, which are otherwise unknowable by a prospective employer (OECD, 2019). Fialho, Quintini and Vandeweyer (2019) have been strong proponents of this latter approach. These authors used several datasets on skills and education in EU and OECD countries level to show that informal learning are rewarded by sizeable wage and productivity returns. Steps to render certification of informal learningpossible would increase employees' ability to reap the benefits of their accumulated human capital, ensure higher quality matches between labour demand and supply through improved job mobility, and strengthen incentives to invest in training, thereby starting a virtuous cycle (Fialho, Quintini and Vandeweyer, 2019).

Lastly, it could be useful to briefly look at what some beneficial uses of digital tools could be, with regard to the labour supply channel. A first such use concerns open online learning, which has the potential to democratize education by enabling access to it for previously excluded categories of people (Oudeweetering and Agirdag, 2018) (provided however that these people could afford and use digital tools and communications). Indeed, although descriptive evidence suggests that the most proficient users of online learning opportunities are well-educated individuals who already work in relatively safe occupations, such type of resource could play a more prominent role in the future. Another area in which digital tools could be beneficial to the labour supply channel is when it comes to better forecasting occupational needs. This could be done by relying on online-generated data from webistes where one can offer his or her freelance work, or from platforms where job vacanices are posted, which could help to better inform the contents of re- and up-skilling trainings to make them more relevant to employers' needs and, crucially, timelier (Stephany, 2022).

A.4. Functional distribution of capital and labour

Besides trends in inequality of labour income, there is another important trend impacting inequality in disposable income, which is the pulling away of the top 1% from the rest of society, whichis likely driven by the accumulation of capital rather than labour income. The following section explores the literature concerning the functional distribution of capital and labour, i.e., the share of national income that is going to workers in the form of wages and salaries, and the share that instead accrues to capital owners in the form of profits.

From a brief literature review, it appears that skill-biased technological change has been a key determinant in influencing firms' hiring decisionsresulting in a highly dispersed wage distribution. This phenomenon has considerable weight in explaining the observed patterns in labour income inequality. But another stream of literature points to another phenomenon that has led to a more unequal distribution of income across the developed world: the declining share of labour in national income, and accordingly, the rising share commanded by capital.

Up until the first part of the 20th century, it was generally believed that the respective shares of capital and labour in national income were practically constant, so much so that this steadiness was granted the status of a "stylised fact" (Kaldor, 1957). However, no unified theory could explain this constancy, and the validity of the statement rested on rather shaky *ad hoc* hypotheses, such as the unity of the labour-capital elasticity of substitution or the "neutrality of technical progress" (Kaldor, 1957). Assuming an elasticity of substitution between capital and labour equal to one is at the heart of the Solow growth model; indeed, within a standard Cobb-Douglas production function the shares of labour and capital are "pinned down" by technology alone, and are allowed to remain constant over time (Acemoglu, 2003). If elasticy of substitution were to be above one, on the other hand, capital and labour would be gross substitutes, and an increase in the efficiency of capital, or a decrease in its price may effectively drive up the income share commanded by capital, as we already hinted at in Section 2.1.3.1.

As observed by Karabarbounis and Neiman (2014), the labour share of national income has been declining since at least the 1980s, showing a surprising regularity across countries and industries, which suggests the presence of a common underlying factor. The authors relied on an extensive dataset comprising 59 countries over the period 1975-2012, and showed descriptive evidence of a decline of five percentage points in the global share of value added paid to labour. They emphasised the role of declining prices of investment goods compared to labour, largely driven by falling prices of ICT, as the engine of this downward trend. They estimated an elasticity of substitution between capital and labour of 1.25, which is an unusual figure within this field of research. This implies that, even when assuming a perfectly competitive economy, a rise in the stock of capital is not met by noticeable decreases in the rate of return, which allows the profit share to increase at the expense of the wage share (763). An elasticity of substitution below one - as it is commonly found, especially in the short term -, on the other hand, would imply that the economy can scarcely absorb new capital, and the profit share would be bound to decrease (Atkinson, 2015). Nevertheless, a more granular approach was taken 5 years prior by Arpaia et al. (2009). These authors also observed a rather pervasive decline in the labour share starting in the 1980s: relying on EU KLEMS data for 15 Member States, they showed a decline in all the countries considered except for Belgium and Portugal. Most importantly, they relied on a micro-founded model which explains the labour share in terms of technological and institutional factors within the framework of a CES production function, and traced back the falling labour share to an "interaction of capital deepening, capital-augmenting technical progress and labour substitution across skill categories" (Arpaia et al., 2009). This explanation emphasised the skill bias of recent technological change, and hinted at the role of automation in compressing wage levels. More recently, Autor and Salomons (2018) found that automation has led to a decline in employment and in the labour share in the most affected industries, and that, whereas jobs lost were recuperated in adjacent industries thanks to positive productivity spillovers, that was not the case for the aggregate labour share of income (Autor and Salomons, 2018). This suggested that while aggregate employment may remain unchanged in the “second machine age”, the quality of jobs, as proxied by real wages, may decline. Indeed, their results supported the idea for which "the decline in the labour share since the 1980s is consistent with a shift toward more labour-displacing technologies" (Autor and Salomons, 2018).

How then did the falling share of labour income contribute to inequality? The answer was the core of the argument propounded by Thomas Piketty in "The Capital in the XXI century" (Piketty, 2014), and was captured by the popular "rich-get-richer dynamics" slogan coined by Robert Solow (Solow, 2014). Piketty constructed protracted time series of the top disposable income shares in a number of countries. In order to make comparisons across time, geography and currencies, Piketty then divided the level of wealth by the level of income, thus obtaining a ratio with the dimension in years (as in, how many years it would take to build up the current capital stock at the going level of national income?). He then observed that this wealth-income ratio had been increasing since the 1950, and predicted, cautiously, a further increase to "just over 6.5 at the end of this century" (Piketty, 2014). The problem, from a distributional viewpoint, is that wealth tends to be concentrated in the hands of few, much more so than labour income. This is especially true in the United States, where "the top 1% owned a record 32.3% of the nation’s wealth as of the end of 2021" (764) but also in Europe, where, despite society being generally more egalitarian, "the wealthiest 1% own 19% of total wealth" (765). When one looks at the bottom of the income distribution,

(763) One must note that Karabarbounis and Neiman (2014) avoided the commonly cited measurement issue of how to account for proprietors and self-employed in general by only referring to the corporate sector; however, given the predominance of the latter and the long-time horizon considered, this simplification is not likely to revert results.
(764) Retrieved from: https://www.cnbc.com/2022/04/01/richest-one-percent-gained-trillions-in-wealth-2021.html
(765) Retrieved from: https://www.lgt.com/en/magnet/financial-markets/european-wealth-report-the-pandemic-has-increased-wealth-concentration/#button2

the bottom 50% persons' share in wealth "is usually below 5%" (Piketty and Saez, 2014). Thus, in an economy where technological progress is biased in favour of capital, as testified by Arpaia et al. (2009), so that the rate of return to capital is only marginally dampened by an ever-increasing stock, those whose incomes derive mostly from capital will pull away from the rest of society (Solow, 2014). The issue is even more critical due to the historically low productivity growth registered in the last decades (Andrews et al., 2016), which causes wages to stagnate.

While these dynamics hold, in theory, for all types of capital, Guellec and Paunov (2017) made the case that they are even more accentuated when one considers the realm of digital markets. They argued that digital innovation has introduced some distortions in the market for products and services; in particular since digital innovation has a non-rival character, insofar as digital products can be reproduced and dispersed globally at virtually zero marginal costs. Thus, companies operating in the digital sphere incur expenses for what concerns R&D, market research and product design, but once a new solution comes to fruition, it can be delivered to a mesmerising number of customers. This feature, which is unheard of in the traditional brick-and-mortar economy, creates the conditions for a "winner-takes-all" market environment, where sales and profits concentrate in the hands of the firm that provides the superior offering. In their approach, these authors connected these peculiar market structures to the rise of the top 1% income share: they argued that market returns (i.e., capital gains coming from innovation) tend to be shared amongst an exclusive group of people, namely shareholders, top executives and key employees, whereas little to nothing trickles down to the average worker (Guellec and Paunov, 2017). These authors argued thatshareholders have been absorbing such a high share of the market returns because, in a market characterised by "winner-take-all" dynamics, even marginally superior products can capture the entire market, which automatically translate into higher share prices for owners and high wages for key employees. This intuition, coupled with the fact that digital innovation has much lower barriers to entry than was the case with traditional industries (e.g., writing a string of code does not require nearly the same resources as setting up a factory), created the conditions for high market volatility, and investors can exact a high risk premium accordingly (Guellec and Paunov, 2017). However, it is also worth mentioning how current digital incumbents are likely to resist an ill-fate: the sheer economic power granted by network externalities, economies of scale and economies of scope, as well as commercial tactics such as product bundling, reduced portability or "killer acquisitions", act quite some way in entrenching them in their privileged position (766).

The work by Guellec and Paunov ties in well with a recent publication by Autor et al. (2020), who attributed the erosion of the aggregate labour share of national income to the "rise of superstar firms" (Autor et al., 2020). They recognised technology as the *prima causa* that lead markets to high concentration. They argued that the lower labour share was then explained by the fact that "superstar firms", namely the most productive firms in the economy, have been generating high turnovers but have been employing relatively few people, tilting the scale in

(766) See: https://www.worldcommercereview.com/html/anderson-and-mariniello-regulating-big-tech.html

favour of capital. They tested this assumption for the US and a number of OECD countries; whereas evidence for the latter is not as clear-cut as it is for the US, they noticed some consistency, in the sense that the decline in labour share was most prevalent in the sectors where market concentration was highest, and that it was mainly explained by the reallocation of value added or sales between, rather than within firms (Autor et al., 2020).

A.5. Matching between labour supply and demand: the rise of digital platforms

Most of the successful firms in the digital era seem to operate with a particular type of business model: the platform. Platforms, defined by the European Commission as "an undertaking operating in two (or multi)-sided markets, which uses the Internet to enable interactions between two or more distinct but interdependent groups of users so as to generate value for at least one of the groups" can be either two-sided, where they simply act as intermediaries between two sides of an economy; or multi-sided, where one class of users subsidises the use of the platform for another class of users, who enjoys free access which they effectively pay with attention and engagement. Regardless of their conformation, platforms are one true innovation of the digital era, and they pose both great promises and great challenges to productivity, employment, and welfare systems. This section explores this issue and provides evidence as to the size of this phenomenon, its impact in terms of economic outcome and the policy-related concerns it may raise.

The technological developments of the past decades brought about a profound transformation in the organisation of labour. Indeed, one of the most interesting phenomena that is fuelled by the digital transformation is the rise of digital platforms, which contributed to a flourishing of terms including "gig economy", "platform economy", and "sharing economy", which are all interrelated facets of the same trend towards alternative consumption philosophies and alternative working arrangements. For the sake of clarity, we will draw on the definition of platform work as provided by the European Commission (2020a), namely "platform work is a form of employment in which organisations or individuals use an online platform to access other organisations or individuals to solve specific problems or to provide specific services in exchange for payment". Importantly, the mediation, allocation and evaluation of work is facilitated by the existence of an app or generally by the exploitation of a digitally enabled matching algorithm, which also allows for the extensive collection and scrutiny of the data generated with each transaction (Hauben et al., 2020).

In what follows, the focus is mainly put on work platforms (and not on commercial products platforms). Platforms tend to exhibit two features that one must consider when trying to assess their impact on economic outcomes. First and foremost, leveraging technology, they are usually able to enhance matching efficiency between clients and providers compared to traditional counterparts; and second, the relative ease with which one can participate to the platform economy suggests that barriers to entry for workers are lower than is the case in the traditional economy. The former feature would point to an increase in productivity which may reflect in lower prices or higher consumer welfare, whereas the latter would point to a positive effect of the gig economy on employment growth, but the impact on dependent employment and earnings is ambiguous. Indeed, increased productivity may have substantial market expansion effects, which may lead to positive dependent employment growth as even traditional firms increase output; but it can also be the case that platform workers would substitute for employees under traditional working arrangements, impacting negatively on the latter (Schwellnus et al., 2019). In the case where services can be provided online, platform entry has larger downward effects on prices and employment, as companies can seamlessly offshore activities to countries with lower labour costs (Schwellnus et al., 2019). A Pew Research Center's survey reveals that platform workers show very heterogeneous take home pay, reflecting the wide variety of tasks one can perform on platforms, ranging from sophisticated professional assignments to low-level services (Pew Research Center, 2016), where such low-level services tend to provide very low wages, often below minimum wage levels (OECD, 2018). Also noteworthy, the promise of filling gaps for individuals who are generally overlooked by employers (such as the long-term unemployed) seems to have been betrayed, as the majority of platform workers tends to be young, male, on average well-educated and concentrated in urban areas, and engage in this type of activity mostly to round up their income rather than as their primary means of living (Piasna, Zwysen, and Drahokoupil, 2022). This highlights an important structural difference between workers: the ones who depend to a great extent on the earnings they make through the platform tend to come from low-income households, have poorer career prospects, and tend to gravitate towards physical tasks (such as ride hailing or cleaning).

Empirical work on the topic of work platforms is not exhaustive, especially in the European context, but some of the initial estimates seem to show some positive effects on productivity and overall employment, and either small negative or insignificant changes in traditional dependent employment and wages (Farrell, Greig and Hamoudi, 2018). It is however important to note that the phenomenon of platform work may be poorly represented by the available data sources, raising concerns as to the validity of results: Abraham et al. (2018) point to the fact that household surveys and administrative data in the US provide very different pictures as to the size of the platform economy. Boeri et al. (2020) documented a vast increase in the number of solo self-employed - i.e., self-employed workers without dependent workers on their payrolls - across the developed world over the last twenty years: this shift is likely caused by both favourable tax regimes for the self-employed and technology (OECD, 2018) but also, for some other persons, by unemployment or the need to earn some complementary income. While this peculiar type of self-employment is usually associated with professionals such as hairdressers, plumbers or gardeners, platform workers are likely to have contributed to the bulk of the growth in recent years. Unfortunately, the data at hand does not allow to separate the two. Indeed, existing household and labour force surveys lack the detail necessary to capture the extent of platform work, and the most reliable figures are obtained via *ad hoc* surveys (OECD, 2018). The only sector where the rise of platforms is undeniable is that of personal transport, as testified by a staggering 298% growth in own-account drivers between 2010 and 2016 in the US (Abraham et al., 2019). For what concerns the rest of the economy, Schwellnus et al. (2019) find that the "gig economy platform's size remains modest (1-3 per cent of overall employment across OECD countries)"

(Schwellnus et al., 2019), with only a limited number of services being revolutionised by platform entry. An *ad hoc* survey by the European Trade Union Institute (ETUI) on 14 European countries provides mild support to the previous figure, with 4.3% of respondents identifying as platform workers (Piasna, Zwysen, and Drahokoupil, 2022).

Still, the rise of platform work, which sits in a wider trend of growing self-employment, raises severe policy concerns. The conundrum related to interventions in this field lies in how to balance the innovation and entrepreneurship granted by platforms' business models while preserving job quality, workers' rights, and flexibility, since many platform workers report high levels of satisfaction with the possibility of scheduling their own commitment (Berger et al., 2018). Part of the problem is a pure labelling exercise, as legal definitions are lagging behind the ongoing revolution in the organisation of labour. The phenomenon has been captured by the term "false" or "bogus" self-employment, which refers to the situation in which workers take on the status of independent contractor, but the client/platform for whom they work holds great power in determining compensation packages and, most importantly, working hours (Thörnquist, 2015), so that this type of arrangement features *de facto* dependent employment conditions with poor social protection. It is also unclear whether platforms can be considered as employers per se, and whether they would be equally profitable if more stringent requirements were asked of them, as much of their competitive edge lies precisely in the denial of employee status (Prassl and Risakt, 2016). Accordingly, it may be useful to develop more precise taxonomies of work, which might shed light on the gray area between dependent employees and independent contractors and suggest new or amended tax regimes as well as new ways of administering social protection. This would also make it easier for both workers and employers to be clear about the rights they enjoy and the responsibilities they owe (Kennedy, 2016). Discussions have also been focused on the possibility of extending minimum wage regulation, or collective agreement guarantees to the most vulnerable amongst the platform workers (Donini et al., 2017; OECD, 2018). Another dimension which is ripe for intervention is that of working hours. It is claimed that platform workers enjoy very high flexibility in terms of time commitment, and this turns out to be one of the most appreciated features of engaging in this type of work. However, this may not be the case for those workers who severely depend on the income provided by their platform activity; for these people, an expansion of labour legislation concerning hours worked, weekly rest and paid annual leave would be greatly beneficial (OECD, 2018).

A.6. The digital transformation’s impact on purchasing power

This section seeks to explore the impact of the digital transformation on purchasing power. At the outset, it is important to note that, to date, this specific channel has not been much investigated in the literature. The section looks at two possible key aspects of the digital transformation’s impact on purchasing power. First, it considers the evidence surrounding the impact of e-commerce on the overall level of prices (Online markets are a salient feature of the digital transformation, and they are generally believed to charge lower prices. If this is true, this could be cited in favour of a positive impact of the digital transformation on purchasing power). Second, the section looks at the impact of digital transformation on the consumer surplus, which may be relevant to consider when it comes to the impact on purchasing power (indeed, some aspects of the digital transformation – like free web services – are often said to elude official productivity statistics because theyare largely offered free of charge. Still they may be relevant to consider as they could increase the consumer surplus, thus positively (indirectly) impacting on purchasing power)).

The impact of the digital transformation on prices: the e-commerce channel

A particularly salient channel through which the digital transformation impacts prices is online shopping. The onset of the COVID-19 pandemic brought many consumers to resort to "e-tailers" for their ordinary expenses, with almost four out of five persons claiming that they had used the internet to buy goods or services for private use over the year (767). Even before the pandemic, online shopping has been a growing phenomenon since the early 2000s; indeed, the share of the EU population that routinely engages in online transactions increased from roughly half in 2011 to slightly less than 80% in 2021 (768). What is interesting to look at is the extent to which prices have been affected by the up-take of online shopping. Indeed, if online prices are generally lower than the ones offered in brick-and-mortar shops for the same goods, this would imply a positive impact of the digital transformation on purchasing power. Anecdotal evidence abounds, and marketers and store owners alike are very familiar with the phenomenon of "show rooming", whereby would-be customers inspect the features of a product by visiting the shop physically to later buy it online for cheaper (Gensler et al., 2017).

Some recent work, however, cautions against unquestioned belief in the internet's capacity to compress prices. Jolivet and Turon (2018) developed a sequential search model and show that acquiring and processing information for a given good may still be costly for consumers, and the scale of these search costs may prevent the "law of one price" to prevail. It is also argued that differences in non-price characteristics across sellers are important drivers of price dispersion (Jolivet and Turon, 2018).

While it is somewhat unclear whether the internet entirely abated search costs, no one questions how it dilutes information asymmetries. This seems particularly relevant for lower-income groups. A well-established concept in development economics is that of the poverty penalty. In a nutshell, poorer households shoulder relatively higher costs than well-off ones in their participation to certain markets. This can take various forms: the poor can be charged higher prices, offered lower quality, lack access, or be forced to opt out of certain markets because participation is not affordable (Mendoza, 2011). While this literature grew largely with reference to developing countries, it still offers a useful theoretical bedrock on which to consider the richer EU context. Indeed, one of the most significant causes for the poverty penalty is imperfect information. Imperfect information and

(767) Retrieved from: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=E-commerce_statistics_for_individuals
(768) Ibid.

higher search costs may push poorer individuals to settle for offerings that are more expensive or of lower quality than what could be obtained elsewhere. The internet thus serves as a tool to enable poorer households to make more optimal decisions in the short-run, and crucially, lead to price convergence in the long-run. Nevertheless, there are also reasons why the digital transformation may lead to greater socio-economic disparity. The digital divide, defined as “the gap between individuals, households, businesses and geographic areas at different socio-economic levels with regard both to their opportunities to access ICT and to their use of the Internet for a wide variety of activities” (OECD, 2001) gives only marginal signs of narrowing; especially when taking into account the “second-order” digital-divide, that is ICT usage and proficiency as opposed to mere physical access to ICT infrastructure (Elena-Bucea et al., 2020). Hernandez and Roberts (2018) point to the fact that the advent of digital technologies is exacerbating existing socio-economic gaps, as disadvantaged people have less access to the benefits afforded by internet technologies. Adopting a global perspective, they argue that “the least connected are rendered relatively disadvantaged to the precise extent that the most connected are advantaged by their use of digital technologies”, as the latter can capitalise on digital dividends that those left behind are precluded from (Hernandez and Roberts, 2018).

While short-term gains afforded by lower prices may be greeted by many, economists and anti-trust officials may be less prone to welcome this phenomenon ([769]). Indeed, strong market concentration can raise new issues: the accumulation of big data and the refinement of machine learning algorithms has allowed many big actors of the internet arena to offer increasingly tailored products and services. This can result in an advantage for consumers, who are presented with relevant recommendations. However, e-tailers may capitalise on this information to engage in sophisticated price discrimination. In particular, price discrimination in online shopping websites can occur in two ways: price steering, where different users are presented different products (or the same products but in a different order); and price discrimination, where different users are effectively charged different prices for the same product (Hannak et al., 2014). An interesting project conducted in this area was the MIT’s Billion Prices Project (Cavallo and Rigobon, 2016), a dataset that extracted prices from numerous online retailers to better measure macroeconomic fluctuations. One interesting result from this project was that online and offline prices are actually identical about 72% of the time, although heterogeneity exists at the sector and country level. Furthermore, when price differences are found, they tend to be small, with online prices being on average only 4% lower than offline counterparts when a discrepancy is detected (Cavallo, 2017).

In review, the evidence discussed so far does not lead to a single conclusion: while online markets may offer great one-time bargains, they do not necessarily always charge lower prices, or if so, the savings tend to be marginal. Furthermore, they offer incumbents the capability to engage in more aggressive marketing and pricing strategies.

([769]) See: https://www.nytimes.com/2020/09/11/world/europe/eu-us-china-technology.html

The impact of the digital transformation on value: increased consumer surplus

Traditionally, the concept of purchasing power has been understood as the capacity to buy more goods and services for a given unit of currency. Yet such a conceptualisation is somewhat ill-suited for the digital economy: 21st century frontier firms increasingly offer goods and services free of charge, exploiting multi-sided markets for monetisation (Varian, 2006). This renders the idea of a basket of products and their related prices, on which conventional measures of purchasing power are built, less informative. Therefore, in this section, we employ another concept from the economics toolbox: consumer surplus.

Marketing studies have highlighted how the choice to shop online is driven mostly by usefulness and relevance of the online product descriptions, by habit, by convenience and by efficiency (Venkatesh et al., 2022). While cost savings do appear in the decision-making process, they are not the sole nor the most relevant driver. Increased product variety offered by electronic markets can also impact consumer surplus.

However, increased availability of products is only one of the aspects of the digital economy. Digital services, such as search engines, social media, music and video streaming subscriptions, or even online maps, are also relevant to consider when looking at the digital economy's impact on the consumer surplus. Society attaches a great value to their use and yet they are available at negligible or zero price, largely thanks to the low marginal cost of digital reproduction (Ahmad and Schreyer, 2016; OECD, 2017). Several attempts have been made to estimate the contribution of these products to GDP growth and to consumer surplus. An analysis by McKinsey tries to delineate stated preferences of consumers to identify their willingness-to-pay for given web services. Results reveal a substantial $100 billion a year in consumer surplus, which is projected to grow with increased broadband coverage (Burghin, 2011). Brynjolfsson and Oh (2012) argued that welfare gain arising from web services was about $159 billion per year between 2007 and 2011. Finally, Brynolfsson, Collis and Eggers (2019) developed a direct approach to the estimation of consumer surplus derived from the use of specific services: they relied on "massive online choice experiments", whereby they ask individuals how much they would need to be compensated to forgo the use of an online service (e.g., search engine) for a given amount of time. Their approach allowed to determine the marginal contribution of new and free goods – of which the digital economy abounds – to welfare changes and GDP measures, and the authors accordingly advocated the use of their newly developed statistic, which they call GDP-B, by national statistical offices. Nevertheless, much like conventional GDP measures, the latter may hide potential negative externalities generated by web services, such as the rise of addictive behaviours (Sun and Zhang, 2021), declines in mental health (Deters and Mehl, 2013) or the polarisation of the political discourse (Tucker et al., 2018).

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