

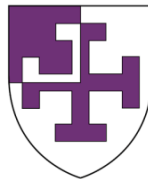


*The promises of “Going digital” for all:
where technology meets social policy?*

A Statistical Analysis of European Union’s Digital Skills Inclusion Policies and Digital Skills Inequality

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Abstract

Digital skills have never been more relevant to social policy. The European Union's policy agenda has been increasingly linking digital skills to social matters such as employment, poverty, income or education. However, wide disparities in national levels of digital skills are observed across member states. This study investigates the associations between digital inclusion policies and national levels of digital skills across the European Union using Eurostat data from 2010 to 2019. Digital skills inequalities are also explored by gender and educational levels. Results suggest that public digital skills policies are associated with higher levels of digital skills, and lower levels of digital skills inequality. Conversely, private digital skills policies increase digital skills inequality. This paper explicitly links digital skills with social welfare, bridging human capital and labour market perspectives with nuanced understandings of digital skills and their reflection of preexisting socio-economic inequalities. The main theoretical contributions lie in thinking of digital skills policies within a social investment framework, inciting a broader reflection on the role of digitalisation for the future of social policy and the welfare state.

Keywords— Digital skills, Digital skills policies, Digitalisation, Digital Agenda for Europe, Digital inclusion, Skill inequality, Digital Welfare State

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1 Introduction

*It is easy to oversimplify history.
However, if there is one predominant factor underlying economic and social change over the
past two centuries, it is surely the advancement of technology.*

- Carl Benedikt Frey

1.1 Digital skills today

While the Covid-19 pandemic brought chaos to an existing global order of international trade and free movement, it exalted the value of digital technology. From March 2020, national lockdowns forced millions to work from home as companies, families and state politicians saw their communications switch online. As Allman (2020) puts it: *‘It’s a fact we seem to have accepted unproblematically, a happy relief made possible by the historical coincidence of facing a pandemic in the digital age’*.

If the internet has been celebrated to maintain a somewhat normality to the life of individuals and countries, the pandemic has saliently exposed digital inequalities, where a lack of skills have exacerbated the negative effects of the crisis. It is estimated that 43% of the population within the European Union (EU) ¹ do not possess basic digital skills according to the Digital Economy and Society Index (DESI 2019, p.5). This represents almost 200 million individuals facing risks of digital exclusion regarding working from home, accessing government information/sanitary advice or following remote schooling.

Yet today, digital skills² are considered as essential skills of the twenty-first century (van Laar et al. 2017). As automation and non-standard forms of jobs are on the rise (Frey 2019; Blix 2017), digital skills have become an effective barrier against worker displacement and at the same time a facilitator for re-employment (Peng 2017). For instance, the UK’s Department of Education highlighted computational thinking as an essential ‘life’ skill (Department for Education 2019). Digital skills are even so crucial for today’s ageing population: ‘keeping up’ with technology is a relevant topic to all individuals within society, as a life-long learning approaches to skills are increasingly put forwards by governments.

1.2 When digital inclusion policies meet social policy

Digital skills have never been more relevant to social policy, shifting from being a political priority to a practical need (EU Social Commission 2020). In light of the Covid-19 crisis, governments and businesses have responded by calling for pledges to address the surging need for digital skills (Europa 2020). Digital inclusion policies have witnessed a diversification in their scope of action. Instead of focusing on commercial policy areas, they are increasingly being related to social matters, such as poverty, income and education. Addressing the ‘digital

¹The United Kingdom (UK) exited the EU on 31st of January 2020. As for the remainder of this paper, the UK will be included within the analysis and data sets of EU member states.

²*Digital skills* relate to the technical proficiency a user may have, whereas *digital literacy* more widely defines the cognitive ability of a user to use digital tools, identify and judge their strengths and limitations (Beradi 2017). This research will use digital skills as an umbrella term including both skill and literacy dimensions.

divide’ has become a central theme within governments, as academics and practitioners become aware that it can ‘*compound existing socio-economic inequalities*’ (OECD 2019).

These concerns have been illustrated by the EU’s growing interest in supporting human capital development. Initiatives such as the *Digital Agenda for Europe*¹, the *Education and Training Strategic Framework*², the *Grand Coalition for Digital Jobs*³, the *EU Code Week*⁴ or the *New Skills Agenda*⁵, sit within a social investment framework, where activation policies seek to address growing demands for skills which are necessary in a knowledge-based service economy (Esping-Andersen et al. 2002).

While digital skills inclusion policies are inscribed within the European social policy agenda, they are not necessarily an area of convergence among member states. Whereas Estonia is hailed as Europe’s ‘digital republic’ with almost 99% of its public services online (e-estonia 2020), Italy is within the 3 last ranking countries scoring on the DESI 2019 Index, only awakening to the potential of digital solutions due to Covid-19 (Guerrini 2020). The disparity of digital skills across the EU prompts the investigation of the impact of inclusion policies on national levels of digital skills. The first research question asks: *What are the effects of digital skills inclusion policies on population levels of digital skills across EU countries?*

1.3 The promises of ‘Going digital’ for all

There seems to be an empirical and theoretical simplification which assumes that increasing digital skills would lead to positive social outcomes. While research has demonstrated that in given contexts digital skills increase the probability of getting a job, this does not mean that aggregate levels of employment or income equality would increase as well. A greater labour market competition may well reinforce inequalities between individuals who possess digital skills and those who do not. As Gould, Barry, and Wilkinson (2015) resume, ‘*skill formation and the expansion of human capital do not automatically lead to higher levels of economic production; rather, the institutional context of the employment relationship pushes firms along a ‘high skills versus low skills’ avenue of economic competition.*’ (p.4).

Increasing the overall levels of digital skills possessed by the general population does not necessarily mean that the distribution of digital skills will benefit those with the least skills. The argument underpinning this line of thought relies on the criticism of understanding digital skills as assets that could transcend other structural conditions of the job market such as discrimination, competition or employer’s preferences (Davies and Eynon 2018). Digitally socially excluded individuals may not even be affected or reached by such policies. One ought to ask if the EU can truly talk of digital inclusion if there is an overall greater level of digital skills yet not a significant decrease in digital skills inequality. The second question guiding this research is: *What are the effects of digital skills inclusion policies on digital skills inequalities across EU countries?*

¹<https://ec.europa.eu/digital-single-market/en>

²https://ec.europa.eu/education/policies/european-policy-cooperation/development-skills_en

³<https://ec.europa.eu/digital-single-market/en/digital-skills-jobs-coalition>

⁴<https://codeweek.eu/>

⁵<https://ec.europa.eu/social/main.jsp?catId=1223>

1.4 The present research

Digital skills are rarely understood as a ‘social policy’ matter within the literature. The theoretical contribution of this research lies in how digital skills are linked to the social investment framework, providing new insights to welfare state theories and technological change. Though qualitative approaches generally focus on individual skill adoption (Breit 2015; Yu, Lin, and Liao 2017; Gui and Argentin 2011), quantitative ones tend to look at the economics of skills (Jandrić and Randelović 2018; Bynner et al. 2008): few studies have particularly explored digital skills inequality from a comparative policy perspective at the EU level.

Using a cross-national quantitative research design, I analyse data from Eurostat to determine if digital skills inclusion policies are associated with higher levels of digital skills. I then investigate digital skills inequality by gender and educational level between member states. Results suggest that public digital skills policies are associated to higher levels of digital skills, and lower levels of digital skills inequality. Conversely, digital skills policies dispensed by the private sector increase digital skills inequality.

This research is structured as follows. The literature review sets out the theoretical background of this study in section 2, succeeded by a detailed account of methodology in section 3. The results are then presented and discussed in section 4, resulting in a conclusion (section 6).

2 Literature Review, Theory and Hypotheses

This section is divided into three parts. First, a theoretical framework explores the effects of digitalisation on the welfare state. This enables to understand and frame the importance of digital skills from a social policy perspective. The next two sub-sections present and discuss policy approaches to address digital skills, leading to the formulation of hypotheses which will be tested in this research.

2.1 Digitalisation and The Welfare state: what consequences?

Digitalisation is defined as ‘*the process of changing data into a digital form that can be easily read and processed by a computer*’ (Oxford’s Learner’s Dictionaries 2020). Beyond a mere transition from paperback to screen, this process has deeply transformed the welfare state. To understand the nature of these changes, digitalisation needs to be contextualised within social investment theory.

Social investment can be understood in various ways within the academic literature: from a paradigm for social spending, to a conceptual framework passing by a platform for political engagement (Nolan 2013; Hemerijck 2018). Here the social investment framework is defined as a set of social policies targeted throughout the life course which aim to invest in the skills and capacities of individuals to maximise employment within the labour market and enhance social inclusion (Esping-Andersen et al. 2002; Kvist 2015). This approach is relevant because it frames welfare state spending as a potential to enhance growth and equity, unlike the neoliberal suggestion that regards social policy as a cost and burden to economic prosperity (Morel, Palier, and Palme 2012). In this sense, digitalisation follows the social investment paradigm: the digital becomes a tool to provide services cost-efficiently while being accessible and inclusive to all individuals and societal actors. The idea of ‘investing’ closely resonates to digitalisation, where the benefits yielded from ‘going digital’ are presented as economic and social. The transition from centralised community social welfare to wide networks of automated digital services is fundamentally inscribed within the wider paradigm shift from post-war Keynesian welfare to Social Investment.

The digitalisation of public services is a primary example of how the digital can affect the welfare state. From health care data to educational tools, passing by digital identification or e-benefit claiming, the welfare state is increasingly digitalising (Larsson and Teigland 2020). Technologies such as blockchain or artificial intelligence are revolutionising the interactions between the nation and the state, making these more accountable, accessible and flexible by unbinding the imperatives of place and time. Yet fast paced digitalisation may be seen as a threat to the welfare state (Blix 2017): benefits yielded from greater accessibility do not equate to inclusiveness or democracy (Bridle 2018). In 2018, the UK Department for Work and Pensions (DWP) began testing machine learning to detect fraudulent benefit claiming (Marr 2018). An investigation by The Guardian revealed unintended consequences of this initiative, relating the negative experiences of users as their benefits were cut due to system errors (Booth 2019). This prompts a new discussion. If increasing privatisation and decentralisation of social services led the literature to critically think about a ‘social investment state’, it is necessary to ignite a debate on the conceptualisation of a ‘digital welfare state’.

Shifting the core functions of the welfare state online carries an underlying expectation: having access to a computer and possessing the skills to use it. If governments have previously made efforts to accompany the transition of public services online, their emphasis today on digital skills is framed as a protection against unemployment. Research has shown that digital skills and literacy required by digital transformation are increasing in standards: basic digital skills are no longer enough to thrive in an everyday life or within the labour market (Martínez-Cantos 2017). As the OECD report on Measuring the Digital Transformation shows, ‘*more people are connected than ever before, but other gaps may emerge*’, notably within the workplace, where ‘*advanced digital skills are becoming a prerequisite for entry into many jobs*’ (OECD (a) 2019, p.7). Workers are increasingly having to keep up with new software and other computerised equipment within their work (ibid., p.10). These transformations have put pressure on individuals to acquire digital knowledge paired with a mixed skillset.

2.2 Increasing populations levels of digital skills

2.2.1 The EU’s social investment project

Figure 1 illustrates the socio-economic policies of the EU regarding digital skills. These are diverse and have ramified into sub policy components which are discussed below, moving from the left to the right hand-side of the figure.

In line with the European Union’s Single Market policy, the Juncker Commission announced in 2015 the Digital Single Market (DSM) to promote the use of digital marketing, e-commerce and telecommunications (European Commission 2015). The third pillar of the DSM, Economy and Society, carries social implications such as changing modes of consumption or the creation of digital jobs related to education or well-being (Technequality 2020). The digital society axis reflects this by focusing on specific projects such as increasing the adoption of digital governance (eGovernment), health (eHealth) or identification (eIDAS).

Digital skills are accorded a separate policy framework: alongside increasing the uptake of vocational education and training (VET), the New Skills Agenda stipulates the importance to develop and implement policies aimed at increasing digital skills until 2020 (European Commission 2016). The successive European Skills Agenda puts digital skills on the forefront of the EU’s strategy. In what is described by the European Commission as a ‘*paradigm shift*’, digital skills are today seen as a solution for a European post-pandemic recovery (Europa 2020). They are also considered as a priority policy area for the Commission until 2024.

The Digital Agenda for Europe¹ lays the basis for the Digital Skills and Jobs, which is an umbrella framework to various policies focusing on digital skills. For instance, the Digital Skills and Jobs Coalition attempts to mobilise member states, companies, social partners and non-profit organisations to enact digital skills policies on regional and local levels through various projects, such as the creation of community digital classes, digital public libraries or training jobseekers into web development (Europa 2017). Finally, the Education and Training Strategic Framework tackles education by supporting components such as the Digital Europe Program which fund educational and research projects directed at increasing digital skills.

¹It has recently been renamed to the *European Digital Strategy*.

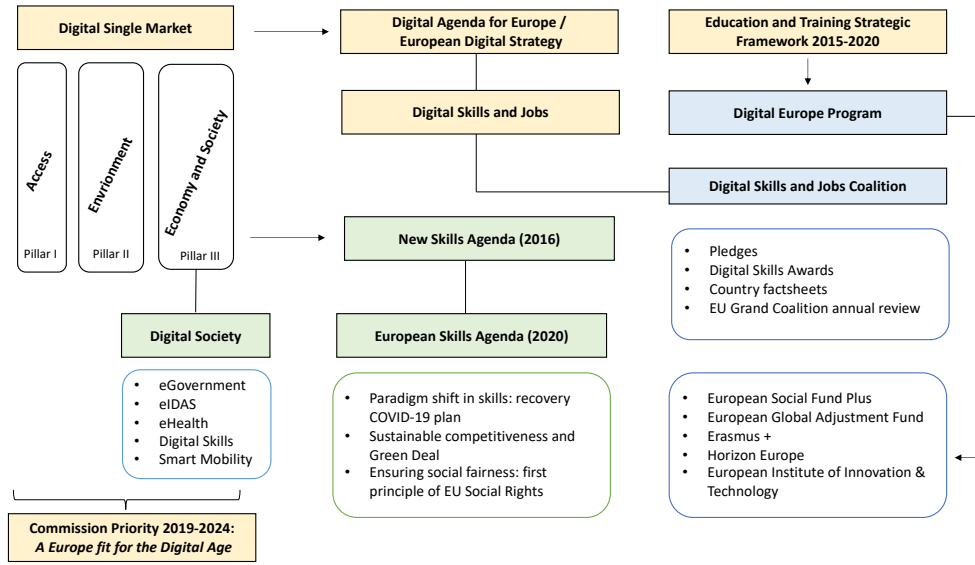


Figure 1: Overview of EU's main digital skills and social policies. *Overarching strategies and frameworks* are shown in yellow, *general policies* in green and *specific policy components and/or projects* in blue. (Source: Author's own compilation).

It is clear that the EU's take on digital policies sit within an economic and activation framework, embracing digital skills as human capital (Becker 1993). By enabling individuals to move freely within a competitive labour market (Streeck 2012), digital competences have been framed as an essential feature for '*the adaptability of the workforce and the employability of all citizens*' (eEurope 2000, p.16). There is an inevitable functionalist dimension to digital skills, where a 'digitally savvy' population generates higher employment. One of the motivations behind the EU's Digital Skills and Jobs policy is a clear recognition of the need for more skilled ICT professional due to unfilled vacancies in that sector (Europa (b) 2020). It also invokes the wider necessity of digital skills for various professions such as engineering, accountancy, nursing, medicine, art or architecture (ibid.).

Digital skills policies distinctly sit within a social investment paradigm, where the economic benefits of digital skills combine with positive social outcomes (Kvist 2015; Esping-Andersen et al. 2002). It is indeed a persuading (Rantala and Suoranta 2008) and two-fold language with which the EU frames digital skills: they are '*needed for growth, jobs and European competitiveness*' yet also indispensable for the average citizen '*to live, learn and participate in the modern society*' (Europa (b) 2020). Therein lies the difficulty of situating digital skills within the skill classification literature (Streeck 2012; Busemeyer and Trampusch 2012; van Laar et al. 2017). In the early days of computing, digital skills were highly specific, and still are today as programming or web development require distinct ICT tools and knowledge. Yet, digital skills and literacy are also extraordinarily general, mobile and transferable across industries, countries, cultures and societies. The dualised nature of digital skills is echoed in the EU's '*double strategy of combining social justice with high economic performance*' (Rodrigues 2006, p.412-413), also following the principles of the social investment strategy.

Critics reproach an excessive emphasis on digital skills as an individualised, life-chance ‘maximiser’ tool rather than an intrinsically socially embedded activity (Buckingham 2003; Livingstone 2003; Tuschling and Engemann 2006, p.452; Rantala and Suoranta 2008, p.97-107). As the digital is product and producer of language, they suggest that digital skills and literacy should be increasingly understood and studied from a social cultural perspective, integrating employment and labour economics with conceptions of class and welfare.

The EU’s digital strategy paints a straightforward picture: to increase the EU’s citizens overall levels of digital skills for economic and social ends. However, the Open Method of Coordination (OMC) strategy, allows only the EU to prescribe and suggest social policy through discourse rather than through legally binding legislation (Falkner 2010, p.4). It is thus necessary to look at policy approaches at a national level.

2.2.2 Diversity of national policy approaches

Unlike tax redistribution or pensions, digital policies appear to be a subject of political entente. In a comparative analysis, König (2019) reveals signs of convergence in party policies stances on digital technologies. His findings suggest that *‘the economic importance of digital technologies prevail over political-economic and socio-cultural country differences in shaping political actors’ policy priorities’* (p.137). While the will to increase digital skills may arise from political consensus, the disparity in levels across EU member states tells a different story. Figure 2 shows member state’s scores in digital skills and competences for 2020.

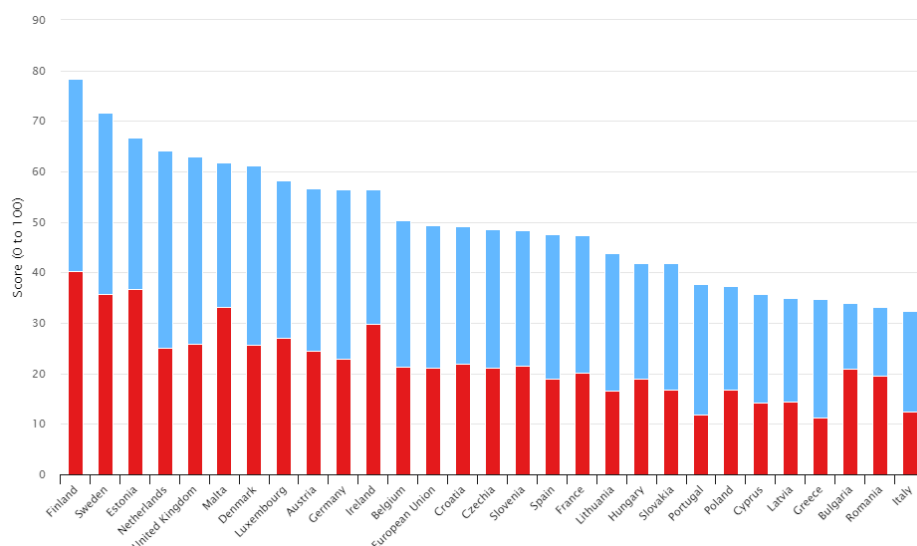


Figure 2: Digital skills score of EU member states of the Digital Economy and Society Index for 2020, Human Capital Dimension (Source: DESI 2020, p.4). Blue bars represent *Internet User Skills* whereas red ones show the *Advanced Skills and Development* indicator.

Top performing countries include Finland, Sweden, the Netherlands, the UK, Denmark, Luxembourg and Austria, which all have moderate to high levels of GDP. Mediterranean or Eastern European countries such as Italy, Romania, Bulgaria or Greece rank the lowest. Differences in digital skills levels hint to diverse national policy approaches which need to be investigated. Table 1 provides a non-exhaustive overview of the main national digital skills policies in all 28 countries. It can be found at the end of this section.

As shown by the overview, education is the most common policy area across member states for developing national levels of digital skills. Almost all countries at least mention digital skills in educational strategies for primary or secondary school. For instance, Slovakia relies on adapting the educative system to develop digital skills through national policies such as the *Learning for the 21st century* (2017) or the *National Education Strategy* (2018). Digital skills and literacy are also included in VET programs, yet the degree of involvement varies by country. Germany or Denmark have not only covered digital skills in the VET curriculum but have also created courses solely focused on digital and ICT professions, (See: *Education in the digital world or Centre for Use of IT in Education on Vocational Training*).

The palette of economic differences of member states within the EU (Cini and Borragán 2016) echo to different labour market structures. Countries such as Poland, Portugal or Greece possess high levels of STEM graduates and ICT experts in the labour market but have disproportionately low levels of national digital skills.

On the contrary, high digital skills performers such as Luxembourg or Sweden signal a shortage of ICT supply and find it difficult to fill vacancies with high digital skills. These observations support the academic literature in how digital skills foment a gap between the few highly digitally skilled individuals versus the rest of the population (Gould, Barry, and Wilkinson 2015; Peugny 2019), including the lower-educated, women or the elderly (LloydsBank 2019; ONS (a) 2019).

Two types of digital skills policies can be distinguished from Table 1 : economic and holistic-oriented approaches. Economic-oriented approaches mostly focus on the importance of digital skills for their effect on businesses, foreign investment and innovation. Belgium, The Netherlands or France are examples of countries which display digital skills as a nexus for growth: digital upskilling is targeted at small and medium enterprises (SMEs) or at employees within the labour market. Holistically oriented countries formulate and frame digital skills policies as necessary for the whole population: the importance of digital skills for the ‘knowledge economy’ is recognised, yet it does not supersede the social and individual dimension of skills. Portugal or Slovenia are examples where national policies make digital skills a priority for citizens and opt for implementation through local scale projects and grassroot initiatives (See: *Digital Slovenia 2020, Portugal INCoDe.2030*).

Empirically, one would expect that countries which have holistic and integrated policy approaches would perform the best in national levels of digital skills. Increasing the number of national policies that focus exclusively on digital skills are expected to have an impact on national levels of digital skills. Thus, *higher levels of digital skills inclusion policies are expected to increase the overall level of a population’s digital skills* (Hypothesis 1).

2.3 Digital skills inclusion policies for digital inequality

Increasing the levels of digital skills of a population is not only a policy priority, but a fact: since 2016, the levels of digital skills in the EU have increased from 56% of individuals having at least basic digital skills to 58% (DESI 2020).

However, focusing on national statistics to infer higher overall levels of digital skills has its limitations. Population statistics do not account for high disparities within the sample (Agresti and Finlay 2009), leading the analysis to lose subtlety. A country with an acceptable level of digital skills may be a scenario in which a minority of highly skilled individuals carry up the national average, concealing the skills gap. Therefore, digital inclusion policies should not only aim to ‘include’ populations to digitally up-skill but actively seek to reduce skills inequalities.

2.3.1 Policies to reduce inequality

If social policy aims at ‘*securing or enhancing well-being and the life chances of individuals*’ (Clasen 2013, p.71), so do digital skills inclusion policies. This is particularly relevant for already disadvantaged groups presenting gaps in digital knowledge, such as women or ethnic minority groups: for example, less than half of young women compared to young men are able to program (OECD (a) 2019). The literature also shows a strong association between age, education and digital skills: the elderly and less educated are among the most lagging in digital skills (Digital Nation 2018; Broady, Chan, and Caputi 2010).

Digital skills policies can act as a form of social protection and ‘*reduce the negative welfare consequences of rapid technological changes*’ (Blix 2017, p.159) when targeted towards vulnerable or excluded populations. European funded projects such as the *Digital Skills for Active Integration and Active Citizenship* (DISC) specifically focus on digitally training migrants and ‘*digitally excluded groups*’ in order to improve their autonomy in the educational process and facilitate their inclusion into society through digital technology (DISC 2020). Similar to DESI, The Women in Digital (WID) Scoreboard is a EU policy index monitoring women’s participation in the digital economy (Europa (c) 2020). For digital skills, the gender gap is 11% and is higher for those over 55 years (ibid.). Digital inequalities are usually targeted through regional or local policies. In Malta, policies focus on upskilling digitally excluded groups: the *Ċavetta Digitali initiative* targets senior citizens from day care centres and residents in Government elderly homes (DESI 2018). Here, digital skills policies intersect with gender, age and geographical inequalities, demonstrating relevant social and welfare implications.

In July 2020, the EU Commission met for the annual review of the European Skills Agenda which declared: ‘*This unprecedented crisis needs an unprecedented answer. (...) Now, it is time to join hands and unlock a skills revolution, leaving nobody behind*’ (Europa (d) 2020). Reducing skills inequality becomes not only a matter of human capital and growth: it fundamentally embraces social and structural inequalities, becoming a matter of empowerment and social justice (Denison, Sarrica, and Stillman 2014; Sweeny and Rhinesmith 2017).

Comprehensive digital skills policies will not only have effects on population’s levels of digital skills but reduce the digital skills gap. Thus, *higher levels of digital skills inclusion policies among countries are expected to decrease the levels of inequality of digital skills by gender and education* (Hypothesis2a).

2.3.2 Policies as increasing inequality

The paradox of redistribution posits that schemes designed to decrease inequalities by targeting specific populations have usually less effect on inequality than larger universalistic programs (Korpi and Palme 1998). While some studies empirically refute this argument (Brady and Bostic 2015; Kenworthy 2011), others find evidence to support it (Jacques and Noël 2017). Transposing the redistribution literature to a digital skills frame opens a new critical perspective: could targeted digital skills inclusion policies at ‘the digitally poor’ be doing more harm than good?

The issue with digital skills surfaces when it is portrayed as the ‘key’ to solve unemployment, automation, skills mismatches and income inequality. The argument underpinning this line of thought relies on the criticism of understanding digital skills as assets that could transcend other structural conditions of the labour market such as discrimination, competition or employer preferences (Davies and Eynon 2018).

Given the theory of scarcity, it is likely that the increase of a population’s digital skills may increase labour market competition, thus reinforcing inequality gaps between individuals which possess digital skills and those who do not: the ‘winners’ of digitalisation are the high-skilled, who are ‘*well-equipped to make use of the benefits offered by new technology*’ (Kurer and Gallego 2019, p.2). This skill division is also reflected in cleavages between workers over support for unions, impacting trade union density and coverage of collective agreements (Meyer and Biegert 2019).

From a normative perspective, digital skills policies can also be problematic. The act of moving ‘online’ may be far from empowering and emancipatory for disadvantaged minorities. Virginia Eubanks (2018) skillfully conceptualises the intersection of welfare poverty scrutinisation with technology in the concept of ‘digital poorhouse’:

Think of the digital poorhouse as an invisible web woven of fiber-optic threads. Each strand functions as a microphone, a camera, a fingerprint scanner, a GPS tracker, a trip wire, and a crystal ball. (...) As you go down the socioeconomic scale, the strands are woven more densely and more of them are switched on.

By denouncing greater digital scrutiny by social class, she underlines a crucial argument against digital inclusion policies: they may very well reach ‘minorities and disadvantaged groups’ — as long as these actively participate. Can we really discuss about ‘digital’ inclusion when digital skills policies target medium class individuals with a preexisting interest in technology rather than the uneducated working class? The ambiguity in EU digital skills and literacy policies is understood by Porter and Craig (2004) as *inclusive liberalism* where ‘*manufactured inclusion obscures real social differences*’ (p. 111). The risk incurred for those who do not participate in the ‘inclusive state’ is the labeling of being socially least deserving (ibid.), a familiar tune echoing the early connotations of social benefits (Kuhnle and Sander 2010; Williams 2016). Thus, *increasing higher levels of digital skills inclusion policies among countries could be expected to increase the levels of inequality of digital skills by gender and education* (Hypothesis2b).

Table 1: Overview of main national digital skills policies of EU member states
(Source: Author’s own compilation).

Member State	Major Digital Skills Policies	Main type of approach	Observations
Austria	• HELP.gv.at (1997) • Digital Skills Plan within the 2015 Education Plan • Digital Roadmap for Austria (2016)	• Education and vocational training • Company training and partnerships	• Austria’s initial transition to a digital economy and society is slower than other high income small open European countries (Gönenç and Guérard 2017) • Digital Roadmap for Austria is based on twelve guiding principles for shaping the digitisation process in Austria, presents around 150 specific measures in twelve fields of action
Belgium	• Digitaal.Talent@Gent (2006) • Action Plan for STEM (2012-2020) • Digital Agenda for Belgium (2013) • #WallCode Digital Wallonia project (2015) • Digital Belgium (2015) • BeCentrall (2017) • Digital Belgium Skills Fund (2020)	• Education • Company training and partnerships	• While Belgium has not yet adopted a comprehensive digital skills strategy, every region has specific policy instruments in place, aiming to address the digital skills shortages at various levels of education (DESI 2020) • The Flemish Public Employment Service offers training courses on digital skills such as an open online course (MOOC), on artificial intelligence aimed at employers (ibid.)

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Member State	Major Digital Skills Policies	Main type of approach	Observations
Bulgaria	• Strategy for the effective implementation of ICT in Education (2014-2020) • National education programme ‘Information and communication technologies (ICT) in pre-school and school education’ (2019) • Digital National Alliance Bulgaria • Digital Skills for Small and Medium Sized Enterprises in Bulgaria (2017) • Digital Bulgaria 2025	• Education • Company training and partnerships	• Mostly EU-funded projects to increase and invest in digital skills in education and for businesses • Below EU average in digital skills levels and digital human capital yet progress since 2019 (DESI Performances 2020) • Bulgaria has one of lowest score on the Women in Digital Scoreboard (WID 2020)
Croatia	• E-Schools project, Digital Maturity of Schools (2017) • Obligatory ICT classes were introduced in the fifth and sixth grade of primary school in 2018 • National Development • Digital Citizen Project (2018) • Digital Strategy, Croatia 2030 (2019)	• Education and vocational training • Company training and partnerships	• Croatia did not have a strategy in place to address its digital skills challenges until 2018 (DESI Performances 2020) • Investment and funding in universities and research centre focusing on the development of ICT professionals
Cyprus	• Great Alliance (Grand Coalition for Digital Jobs) • Memorandum of Understanding with partners (2015) • National Youth Strategy (2017-2022) • National Action Plan 2020	• Education and vocational training • Company training and partnerships	• Later focus on education and digital skills • Strategy emphasis on supply of ICT graduates to fill high number of ICT vacancies

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Member State	Major Digital Skills Policies	Main type of approach	Observations
Czech Republic	• The Strategy for Digital Education (2014-2020) • Strategy for Digital Literacy (2015-2020) • DigiKoalice (2018) and projects • Digital Czechia, 'Digitální Česko' (2018)	• Education and vocational training • Company training and partnerships • Lifelong learning	• Despite an existing strategy for digital education, the education system is not adapting to the digital transformation fast enough (DESI 2020, p.8) • Initial focus on education but later interest in digital skills for businesses and society
Denmark	• Citizen.dk (2007) • Digital Strategy (2016-2020) • New Strategy for Denmark Digital Growth, Strategi for Danmarks digitale vækst (2018) • Danish Technology Pact (2018) • 'Centre for Use of IT in Education on Vocational Training' (2019) • eKursus.nu, Digitalisation courses offered through local libraries	• Education and vocational training • Company training and partnerships • Lifelong learning	• Digital skills approach focused on coordinating education for labour markets and businesses needs • Denmark has one of highest score on the Women in Digital Scoreboard (WID 2020) • The Danish Technology Pact is a collaborative partnership between the government, educational institutions and the business sector. The main objective is that 20% more Danes will complete higher STEM education, and that 20% more will complete a STEM vocational education in ten years (DESI Performances 2020)

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Member State	Major Digital Skills Policies	Main type of approach	Observations
Estonia	• e-Estonia Briefing Centre (2009) • Vocational Educational Institution Act (2013) • Lifelong Learning Strategy (2014-2020) • Digital Agenda for 2020 • IndustryDigiABC (2017-2020)	• Education and vocational training • Company training and partnerships • Lifelong learning	• Estonia ranks 3rd in the EU on Human capital with 62% of the population have at least basic digital skills and 37% have above basic digital skills, both above the EU average (DESI 2020) • Digital skills policies emphasise the need to integrate education into labour market perspectives, in light of the unmet demand for labour in the ICT sector (ibid.)
Finland	• Digabi project (2016) • LUMA-SUOMI Programme 2013-2019 • Digital Finland Framework (2018) • Vision: Finland 2025	• Education and vocational training • Company training and partnerships	• ‘<i>The digital skill creation is accelerated from basic education to company employees. The train-the-trainee approach for digital skills is applied in education but also in companies.</i>’ (Digital Finland Framework 2018) • Finland has one of highest score on the Women in Digital Scoreboard (WID 2020)
France	• Digital Education Plan (2015) • The Digital Republic in Action (2015) • University of the Digital, L’Univeristé du Numérique (2018) • National Strategy for Digital inclusion (2018-2022)	• Education and vocational training • Company training and partnerships	• Investment in digital policies usually focus on enterprises, research, commercial and innovation areas at expense of the digital skills of citizens (DESI 2020) • The French Digital Skills and Jobs coalition is contributing to the national strategy for digital inclusion (2018-2022) with three task forces: reducing the digital skills gap; ICT professionals; raising the level of digital skills of SMEs

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Member State	Major Digital Skills Policies	Main type of approach	Observations
Germany	• Education in the digital world (2016) • Digital Knowledge Based Society and DigitalPakt#D (2016) • National Skills Strategy (2019) • Digital Strategy 2025	• Education and vocational training • Company training and partnerships	• The level of digital skills of the German population is relatively high and above EU averages (DESI 2020) • Digital education is the joint responsibility of the federal and state governments • High focus on digital skills in VET • Digital Strategy 2025 links digital skills with sustainability
Greece	• Association of the Information and Communication Technology (SEPE) (1995) • Ministry of Digital Governance (2011) • Protocol of Cooperation with the Hellenic Open University (2017) • National Coalition for Digital Skills (2018) • ReBrain Greece initiative (2019) • Ministry of Administrative Reconstruction Action Plan 2019-2022	• Education • Company training and partnerships	• Greece suffers from a ‘Brain drain’ of ICT graduates alongside ‘a severe digital skills gap’ (DESI Performances 2020) • Policies focused on developing levels of digital skills and attracting young graduates into the ICT workforce • Greece has one of lowest score on the Women in Digital Scoreboard (WID 2020)

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Member State	Major Digital Skills Policies	Main type of approach	Observations
Hungary	• E-Government Strategy and Programme Plan (2005) • Digital Literacy Action Plan (2009) • National Information Society Strategy (NISS, 2011) • Digital Renewal Action Plan (2011) • National Infocommunication Strategy (2014-2020) • Digital Competences Strategy (2016) • Digital Success Program 2.0 and Digital Labour Force Program (2018)	• Education and vocational training • Company training and partnerships • Lifelong learning	• In 2016, only 50% of Hungarians had at least basic digital skills (55% EU average) (DESI Performances 2020) • Despite numerous governmental policies targeting digital skills for citizens and lifelong learning perspective, population's levels of basic digital skills have not progressed since 2016 (ibid.)
Ireland	• Digital Hub Development Agency Act (2013) • National Digital Strategy (2013) • ICT Skills Action Plan (2014-2018) • Digital Strategy for Schools (2015-2020) • National Skills Strategy (2016) • National Development Plan (2018-2027) • Future Jobs Ireland (2019) • Technology Skills 2022	• Education and vocational training • Company training and partnerships	• Ireland ranked first for %STEM graduates yet ranked very low for basic digital competences of the population (ibid.) • Digital Policies around 2007 focused on digital infrastructure but diversified until 2017, highlighting innovation, competitiveness and e-government (König 2019, p.147)

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Member State	Major Digital Skills Policies	Main type of approach	Observations
Italy	• Coalizione per le Competenze Digitali¹⁵ (The national Coalition for Digital Competences) 2015 • National Plan for Digital School (2015) • Italian Industry 4.0 (2017) • ‘Crescere in digitale’ programme (2017) • ITS 4.0 (2019) • Italia 2025, ‘Digital Republic’ (2019)	• Education and vocational training • Company training and partnerships	• Italy has been in the lowest ranking for the level of digital skills of its population hindering its digital economy (DESI Performances 2020) • Italy has one of lowest score on the Women in Digital Scoreboard (WID 2020) • The effect of COVID-19 on Italian society and economy has put digital skills on the forefront in the public debate (Guerrini 2020)
Latvia	• eLatvia 2005-2008 programme • ICT for Quality of Education (IKTIK) 2007 programme • The 2014-2020 Information Society Development Guidelines 2014-2020 • Adult Education Governance Model Implementation Plan for 2016-2020	• Education and vocational training • Company training and partnerships	• With a budget of 24.8 million euros, the eLatvia four-year programme aimed to provide the educational tools appropriate for the knowledge economy (Kalis 2008) • Policies focusing on access rather than skills

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Member State	Major Digital Skills Policies	Main type of approach	Observations
Lithuania	• Lithuanian National Concept of the Development of Information Society (2001) • Programme for the Implementation of Information and Communication Technologies into Lithuanian Education (2005-2007) • Lithuanian Information Society Development Programme 2011- 2019 • Digital Strategy Agenda for Lithuania 2014-2020 • Discover Yourself (2016) • ‘Fast track to it’ training (2018) • ‘Kompiuteriukai Vaikams’ initiative (2018) • Demaskuok.lt (2019)	• Education and vocational training • Company training and partnerships	• Lithuania has one of the best scores for connectivity and digital infrastructure in the EU but its population levels of digital skills are not as high (DESI Performances 2020), despite having early policies focusing on the ‘information society’ in the 2000s • ‘Discover yourself initiative’, implemented by the Lithuanian Labour Exchange aims to teach more than 35 000 unemployed young people who are not currently studying basic computer skills • Lithuania is gradually improving in human capital thanks to policies dedicated to: (i) reducing basic shortfalls in digital skills; (ii) narrowing the gender-gap; and (iii) investing in the up-skilling of the ICT labour force (ibid.)

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Member State	Major Digital Skills Policies	Main type of approach	Observations
Luxembourg	• Digital Luxembourg, Digital Lëtzebuerg (2014) • digital4Education strategy (2015) • Digital-Inclusion.lu (2015) • La House of Training (2015) • FutureHub (2017) • Digital Skills Bridge Project (2017) • Creation of the Ministry of Digitisation (2018) • Survey of the Perception and expectations of residents vis-à-vis digitization (2019) • First inter-ministerial work group for digital inclusion (2019) • Coding and computational thinking, Ministry of Education for 2020-2021 (2019)	• Education and vocational training • Company training and partnerships	• Luxembourg has been facing a labour mismatch between a demand for ICT professionals and low percent of graduates with digital skills (DESI Performances 2020) • Digital skills policies have mostly focused on education and upskilling of the labour force: progress has been made on a national coordinated strategy on digital skills inclusion for the population and to address labour shortages • Luxembourg has one of highest score on the Women in Digital Scoreboard (WID 2020)

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Member State	Major Digital Skills Policies	Main type of approach	Observations
Malta	• e-Skills Demand and Supply Monitor (2011) • Digital Malta Strategy (2014-2020) • Ċavetta Digitali initiative (2017) • eSkills Malta Foundation (2014) • ICT Skills Audit (2017) • Malta Communication Authority, Strategy update on achieving widespread e-literacy and digital inclusion (2018-2020) • ‘One Tablet per Child’ scheme in primary schools (2019) and upskilling of teachers • National eSkills Strategy (2019-2021)	• Education and vocational training • Company training and partnerships • Lifelong learning	• Malta’s main actors of digital policies include independent and semi-governmental agencies such as: the Malta Information Technology Agency (MITA), the Malta Communications Agency (MCA), Malta Enterprise, the Malta Gaming Authority (MGA) in coordination with the Malta Chamber of Commerce and the Ministry of Education and Employment (DESI 2019) • The Ċavetta Digitali initiative, is an ICT training programme targeting 2000 senior citizens from day care centres and residents in Government elderly homes (DESI 2018) • Recent digital skills policies have been focusing on inclusion and targeting the upskilling of women and migrants

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Member State	Major Digital Skills Policies	Main type of approach	Observations
Netherlands	• Mediawijzer.net: Dutch media literacy network (2008) • Technology Pact 2020 (2013) • Human Capital Agenda (HCA) for ICT (2015) • e-Dutch Digital Agenda 2016-2017 • Dutch Digitisation Strategy (2018) • The Digitalisation Agenda for Primary and Secondary Education (2019) • The Dutch Strategic Action Plan for Artificial Intelligence (2019)	• Education and vocational training • Company training and partnerships • Lifelong learning	• The Netherlands belongs to the high performing cluster of countries (DESI Performances 2020) • Besides education, areas of interest for Dutch digital skills are oriented towards SMEs employees and the labour force • The Dutch Strategic Action Plan for Artificial Intelligence underlines the importance of investing in AI-relevant skills for everyone, focusing both on advanced digital skills and on basic competences (DESI 2020)
Poland	• Digital Poland Operational Programme for 2014-2020 • Broad Alliance on Digital Skills in Poland (2017) • IT for SHE (2017) • IT Master Centre ‘Centrum Mistrzostwa Informatycznego’ (2018) • Operational Programme Digital Poland (OPDP) for 2021-2027 • IT Talent Development Programme for 2019-2029	• Education and vocational training • Company training and partnerships	• Poland has overall low levels of digital skills, sitting at the low end of the distribution of countries’ performances for human capital (ibid.) • With initiatives as IT for SHE or Women in Tech Camp, Poland has been noticed at the European level for successful policies aiming to bridge the gender digital skills gap

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Member State	Major Digital Skills Policies	Main type of approach	Observations
Portugal	• Agenda Portugal Digital (2012) • Portuguese Coalition for Digital Employability (2013-2015) • eSkills Campaign for Jobs (2014-2016) • National Digital Competences Initiative, Portugal INCoDe.2030 (2017) • Agenda Portugal Digital, Pillar I ‘Capacity Building and Digital Inclusion’ (2020)	• Education and vocational training • Company training and partnerships	• The only indicator where Portugal performs better than the EU average is in STEM yet this is not enough to compensate for Portugal’s severe digital skills deficit (DESI Performances 2020) • Portugal INCoDe.2030 focuses on skill formation in education and training for individuals rather than for businesses: it offers schemes for citizens, the elderly and disadvantaged groups (incode2030.gov.pt 2020)
Romania	• National Strategy for the Romanian Digital Agenda 2020 (2015) • GovITHub (2016) • Coding and technology classes introduced as of the 5th grade in school (2018) • Wireless Campus (2018) • AVirtual Library open educational resources digital platform project (2019)	• Education • Company training and partnerships	• Romania has one of lowest score on the Women in Digital Scoreboard (WID 2020) • Digital skills still seem to be mostly promoted through private sector initiatives, rather than by public policy (DESI Performances 2020)

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Member State	Major Digital Skills Policies	Main type of approach	Observations
Slovakia	• National Strategy of the Slovak Republic for Digital Integration (2008) • Operational Programme Information Society (2007-2013) • Digital Growth and Next Generation Access Infrastructure (2014-2020) • IT Academy Project (2016) • Learning for the 21st century project (2017) • National Action Plan for Smart Industry (2018) • National Education Strategy (2018) • Strategy for the digital transformation of Slovakia 2030 (2019)	• Education • Company training and partnerships	• Improving digital skills is one of the priorities of the Slovak Digital Transformation strategy 2030, in order to adapt the education system and focus on skills for jobs (DESI 2020) • Slovakia's approach to digital skills lies mainly through education • Slovak business leaders think 18% more people can perform daily digital tasks than the EU estimates in DESI 2019 (PwC 2020)
Slovenia	• Slovenian Internet Forum (2013) • Opening up Slovenia (2014) • Digital Slovenia 2020 (2016) • Strategic guidelines for the implementation of ICT in education (2016) • Digital Academy (2017)	• Education • Company training and partnerships • Lifelong learning	• Slovenia's strategy for the increase of digital skills is mostly brought through education policies and bottom-up initiatives (DESI 2019; DESI 2020) • Digital skills policies are targeted to the whole population in a lifelong learning perspective

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Member State	Major Digital Skills Policies	Main type of approach	Observations
Spain	• Digital Skills and Competence Framework (2012) • Digital Education System (2013) • Strategy for a Smart Spain (Pillar: Citizenship and Digital Employment) (2017) • Digital Professionals (2018) • School of Computational Thinking (2018) • DigitalES (2019)	• Education and vocational training • Company training and partnerships	• Spain's digital skills policies ranges from educational reforms to private-public partnerships through the funding of upskilling schemes such as DigitalES • 43% of people between 16 and 74 years of age lack basic digital skills (DESI 2020)
Sweden	• Ministry of Enterprise and Innovation (2015) • National Agency for Education (NAE) Strategies for digitization of upper secondary and adult education (2016) • Smart Industry Strategy (2017) • Swedish Digitalisation Strategy (2017) • Digitalisation Council (2017) • National Focus on Artificial Intelligence (2018) • Programming in the educational curriculum (2018) • Digital@Dag, Digital Day (2019)	• Education • Company training and partnerships • Lifelong learning	• Sweden belongs to the high performing cluster of countries (DESI Performances 2020) with almost half of the Swedish population having above basic skills and nearly eight out of ten Swedes having basic software skills (DESI 2019) • There is however a lack a supply of professionals with advanced digital skills (DESI Performances 2020) • Sweden has one of highest score on the Women in Digital Scoreboard (WID 2020) and one of the most digitalised education curriculum

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Member State	Major Digital Skills Policies	Main type of approach	Observations
United Kingdom	• Comprehensive computing curriculum (2014) • Digital Inclusion Strategy (2014) • Digital Strategy and Digital Economy Act (2017) • Digital Skills Solutions (DSS) apprenticeships (2017) • Basic Digital Skills Framework (2018-2019) • Tech Talent Charter (2018) • Consultation on adult digital skills qualifications (2019)	• Education and vocational training • Company training and partnerships	• The UK population possess high levels of digital skills, yet gaps exist in supply of ICT professionals especially for women (DESI 2018) • Policies put in place to support the development of digital skills suggest that national levels should continue to improve. By contrast the availability of advanced digital skills remains a problem, partly due to rising demand for these skills (DESI 2019)

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3 Methodology

After justifying the design for this research, the process of data collection and operationalisation of concepts is explained. Techniques of data analysis are then covered, where control variables and robustness are discussed. Ethical concerns close this section.

3.1 Research design

The present research uses a quantitative cross-national comparative design. The sample consists of the 28 EU member states. This approach and case selection are motivated for three main reasons. Firstly, the design is adapted to the nature of the research problem, which asks what variations can be observed across several units of analysis. A quantitative design allows to measure continuous levels of skills and policies, systematising information to capture country differences (Bryman 2008). This enables to understand the general trends and associations between policies and digital skills, rather than localised initiatives with small-scale impact. Secondly, while the research topic originated from assessing the EU’s digital skills agenda, the unit of analysis is here national. It is empirically impossible to quantify digital skills policies emanating from the EU: beyond ‘recommendations’ their existence lies through the expression of national policy. It is fundamental to use a quantitative approach to fully engage with the policies of all 28 member states. Finally, a cross-national framework fully echoes to the comparative logic of welfare regime types in social policy. Here, the statistical method bridges the analysis between an outcome variable with national economic, social and political characteristics. Therein lies the richness of quantitative social research: to adequately superimpose the empirical and theoretical demands of a broad dataset (Imai 2017; Agresti 2018). Table 2 recalls the hypotheses formulated in the literature review.

Table 2: Operationalisation and summary of hypotheses.

Hypotheses	Y (dependent variables)	X (independent variables)
1 <i>Higher levels of digital skills inclusion policies are expected to increase the overall level of a population’s digital skills</i>	Levels of digital skills (2016-2019)	
2a <i>Higher levels of digital skills inclusion policies among countries are expected to decrease the levels of inequality of digital skills by gender and educational level</i>	Levels of digital skills inequality by gender and educational level (2016-2019)	Digital skills policies (2010-2015)
2b <i>Higher levels of digital skills inclusion policies among countries could be expected to increase the levels of inequality of digital skills by gender and educational level</i>		

3.2 Data collection and operationalisation of variables

As the official provider of EU statistics, the Eurostat database contains quality data for all 28 member states. It also possesses rich statistics on the ‘Digital economy and society’ directly including measurements of national levels of digital skills. Variables are selected within this pool of indicators, according to two criteria: timeframe and qualitative coherence.

While Eurostat possesses data on digital policies, they are only available across countries since 2010. This coincides with EU initiatives as the Digital Single Market in 2015. Despite having data after 2010, some indicators are not available annually: an average between various years is necessary to account for missing data and year-to-year fluctuations. This only allows to provide a cross-sectional analysis instead of a longitudinal approach.

To rule out reverse causality of levels of digital skills influencing the prevalence of policies, a specific time frame is applied to variables. Data for digital skills policies need to be selected for the years *preceeding* levels of digital skills to ensure that the direction of the statistical inference goes from policies to national outcomes as shown in Figure 3. Independent variables are averaged from a selection of years 2010 to 2015 and dependent variables from 2016 to 2019.

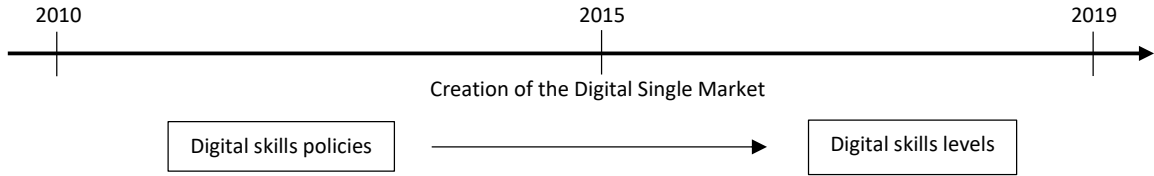


Figure 3: Direction of the analysis and correlational inference of variables.

It is necessary to recall that this research design is correlational, not causal: the data extracted here does not allow to make any statements about causality (Angrist and Pischke 2015), but about theoretically grounded correlations.

Secondly, qualitative coherence between indicators and variables ensures a transparent and logical operationalisation of concepts (See Table 3). Digital skills levels are a given Eurostat composite indicator based on activities in four areas (information, communication, problem solving and software skills) by individuals aged 16 to 74 (Eurostat 2019). The variable is operationalised as the percentage of individuals ‘*who have basic or above basic digital skills*’, according to Eurostat (indicator *isoc_sk_dskl_i*).

The second dependent variable, digital skills inequality, is operationalised by creating inequality variables: they are calculated using the digital skills variable and subtracting digital skills levels of women from men and of low from high educated individuals (i.e. digital skill levels of ‘*individuals with high formal education*’ minus digital skill levels of ‘*individuals with no or low formal education*’, according to the Eurostat database).

The main independent variables are more challenging to operationalise. Two indicators appropriately represent digital skills policies. Firstly, the indicator of the percentage of individuals who ‘*interact[ed] with public authorities through internet*’ (Eurostat indicator *isoc_ciegi_ac*) provides a good measure of the extent that a country has digitalised public services.

Whereas high levels of digital interactions with public authorities signals national digital inclusion, low levels indicate difficulties for a country to provide digital platforms and the skills or incentives for citizens to use them. The second indicator illustrates the ‘*percentage of enterprises providing training for digital skills*’ (Eurostat indicator *isoc_ske_ittn2*) for employees and non-employees, representing policies from the private sector. Integrating this indicator is crucial because the digital skills debate is shaped by the demands of the private sector. Thus, combining both indicators not only provides a reliable measure for digital skills policies, but adds a nuance to the theoretical concept.

Table 3: Operationalisation of key theoretical concepts into variables.

Theoretical Areas		
Digital Skills Policies	Digital skills	Digital skills inequality
Theoretical Concepts		
Public digital skill policies	Levels of digital skills	Digital skills gender and educational gap
Private digital skill policies		
Operationalisation of Concepts		
Digitalisation of public services	Population level of digital skills	Relative inequality of digital skills by gender and educational level
Digital skills training from the private sector		
Measurable Indicators		
Percentage of individuals who interacted with public authorities through internet	Percentage of individuals who have basic or above digital skills	Difference between variables of digital skills: • For men and women • For individuals with high and low education
Percentage of enterprises that provided training for digital skills		

3.3 Data analysis

Using the statistical software STATA, data analysis is carried out in three stages: univariate, bivariate and multivariate. Univariate analysis provides descriptive and summary statistics on outcome and explanatory variables. Bivariate analysis looks at correlations between variables while multivariate analysis consists of 6 regressions models, each addressing their respective hypotheses as shown by Table 4.

Table 4: Description of the 6 OLS Regression models.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
<i>Dependent variable</i>	Digital skills levels		Digital skills inequality (gender)		Digital skills inequality (education)	
<i>Controls</i>	No	Yes	No	Yes	No	Yes

Control variables are used from the Comparative Political Data Set from Armingeon et al. (2019), which provides high quality cross-national indicators relevant to social and public policy research (Vlandas 2013; Scheuer and Schmitt 2009; Weisstanner 2017). The four variables control for economic, political and institutional dimensions. Accounting for these factors is vital in cross-national comparisons as these may confound associations between variables. Ultimately, controls epitomise the main theories of welfare state change: GDP growth and unemployment echo to theories of functionalism (Wilensky 1975), the strength of left-wing governing parties to Power Resource Theory (Korpi 1983) and the disproportionality of electoral system to institutionalism (Immergut 2010; Heclo 1974). All variables used in this research are detailed in Table 5.

The variable ‘*Digital inclusion*’ was considered as a possible alternative independent variable (See Appendix B). It was operationalised as ‘*the frequency of internet access*’ for individuals. While correlating highly with the two other policy indicators (See Appendix A), this variable was discarded from the regressions. It displays a high variance of inflation factor ($VIF > 10$), confirming multicollinearity. Since internet access is a necessary condition to acquire digital skills, this spurious correlation is likely to compromise the quality of statistical inference.

Finally, while statistics are the primary method of analysis, a qualitative policy table (Table 1) complements and contextualises statistical data. Information is mainly collected through the European’s Commission website¹ where all DESI reports are compiled by country. Where information could not be found there, governmental websites of member states were used to locate digital skills policies.

3.4 Ethics

This research has been accepted by the Departmental Research Ethics Committee of the University of Oxford, approved on the 10th of August 2020 (See: Appendix D). In fulfillment of the principles of transparency for ethical research (Oxford 2018; Panter and Sterba 2011), all documents and code² relevant to this paper can be found in the Appendix.

¹<https://ec.europa.eu/digital-single-market/en/countries-performance-digitisation>

²The STATA do-file to replicate the analyses has not been included in its entirety given word count constraints. A sample is provided in Appendix C. The full version and data set can be accessed under the following anonymous link: <https://drive.google.com/drive/folders/1rpAT0WqWr3duWC2BaT9cdmZZk-MiE3KX?usp=sharing>

Table 5: Summary of all independent, dependent, control and robustness variables.

Variable	Label	Description
Dependent:		
Level of digital skills	<i>isoc_sk_dskl_i</i>	Percentage of individuals with basic or above digital skills
Level of digital skills for men	<i>isoc_sk_dskl_i_males16_74</i>	Percentage of men from 16 to 74 years with basic or above digital skills
Level of digital skills for women	<i>isoc_sk_dskl_i_females16_74</i>	Percentage of women from 16 to 74 years with basic or above digital skills
Level of digital skills for individuals with low education	<i>isoc_sk_dskl_i_low_ed</i>	Percentage of individuals with low or no education with basic or above digital skills
Level of digital skills for individuals with high education	<i>isoc_sk_dskl_i_high_ed</i>	Percentage of individuals with high formal education basic or above digital skills
Levels of digital skills inequality by gender	<i>inequality_gender</i>	Difference between the percentage of men and women with basic or above digital skills
Levels of digital skills inequality by education	<i>inequality_edu</i>	Difference between the percentage of individuals with high and low education with basic or above digital skills
Independent:		
Digital skill policies (public)	<i>isoc_ciegi_ac</i>	Percentage of individuals who interacted with public authorities through internet
Digital skill policies (private)	<i>isoc_ske_ittn2</i>	Percentage of enterprises that provided training for digital skills
Control:		
Unemployment	<i>unemp</i>	Unemployment rate
Real GDP growth	<i>realgdpgr</i>	Growth of real GDP
Effective number of parties	<i>gov_party</i>	Cabinet composition (Schmidt-Index)
Disproportionality of electoral system	<i>dis_rel</i>	Index of relative disproportionality of electoral system

4 Results

This section is structured as follows: results for each hypothesis are presented in their respective sub-sections. These are separated into three parts: univariate, bivariate and multivariate analyses, progressing from descriptive to inferential statistics.

4.1 Hypothesis 1

Table 6 provides summary statistics on all dependent and independent variables for hypothesis 1, including controls. On average, about 56% of individuals in each EU state possess basic or above-basic digital skills, according to the Eurostat measure, with Bulgaria having the lowest average levels of digital skills (28%) and Luxembourg the highest (79%). Figure 4 displays digital skills levels by country. Similarly to the DESI ranking, high performing countries include Luxembourg, the Netherlands and Nordic nations whereas low performing countries include Bulgaria, Romania and Italy.

For independent variables, the average prevalence of public digital skills policies across EU countries is 45%. There is a large variance between countries as shown by a high standard deviation of 16%. Like with digital skills levels, high performing countries are here Nordic countries, followed by the Netherlands and Luxembourg (Fig. 5). The level of private digital skills policies in the EU is comparatively lower to public policies, as on average across the EU countries, only 19% of the enterprises provide ICT/digital training.

Table 6: Summary statistics for independent, dependent and control variables for H1.

Variable	N	Mean	Standard Deviation	Minimum	Maximum
Level of digital skills	29	56.37	12.97	28 (Bulgaria)	78.68 (Luxembourg)
Digital skill policies (public)	29	45.24	16.91	12 (Romania)	83 (Denmark)
Digital skill policies (private)	29	19.44	7.79	4.5 (Romania)	37.33 (Finland)
Unemployment	29	10.41	4.48	5.17 (Austria)	23.13 (Spain)
Real GDP growth	29	1.58	1.99	-4.12 (Greece)	6.69 (Ireland)
Strength of left-wing parties	29	2.42	0.68	1.33 (Hungary)	3.83 (Slovakia)
Disproportionality of electoral system	29	0.19	0.10	0.04 (Denmark)	0.45 (France)

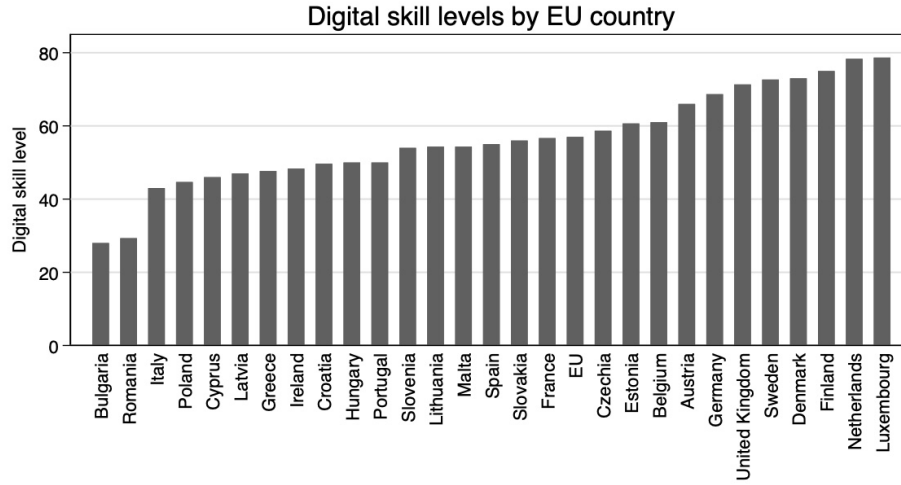


Figure 4: Digital skills level by EU country, average levels from 2016-2019.

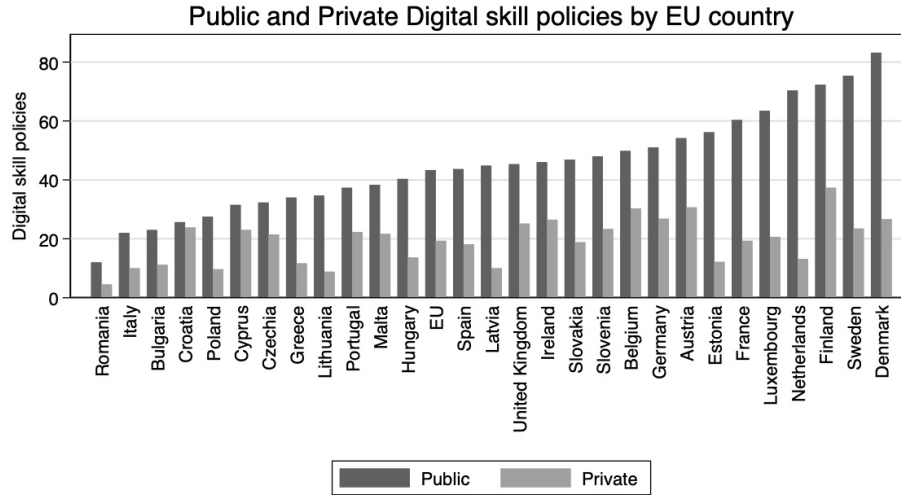


Figure 5: Public/Private digital skills policies by EU country, average levels from 2010-2015.

Bivariate analyses show a positive correlation between levels of digital skills and digital skills policies ($r_{public} = 0.85$, $r_{private} = 0.58$), as illustrated by Figures 6 and 7. Public digital skills policies display a higher association with levels of digital skills compared to private policies. Here, digital skills policies by the private sector do not necessarily correlate to levels of digital skills. For instance, Bulgaria and Estonia have approximately similar levels of private digital skills policies, yet their national levels of digital skills display a 33-percentage point difference. This can also be observed for Cyprus and Sweden or Estonia and the Netherlands.

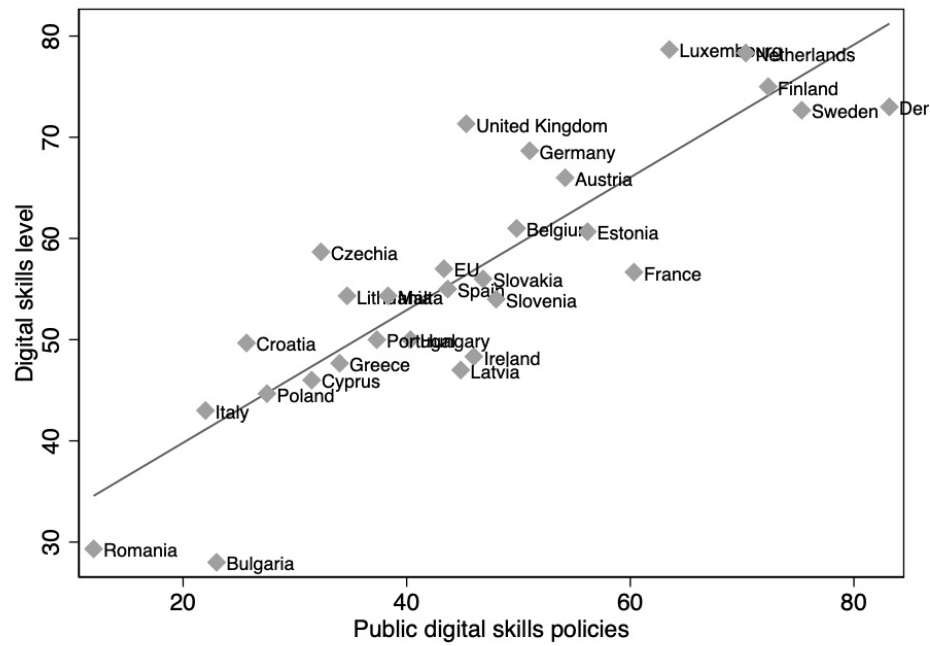


Figure 6: Scatter plot of levels of digital skills against public digital skills policies (Note: line indicates fitted values).

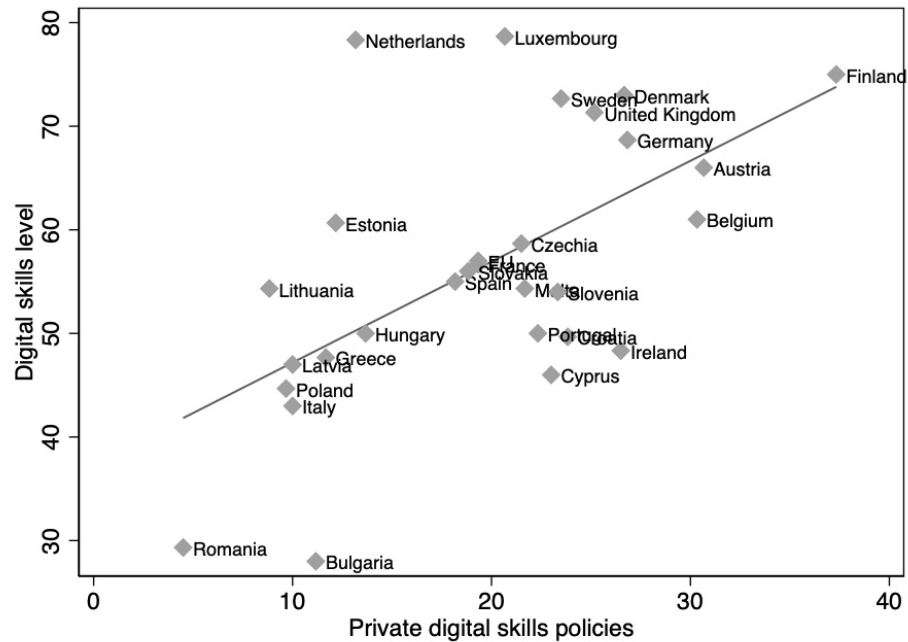


Figure 7: Scatter plot of levels of digital skills against private digital skills policies (Note: line indicates fitted values).

Table 7 displays the results of the ordinary least squares (OLS) regression analysis for hypothesis 1 in two models. Model 1 (M1) contains only the two main explanatory variables, model 2 (M2) additionally includes control variables.

Public digital skills policies have a statistically significant positive association with levels of digital skills: for one unit increase in public policies, digital skills are expected to increase by 0.58 ($p < 0.001$). Private digital skills policies show a comparatively lower positive effect on digital skills: for a one-unit increase in private policies, digital skills increase by 0.29 (M1) and 0.24 (M2). This association is however not statistically significant ($p_{M1} = 0.11, p_{M2} = 0.18$).

The adjusted R-squared value is high in both models, meaning that, when controlling economic, political and institutional factors (M2), both public and private digital skills policies predict 73% variance of digital skills levels. Besides indicating a well-specified model, this confirms the substantive importance of digital skills policies in affecting national digital skills.

Table 7: Regression analysis for Hypothesis 1 (OLS regression, Models 1 and 2).

Level of digital skills	Model 1	Model 2
Digital skills policies (public)	-0.58*** (0.10)	0.58*** (0.10)
Digital skills policies (private)	0.29 (0.18)	0.24 (0.18)
Unemployment		-0.53 (0.31)
Real GDP growth		-0.62 (0.68)
Strength of left-wing parties		-1.36 (2.01)
Disproportionality of electoral system		7.53 (16.10)
Constant	24.23*** (3.50)	33.67** (9.72)
<i>Adjusted R-square</i>	0.74	0.73
<i>N</i> = 29		
Robust standard errors in parentheses		
* $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$		
Source: own calculations		

While descriptive statistics provide a picture of the distribution of digital skills policies in member states, bivariate statistics clearly show a positive association between previous policies and recent levels of digital skills. The regression analysis confirms the significant association between public digital skills policies and increasing levels of digital skills. This cannot be said for private digital skills policies.

4.2 Hypothesis 2

To understand the relative distribution of digital skills, we now look at descriptive statistics of the digital skills gaps in the EU by gender and educational levels provided by Table 8.

The distribution of digital skills by gender reflects significant inequalities: women show on average lower levels of digital skills than men (Fig. 8). Approximately 55% of women have basic or above basic overall digital skills in the EU, which is 3 percentage points below men (58%). A paired t-test in Table 9 reveals that the observed differences between the levels of digital skills for men and women are statistically significant ($p < 0.001$, $N = 29$).

While Romania scores the lowest in digital skills for women (27%), countries such as Croatia, Austria or Germany show a greater disparity of digital skills at the advantage of men. On the contrary, in Cyprus, Latvia or Finland, women show higher levels of digital skills than men. Lithuania displays the most equal distribution of digital skills by gender (Fig. 8).

Figure 9 reflects the wide disparities of the average levels of digital skills by educational level. On average across EU countries, 83% of individuals with high formal education have basic or above basic digital skills: this is only the case for 34% of individuals with low education. This represent an overall difference of 50 percentage points, which is statistically significant at $p < 0.001$ (See Table 9).

There are also wide cross-national variations of digital skills by educational level suggested by a comparatively lower standard deviation for high education (8.0) than for low education (15.9) as seen in Figure 9. The digital skills ‘gap’ is thus multidimensional: not only it is segmented by educational levels but widely differs by country.

Table 8: Summary statistics for dependent variables for H2.

Variable	N	Mean	Standard Deviation	Minimum	Maximum
Level of digital skills for men	29	57.85	13.55	27.33 (Bulgaria)	82.33 (Luxembourg)
Level of digital skills for women	29	54.88	12.57	27.67 (Romania)	76.33 (Finland)
Level of digital skills for individuals with low education	29	34.28	15.90	9.67 (Bulgaria)	64.67 (Denmark)
Level of digital skills for individuals with high education	29	82.83	8.00	60.67 (Bulgaria)	94.67 (Netherlands)
Levels of digital skills inequality by gender	29	2.96	3.66	-4.66 (Latvia)	10 (Croatia)
Levels of digital skills inequality by education	29	48.55	13.30	19.67 (Estonia)	69.33 (UK)

Table 9: Paired t-test for levels of digital skills by gender and education

Level of digital skills	Mean	Standard Deviation	95% CI
For men	57.85 (2.52)	13.56	(52.69) - (63.01)
For women	54.88 (2.33)	12.57	(50.10) - (59.67)
Difference	2.97*** (0.68)	3.66	(1.57) - (4.36)
t-value	4.3		
For the high educated	82.84 (1.49)	8.00	(79.80) - (85.88)
For the low educated	34.29 (2.95)	15.91	(28.24) - (40.34)
Difference	48.55*** (2.47)	13.30	(43.49) - (53.61)
t-value	19.65		

$N = 29$

* $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$

Source: own calculations

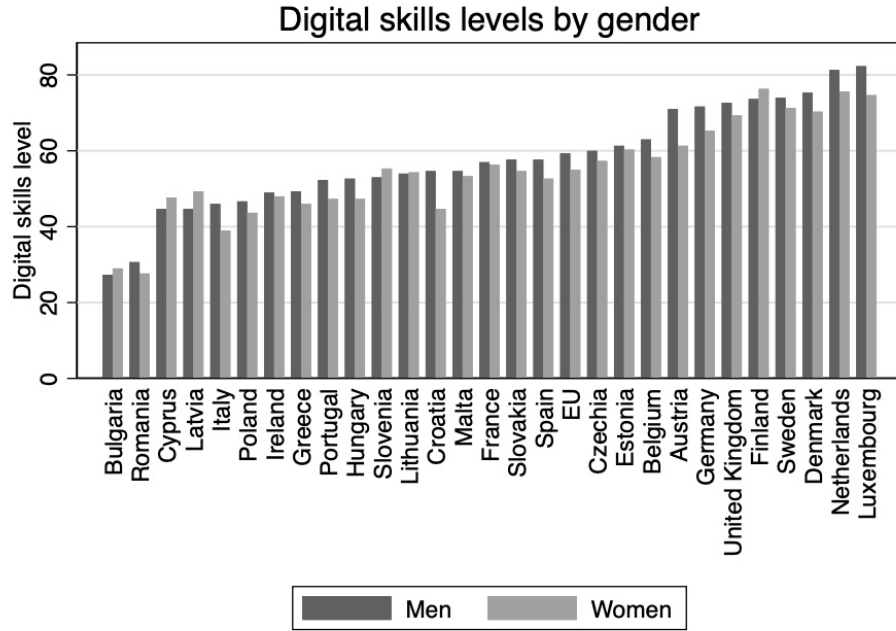


Figure 8: Digital skills levels by gender, average levels from 2016-2019.

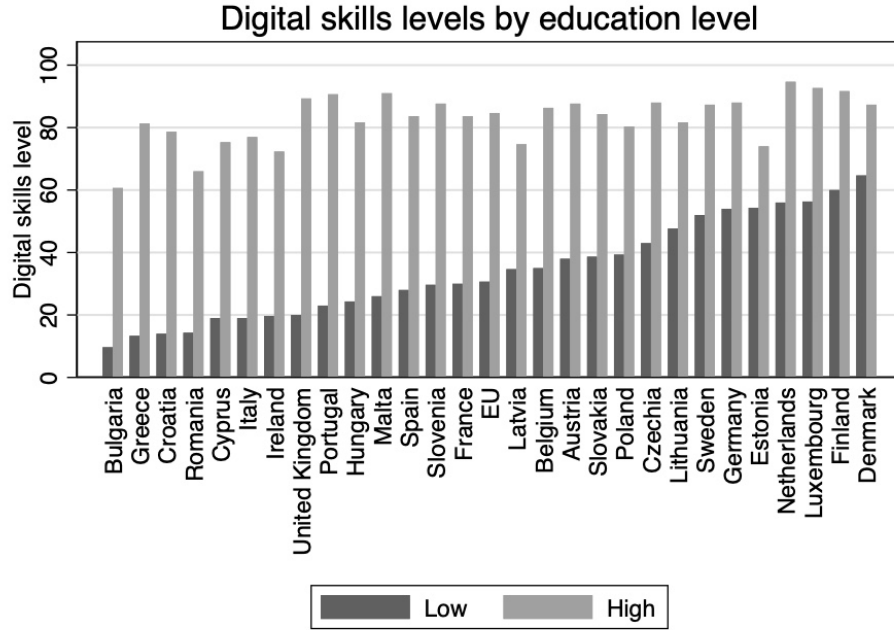


Figure 9: Digital skills levels by education level, average levels from 2016-2019.

If digital skills levels have been described by gender and education separately, relative inequalities are now discussed. The average difference between digital skills levels of men and women in the EU is only 3 percentage points whereas it is almost 49 between individuals with high and low levels of education.

High levels of digital skills inequality are displayed in Figure 10. The UK, Greece or Portugal show a difference of 65 to 70 percentage points of digital skills possession of the highly educated relative to the low educated, about 3 times more than in Estonia, the country with the least educational digital skills inequality.

Bivariate associations between digital skills policies and skills inequalities are now analysed. There is no strong correlation between digital skills policies and digital skills inequality by gender ($r_{public} = 0.02$, $r_{private} = 0.12$; both not statistically significant at the 95% level, See Appendix A). In contrast, there is a relatively strong negative relationship between public digital skills policies and digital skills inequality by education ($r = -0.56$, $p = 0.0013$), as pictured in Figure 11.

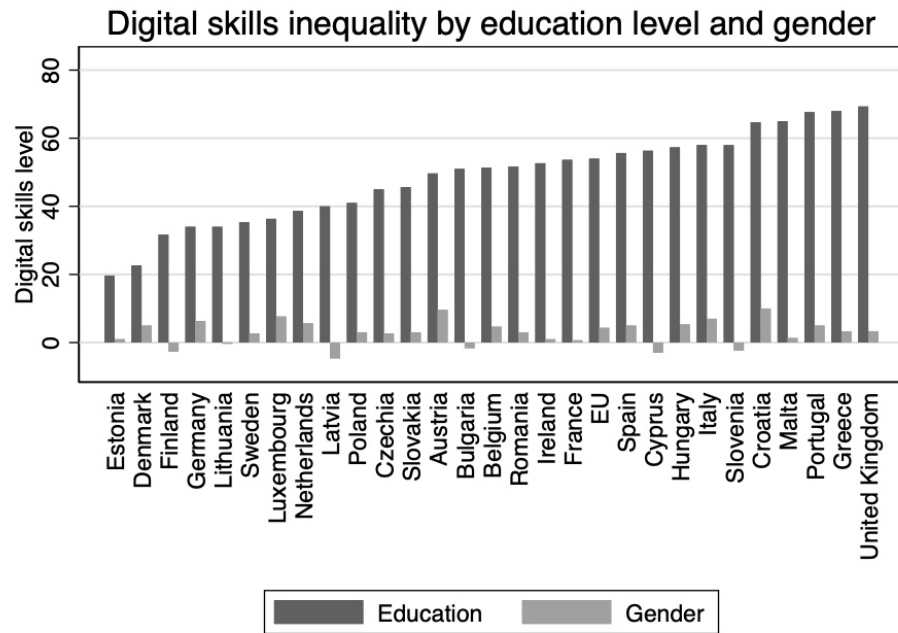


Figure 10: Digital skills inequality by education and gender, average levels from 2016-2019.

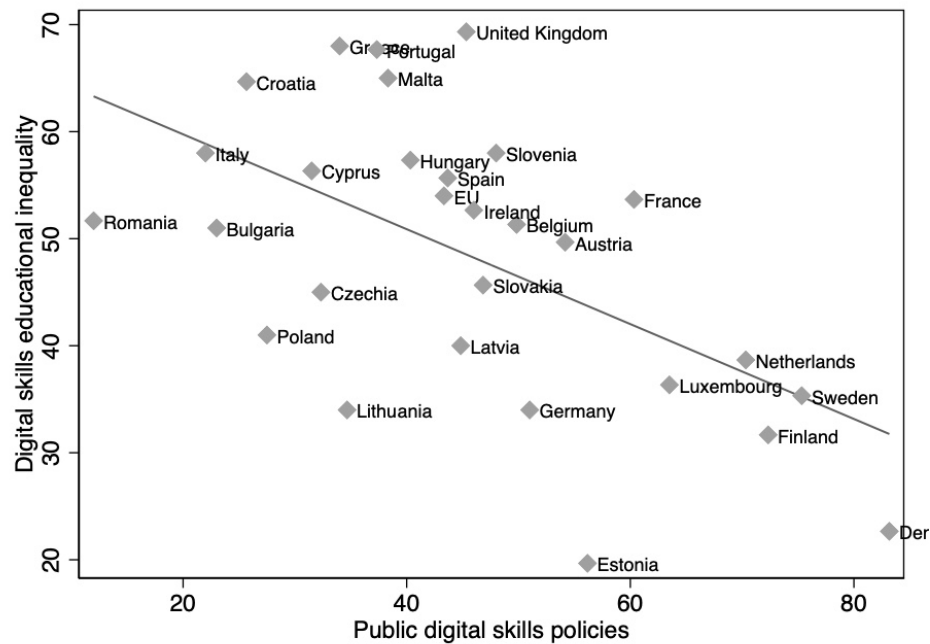


Figure 11: Scatter plot of digital skills inequality by education against public digital skills policies (Note: line indicates fitted values).

4.2.1 Gender inequality

Table 10 displays the regression analysis results for hypothesis 2 in two models, one without (M3) and one with control variables (M4). Digital skills inequality is here analysed by gender. In model 3, public digital skills have a weak and not statistically significant negative association of -0.01 on gender digital inequality whereas private digital skills policies have a minor positive association of 0.07. These associations diminish further in model 4. All confidence intervals include the null hypothesis. As preempted by the insignificant correlations, this regression confirms a lack of significant or substantive effect of digital skills policies on digital skills gender inequality.

Table 10: Regression analysis for Hypothesis 2 (Gender) (OLS regression, Models 3 and 4).

Level of digital inequality (Gender)	Model 3		Model 4	
Digital skills policies (public)	−0.01	(0.05)	0.00	(0.05)
Digital skills policies (private)	0.07	(0.13)	0.05	(0.13)
Unemployment			−0.17	(0.17)
Real GDP growth			−0.38	(0.27)
Strength of left-wing parties			0.15	(1.04)
Disproportionality of electoral system			3.75	(9.04)
Constant	2.07	(2.26)	3.57	(4.64)
<i>Adjusted R-square</i>	-0.05		-0.17	
<i>N</i> = 29				
Robust standard errors in parentheses				
* <i>p</i> ≤ 0.05, ** <i>p</i> ≤ 0.01, *** <i>p</i> ≤ 0.001				
Source: own calculations				

4.2.2 Educational inequality

Table 11 shows the regression analysis for hypothesis 2, focusing on digital skills inequality by educational level. As for gender inequality, public digital skills policies in model 5 seem to decrease digital inequality, but do so significantly. For a one-unit increase in public digital skills policies, the digital skills advantage of the high relative to the low educated decreases by 0.61 percentage points, *ceteris paribus* ($p < 0.001$). On the contrary, private policies show a significant positive association regarding digital skills inequality by education ($p < 0.01$). Here, a one-unit increase in private digital skills policies rises the educational digital skills advantage of 0.69 percentage points.

When adding controls, the variables' level of statistical significance decreases slightly, yet their respective coefficients do not fluctuate substantially. All variables in model 6 predict 43% of the variance in digital skills inequality by educational level: while this is comparatively lower than for digital skills levels (M2), this still provides evidence of public and private digital skills policies influencing digital skills educational inequality.

Table 11: Regression analysis for Hypothesis 2 (Education) (OLS regression, Models 5 and 6).

Level of digital inequality (Education)	Model 5	Model 6
Digital skills policies (public)	-0.61*** (0.12)	-0.51** (0.15)
Digital skills policies (private)	0.69** (0.31)	0.67* (0.31)
Unemployment		0.37 (0.34)
Real GDP growth		-1.16 (1.17)
Strength of left-wing parties		1.77 (3.15)
Disproportionality of electoral system		21.67 (22.34)
Constant	62.86*** (5.74)	47.97*** (9.69)
<i>Adjusted R-square</i>	0.39	0.43
<i>N</i> = 29		
Robust standard errors in parentheses		
* $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$		
Source: own calculations		

To summarise, descriptive statistics for hypothesis 2 provide evidence for the digital skills gap. If skills are unequally distributed by gender, they are even more so by educational level. The gap between the digital skills of the high relative to the low educated is extensive: not only the high educated have slightly greater levels of digital skills than the overall population, but the digital skills of the low educated are disproportionately below the population's levels. These disparities are also reflected cross-nationally as inequality levels widely differ by states.

The gender skills gap is not affected by digital skills inclusion policies as multivariate regressions do not translate into statistically or substantively significant effects. Public digital skill policies are associated to a reduction in digital skills inequality by educational level. Conversely, private digital skills policies increase the educational digital skills gap. Mirroring findings from hypothesis 1, public digital skills policies yield greater significant outcomes on digital skills.

4.3 Robustness

As a robustness test, all correlations and regressions are repeated excluding potential outliers, based on the countries that stand out with exceptionally high levels of digital skills (Netherlands and Luxembourg) or exceptionally low levels of digital skills (Romania and Bulgaria) as presented in Figure 4. These are carried out in three stages:

- i. excluding Luxembourg and Netherlands,
- ii. excluding Romania and Bulgaria,
- iii. excluding all four countries.

When excluding Luxembourg and Netherlands, the effects of public digital skills policies are substantively similar, but the positive effect of *private* digital skills policies on digital skills is higher and becomes significant ($p_{M1} = 0.008$, $p_{M2} = 0.025$) in both models. When excluding Bulgaria and Romania, the prior positive association between public policies and gender digital skills inequality becomes negative yet stays non-significant.

In regressions, the relationship between private policies and digital skills inequality by education becomes insignificant ($p = 0.06$) in both models. Finally, when excluding all four countries, the association between gender inequality and public digital policies becomes negative while remaining insignificant ($p = 0.47$).

In sum, these four countries do not disproportionately modify the relationship between public digital skills policies. However, it is possible for the role of private digital skills to have been under- or overestimated. Although these outliers may alter conclusions on the significance of private policies, the robustness tests corroborate the validity of models and findings.

5 Discussion

This section is organised in three parts. The first two examine results for the hypotheses: digital skills levels and digital skills inequalities. The third sub-section examines the comparative dimension of this study.

5.1 Increasing digital skills: the role of public policy and digitalisation

Digital skills inclusion policies have an increasing effect on population levels of digital skills across the EU. The significance of this increase is distinguished by public or private policies. Both variables were used to capture different aspects of digital skills policies and reveal how providers of policy and their respective approaches are equally influential in yielding different outcomes (Spicker 2014; Walker 2005).

Multivariate regressions only provide significant evidence of digital skills increasing as a result of *public* digital skills policies. This could relate to the greater prevalence of state-led policies in the EU compared to private policies. Difference in indicators may also explain this, as public policies are expressed as a percentage of national population whereas private policies refer to a percentage of enterprises.

Besides operationalisation, the most plausible interpretation lies in the extent to which these policies reach the overall population. While digital state-driven policies target all citizens, private digital skill policies have a narrower scope. The training provided by companies tends to be aimed at existing employees or staff, thus benefiting labour market insiders which already have higher levels of digital skills. Even when companies provide local and community training to other segments of the population, the scale and impact of these is insufficient to make a difference on a national scale.

For instance, private led initiatives such as the Estonian *Smart tour ‘Nutituur’* consisted of seminars that took place in 67 locations all over Estonia within 2 months, aiming to improve digital literacy among the older population in rural areas. While this national yet locally implemented policy was successfully welcomed by citizens, its training output was only of 700 individuals (Look@WorldFoundation 2017). When looking at *inclusivity* as encompassing the overall population, punctual, locally scaled and uncoordinated policies from different firms fail to substantively influence national levels of digital skills levels.

Conversely, public digital policies are operationalised as the proportion of digital interaction with public authorities, ultimately embodying the digitalisation of public services. Instead of a voluntary and passive act of receiving training, digitalising public services makes digital skills and literacy indispensable in a drastic way: taxes, benefits or social insurance become inaccessible if an individual cannot navigate through a network of digitalised services. Platforms such as *France Connect*, *NemID*, *Sede Electrónica* or *ePUAP* are respectively France’s, Denmark’s, Spain’s and Poland’s portals for digital identification to use a variety of governmental public and social services. Centralising services into unique platforms not only facilitates accessibility for users (Nixon 2018; Service et al. 2014) but mostly provides a cost-efficient way for governments to process large quantities of information.

It is this cost-containment, user-centered approach, and notion of positive social outputs that positions digitalisation within a social investment framework (Ansell and Gingrich 2015; Adema and Whiteford 2010). Digitalising public and social service puts pressure on acquiring digital skills: their *necessity* to thrive within the modern society is here aligned to the importance that social investment strategies yield to skills.

The ‘digital’ transformation of social services is inscribed in a long-term vision for a modern society and economy. By this standard, public digital skills policies are a successful example of social investment policies: they embody a future vision of the welfare state which align with the goals of the social investment state.

If results provide quantitative evidence of a significant increase in overall levels of digital skills, the meaning of such increase may not be a direct result of public digital policies. We need to ask if these observed effects are a move towards inclusion rather than an imposed adaptation. Critiques of social the investment paradigm may find in public digital skills policies a similar tendency to construct and deliver skill activation policies in a top-down approach in which ‘inclusion’ associates to ‘recommodification’ (Nolan 2013; Pierson 2001).

For example, Greece’s digital skills policies have been focused on targeting young graduates to attract them into ICT workforce in light of the extensive ‘Brain Drain’ the country suffers from. In December 2019, pilot initiatives were presented by the Ministry of Labour and Social Affairs, including the ‘*Choose... Greece!*’ program to encourage ‘*young Greek talented expatriates*’ to return to high-tech jobs. Similarly, the ‘*Agrodigital entrepreneurship*’ initiative aimed to provide training to young entrepreneurs to gain business knowledge in agriculture through digital tools such as artificial intelligence (AI) (DESI (a) 2020, p.10). While these policies address deficiencies within the labour market, they overlook the necessity of digital skills for Greek’s elderly or rural communities to navigate through digitalised services. Can states really talk of digital *inclusion* policies if their policies rest on the assumption that the instruments of social policy will drive the adaptation by those needing such services?

If issues around the qualitative aspect of ‘increasing digital skills’ ought to be raised, they are beyond the scope of this paper: the first aim of this research was to determine an effect of policies on a measurable outcome. Descriptive and inferential statistics provide evidence to answer the first research question and partially confirm hypothesis 1: only *public* digital skills policies have a significant increasing effect on overall levels of digital skills.

5.2 The digital skills gap starts with educational inequality

Women and the low educated have significantly lower levels of digital skills. However, the gap in digital skills is quantitatively larger by educational level. These differences become relevant when looking multivariate regressions, as digital skills policies only affect digital skills inequality by education and not by gender.

The high significance of education when considering digital skills is not unexpected. While characteristics such as class, demography or age are relevant to understand the distribution of skills, educational levels are intrinsically related to skills because it is via education they are acquired. Lower levels of digital skills inequalities by gender could also be the result of recent efforts to recognise and reduce the disparities faced by women. Starting with the EU’s WID,

member states have worked on an array of initiatives and policies to include women in STEM and equip them with digital skills, such as IT for SHE¹, Simplon² or Digital Women UK³.

The absolute and relative disparities of digital skills levels are distinctively higher between individuals with low and high education. Educational inequality is here established as a driver of digital skills inequality, echoing to conflict theory approaches to education as a means to determine or perpetuate other inequalities (Bourdieu 1986; Friedman and Laurison 2019; Bukodi and Goldthorpe 2019). When comparing gender and educational inequality in digital skills, it is important to also interpret the *structure* of inequality rather than focus on absolute measures (Lupu and Pontusson 2011, p.4). The standard deviation of digital skills inequality by gender is of 3.66 compared to 13.30 for skills inequality by educational level. The structure of digital skills inequality by educational level reveals much more variation in the data than for gender. There is a necessity to pay greater attention to the intersection between educational inequality and digital skills.

This does not mean that gender should be completely dismissed. Intersectional approaches are crucial to social research because they reveal the superimposition of inequalities and their aggravating effects (Clarke and McCall 2013; Davis, Brunn-Bevel, and Olive 2015; Codioli McMaster and Cook 2019). Here, low educated women may be in a greater precarity compared to low educated men. Cross-comparative approaches tend indeed to lose this granularity in the analysis, thus is it imperative to keep in mind a qualitative picture of how inequalities intersect with social identities within a specific cultural environment.

Findings on digital skills policies and educational digital skill inequality reveal two opposite effects. Aligning with results from hypothesis 1, public digital skills policies are significantly associated with a *reduction* in digital skills inequality. Conversely, private policies tend to be associated with *increasing* digital skills inequality between individuals with high and low education. Unlike for hypothesis 1, the effect of private digital skills policies on digital skills levels is here statistically significant.

Private policies increase digital inequality by educational level because ICT training provided by companies mainly target labour market insiders which already have high levels of digital skills (Iversen and Soskice 2019). This reinforces the divide between those with high versus low education. Individuals with low levels of education cannot rely on private entities to provide them with training: there are little incentives and much costs for companies to fully form and train individuals that are not already employed or that do not constitute attractive recruits. In this sense, it is not viable for private actors to dispense policies of ‘total’ inclusion, unlike public policies.

An analogy could be made between the private/public policies divide and the conditional/universal benefits divide. Unemployment benefits are an example. If they usually constitute a public provision, they can be subsidised by private social security depending on countries, social security regimes or on individuals past contributions (Boeri and van Ours 2013). Public digital skills policies are as pertinent as publicly provided benefits: they protect individuals against unfair market developments, competition and thus educational inequality. Policies which are

¹<http://www.itforshe.pl/pl/>

²<https://femmes.simplon.co/>

³<https://digitalwomenuk.co.uk/>

conditional on a social status are *de facto* limiting ‘inclusion’, perhaps even ‘excluding’. Here, *public* digital policies act as an universal way of dispensing digital skills knowledge, having the most effect on reducing inequalities.

Given findings from the analysis, there is some support for hypothesis 2a as public digital skills policies decrease levels of digital inequalities. It is however rejected for private digital skills policies. On the contrary, Hypothesis 2b is rejected for public digital skills policies, but there is some support for it when looking at private digital skills policies as these *increase* levels of inequality for digital skills.

5.3 Comparative insights in a diverse EU

The analysis provides a complex picture of the variety of cross-national approaches to digital skills. Comparing policies across EU member states when using statistical data is challenging: this process simplifies the relationships between types of policies and outcomes. It is therefore important to look at the characteristics of high and low scoring countries in order to understand what can be learnt from the differences observed cross-nationally.

For digital skills levels, the lowest performing countries are recurrently Bulgaria and Romania. Their overall low position in the DESI shows that both countries lack technological infrastructure and quality connection and broadband (DESI (b) 2020). Adding to this, both countries score comparatively low in economic and socio-economic indicators across the EU, including GDP, income equality or education (Eurostat 2017; Eurostat 2013). For instance, the 2018 OECD PISA reveals that 15% of the variance in reading performance in Bulgaria is explained by socio-economic status, where the OECD average is of 12% (OECD 2018).

High performing countries include Denmark, Finland or Luxembourg, which are on the contrary countries with high levels of GDP and education compared to the EU average (Eurostat (a) 2019). Yet countries with high digital skills levels are not exactly those with the highest digital skills policies. Here, Nordic countries have greater scores than Luxembourg or the Netherlands. Despite these having highly skilled population, they tend to have a greater emphasis on social policies geared towards inclusion (Esping-Andersen 1990; Johansson 1970).

The Danish Technology Pact (2018) is constituted of a variety of local and regional scales projects which inclusively target students, as much as teachers, children, women, ethnic minorities and citizens with low digital skills (See: *Sustainability with Science, Coding Class for teachers, Digital empowerment of ethnic minority women, IT camp for girls, IT for everyone (ITTA)*) (Teknologipagten 2020). Likewise, the Digital Finland Framework (2018) understands growth of the digital economy as a response to an aging population, where innovation and business models propose solutions alongside citizens.

Finland has been a precursor in ensuring inclusive digitalised services (ITU 2011) and continues to through its III Open Government Action Plan (Ministry of Finance 2017), aimed to enhance digital citizen engagement. Policy objectives include: supporting everyone’s participation, strengthening the skills of citizens to access public legislation and ensuring that administrative reforms are easy to understand (Digital Government Factsheet Finland 2019, p.7).

The results for digital skills inequality are compelling: countries which show the lowest levels of inequality are not high performers in other indicators. Baltic countries such as Latvia and Estonia show the lowest levels of digital skills inequality by gender and educational level. Latvia is making progress through educational and sectorial policies (DESI (c) 2020) in addition to its recent involvement in the European project Women4IT. Estonia on the other hand has been since the 2000s a technological pioneer, aiming to build a fully digitally literate Estonian society (A.A.K. 2013).

Cross national insights on inequality are here very different: Croatia and the UK display the highest levels of digital skill inequality by gender and education respectively. For Croatia, this could be interpreted by persistent traditional gender roles (Sikiae 2007) and a lack of effective policies to attract women to develop digital skills or study STEM subjects. In addition, it did not have a strategy in place to address its digital skills challenges until 2018 (DESI 2017), which could also account for the delay of observed outcomes. For the UK, high digital skills inequality by educational level could relate to overall economic and labour market inequality. The UK is a highly unequal country (Esping-Andersen 1990) where individuals with low education cannot fully integrate into the market because of a lack of skills. Unlike countries with an extensive vocational education system, it is possible that individuals with low education are preemptively excluded to acquire digital skills since they are unlikely to be recruited into working sectors which will require them to have digital skills.

The tensions between the EU's Skills Agenda and member states's social agenda lie in the different understandings of digital skills. Some countries such as Bulgaria or Romania may not be in the political, economic or infrastructural conditions to conceptualise digital skills as part of social policy, but rather identify them as an area of interest pushed by the EU.

The lessons yielded by this cross-national comparison show that the socio-economic performances and labour market structures of member states relate to how they successfully implement to digital skills policies and respond to inequality. In order to promote digital skills as a social policy goal, countries need to drift from the inextricable association between digital skills and employment.

6 Conclusions

The aim of this research was to advance an understanding of the EU's member states digital skills inclusion policies and their effects on national levels of skills. This was motivated by an observed discrepancy: how could the digital skills gap between countries or individuals be explained if the EU had been increasingly formulating digital skills policies, seeing them as a key area for social and economic growth? To understand how variations in policies could affect the distribution of digital skills, the research differentiated between public and private policies, and digital skills inequality by gender and education.

6.1 Effective digital inclusion depend on national social policies

The first hypothesis expected that higher levels of digital skills inclusion policies would be associated with higher levels of national digital skills. There is a significant positive relationship between public digital skills policies and a population's level of digital skills. While there are wide disparities across the EU in the provision of such policies, their effectiveness to increase citizen's digital skills is considerable. Digital skills policies embody a social investment perspective: as public policies are large-scale, coordinated and socially targeted, they are likely to have an observable impact on national skills levels.

These findings inspire several recommendations. While countries such as Romania, Italy or Bulgaria would benefit from drastically increasing the existence of public digital skills policies, EU member states should aim to go beyond incremental policy changes. It is the *quality* and *design* of policies which need to be substantially thought of. Public digital skills policies should be inclusive and accessible to all citizens, not just to the most digitally savvy.

This would mean for governments to dispense greater funding and attention to user experience design and research in human-computer interaction (HCI) when formulating policies. Where public or social services should be digitalised, systematically rolling out large-scale public training would enable to adequately support individuals in the use of these services while developing their digital skills.

The second hypothesis consisted in understanding the relationship between digital skills inclusion policies and levels of digital skills inequality by gender and education. Women and low educated individuals have significantly lower levels of digital skills across all 28 EU member states. However, the skill gap is most severe by educational level.

Public digital skills policies have a decreasing effect on skill inequality by educational level. On the contrary, private digital skills policies significantly increased these. Private sector training mostly target individuals who are already in employment, thus excluding the low educated and reinforcing inequalities. When programs do reach citizens, the scope and impact of such initiatives tend to be local, thus not having an observable impact on national statistics.

These findings highlight the role of educational inequalities in digital skills. While efforts to reduce the gender gap should be sustained, there is a necessity for social investment approaches to focus on policies to tackle digital skills inequality for the least educated.

Specific policy recommendations include a stronger integration of digital skills in national educational programs while sustaining a life-long learning approach for individuals outside of school. If community-based and locally grounded actors successfully tackle digital skills inequality for the most socially deprived, governments need to complement and support these through large-scale yet targeted programs. As for the private sector, it should aim to tailor its corporate social responsibilities towards individuals with the least education.

6.2 Associating digital skills with social welfare

Twenty years ago, *‘digital skills for the least educated’* might have been considered incongruous to the most pressing social issues of that time. As for most technological inventions, early adopters tend to be the few privileged and educated. Today, the digital transformation fails to unanimously bring digital skills to all: wide inequalities still remain, between individuals and countries.

There needs to be a paradigm shift in how digital skills are conceptualised: beyond an asset for employment, they ought to be fundamentally recognised as linked to the welfare state. There is a real risk for governments to ‘skip a step’ in the formulation of digital policies. The growing integration of technology as instruments for public policy can quickly become a dangerous path if citizens and populations are kept at the margin of such transformations. Predictive policing, benefit automation or facial recognition are some of the social policies of tomorrow which can, and have already, raised issues of discrimination and social exclusion. A digitally skilled population with few disparities is the ‘first’ step to prevent such issues: digital inclusion not only raises societal awareness but enables a wider participation in policy design.

It is thus vital to focus on reducing the digital skills gap and increase the skills of citizens before presenting them with solutions they will not be able to understand. The EU has to reconsider how it can successfully integrate its digital economy strategy alongside a coherent social project of digital skills inclusion.

6.3 The future of digital skills: from promises to commitment

This research acknowledges several limitations. First, it is known from the literature that digital skills inequality is highly correlated to age (Digital Nation 2018; Schreurs, Quan-Haase, and Martin 2019). It was deliberately not included in the analysis as theoretically less relevant: there is limited evidence of impactful national digital skills policies for the elderly (AgeUK 2013). While there is a shift towards life-long learning policies, these have not been adopted by enough member states to infer an effect on levels of digital skills.

Second, despite variables being selected with specific time frames, reverse causality may still be a limitation. Because of the nature of cross-sectional and observational data, it was not possible to draw causal inferences. Instead, the results provide theoretically meaningful observations.

Further research would benefit from using a longitudinal design, where age and other population characteristics could yield a complete understanding of the skill distribution. For digital skills policies, it is crucial for research to work on indicators to improve the translation of concepts into reliable variables.

Now more than ever, it is crucial for governments to step in. The digital transformations that Covid-19 has imposed ought to be seen as an opportunity for effective change. A digital welfare state should not be exclusionary but pivotal to social justice, holding *promises* for a fairer future yet always *committed* to its citizens.

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Appendices

A Table of correlations

Table 12: Correlations between all variables, Source: own calculations.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Dependent variables														
<i>Level of digital skills</i>														
1. For the overall population	1													
2. For men	0.99	1												
3. For women	0.98	0.96	1											
4. For individuals with low education	0.78	0.75	0.80	1										
5. For individuals with high education	0.82	0.82	0.79	0.55	1									
6. Inequality by gender	0.27	0.39	0.13	0.04	0.32	1								
7. Inequality by education	-0.44	-0.40	-0.47	-0.86	-0.05	0.13	1							
Independent variables														
8. Digital skill policies (public)	0.85	0.82	0.88	0.77	0.60	0.02	-0.56	1						
9. Digital skill policies (private)	0.58	0.57	0.58	0.28	0.54	0.12	-0.01	0.53	1					
Control variables														
10. Level of unemployment	-0.41	-0.41	-0.40	-0.45	-0.31	-0.11	0.35	-0.31	-0.26	1				
11. Real GDP growth	0.11	0.11	0.13	0.27	-0.04	-0.13	-0.35	0.14	0.01	-0.43	1			
12. Strength of left-wing parties	-0.03	-0.03	-0.04	-0.05	0.14	0.06	0.15	0.03	0.06	0.10	-0.26	1		
13. Disproportionality of electoral system	-0.28	-0.28	-0.30	-0.41	-0.15	0.06	0.39	-0.37	-0.16	0.26	-0.10	0.00	1	
14. Digital inclusion	0.93	0.93	0.94	0.77	0.66	0.12	-0.52	0.91	0.56	-0.46	0.30	-0.11	-0.29	1
All countries (N = 29)														

B Alternative variable ‘digital inclusion’

Table 13: Regression model of digital skills levels including digital inclusion.

Digital skills level	Regression for robustness		
	Coefficient	t-value	95% CI
Public Digital skills policies	-0.20 (0.14)	-1.4	(-0.50) - (0.10)
Private Digital skills policies	0.03 (0.13)	0.27	(-0.23) - (0.30)
Digital inclusion	1.21*** (0.20)	5.93	(0.80) - (1.64)
Unemployment	-0.05 (0.22)	-0.21	(-0.51) - (0.42)
GDP growth	-1.44** (0.48)	-3.02	(-2.43) - (-0.45)
Strength of left-wing parties	1.23 (1.27)	0.97	(-1.40) - (3.86)
Disproportionality of electoral system	-5.96 (8.56)	-0.69	(-23.83) - (11.91)
Constant	-20.16 (10.52)	-1.92	(-42.03) - (1.71)
Adjusted R-square	0.87		

$N = 29$
 Robust standard errors in parentheses
 $* p \leq 0.05$, $** p \leq 0.01$, $*** p \leq 0.001$
 Source: own calculations

Table 14: Variance of Inflation Factor (VIF) test for digital inclusion.

Variable	VIF	1/VIF
Digital inclusion	11.49	0.087,04
Public Digital skills policies	9.75	0.102,589
Unemployment	1.63	0.612,671
Private Digital skills policies	1.58	0.634,566
GDP growth	1.45	0.690,854
Disproportionality of electoral system	1.29	0.774,743
Strength of left-wing parties	1.23	0.813,377
Mean VIF	4.06	

C Sample of STATA code

The following code is provided as a preview to the full do.file which can be found at: <https://drive.google.com/drive/folders/1rpATOWqWr3duWC2BaT9cdmZZk-MiE3KX?usp=sharing>

```
***** BEGINNING OF DOCUMENT *****

cd /Users/candidatename/Desktop/Data
use Corrected.data.dta,clear

browse

* 29 observations (28 MS + EU average)
* 15 variables (1 countries, 2 independent, 7 dependent, 4 controls, 1 robustness )

*** FOR GRAPHS
set scheme s1mono // looks better than Stata's default for graphics

* Create shorter country labels for Germany and the EU (to make nicer graphs)
replace country = "Germany" if regexm(country, "Germany ") // replace if the variable
contains the expression "Germany "
replace country = "EU" if regexm(country, "European Union ") // replace if the
variable contains the expression "European Union "

*** INDEPENDENT VARIABLES ***
*Percentage of enterprises that provide training in ICT skills
isoc_ske_ittn2 (2012 - 2015)

*Internet use interaction with public authorities (last 12 months)
isoc_ciegi_ac_all (2010 - 2015)

*** DEPENDENT VARIABLES ***
*Individuals who have basic or above basic overall digital skills
isoc_sk_dskl_i (2016 - 2019)
isoc_sk_dskl_i_males16_74
isoc_sk_dskl_i_females16_74
isoc_sk_dskl_i_low_ed
isoc_sk_dskl_i_high_ed
inequality_gender
inequality_edu

*create the inequality variable
generate inequality_gender = ( isoc_sk_dskl_i_males16_74 - ///
isoc_sk_dskl_i_females16_74)
generate inequality_edu = (isoc_sk_dskl_i_high_ed - isoc_sk_dskl_i_low_ed)

*** CONTROL VARIABLES ***
*Unemployment rate
unemp (2010 - 2015)
*Growth of real GDP
realgdpgr (2010 - 2015)
*Cabinet composition (Schmidt - Index)
gov_party (2010 - 2015)
*Index of relative disproportionality of electoral system
dis_rel (2010 - 2015)

***** STEP 1: UNIVARIATE STATISTICS *****

*Descriptive statistics consists of two basic categories of measures:
*measures of central tendency and measures of variability or spread
*Descriptive statistic provided= mean, standard deviation (SD) min and max value
```

D Ethics approval



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██████████
Department of Social Policy and Intervention
University of Oxford

SPI_DREC_20_042

10th August 2020

Dear ██████████,
The promises of “Going digital” for all: where technology meets social policy? A Statistical Analysis of European Union’s Digital Skills Inclusion Policies and Digital Skills Inequality

Your application for research ethics approval in connection with your research project has been considered by the Departmental Research Ethics Committee (DREC) in accordance with the procedures laid down by the University for Ethical Approval.

I am pleased to inform you that, on the basis of the information provided, the proposed research has been judged as meeting appropriate ethical standards and DREC approval has been granted.

If any revisions to your research methodology are made subsequent to this approval, these must be detailed in writing and submitted to DREC immediately.

Yours sincerely,

A handwritten signature in black ink, appearing to read 'J. Lachman'.

Dr Jamie Lachman
Chair of DREC

Point of contact: ethics@spi.ox.ac.uk | +44 (0) 1865 280734
General enquiries: tel. +44 (0) 1865 270325