

The Effects of Individuals' Levels of Computer Skills on the ICT Sector Employment in the European Union during the COVID-19 Pandemics

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Abstract

The COVID-19 pandemic had a significant impact on the ICT employment landscape throughout Europe, confirming the importance of digitalization not only for long-term productivity and growth, but also for the economy's resilience against shocks. The current paper analyses the relationship between the individuals' levels of computer skills and the employment in the ICT sector among the EU Member States in the context of the COVID-19 pandemic. The levels of computer skills among individuals in the EU were analysed in the context of the need to adapt to remote work, access information and services, and participate in the digital economy. The research methodology involves correlation and regression analyses to assess the relationship between individuals' computer skills and ICT employment among the EU Member States. The results confirm a strong positive correlation between computer skills and employed ICT specialists, while emphasizing the need for comprehensive approaches to improve the EU population's computer skills through long-term commitment and collaboration among various stakeholders. The research concludes that increased computer skills can lead to job creation and contribute to the digital transformation and economic development of the European ICT sector.

Keywords: ICT sector, individuals' computer skills, European Union, COVID-19.

JEL Classifications: J21, I25, L86, O52, O33.

1. Introduction

The advent of digitization and the integration of new technologies, often referred to as the fourth industrial revolution, are exerting a profound influence on global society, transforming the way people engage with one another, work, reside, and progress in their lives. Furthermore, Information and Communication Technology (ICT) has assumed a vital role across various industries, bringing about significant

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changes in manufacturing, employment, and services (Postula et al., 2021). Consequently, policymakers and researchers in the European Union express a keen interest in monitoring, evaluating, and taking appropriate measures in the ICT sector at national, regional, and organizational levels. Employment and ICT development are closely intertwined with a country's competitive edge over others and can play a pivotal role in economic and political negotiations.

The growing prevalence of e-commerce and the adoption of information and communication technologies (ICT) have brought about notable transformations in the labour market. The accessibility of self-study resources and the rapid pace of digitalization have compelled workers to transition across different skill levels. Consequently, all ICT personnel with intermediate and lower skill levels have the opportunity to advance to the high-skilled category (Zatonatska et al., 2022). Individuals with higher levels of computer skills are more likely to secure employment in the ICT sector and contribute effectively to its growth. Proficiency in computer skills enables individuals to navigate digital technologies, software applications, and programming languages, making them valuable assets in the ICT industry (Balsmeier & Woerter, 2019). They can effectively adapt to evolving technological advancements and contribute to innovation and problem-solving within the sector (Dosi & Mohnen, 2019). The ICT sector's contributions to economic output, productivity gains, innovation, and entrepreneurship all play a significant role in driving economic growth and shaping a nation's overall economic performance. According to Şişman et al. (2023), there is a positive and significant relationship between employment in the ICT sector and the real gross domestic product (GDP) per capita and the frequency of Internet use among the EU Member States.

2. ICT Sector Employment in the European Union

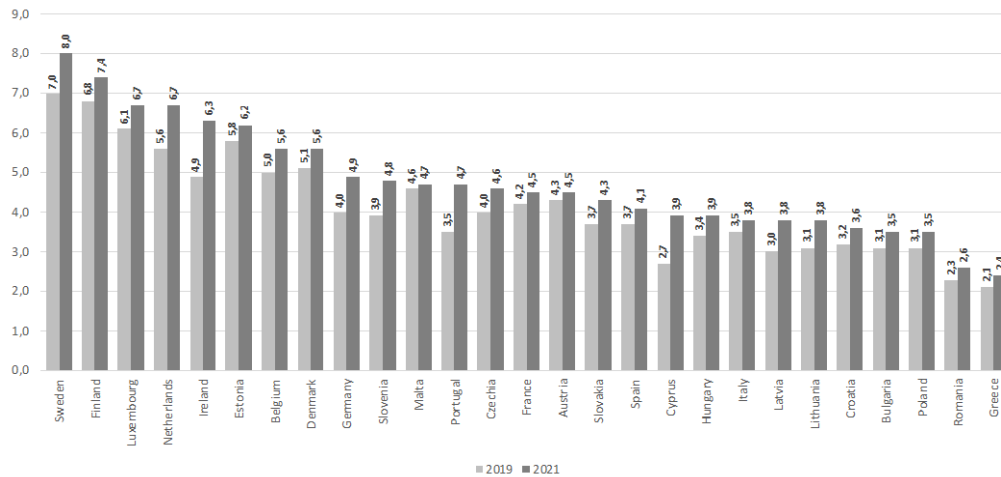
The ICT employment rate in the European Union reached 4.5% of the total EU workforce in 2021, from 3.9% in 2019, the year before the COVID-19 crisis began. One of the most important growth drivers of the ICT employment in the European Union was the COVID-19 pandemics, which accelerated the adoption of the new technologies, in the context of the increasing need for digital services and remote interactions. The COVID-19 pandemic has demonstrated that digitalization is crucial not only for long-term productivity, but also for the economy's resilience against shocks. However, despite some progress prompted by the pandemic, significant disparities in digitalization persist across sectors and countries (Jaumotte et al., 2023).

The increased availability of ICT mitigated the economic decline by enabling businesses to sustain operations through e-commerce, facilitating digital

transactions for financial activities, allowing individuals to work remotely during lockdowns, and promoting well-being through digital health services and social interactions (Kim et al., 2022).

Among the EU Member States, in 2021, the proportion of employed ICT specialists was highest in Sweden (8.0%) and Finland (7.4%). The smallest shares were registered in Romania (2.6%) and Greece (2.4%). Overall, the number of ICT specialists in the EU increased by more than 15% from the beginning of the COVID-19 pandemics to 2021.

Figure 1. ICT specialists in total employment in the EU (%), 2019 & 2021



Source: Eurostat, Percentage of the ICT personnel in total employment, 2023

The COVID-19 pandemic had a significant impact on the ICT employment landscape throughout Europe. With widespread lockdowns and social distancing measures, most of the organizations shifted rapidly to remote work setups (Banga & te Velde, 2020). This sudden shift increased the need and importance of ICT professionals to set up and maintain the necessary digital infrastructure, provide technical support to remote workers, and ensure proper communication channels. The increase in reliance on digital platforms and remote work raised concerns about cybersecurity and data privacy (Adelmann & Gaidosch, 2020). Organizations needed more ICT professionals to strengthen their cybersecurity measures and protect sensitive data, while ensuring compliance with the EU privacy regulations. Moreover, the pandemic accelerated the pace of digital transformation in various industries (OECD, 2020). Organizations that previously had limited digital capabilities or online presence had to rapidly adapt and invest in ICT solutions to maintain business continuity and competitiveness, leading to an increased demand

for ICT professionals skilled in software and web development, cybersecurity, cloud computing, and data analytics. The increase in e-commerce and digital services during the pandemic created new job opportunities for ICT professionals (Alcedo et al., 2022) in areas related to the development and maintenance of online platforms, such as web development and digital marketing.

3. Individuals' Levels of Computer Skills in the European Union

The COVID-19 pandemic has further emphasized the critical importance of individuals' computer skills for economic resilience. These skills are important in empowering individuals to adapt to remote work environments, pursue online learning opportunities, access crucial information and services, interact with authorities, and utilize digital financial systems. Individuals with strong computer skills were better equipped to transition to remote work setups, using digital tools and communication platforms to manage projects, maintain productivity, and collaborate effectively within teams (Saputra et al., 2021). Moreover, the ability to access information, essential services, and government support via the Internet became very important during the pandemic. Individuals with computer skills managed to navigate digital platforms and use digital instruments, access reliable information, financial assistance, and online healthcare services, enabling them to make informed decisions and stay connected. The reduced level of physical interactions during the pandemics emphasized the importance of digital financial transactions (Demirgüç-Kunt et al., 2021). Individuals with computer skills were able to use online banking platforms and engage in mobile payments.

Moreover, with the closure of educational institutions, online learning became the primary mode of education (Camargo et al., 2020). Therefore, individuals with computer skills were able to access digital learning platforms and continue their educational efforts, increasing their knowledge and enhancing their adaptability and employability.

The level of individuals' computer skills measures their proficiency and capability in utilizing computers, digital devices, software applications, and online platforms to perform various tasks and achieve specific goals and encompasses a range of abilities and knowledge related to computer literacy and technological competence. For the purpose of this study, the individuals' levels of computer skill throughout the European Union were calculated as a composite index of four dimensions: the ability to manipulate files, the ability to download and install software, basic knowledge of customizing software settings, and the ability to edit photo, video, or audio files:

$$CSK_IDX(\%) = FILE \times \beta_1 + SOFT \times \beta_2 + SET \times \beta_3 + MM \times \beta_4$$

Where, $\beta_{[1,4]}$ represent weighted coefficients corresponding to each of the four dimensions studied, determined by the author in accordance with their relative contribution to the overall index score:

$$\beta \begin{pmatrix} 1 \\ 2 \\ 3 \\ 4 \end{pmatrix} = \begin{pmatrix} 0.25 \\ 0.35 \\ 0.25 \\ 0.15 \end{pmatrix}$$

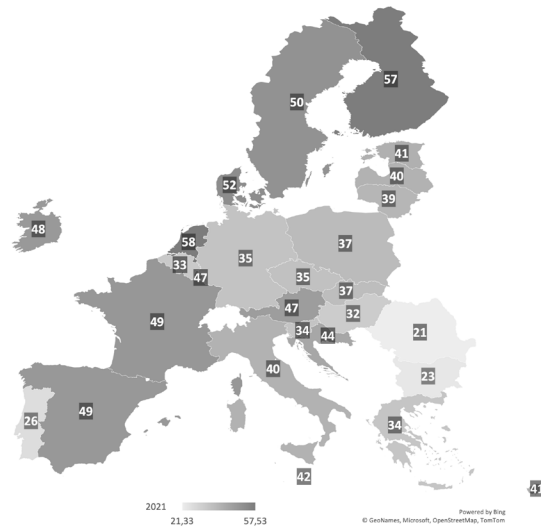
Table 1. Variables

Id	Description	Source
FILES	Individuals who have copied or moved files between folders, devices or on the cloud in the last 3 months (% of individuals)	Eurostat ²
SOFT	Individuals who downloaded or installed software or apps in the last 3 months (% of individuals)	Eurostat ²
SET	Individuals who changed the settings of software, app, or device in the last 3 months (% of individuals)	Eurostat ²
MM	Individuals who edited photos, video, or audio files in the last 3 months (% of individuals)	Eurostat ²
CSK_IDX	Individuals' Levels of Computer Skills Composite Index (% of individuals)	Own
ICT_SPEC	ICT specialists in total employment in the EU (%)	Eurostat ¹

Source: own research.

Among the EU Member States, the Individuals' level of Computer Skills Composite Index was highest in Netherlands (58%) and Finland (57%), and registered the lowest values in Bulgaria (23%) and Romania (21%). While the average value EU value was 41%, the level of computer skills varies significantly across EU Member States, due to national educational systems, access to technology, socioeconomic factors, and governmental digital inclusion initiatives and policies.

Figure 2. Individuals' Levels of Computer Skills Composite Index, 2021 (% of individuals)



Source: Authors' own creation.

4. Research Methodology

The level of computer skills can vary from basic proficiency to advanced mastery, and it plays a significant role in an individual's ability to adapt to technology-driven environments, perform tasks efficiently, access information, communicate effectively, and participate in various aspects of modern society and the economy. Possessing computer skills enable individuals to adapt to evolving technologies, contribute to efficiency and productivity, and increases employability. Therefore, the following hypothesis can be formulated (*H1*): *The individuals' levels of computer skills influences the employment rate in the ITC sector within the European Union.*

The current analyses refer to the 27 Member States of the European Union, taking into consideration the data for 2021 (latest available values). The variables of the research model are presented in Table 1. The software used for data analyses was Microsoft Excel[®], XLSTAT[®], and IBM SPSS Statistics[®].

Correlation and regression analyses were performed in order to assess the effects of the individuals' levels of computer skills on the EU employment rate in the ITC sector. For this purpose, a general probabilistic model for simple linear regression was used:

$$ICT_SPEC_i = b_0 + b_1 \times CSK_IDX_i + \varepsilon_i$$

Where, ICT_SPEC_i represents the dependent variable (ICT specialists as % of total employment in the EU), CSK_IDX_i represents the independent variable

(Individuals' Levels of Computer Skills Composite Index as % of individuals), b_0 and b_1 are the coefficients of the regression function, ε_i is the residual component for the values of $i = [1, 27]$.

5. Results

In order to test the research hypothesis ($H1$), a visual inspection of the datasets was performed in order to determine the type and strength of the relationship between the two variables, followed by a Pearson correlation computation and regression analyses.

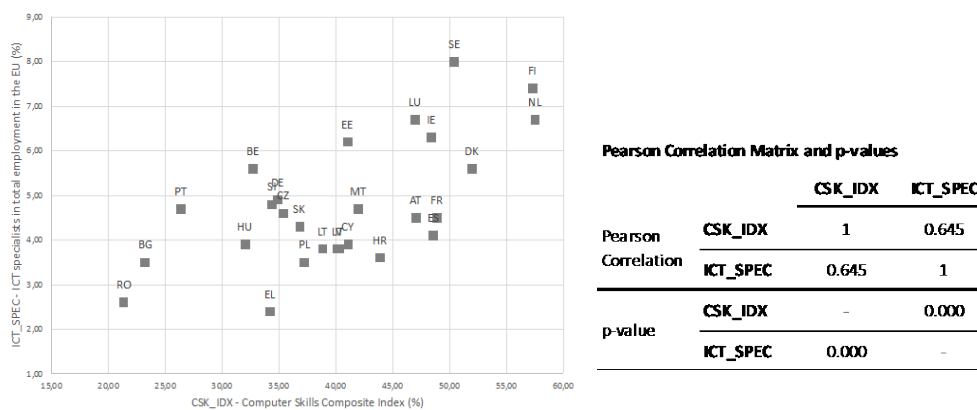
Table 2. Data Normality Tests

	CSK_IDX	ICT_SPEC
Shapiro-Wilk test (df=27)		
W Statistic	0.978	0.946
p-value (two tailed)	0.826	0,172
Significance level – Alpha	0.050	0.050
Skewness z-value	-0.279	1.444
Kurtosis z-value	-0.305	-0.040

Source: own research, using IBM SPSS Statistics®.

The results of the normality tests (Table 2) show that the data are approximately normally distributed for a significance level of 5%, with the computed p-values greater than $\alpha = 0.05$ and z-values within the accepted interval of [-1.96, 1.96].

Figure 3. Pearson Correlation Analysis



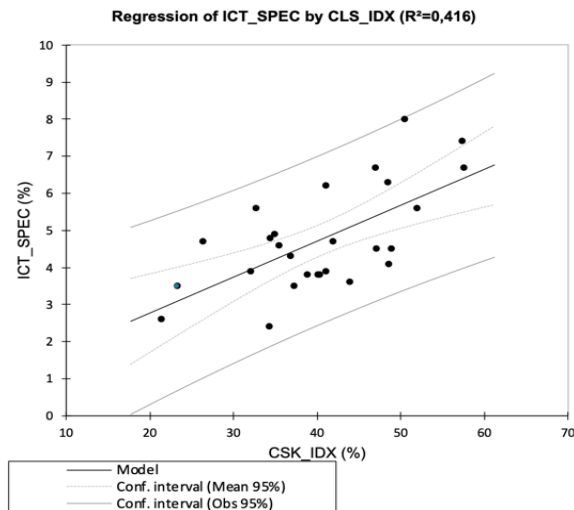
Source: own research, using IBM SPSS Statistics® and Microsoft Excel®.

As shown in Figure 3, the statistically significant Pearson correlation coefficient ($r=0,645$) illustrates a linear strong positive relationship between CSK_IDX and ICT_SPEC, for $\alpha = 0.05$ and p-value < 0,002 (Rodgers & Nicewander, 1988).

Figure 4. Regression Analysis

Goodness of fit statistics**(ICT_SPEC):**

Observations	27
Sum of weights	27
DF	25
R ²	0,416
Adjusted R ²	0,393
MSE	1,184
RMSE	1,088
MAPE	20,031
DW	1,034
Cp	2,000
AIC	6,477
AICC	6,977
SBC	9,069
PC	0,677

**Analysis of variance (ICT_SPEC):**

Source	DF	Sum of squares	Mean squares	F	Pr > F
Model	1,000	21,092	21,092	17,818	<0,0001
Error	25,000	29,594	1,184		
Corrected Total	26,000	50,687			

Computed against model $Y = \text{Mean}(Y)$

Model parameters (ICT_SPEC):

Source	Value	Standard error	t	Pr > t	Lower bound (95%)	Upper bound (95%)
Intercept	0,843	0,950	0,888	0,383	-1,113	2,800
CLS_IDX	0,097	0,023	4,221	<0,0001	0,050	0,144

Source: own research, using XLSTAT®.

The regression model presented in Figure 4 explains 41.6% of the variation of the number of ICT specialists employed as a percentage of total employment throughout the European Union ($r^2=0.416$), being statistically significant for a significance level of 5%. The equation of the statistical model is:

$$ICT_SPEC(\%) = 0,843 + 0,097 \times CLS_IDX(\%).$$

Conclusions

The results of the research conducted validate the hypothesis and illustrate a strong significant positive correlation between the individuals' level of computer skills, as a percentage of individuals, and the employed ICT specialists, as a percentage of total employment, among the European Union Member States. The research model shows that an increase by 1 percentage point of the individuals' levels of computer skills composite index value determines an increase in ICT specialists' employment by almost 0.1 percentage points. As the model presents no significant outliers (Figure 4), the results can be used to predict the future impact of the population's computer skills development on the ICT employment dynamics. This is especially important for low-performing countries like Romania and Bulgaria, in terms of assessing the impact of future government measures and initiatives to increase the population's digital skills. Since the COVID-19 pandemic accelerated the need for individuals to improve their computer skills in order to adapt to the changing landscape of remote work, online learning, and digital communication, the governments can use this momentum to successfully develop comprehensive approaches that address various aspects of education, training, and access to technology. Nevertheless, increasing computer skills requires a long-term commitment and sustained effort from multiple stakeholders, including the government, educational institutions, private sector, and civil society organizations (European Commission, 2020).

According to the World Economic Forum (2023), the growth in computer skills can lead to the creation of new jobs in the ICT sector and can even reshape the employment landscape as a result of the need to upskill or reskill the existing workforce. Improved computer skills enable individuals to contribute to the digital transformation of industries, by implementing new technologies, optimizing processes, and leveraging data-driven decision making. Further research might address the dynamics of the ICT employment landscape after the pandemic's restrictions have been lifted, in terms of demand for ICT professionals and new jobs creation in the context of technological advancements and digital transformation of industries.

Although the effects on ICT specialists' employment vary depending on the region, industry, and the pace of technological advancements adoption, increasing the population's computer skills can, overall, contribute to employment growth, digital transformation and economic development of the European ICT sector.

References

- Adelmann, F., Gaidosch, T., (2020), Cybersecurity of Remote Work During the Pandemic, *International Monetary Fund – Monetary and Capital Markets*, [online] Available at: <https://www.imf.org/-/media/Files/Publications/covid19-special-notes/en-special-series-on-COVID-19-cybersecurity-of-remote-work-during-pandemic.ashx> [Accessed 20 May 2023].
- Alcedo, J., Cavallo, A., Dwyer, B., Mishra, P., Spilimbergo, A., (2022), E-commerce During COVID: Stylized Facts from 47 Economies, *NBER Working Paper Series*, No. 29729, February 2022.
- Balsmeier, B., Woerter, M., (2019), Is this time different? How digitalization influences job creation and destruction, *Research Policy*, 48 (8), 103765, <https://doi.org/10.1016/j.respol.2019.03.010>.
- Banga, K., te Velde, D., W., (2020), COVID-19 and disruption of the digital economy; evidence from low and middle-income countries, *Digital Pathways at Oxford Paper Series*; no. 7. Oxford, United Kingdom, [online] Available at: https://pathwayscommission.bsg.ox.ac.uk/sites/default/files/2021-01/COVID-19_and_disruption_of_the_digital_economy_28jan21.pdf [Accessed 20 May 2023].
- Camargo, C., P., Tempiski, P., Z., Busnardo, F., F., Martins, M., A., Gemperli, R., (2020), Online learning and COVID-19: a meta-synthesis analysis, *Clinics*, vol. 75, e2286, <https://doi.org/10.6061/clinics/2020/e2286>.
- Demirgüç-Kunt, A., Klapper, L., Singer, D., Ansar, S., (2021), The Global Findex Database 2021: Financial Inclusion, Digital Payments, and Resilience in the Age of COVID-19, *Washington, DC: World Bank*, doi:10.1596/978-1-4648-1897-4.
- Dosi, G., Mohnen, P., (2019), Innovation and employment: an introduction, *Industrial and Corporate Change*, 28 (1), pp. 45-49, <https://doi.org/10.1093/icc/dty064>.
- European Commission, (2020), Digital Education Action Plan 2021-2027 - Resetting education and training for the digital age, *COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS, COM(2020) 624 final*, [online] Available at: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0624> [Accessed 20 May 2023]
- Eurostat¹, (2023), *Employed ICT specialists - total*, [online] Available at: https://ec.europa.eu/eurostat/databrowser/view/isoc_sks_itspt/default/table?lang=en [Accessed 20 May 2023].

- Eurostat², (2023), *Individuals' level of computer skills (2021 onwards)*, [online] Available at: https://ec.europa.eu/eurostat/databrowser/view/ISOC_SK_CSKL_I21/default/table?lang=en [Accessed 20 May 2023].
- Jaumotte, F., Li, L., Medici, A., Oikonomou, M., Pizzinelli, C., Shibata, I., Soh, J., Tavares, M., (2023), *Digitalization During the COVID-19 Crisis: Implications for Productivity and Labor Markets in Advanced Economies*, IMF Staff Discussion Notes, [online] Available at: <https://www.imf.org/-/media/Files/Publications/SDN/2023/English/SDNEA2023003.ashx> [Accessed 20 May 2023].
- Kim, J., Estrada, G., Jinjark, Y., Park, D., Tian, S., (2022), ICT and Economic Resilience during COVID-19: Cross-Country Analysis, *Sustainability*, 14, 15109, <https://doi.org/10.3390/su142215109>.
- OECD, (2020), Digital Transformation in the Age of COVID-19: Building Resilience and Bridging Divides, *Digital Economy Outlook 2020 Supplement*, OECD, Paris, [online] Available at: www.oecd.org/digital/digital-economy-outlook-covid.pdf [Accessed 20 May 2023].
- Postula, M., Chmielewski, W., Puczynski, P., Cieslik, R., (2021), The Impact of Information and Communication Technologies (ICT) on Energy Poverty and Unemployment in Selected European Union Countries, *Energies*, 14(19), 6110.
- Rodgers, J., L., Nicewander, W., A., (1988), Thirteen Ways to Look at the Correlation Coefficient, *The American Statistician*, 42:1, 59-66, DOI: 10.1080/00031305.1988.10475524.
- Saputra, N., Nugroho, R., Aisyah, H., Karneli, O., (2021), Digital Skill During COVID-19: Effects of Digital Leadership and Digital Collaboration, *Journal of Applied Management (JAM)*, 19(2), pp. 272-281, <http://dx.doi.org/10.21776/ub.jam.2021.019.02.04>.
- Şişman, D., Şişman, M., Yanık, A., H., (2023), Labour Demand Analysis in the ICT Sector: EU Countries and Türkiye, *Journal of World Economy: Transformations & Transitions (JOWETT)*, 3(06):24, <https://doi.org/10.52459/jowett36240323>.
- World Economic Forum, (2023), *Future of Jobs Report 2023*, [online] Available at: https://www3.weforum.org/docs/WEF_Future_of_Jobs_2023.pdf [Accessed 20 May 2023].
- Zatonatska, T., Klapkiv, Y., Dluhopolskyi, O., Fedirko, O., (2022), Forecasting of the Employment Rate in the EU ICT Field, *Comparative Economic Research. Central and Eastern Europe*, 25(3), pp. 7-25.