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Gender, automation, access to digital skills and the digital labour market

Michał Polakowski, Dorota Szelewa

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Introduction

The purpose of this review is to explore the main subjects of academic and policy-related discussions concerning a gendered dimension related to technological change in the labour market and digital skills. Given the breadth and complexity of these topics, it only focuses on the main arguments and empirical results. The analysis of the role of ICT and automation in contemporary labour markets is extensive, yet this review shows that the gender aspects of such research deserve more attention.

This review starts with a general overview of technological change and employment debates. One of the key topics in this debate has been whether automation (which might cover robotisation or the use of algorithms) displaces workers. The overview points out that research needs to be more conclusive in this respect, and therefore one should talk about multiple scenarios depending on skills, education or sectors of the economy. In the second section, the review focuses on the demand for digital skills and how they are conceptualised in policy and academic debates. This section shows that the demand for digital skills has been growing, and a digital skills mismatch exists. Again, the demand is highly context-specific. What is a policy response present at the EU level? The third section tackles these questions by showing that especially promoting digital skills is at the centre of the EU's policy agenda. The EU monitored progress in this field, devoting considerable resources to financing digital transformation. Section four of this paper discusses the main challenges and opportunities related to women's presence in digital labour markets – in e-trade and platform economy. It looks if and how such work can contribute to labour market inclusion and gender equality. Finally, the impact of the Covid-19 pandemic is described with respect to the remotability of work, also with respect to non-gendered factors, which might hamper a shift to work from home. The period of the pandemic can be seen as 'revelatory' as, on the one hand, many

individuals started working remotely and on the other – a considerable share of workers has been unable to do so given the characteristics of their jobs.

In general, this review shows considerable gender imbalances, especially in formal education, that would contribute to digital skills formation – both in terms of ICT specialists and ICT tertiary education graduates. This issue has been recognised by EU policy-makers who envisage a doubling of the number of such specialists in the EU labour market and 'convergence' of the number of females and males with such specialisation by 2030.

There has yet to be a consensus on what exactly the digital economy is. Also, the discussions continue on whether the developments observed in the 21st century are uniquely new or carry some continuities from the past (Valenduc and Vendramin 2017). Degryse (2016) captures the principles of such an economy in the following terms. First, digital information is a strategic resource; the network is the central organising principle. Second, the digital economy could be characterised by the principle of growing returns from investment and zero (or nearly zero) marginal costs. Thirdly, new business models emerge that take advantage of (online) collaboration or sharing. Fourth, the digital economy is accompanied by a new model of industrial production and disappearing differences between producers, clients and traders. Also, there is a diminishing difference between industry and services. Fifth, reducing technology and equipment costs contributes to high rates of return.

Eurofound's (2015) research sees ICT-based mobile work as a new form of employment. While beneficial to employers and employees alike, the Eurofound study points to a number of challenges related to this form: the issue of supervision on the one hand, for example, and problems with informal information exchange on the other. More on the structural level, one of the challenges is the risk of 'leaving behind' some social groups.

The Covid-19 pandemic has been a litmus test for the ability to work outside of companies' premises – it has been noticeable that only a share of work can be done online. A recent Eurofound study (Eurofound 2022b) demonstrates that in 2021, more women than men were working from home, and the increase from 2019 was more dynamic for women; thus, a positive gender gap in this respect has been noticed. An important aspect of this phenomenon (explored further in this review) is the structure of a given economy – some European

economies, due to their occupational characteristics, allow for more remote work, whereas others are limited in this respect.

Impact of technological change

A digital transformation of labour markets goes beyond the Information and Communication Technologies (ICT) domain. Such transformation has two facets. First, it concerns the replacement of some jobs performed by humans by machines and digital technologies. The second aspect of digital transformation involves a growing demand for digital skills.

Warhurst and Hill (2019) indicate three directions of change in labour related to technological progress: Artificial Intelligence, digitalisation of information processing and similar processes, and coordination of economic transactions with the use of digital networks.

An integral part of a discussion related to the impact of technological change on the labour market concerns the automation of work. A discussion on the consequences of a technological change for employment is not new – its historical roots can be traced back to the Luddite debate in the 19th century – and, in general, focused on the issue of labour market disruption. The recent iteration of this debate revolves around the notion of Industry 4.0 (Schwab and Davis 2018), or even 5.0. With the growing complexity of contemporary labour markets, the impact of automation (technology) is more multifaceted and might differ from one sector or occupation to another. In general, the literature discussed below tends to be inconsistent regarding the impacts of such technological change.

In the contemporary discussion of the impact of technology (automation) on the labour market, at least two strands of a debate be identified (Burgess and Connell 2020) – regarding the impact of automation (presented below) and concerning digital skills (introduced in the following section).

First, there is considerable debate regarding innovation (new technologies) as a driver of inequalities in the labour market, as certain skills or routing tasks could be displaced by technology. Acemoglu and Autor (2011) argued that technological progress in ICT since the 1980s did not affect all categories of workers equally – the authors talk about the 'polarisation' of wages. Such 'polarisation' means that individuals with low and high skills were affected by

wage increases that were not noted for those in the middle of the skills distribution. Acemoglu and Autor (2011) consider such results in the context of the tasks performed by middle-skilled that are repetitive, do not require social interactions, and are thus prone to be replaced by technology. Such findings call for refining the 'canonical' perspective on the returns from skills (and education), the so-called 'skill-biased technological change' that saw only labour demand increases for highly skilled workers.

From a company's point of view, technology-related innovation can take the form of product innovation or process innovation (new processes involved in the production of products), whereas non-technological innovations involve organisational innovation (new ways of organising work) as well as marketing innovation (Warhurst and Hunt 2019). In other words, this debate concerns the digitalisation of production. Whereas the accounts for the magnitude of displacement caused by robots and related technologies differ, also the sectoral concentration of this process varies between countries. At the same time, the increased use of robots and advanced digital technologies might contribute to the additional demand for jobs (or their reconfiguration in terms of tasks). Further, the operating mechanism might be conceptualised differently depending on the technology under study (such as algorithmic decision-making, industrial robots or autonomous vehicles) (Dachs 2018). In general, the recent review points out that the displacement effects seem limited until now (Hötte, Somers, and Theodorakopoulos 2022).

Whereas digitalisation of production is often debated in the context of industrial production, where workers become integrated into the company's IT network that relays information and at the same time controls them, it also affects other less obvious areas such as care services. In the latter, the gender dimension particularly stands out as the sector is generally highly feminised. For example, Green et al. (2018) studied home care in Hungary, the Netherlands and the UK and found the increased use of technology to control the performance of care workers. At the same time, no major displacement effects could be identified.

In general, the debate on the gendered impacts of technology on employment is relatively limited. The comparative research by Brussevich et al. (2019) indicates that women perform more routine tasks than men; consequently, they are more prone to the consequences of automation. Accordingly, based on an index of routine task intensity (RTI, such intensity depends on whether tasks are defined by a set of rules) calculated for 30 countries, the

authors find that this index is 13% higher for women. This translates into the probability of automation of 40% in the case of women, two percentage points higher than for men. Such likelihood decreases with companies' size, individual income and educational attainment and is highest in sectors such as accommodation and food services, retail trade and transportation, yet lowest in feminised sectors such as education or care. Finally, occupations-wise, elementary occupations, clerks and services workers face the highest probability of automation.

Aksoy et al. (2020) focused on an automation-driven gender pay gap potential in 20 European countries and found that automation contributes to an increase in the gender gap. Looking at industrial 'robotisation' (the number of robots per 10,000 workers), the paper finds that a 10% increase in robotisation contributes to a 1.8% increase in the pay gap between 2006 and 2014. Such an increase in the pay gap is driven by countries with initial gender inequality where a dynamic growth of robotisation occurred. Such effects are caused by wage dynamics in high and medium occupations where men dominate.

Warhurst and Hunt (2019) emphasise that due to the complexity of digital technologies' impact on jobs and employment, it is more appropriate to talk about the futures of work rather than a future of work. Further, while the debate tends to focus on the stock of jobs (Klenert, Fernández-Macías, and Antón 2023), it seems equally appropriate to focus on the quality of restructured and newly created jobs. Recent research on algorithmic management by Baiocco et al. (2022) explores this issue extensively. The authors define algorithmic management as 'the use of computer-programmed procedures for the coordination if labour input in an organisation' (ibid: 6) and explore how such management might be understood in different types of organisations (contexts). Importantly, this research states that several aspects of algorithmic management have been implemented even before the digital revolution and that this type of management can potentially reduce the quality of jobs by diminishing workers' autonomy or increasing work intensity. A brief empirical exploration of this phenomenon in Germany and Spain (Urzi Brancati, Gonzalez Vazquez, and Fernandez-Macias 2023) points out that in the case of workers equipped with digital devices, digital monitoring is most often used to track working times, followed by the access control (movements in the workplace) and tracking vehicle locations. As for algorithmic management,

the most frequent use was the allocation of work. Both aspects were associated with work organisation characterised by monotony.

As a way of summarising this section, one could recall the publication by Filippi et al. (2023), who, in their meta-review, argue that the academic debate on the impact of automation on employment is complex (due to the richness of approaches applied), does not deliver robust results and remains at an early stage. While there is a considerable discussion on the negative impacts of automation on the labour market, the available studies focusing on the quantitative dimension of this phenomenon do not provide extensive, compelling evidence to support such a claim (Klenert, Fernández-Macías, and Antón 2023). It should be noted, nonetheless, that given the concentration of industrial robots in some countries and sectors and also because several studies focus on *the potential* to automate jobs, such results should be treated cautiously. At the same time, the studies on the qualitative dimension of work point out the potential for diminishing job quality. Also, the results tend to vary according to place in occupational structure. Finally, it should be stated that the gender dimension of research into automation remains relatively underdeveloped. The available research tends to emphasise the widening of the gender gap due to technical change.

Demand for digital skills and their definitions

It has been estimated that around 85% of EU jobs require at least basic digital skills, and such demand is growing fast (Centeno, Karpinski, and Urzi Brancati 2022). Between 2017-2019, the share of workers with basic skills and above declined from 64 to 63%, yet in the workplace, there is a growing emphasis on the adjustment to the changing IT environment.

Cedefop's research based on the second European Skills and Jobs Survey (ESJS2), which is the most comprehensive research tool on the topic, argues that the Covid-19 pandemic accelerated the digitalisation of European economies – as compared to the pre-Covid-19 situation, 46% of respondents indicated more frequent use of digital communication tools or platforms, whereas 39% use more of the digital technologies to perform some work tasks (Cedefop 2022). Looking at the cross-country distribution of the latter, the highest share of respondents who noted such change were identified in Ireland (55%), the lowest – in Bulgaria (31%).

Cedefop measures the use of digital or computer technologies by referring to devices (laptop, computer etc.), activities using software/programming and computerised machine technologies (scanners, robots etc.). On average, 87% of workers in the EU used computing devices in 2021, while 39% used computerised machines. The more frequent use of devices is positively correlated with occupational group (53% for elementary and 97% for skilled workers) and education attainment. It drops slightly with age and depends on industry (lowest in agriculture, highest in public services, education and health). Interestingly, the distributions of the use of computerised machines are different – it is highest among manual workers, with low levels of education, among youngest workers and in manufacturing. Finally, in the case of 43% of workers, new digital technologies were introduced in their jobs 12 months prior. All this suggests the magnitude and pace of technological development workers, employers and other stakeholders of the labour market need to respond to.

According to the analysis conducted by Grundke et al. (2018), the ability to learn and utilise such skills in a work environment might affect wage differentials based on digital skills proficiency. In other words, having a skillset that corresponds with the demands of the economic change driven by digital transformation provides a higher rate of return. Based on the comparative PIAAC data, the study focuses on two types of skills: cognitive and non-cognitive. Cognitive skills cover those acquired through education, such as literacy, numeracy and problem-solving. In contrast, non-cognitive skills refer to managing, communication, self-organisation, and socio-emotional skills: readiness to learn and creative problem solving (ibid.). The study isolates the skills that are particularly important in digital-intensive industries as opposed to less intense ones: advanced numeracy skills (cognitive) and self-organisation skills (non-cognitive). Further, for digital-intensive industries, the study finds the 'skills bundle' of ICT skills and self-organisation as particularly rewarding. Such results suggest that given the fast pace of technological change, it is essential to equip workers with ICT and numerical skills, but also other skills which tend to be seen as 'soft'.

When it comes to the priority groups regarding diminishing the digital skills gap, the JRC study (Centeno, Karpinski, and Urzi Brancati 2022) provides some estimates on the size of such gap as well as identifies the target groups. Accordingly, in 2019, 40% of individuals had digital skills below a basic level. Among the target groups for policy action, the study lists the youngest and oldest individuals in working age, individuals with low and medium-level education,

inactive and unemployed persons, third-country nationals, those who live in rural areas and those employed in semi-skilled and low-skilled occupations. As far as the digital skills mismatch is concerned, the analysis states that for 3-11% of active workers, such mismatch can be identified. Centeno, Karpinski, and Urzi Brancati (2022) provide an extensive discussion of data sources as well as different conceptualisations of digital skills.

Digital Competence Framework for Citizens (DigComp), launched in 2013, is a conceptual tool allowing a common understanding of the key areas of digital competence with a view of improving it. It also serves as a basis for the development of the Digital Skills Indicator (DSI), described below. The most recent Digital Competence Framework 2.2, updated in 2017, conceptualises digital skills so that it takes into account the technical progress in the ICT (Internet of Things, AI). According to the Council Recommendation on Key Competences for Life-Long Learning from 22 May 2018, digital competencies involve the confident, critical and responsible use of, and engagement with, digital technologies for learning, at work, and participation in society. Such competencies include information and data literacy, communication and collaboration, media literacy, digital content creation (including programming), safety (including digital well-being and competencies related to cybersecurity), intellectual property-related questions, problem-solving and critical thinking.

The definition presented above is relatively broad and comprises knowledge, skills and attitudes that refer to overcoming the challenges of digitalisation in several aspects of lives and thus goes beyond the labour market needs. Also, regarding gender-sensitive aspects, the only reference has been made to the awareness that AI can introduce gender biases (in terms of 'male jobs' or 'female jobs', for example).

The exploration of digital competencies by gender has been provided by Women in Digital Scoreboard, which presents detailed elements of the composite indicator, and by the online tool[1]. From a policy perspective, but even more importantly, from a research perspective, one

[1] See the online tool available here: https://digital-agenda-data.eu/charts/analyse-one-indicator-and-compare-breakdowns#chart={%22indicator-group%22:%22wid%22,%22indicator%22:%22wid_score%22,%22breakdown-group%22:%22bygender%22,%22unit-measure%22:%22egov_score%22,%22time-period%22:%222022%22,%22ref-area%22:[%22AT%22,%22BE%22,%22BG%22,%22HR%22,%22CY%22,%22CZ%22,%22DK%22,%22EE%22,%22EU%22,%22FI%22,%22FR%22,%22DE%22,%22EL%22,%22HU%22,%22IE%22,%22IT%22,%22LV%22,%22LT%22,%22LU%22,%22MT%22,%22NL%22,%22PL%22,%22PT%22,%22RO%22,%22SK%22,%22SI%22,%22ES%22,%22SE%22]}

should state there are several knowledge gaps regarding digital skills, the digital labour market and gender. Touzet (2023) shows that one of the most acute knowledge gaps exists in career progression, job quality, and work-life balance.

To sum up this section of the review, there is a growing demand for digital skills among European workers. Such demand entails an increasing share of workers using digital technologies and accelerating the need for up- and re-skilling in the digital domain. The available research points to the considerable differences in demand for digital skills by sector, occupation, and educational attainment of workers. Further, the use of digital skills depends on the type of technology used in the workplace. Also, the return from digital skills is the highest when such skills are combined with other - 'soft' competencies. Finally, this section demonstrates that digital skills are defined very broadly in the policy discourse.

European policy framework for digital transformation and digital skills

European framework regarding digital skills, or more generally, 'new technologies' has been included in the EU policy agenda for several years. Already in 2008, the European Commission has recognised the impact of such technologies, especially concerning the 'tails' of skills distribution – that is, among the least and most skilled workers. The next step in the policy framework development was the launch of the Digital Agenda for Europe in 2010, one of the flagship initiatives of the Europe 2020 strategy. Among the obstacles to the virtuous cycle of the digital economy, the Agenda identified a lack of digital literacy and skills and suggested actions to address this situation. One of them was establishing digital literacy and competencies as a priority for the European Social Fund. In 2013, the European Commission published the first iteration of the Digital Competence Framework (DigComp). The purpose of the Framework was to improve citizens' digital competencies by helping the development of policies to build such competencies and plan activities to implement these policies. One of the outcomes was the construction of the Digital Skills Indicator (DSI), discussed further in the review. Two years later, in 2015, the Digital Single Market strategy was presented with a view of equipping European citizens with digital skills, especially in the context of employability. The same year, the Digital Competence Framework 2.0 was announced, which updated the

conceptual reference model of the original Framework and presented five aspects of digital competence for citizens.

More recently, with a proclamation of the European Pillar of Social Rights in 2017 (and its Principle 1: Education, training and life-long learning), the issue of skills has been a central policy priority. Currently, one of the most important policy frameworks in digital skills is the 2030 Digital Compass.

In terms of relations between Member States and the Commission, the 2030 'Path to the Digital Decade' structures cooperation, including the European Parliament and among the targets, it sets out them in terms of digital skills. The 'Path to the Digital Decade' outlines common targets for the EU to be achieved by 2030, whereas the Declaration of Digital Rights and Principles provides a reference framework for achieving these goals.

The 'Digital Decade' stipulates that by 2030, there should be 20 million ICT specialists (in 2021, 8.9% million) and that there should be gender convergence in this respect. Further, 80% of the EU population should have at least basic IT skills. The Digital Economy and Society Index (DESI) serves to monitor progress in this respect, and the 2022 edition has three aspects of the human capital dimension that refer to the 'Digital Decade': the proportion of persons with at least basic digital skills, the number of ICT specialist and the number of female ICT specialists.

The Digital Skills Indicator is a composite indicator in its most recent iteration, which is in line with the Digital Competence Framework 2.0 described above. It measures the following aspects of such skills: information and data literacy, communication and collaboration, digital content creation, safety and problem-solving. The indicator considers activities surveyed individuals perform as proxies of their digital skills.

Such conceptualisation of digital skills has been challenged by Lennon and colleagues (2023). Accordingly, the authors argue that PIAAC data-driven methodology (Grundke et al. 2018) or the methodology applied by the JRC research (Sostero et al. 2020) need to be revised. First, the survey-based occupational indicators are derived from self-reporting and perceptions. Secondly, such a survey might not be up to date with changing composition of tasks in a given occupation. Thirdly, the surveys are not designed to extensively explore the tasks involved for occupations (as this is not their primary aim). Finally, the surveys derive skills from tasks, they

in fact, do not ask about skills as such and thus, according to the authors, might underestimate the extent of digitalisation of occupations under study. A solution proposed in this research is to focus on 'dictionaries of occupations, which map tasks, skills, and knowledge requirements to occupations' (Lennon, Zilian, and Zilian 2023:2). An example of such a dictionary might be European Skills, Competences, Qualifications and Occupations (ESCO) which is a multilanguage classification of these aspects of occupations.[2] The authors construct the Digital Competencies Indicator to identify digital skills among all skills included in ESCO. This, in turn, allows us to identify occupations in the ISCO-8 classification and apply it to labour market survey data. Such an approach, according to the authors, provides a more granular understanding of digital occupations.

Digital transformation is an integral part of the Recovery and Resilience facility. This priority has received a considerable share of budgeting – at least 20% of the funding must be dedicated to the digital transition and related challenges (European Commission 2022). On average, as of 22 June 2022, the average share of funds allocation of digital transformation in the approved national plans was 26% - with the leaders being Austria and Germany (53%) (ibid.). Out of this share, 17% (or 21.6 billion euros) has been devoted to the development of basic and advanced digital skills.

Finally, also some European citizens share concerns regarding challenges linked to the growth of the digital economy. The 2021 Eurobarometer study finds that among worries related to the increased role of digital tools and the internet, 26% of European identify the difficulty of learning new digital skills. Such share is the lowest in Luxembourg (15%), whereas the highest in Greece and Italy (35%). Worries regarding digital skills are more frequent among the older population (55+ years of age – 29%) than in other cohorts. Also, such worry is more prevalent among individuals with regular financial difficulties. Gender-wise, 25% of men and 27% of women share this worry. Also, it is the highest among unemployed individuals (30%) and manual workers (28%), while the lowest among students (20%) and managers (21%) (Eurobarometer 2021).

[2] ESCO is the European Commission project and contains a description of 3008 occupations and 13890 skills. See: https://esco.ec.europa.eu/en/about-esco/what-esco.

This section demonstrates the centrality of digital skills in the EU's policy agenda. As such, they are regularly monitored by the EU, and several policy initiatives have been launched to progress further in this field, including the Recovery and Resilience facility.

Women in digital (labour) markets

The technological change has brought about a major change in the labour market which can have significant emancipatory potential. Yet, the digitalisation of the labour market has been taking place in the context of progressing liberalisation and deregulation, itself contributing to these processes. Puligniano (2023) coins this change as a shift from the 'welfare state capitalism' to the post-Fordist 'flexible capitalism'. For example, platform economy companies tend to treat relations with their workers in flexible business-to-business – relations with minimum or no protection in terms of wages, working time or working conditions. Also, the 'welfare state capitalism' social protection systems find it hard to cope with such new forms of activity. All this requires yet another wave of regulation and definition of employment relations and accompanied rights (social protection and collective bargaining) (Ratti 2022).

All in all, whereas digitalisation in the form of new modes of work is seen as an emancipatory instrument, especially by the observers in the private sector, in other arenas, the technological change and associated adjustments in the labour market are not unanimously considered a positive phenomenon. Grimshaw's recent study (2020) analysed flagship reports published by five international organisations (ILO, UNIDO, UNDP, OECD and World Bank) and found both similarities and differences in the views on the role of new technologies and the future of work. Among similarities, Grimshaw identified the observations that new technologies have an uneven impact on jobs and a decline in labour income share. Whereas ILO, OECD and UNDP are cautious regarding new developments and their impact on inequalities, UNIDO focused on the global digital divide. The World Bank presented the most reserved view on the impact of new technologies and, among the five analysed organisations, was the only one that did not see a need for a response to challenges related to digitalisation. While the analysed reports make several references to the gendered impacts of the technological change, they do not focus on the area of e-commerce, which impacts women more considerably (see also below on the issue of gender discrimination in e-commerce platforms).

Traditionally, among the issues related to female disadvantage in the labour market, one can find a work-life balance problem. The reconciliation of the burdens culturally associated with women (care duties, household chores) has been seen as an obstacle to full female engagement in the labour market. Yet, as this part of the review demonstrates, the use of modern technologies as a tool and a platform of work does not need to automatically translate into higher engagement in the labour market on par with men. Research shows that ICT and digital skills do not eradicate a key challenge, which is gender-based discrimination.

Picatoste et al. (2023) explore factors behind the Gender Digital Divide (GDD) by disentangling the GDD into three stages: economic divide (access), usability divide (use) and empowerment divide (outcomes). Their macro-level analysis points to the fact that age does not influence the GDD in terms of access and use, whereas educational attainment does so. Regarding the outcomes, the authors argue that gender stereotypes are at play here.

Several streams of argumentation explain the GDD. First, the divide might be linked to low educational attainment. Secondly, the GDD might be linked to inhabiting rural areas. Thirdly, the GDD might be seen as a result of labour market 'choices', that is, the lack of interest in pursuing careers in technical occupations by women. Also, the research has identified causes of GDD in the gender stereotypes present in the youth and carried later.

Another facet of ICT-enabled dependent work is work outside of employer premises. In literature, there are three basic concepts which capture it (Sostero et al. 2020). First, it is remote work in which work is performed outside the premises without defining where exactly (it does not have to be the employee's home). Eurofound applies a similar concept in their notion of ICT-based mobile work. Second, telework refers to a situation in which personal IT equipment is used for the purposes of work. Whereas remote work can apply to self-employed and dependent employees, telework mostly applies to the latter category (see 2002 EU social partners agreement on telework). Thirdly, when it comes to the concept of working from home, it captures the place of performing work and does not differentiate between dependent employment and self-employment (ibid.).

During the pre-Covid-19 period, working from home was not widespread: it was 3.2% of all dependent workers in 2019, with little change compared to 2008. In this period, there were no marked gender differences, while such work was more widespread among older workers.

Also, such work was more pronounced among workers with permanent employment and full-time jobs.

Among the sectors with the highest pre-Covid remotability in the case of dependent workers, the education and ICT sectors dominated. However, when it comes to self-employment, knowledge-intensive business services and art, entertainment and recreation led the rank. It should be stated that the dominant form of remote work was occasional. These sectors can be characterised by the presence of highly-skilled, white-collar workers – teaching professionals, ICT professionals or managers, for example. At the same time, even *within* the sectors, inequalities were notable – among individuals with lower levels of skills or with shorter job tenures as compared to highly educated, stable and well-paid jobs. The presence of children in a household was associated with telework, yet not as a permanent mode.

Regarding the prevalence of telework, it was most popular (above 25% of employees) in Sweden, the Netherlands, Luxembourg, Finland and Denmark; however, nowhere was it popular as the usual mode of work (rather as an occasional one). In these countries, the high shares of occasional telework could be associated with the importance of the ICT-intensive sectors in their economies. However, a number of other factors might contribute to the remotability of work (such as within sectors and occupation differences or size of firms).

The 2018 OECD report (OECD 2018) explores several aspects of the gender divide in relation to digital skills and, more generally, the labour market. The study shows that the engagement of women in professional networks is considerably lower as compared to men. When it comes to yet another form of engagement of women through the IT means, such as labour platforms, the available research point to gender discrimination in tasks (delivered jobs evaluation). This, in turn, might hamper their employment chances. When it comes to online market platforms, such as eBay, research suggests comparatively lower prices in the case of products sold by women. In order to avoid discrimination, 33% of women who work online use pseudonyms.

Eurofound research (Eurofound 2022a) demonstrates that employment in the gig economy jobs and the flexibility it offers might be seen as compatible with the demand for flexibility of women with caring duties, which might lead to overburdening with work which can be performed at any time. While new types of employment based on advanced digital technologies can be empowering to several groups, including women, it might be based on

atypical forms of work that do not provide full social protection coverage, decent work conditions or collective bargaining coverage. Thus, women might end up in sectors of a labour market characterised by substandard conditions and precarity (Drahokoupil and Piasna 2017). Further, Touzet (2023) states that telework offers men more robust wage boosts, yet women might be more willing to telework as compared to men. Such gender disparities in wage progression might result from different bargaining power between genders. Associated gaps are the biggest in terms of motherhood wage gaps among highly-qualified women who are expected to work from the office. The issue which further complicates the assessment of gender gaps in work-from-home concerns the lack of productivity assessment.

Indeed, the flexibility of work is seen as the most important benefit of working in the gig economy (with 96% female freelancers that took part in the study), followed a control over earning total (40%), more personal time (39%) and less stress (36%) among women (OECD 2018). Interestingly, the Hyperwallet study indicates that platform work allows women to equalise their income with men, which is considerably more difficult in the more traditional labour markets but also allows for combining unpaid care work and paid work.

These issues are thoroughly explored in the major study prepared by EIGE (2021). In relation to AI-powered employment, the study finds several associated risks, for example, concerning gender biases that amplify the already existing gender inequalities. When comparing gender segregation in the platform work to the traditional labour market, such segregation is less pronounced in the platform work. Also, a notable convergence could be observed in recent years in terms of economic activity. However, the study found that outside of paid work, in the unpaid sphere, gender differences persist. Joint Eurofound-EIGE analysis (Eurofound and EIGE 2023) explores motivations behind entering platform work. In the case of women, a stronger motivation to enter platform work is to gain additional income and combine it with private commitments while for men the motivation is to enter platform work for the opportunities it can bring. The analysis suggests that given women who live in a household with a second earner are nonetheless willing to engage in platform work, this mode of work might be a mitigation strategy to keep economically active thanks to the possible flexibility.

Among the most important conclusions of this section of the review, one can point out the tension between emancipatory expectations towards digitally enabled forms of work and the experiences of such work. Whereas such forms of work might provide an avenue to (re-)

connect with the labour market, they might also bring about more precarious employment and do not solve the fundamental issue of gender equality.

Covid-19 and remote work

The Covid-19 pandemic has had an impact on working from home arrangements – such form of work has significantly increased over a very short period of time. Also, due to the epidemic restrictions, education was moved to the online sphere, while institutional childcare was suspended (Dobrotić and Blum 2023). Such a combination could have had a significant impact on work-life balance and well being of parents (and other carers). At the same time, the data suggests that while the impact of the Covid-19-induced changes in the labour market (i.e. unemployment) has been relatively gender-neutral, it has affected different income groups (Eurofound 2022a). Accordingly, in the case of females if were lowest-paid groups (employed in sectors such as hospitality), whereas in the case of males, the job losses were more equally distributed.

The Covid-19 pandemic has demonstrated that while it is possible to increase the use of ICT and remote work, there are noticeable limits to such change. Accordingly, the JRC study showed that from 33% to 44% (depending on the employment structure) of jobs can be performed as telework (Sostero et al. 2020). For an analysis of such extent in the US (37%), see Dingel and Neiman (2020). The possibility of teleworking is associated with higher wages, greater job security and less arduous working conditions. As the JRC study states, during the pandemic, this category of jobs proved more stable as compared to jobs requiring physical contact with clients. The JRC research also tackles determinants of teleworkability. Drawing on the concept of work tasks, the authors argue that it is the lack of physical handling tasks. Examples of jobs requiring physical handling tasks might include care, manufacturing or farm work. The study defines teleworkability as 'the technical possibility of providing labour input remotely into a given economic process' and constructs an index of thereof. The index is constructed by intersecting two dimensions: a requirement of physical task content and social interaction. Among the least teleworkable occupations are those populated by women: nurses, salespersons, childcare workers. Finally, the authors find that technical teleworkability (i.e., lack of tasks related to physical handling) is closely connected to the use of computers.

The study finds that from a perspective of its indicator of teleworkability, pre-Covid employment was considerably underutilising such work modality. When it comes to the share of telework able employment by country based on the structure of occupations in each economy, it is the highest in Luxembourg (where it exceeds 50%), whereas in the majority of countries, it is below 40% (with Romania and Slovak Republic scoring below 30%). Importantly from the perspective of this review, for the EU economy, women display a higher share of teleworkable employment as compared to men (45% vs 30%). Such difference stands also for particular sectors with low teleworkability (for example, construction – 6% for men and 69% of women). As a caveat, the authors argue that many occupations among most possible to perform remotely (such as clerks or secretaries) were not performed so in the pre-Covid era and this might have to do with internal company hierarchies. Accordingly, as these occupations were considered lower in the hierarchy, they did not enjoy equal freedom to be performed remotely as compared to higher managerial roles (for an exploration of such case in Germany see (Abendroth et al. 2022).

Among the biggest surveys that explore telework one can find Eurofound's Covid-19 survey. Importantly, the survey showed that women slightly dominated (41% while 37% for men) among persons who started working from home since the outbreak of Covid-19, and this was a rule across all EU Member States.

What has been the impact of the pandemic and a partial shift to working from home on the working conditions? The Covid-19 survey organised by Eurofound provided an elaborate set of results (Eurofound 2022b). First, those who had moved to work from home worked longer hours than before the pandemic in several European countries. Also, during the Covid-19 pandemic, there was a higher share of teleworkers with longer time as compared to those who worked in the company's premises.

The research has found that 'remote workers' were prone to work in unsocial and irregular hours while simultaneously, the autonomy of organising working time allowed for adjusting it to individual requirements (which might be related to the 'flexibility paradox' (see Chung 2022). The phenomenon of longer working hours is not only driven by excessive job demands and competition, but also frequent interruptions. Interestingly, such extended working time was most extensive among workers having a hybrid model of work while in terms of a job structure – among professionals and managers. These findings might suggest that the impact

of remote work on the work-life balance is mixed. However, the survey results indicate that the share of teleworkers with a poor work-life balance ('how working hours fit in with their family or social commitments outside work') was lower as compared to the general population of workers. Looking at the EU-wide averages, female full-time, partial and occasional teleworkers had higher shares of poor work-life balance compared to their male counterparts. There was no gender difference in the case of workers with some teleworkability but working primarily at the employer's premises, whereas in case of non-teleworkable workers, more males indicated poor work-life balance. Yet, in all categories of workers, the share of female workers who felt too tired to do some of the household jobs was higher in call categories of telework arrangements. A similar phenomenon was found in the case of difficulties in concentrating on the job because of family obligations. The combined duration of unpaid and paid jobs for females was 68 hours, whereas for males – 61 hours.

A study focused on gender-specific impacts of the Covid-19 pandemic, also published by Eurofound, provides further details. Accordingly, the pandemic did not change the unequal distribution of unpaid work, while the gender gap in intensity of tasks increased. An exception to this related to childcare was a situation where in a household, a man was teleworking and a woman – did not, only in such a setting the engagement of men in childcare and education increase (Eurofound 2022a).

Conclusions

The purpose of this review has been to present the main themes relevant to the study of gendered differences in a digital economy – including both automation and the labour market as well as digital skills. From a policy point of view, the development of digital skills is one of the central priorities in the EU, especially when it comes to increasing the number of individuals with formal ICT training, reducing the gender gap among such specialists, and also regarding making basic digital competencies more universal. The digital skills mismatch can be identified in case of 3-11% of workers and is relatively robust internationally across occupations.

At the same time, the research reviewed in this paper suggests that while there is a growing body of knowledge about the digital economy, and the impact of automation on employment

and digital labour markets, the discussion on digital skills creation still needs to be explored. The presented research shows how to measure such skills and which skills are most useful when it comes to returning from such investment in human capital.

This review also signals 'soft' factors that are rarely quantified – for example, presence of expectations regarding work in the office, internal company hierarchies, gender neutrality in personnel management or the presence of other policies with strong gender impact potential (leave policies, childcare etc.) (van der Lippe and Lippényi 2020).

Further, the reviewed research and policy documents point to a central role employers play in bridging the digital skills gap in general (for an overview of work-based courses and less formal training initiatives in the EU Member State (see Beblavý and Bačová 2022)). Also, the role of Public Employment Services in providing such skills via Active Labour Market Policies should be recognised and emphasised. As stated in the previous sections, the use of digital technologies is not only a domain of workers with high levels of formal education but also involves individuals with middle and lower qualifications. That is why digital skills are required at all levels of education, including Vocational Education and Training.

Cedefop's research indicates a crucial mismatch in the digital skills domain. More than half (52%) of the surveyed workers indicated moderate or great need to further develop computer/IT skills. The EU policy priority regarding 20 million ICT specialists (and 'convergence' in the number of female specialists) by 2030 means a significant increase of the number of the ICT education graduates. Whereas gender selection in STEM education has been a subject of research, it seems that the gender dimension of skills formation requires more thorough research. For example, the flagship publication of Cedefop devoted to skills mentions gender differences relatively sparsely. This opens up an opportunity to further exploit their data by making linkages to gender-specific analysis, especially in the context of intra-EU diversity.

In general, the overview of the literature indicates a complex web of concepts, approaches and levels of analysis when it comes to the impact of digital technologies on employment. Such complexity adds to the lack of robust results of the processes under study.

From a policy perspective, given that from May 2023 to May 2024 European Union will hold the European Year of Skills, one can expect a number of initiatives to move forward or be

accepted. A European Digital Skills Certificate or 'The digital education and skills package to improve digital skills, education, and training' could be mentioned among such initiatives.

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