Economics Ekonomika
Management Management
Innovation Inovace

EMI, Vol. 16, Issue 2, 2024
ISSN: 1804-1299 (Print), 1805-353X (Online)
www.emijournal.cz

DIGITALIZATION OF THE CZECH ECONOMY IN THE CONTEXT OF ECONOMIC DEVELOPMENT

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Abstract

Digitalisation and robotisation have been identified as mega-trends shaping the development of global economies. This article discusses the advancement of these trends, especially digitalisation, within the context of the small open economy – the Czech Republic, which has been long-term lagging behind the average levels of digitalisation among the European Union membership states. This article offers an overview of the selected digitalisation indicators, such as the Digital Economy and Society Index (European Commission), E-Participation Index (United Nations) or Internet Users Share (Czech Statistical Office), to illustrate the current state of the country in the light of available data. By implementing correlation analysis, the article shows that there is a statistically significant association between digitalisation (measured through several indicators) and the economic development of the Czech Republic, measured through the development of Gross Domestic Product (GDP) per capita, economic activity, labour productivity, employment and unemployment rates. The article concludes that official statistical reporting lags behind the mega-trends-related indicators, resulting in a lack of data for more rigorous empirical analysis and stronger policy recommendations. Also, key challenges for the future development of the Czech digital agenda are presented.

Keywords: Digitalization, Czech economy, labour productivity, economic development

JEL codes: D2, E24

1 Introduction

The fourth industrial revolution (also linked with the term Industry 4.0) that the world nowadays undergoes is characterised often by the widespread usage of information and communication technologies (ICT), allowing to enhance productivity, optimise and automatise processes and production capacities with the objective of increasing competitiveness and securing sustainable economic growth (Markhaichuk and Panshin, 2020; Solomon and Van Klyton, 2020; Petrová, 2022; Guo et al., 2023).

Thus, adapting new technological and innovative solutions into business practices, such as cloud computing, big data analytics, Internet of things, artificial intelligence and robots, is a way how to increase productivity and efficiency through better alternative usage of resources and thus promote higher levels of economic performance and societal well-being (Li et al., 2020; Chen and Zhang, 2022; Mattsson and Reshid, 2023). This has been mainly reflected in the information processing theory (IPT) and its applications, assuming that firms adopting innovative technological solutions obtain more accurate and real-time information and gain a competitive advantage in the markets (Colombari et al., 2023).

However, the theoretical assumptions do not always need to be transferred to real-life evidence, which has been documented in numerous empirical studies, finding inconclusive and sometimes even

Paper received: 6.5.2024 Paper revised:15.7.2024 Paper accepted:19.7.2024

negative linkages between digitalisation and economic development, making the findings differentiating across countries and continents. There are also significant moderators that influence the relationship, which include the adaptation time, i.e., consideration of time lags before the economic effects show up, the overall level of digital competencies across the economically active population, quality of institutional, innovative and entrepreneurial ecosystems and the extent to which the entrepreneurial population is willing to adapt technologies and is actually adapting those (Markhaichuk and Panshin, 2020; Li et al., 2020; Vokoun and Dvouletý, 2022; Daud and Ahmad, 2023; Wang and Cen, 2024).

One topic frequently noted in the scholarly literature as a barrier to Industry 4.0 initiatives is the threat of technological unemployment, which scares people of losing their jobs. Undoubtedly, some employees would have to requalify and change their working habits. The claim that "machines overtake people's jobs" is often associated with low-skilled professions, yet historically, there is no evidence that the adoption of the technology would significantly raise unemployment rates across the globe (Petrová, 2022; Braxton and Taska, 2023; Jung et al., 2024). Notably, the fourth industrial revolution challenges the current state of the markets and industrial organisation in the light of the Schumpetrial creative destruction processes, implying that some companies and organisations will be forced into bankruptcy and their employees will lose their jobs. However, this does not imply that there would not be new opportunities for requalification and finding jobs (Balagopal, 2021; Mejia, 2023). Researchers and practitioners continuously discuss the role of digitalisation, robotisation and automation on the professions, pointing out the lists of most endangered professions (to be replaced by robots and artificial intelligence) as well as sectors and occupations that would experience a scarcity of employees, especially social services and healthcare sectors, providing thus (after requalification) opportunities to obtain jobs after the implementation of innovative technological solutions, so if there should a rise in unemployment its character will be only temporary (Lu et al., 2020; Braxton and Taska, 2023).

This article offers a perspective of the Czech Republic, a small, open economy with a historically long tradition of entrepreneurship, innovation culture and industrial production (Dvouletý, 2019; Dvouletý et al., 2022; Mikeska and Urbánek, 2022; Rybanská and Čada, 2024) which is lagging behind the average levels of digitalisation among the European Union membership states. According to the latest available ranking of the Digital Economy and Society Index (DESI), the Czech Republic has obtained 17th position among the EU member states (European Commission, 2024). The ongoing megatrends of digitalisation, robotisation and changes known under the concept of Industry 4.0 cannot be fully addressed in the short term, and they need to be tracked over the long-term periods to reveal economic outcomes on the country's development (Evangelista et al., 2014).

This research provides readers with the most lengthy time series of digitalisation-related indicators, capturing its shifts within the Czech context since early 2003, and the article demonstrates which variables are available for statistical analysis, linking these trends with economic development. The data are uniquely used to test the interrelationships between these within the correlation analyses. The contribution of this article lies in addressing challenges for future research when it comes to setting up the right indicators, their availability and challenges for the future development of the Czech digital agenda.

The structure of the article is conventional. In the forthcoming section, the available measures are introduced and explained. The next section is dedicated to the descriptive and correlation analysis of the data, and the final section concludes the article with recommendations for policymakers and the scholarly community.

2 Data

Measurement of digitalisation progress is a tough and challenging aspect, which requires continuous monitoring and the ability to possess adapted harmonised indicators, allowing to track the changes implemented over time to see their effects on digitalisation advancement (Alsufyani and Gill, 2022; Pisár et al., 2022). The key issue is the persistence and continuous reporting of the selected and created indicators, as noted in the recent Organisation for Economic Co-operation and Development (OECD,

Paper received: 6.5.2024 Paper revised:15.7.2024 Paper accepted:19.7.2024

EMI, Vol. 16, Issue 2, 2024
ISSN: 1804-1299 (Print), 1805-353X (Online)
www.emijournal.cz

2022) Going Digital Measurement Roadmap, which concludes that while the scientific community and policymakers are quite successful in creating those indicators and launching them, their continuous monitoring, especially in five or ten-year-long periods, is highly problematic. The vast majority of the initially selected indicators are promoted with passion but abandoned or discontinued before the second or third-year measurements could take place and reveal the changes over the initial observations.

Thus, in this section, we aim to document Czech-focused indicators with the longest possible history, being thus most suitable for time series analysis. First, we briefly introduce definitions of collected indicators, including the time availability:

- **Digital Economy and Society Index (DESI)** is provided by the European Commission (2024), and it is a "composite index that summarises relevant indicators on Europe's digital performance and tracks the evolution of EU Member States, across four main dimensions: Human capital, Connectivity, Integration of digital technology and Digital public services. "
  - Available years for the Czech Republic: 2017–2022

- **E-Participation Index** is provided by the United Nations (2024), and it is a "multifaceted index, composed of three core components, i.e., e-information, e-consultation and e-decision-making. "
  - Available years for the Czech Republic: 2003, 2004, 2005, 2008, 2010, 2012, 2014, 2016, 2018, 2020, 2022.

- **E-Government Development Index (EGDI)** is provided by the United Nations (2024), and it is an "index that incorporates the access characteristics, such as the infrastructure and educational levels, to reflect how a country is using information technologies to promote access and inclusion of its people. "
  - Available years for the Czech Republic: 2003, 2004, 2005, 2008, 2010, 2012, 2014, 2016, 2018, 2020, 2022.

- **Human Capital Index** is provided by the United Nations (2024), and it is an index that "measures the amount of human capital that a child born today can expect to attain by age 18, given the risks of poor health and poor education that prevail in the country where she lives. It is designed to highlight how improvements in current health and education outcomes shape the productivity of the next generation of workers. "
  - Available years for the Czech Republic: 2003, 2004, 2005, 2008, 2010, 2012, 2014, 2016, 2018, 2020, 2022.

- **Telecommunication Infrastructure Index** is provided by the United Nations (2024), and it is an "index composed of basic infrastructural indicators, which define a country's ICT infrastructure capacity. These are: PC's/1000 persons; Internet users/1000 persons; Telephone Lines/1000 persons; Online population; Mobile phones/1000 persons; and TV's/1000 persons. "
  - Available years for the Czech Republic: 2003, 2004, 2005, 2008, 2010, 2012, 2014, 2016, 2018, 2020, 2022.

- **Enterprises with Internet Connection 100 Mbit/s** is an indicator provided by the Czech Statistical Office (2024a), and it reflects "a percentage of enterprises in the category of 10+ employees with internet Connection of 100 Mbit/s and above. "
  - Available years for the Czech Republic: 2011–2023

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- **Enterprises with Mobile Internet Connection** is an indicator provided by the Czech Statistical Office (2024a), and it reflects "a percentage of enterprises in the category of 10+ employees mobile Internet connection. "
  - Available years for the Czech Republic: 2010–2023

- **Enterprises with Websites** is an indicator provided by the Czech Statistical Office (2024a), and it reflects "a percentage of enterprises in the category of 10+ employees with websites. "
  - Available years for the Czech Republic: 2003, 2004, 2006, 2010–2023

- **E-Commerce Sales of Enterprises** is an indicator provided by the Czech Statistical Office (2024a), and it reflects "a percentage of sales of enterprises in the category of 10+ employees that were obtained from websites, mobile apps or online marketplaces. "
  - Available years for the Czech Republic: 2003–2022

- **IT Professionals in Enterprises** is an indicator provided by the Czech Statistical Office (2024a), and it reflects "a percentage of IT professionals on total number of employees in the category of enterprises in the category of 10+ employees. "
  - Available years for the Czech Republic: 2008–2020, 2022

- **Internet Users Share** is an indicator provided by the Czech Statistical Office (2024b), and it reflects "a percentage of 16–74 years old population that used the Internet within the past three months. "
  - Available years for the Czech Republic: 2010, 2016–2022

- **Households with Internet** is an indicator provided by the Czech Statistical Office (2024b), and it reflects "a percentage of households that used the Internet. "
  - Available years for the Czech Republic: 2003–2023

- **IT Professionals** is an indicator provided by the Czech Statistical Office (2024b), and it reflects "a percentage of IT professionals on the total number of employees. "
  - Available years for the Czech Republic: 2012–2021

To more formally link the advancements in digitalisation with the economic development of the Czech Republic, we also collected five economics-related indicators that we will use in the forthcoming correlation analysis. These were obtained again from the Czech Statistical Office (2024c; 2024d) and include **Gross Domestic Product per capita** (GDP) in purchasing power standard (PPS), **economic activity** (percentage of 15–64 population), **labour productivity** (in constant 2015 prices), **employment** and **unemployment rates** (percentage of 15–64 population) as the most fundamental macroeconomic indicators representing economic development of a country (Krkoska, 2001; Zubíková and Smolák, 2022).

Table 1 provides the mean, standard deviation and number of available observations for each of the variables. While we have 20 years of data for the macroeconomic variables, the availability of digitalisation-related indicators significantly varies from 6 years to 21, as already shown earlier.

Paper received: 6.5.2024 Paper revised:15.7.2024 Paper accepted:19.7.2024

EMI, Vol. 16, Issue 2, 2024
ISSN: 1804-1299 (Print), 1805-353X (Online)
www.emijournal.cz

Table 1: Summary statistics of collected variables

Variable	Mean	Standard deviation	Observations
Digital Economy and Society Index	39.21167	6.320934	6
E-Participation Index	0.3652545	0.2135894	11
E-Government Development Index	0.6645909	0.083585	11
Human Capital Index	0.9015182	0.0256419	11
Telecommunication Infrastructure Index	0.5452545	0.1614263	11
Enterprises with Internet Connection 100 Mbit/s	19.16712	14.85924	13
Enterprises with Mobile Internet Connection	54.31698	29.69489	14
Enterprises with Websites	78.65444	6.685717	17
E-Commerce Sales of Enterprises	22.43462	9.27511	20
IT Professionals in Enterprises	2.605213	0.408292	14
Internet Users Share	78.40734	7.117461	8
Households with Internet	59.03716	25.39623	21
IT Professionals	3.654673	0.4307423	10
GDP per capita in PPS	23299.62	4445.049	20
Economic Activity	72.89521	2.87702	20
Labour Productivity	95.51664	9.853058	20
Employment Rate	69.1036	4.215107	20
Unemployment Rate	5.328759	2.198018	20

Source: own calculations in STATA 14 software

3 Analysis and results

Given the limited number of years available for the statistical time series analysis, we proceed by estimating bivariate correlation coefficients for each set of indicators, digitalisation-related variables on one side, and macroeconomic performance variables on the other, to understand their associations. While this approach has notable limitations, such as a lower degree of freedom and limited statistical power, it still informs us whether some mutual relationships exist and how significant their interdependency is (Sachs, 2012).

For each of the bivariate correlations, we also conducted a test of statistical significance and the results are reported in the form of the correlation matrix, depicted in Table 2. Among the results, we highlighted the statistically significant positive (in green) and negative (in red) associations. With the exception of the Human Capital Index, we find strongly positive correlations (when the coefficient is in absolute values above 0.6) for most of the studied variables (GDP per capita, economic activity, labour productivity and employment rate) and their interlinks, reaching very strong associations (when the coefficient is in absolute values above 0.8), in some cases, such as for the indicators of IT Professionals, Internet Users Share or Telecommunication Infrastructure Index. Also, in line with the economic expectations, we see a statistically significant and negative association with the unemployment rate (with the exception of the Human Capital Index again). The least correlated variable is the DESI index, which also had the fewest statistical observations and was found to be significant only with GDP per capita and economic activity.

Despite the limitations and lack of causal interferences of this methodological approach, we can observe that there is a clear relationship between digitalisation and the economic development of the Czech Republic. We can now discuss the country's progress over time in line with these findings. From the perspective of the longest-tracked development, i.e., the UN-based indicators, where one is the maximum value of each indicator, we can see considerable advancements in all measures. In 2003, the value of the E-Participation Index was 0.24; in 2016, it increased to 0.56 and in 2022, it moved to 0.6.

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Similarly, the E-Government Development Index had a 2003 value of 0.54 and was continuously growing up to 0.81 in 2022. The Telecommunication Infrastructure Index also showed significant changes, moving from 0.39 in 2003 to 0.85 in 2022. This would not be possible without the population getting widely engaged in Internet activities and without the infrastructure being built from public funds. While in 2003, only 11% of households had an internet connection, after 2010, it was 56%, and in 2023, the proportion reached 87.5%. In 2022, the share of internet users in the population reached 84.5%.

Thus, public and private sector economic and administrative activities have inevitably moved online. As a part of the digitalisation agenda, the Czech government has supported projects enabling electronic communication with public sector offices through electronic mailboxes and bank identity, as well as submission of tax reports online through a website called "My Taxes." In 2024, the Czech government plans to implement electronic identity documents (IDs) into mobile phone applications.

According to the Czech Statistical Office (2024e) data, 9.1% of Czech citizens have used communication with public sector electronic mailboxes, and 22.9% have used bank identity. This has been reflected in increased ranking in the DESI index, scoring a value of 64.5 in 2022 and obtaining 17th position among the EU member states. Still, despite these efforts, the country's position remains below the European average, which is 67.3. The ongoing problem remains the lack of skilled ICT professionals in the labour market (Pělucha, 2019; Drmola et al., 2021), which is to be addressed either by attracting professionals from abroad or by providing ICT training, including enhancing skills at educational institutions. The labour market survey data support this, showing that the proportion of ICT professionals was 3.1% of total employment in 2012 and moved to 4.3% in 2021, which is still far from the optimum state and labour demand satisfaction.

Not using the Internet for business is nowadays unimaginable. E-commerce sales of enterprises illustrate these numbers. While in 2003, online sales contributed 6.1% of total sales, in 2020, it reached over 23.4%, and the last available data from 2022 shows that 30.5% of total sales come from online platforms, websites, and marketplaces, and it is undoubtedly, that the global COVID-19 pandemic has even boosted this trend (Dvorak et al., 2021; Pollák et al., 2021). As of 2023, 82.9 enterprises have their own websites, 52.7% have their own social networks, and in 85.4% of businesses, mobile Internet is used. Cloud services were used in 2023 by 47.1% of enterprises, enterprise resource planning (ERP) systems used by 29% and artificial intelligence (AI) based tools by only 5.9% of businesses with more than ten employees.

The current challenge is to broadcast a fast internet connection, i.e. above 100 Mbit/s. In 2011, 6.9% of enterprises had access to fast Internet, while in 2023, it is still less than half, i.e., 44.7%. Continuous efforts to provision access to high-speed internet lines, such as Very High Capacity Networks (VHCN) or Fibre to the Premises (FTTP), are thus needed (Aravantinos et al., 2021; Woźniak-Jęchorek and Kuźmar, 2023).

Paper received: 6.5.2024 Paper revised:15.7.2024 Paper accepted:19.7.2024

EMI, Vol. 16, Issue 2, 2024
ISSN: 1804-1299 (Print), 1805-353X (Online)
www.emijournal.cz

Table 2: Correlation analysis results

No.	Variable/No.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.
1.	GDP per capita in PPS	1.0000																	
2.	Economic Activity	**0.9263***	1.0000																
3.	Labour Productivity	**0.9712***	**0.8844***	1.0000															
4.	Employment Rate	**0.9557***	**0.9831***	**0.9182***	1.0000														
5.	Unemployment Rate	**-0.9255***	**-0.8642***	**-0.9026***	**-0.9396***	1.0000													
6.	Digital Economy and Society Index	**0.9386***	**0.8215***	0.7191	0.6205	-0.1754	1.0000												
7.	E-Participation Index	**0.8374***	**0.9385***	**0.8255***	**0.9361***	**-0.8768***	-0.2757	1.0000											
8.	E-Government Development Index	**0.8540***	**0.7561***	**0.8439***	**0.7947***	**-0.8201***	0.7479	0.7956*	1.0000										
9.	Human Capital Index	-0.2315	-0.5177	-0.2237	-0.4436	0.2473	0.8948	-0.4640	0.0585	1.0000									
10.	Telecommunication Infrastructure Index	**0.9245***	**0.9185***	**0.8971***	**0.9143***	**-0.8235***	0.8423	0.8710*	0.8804*	-0.2710	1.0000								
11.	Enterprises with Internet Connection 100 Mbit/s	**0.8144***	**0.6716***	**0.8061***	**0.6591***	**-0.6294***	0.9229*	0.6614	0.9420*	0.8540*	0.9846*	1.0000							
12.	Enterprises with Mobile Internet Connection	**0.9304***	**0.8633***	**0.9410***	**0.8788***	**-0.8886***	0.6810	0.8561*	0.9340*	-0.0077	0.8492*	0.8191*	1.0000						
13.	Enterprises with Websites	**0.8317***	**0.7784***	**0.8948***	**0.7710***	**-0.7310***	-0.6711	0.6297*	0.6517*	-0.3189	0.7373*	0.3603	0.5940*	1.0000					
14.	E-Commerce Sales of Enterprises	**0.8481***	**0.8035***	**0.8727***	**0.7944***	**-0.7007***	0.1865	0.6895*	0.5807*	-0.4145	0.7677*	0.3888	0.6240*	0.9609*	1.0000				
15.	IT Professionals in Enterprises	**0.8836***	**0.8417***	**0.8976***	**0.8128***	**-0.6855***	0.9649*	0.7695*	0.8173*	-0.1838	0.8964*	0.8842*	0.9431*	0.4336	0.7216*	1.0000			
16.	Internet Users Share	**0.9426***	**0.9938***	**0.9331***	**0.9869***	**-0.9686***	0.9783*	0.9437*	0.8339*	-0.5534	0.8712*	0.8460*	0.8474*	0.9078*	0.8730*	0.7890*	1.0000		
17.	Households with Internet	**0.9027***	**0.8384***	**0.9253***	**0.8394***	**-0.7608***	0.9583*	0.7125*	0.6600*	-0.3588	0.8173*	0.8003*	0.8770*	0.9676*	0.9847*	0.8702*	0.9983*	1.0000	
18.	IT Professionals	**0.9590***	**0.9106***	**0.9947***	**0.8985***	**-0.8867***	0.9849*	0.9390*	0.9078*	0.3966	0.9075*	0.8326*	0.9035*	0.7729*	0.5889*	0.8611*	0.9331*	0.9493*	1.0000

Note: * denominates statistical significance at 10%.
Source: own calculations in STATA 14 software

Paper received: 6.5.2024 Paper revised:15.7.2024 Paper accepted:19.7.2024

4 Conclusions

Implementing innovative technological advancements into today's social, cultural and economic practice brings many challenges and fosters academic discussion (Guo et al., 2023; Chen and Zhang, 2022; Mattsson and Reshid, 2023). The contribution of this study lies in documenting the importance of the relationship between digitalisation and the economic development of the Czech Republic. The research points out that the current availability of the related indicators at the country level is highly limited. By conducting the correlation analysis, we emphasise that the currently available time series indicators are not sufficient and robust enough to employ more rigorous econometric and statistical approaches, determining closer and causal associations. Yet we need to point out that the expected directions of the observed relationships were in the light of the available literature, finding a positive relationship between digitalisation indicators and the development of Gross Domestic Product (GDP) per capita, economic activity, labour productivity and employment rate and a negative association with the unemployment rate.

The best possible empirical techniques the researchers use include the Vector autoregression (VAR) estimations with impulse response functions and Granger causality tests, allowing us to quantify the time lags and durations before the economic effects of Industry 4.0 show up. According to the recent study by Wang and Cen (2024), the lag should be at around two years; however, it depends on the particular context. As shown in this article, more data for the studied indicators are needed, ensuring time comparisons and construction of the time series, as common in macroeconomic analyses. The statistical indicators sometimes lag behind the adoption of new technologies, but once they are observed and collected by the statistical authorities, ministries and international organisations, their monitoring should be maintained to allow ex-post analysis of the trend developments. Even more general indicators can be preferred in this manner, compared to the most precise ones, which are often discontinued to be monitored, which is useful from the long-term perspective analysis (OECD, 2022).

We recommend policymakers and statisticians at least observe the implementation of modern tools into business practice, such as Enterprise Resource Planning (ERP) systems, machine learning tools, artificial intelligence (AI) based tools and most importantly, 3D printing and a number of robots used either for manufacturing or servicing. It is important that the public sector representatives do not lose this opportunity to monitor these crucial indicators; otherwise, the data could be available only through organisations like the International Federation of Robotics (IRF), which require payments for access to the data. The most recent survey of the Czech Statistical Office (Burešová, 2023) informs that there were 111 robots per 10 ths. employees in the country in 2022, and only 5.9% of enterprises with more than ten employees used robots in 2022. The numbers differ across the industries, being highest in the automotive sector (42.8%) and lowest in the real estate segment (0.9%). These numbers illustrate that robotisation and automation still have many opportunities for large-scale implementation among Czech entrepreneurs, business entities and public sector organisations.

Updating studies dedicated to listing "jobs at risk of replacement by automation" should also be an ongoing task for collaboration between the policymakers and scholarly community, delivering citizens key information about which professions could be replaced and thus providing them with enough time to adapt and requalify. This underlines the role of universities as knowledge brokers and other educational providers, promoting the change management mindsets and skills required to face and adapt to the forthcoming changes. From the general education, it is still important to maintain training in ICT skills, reflecting upon the continuous roles of digitalisation and technological advancements, and reducing thus knowledge gaps between skills needed at the labour market and the curriculum of the training and courses taught at schools, ensuring the employability of those graduating and leaving schools to the labour markets (Jung et al., 2023).

In line with the recommendations of Mattsson and Reshid (2023), we encourage future studies to dive into the sectoral analyses, showing in which sectors of the economy firms adapt technological

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EMI, Vol. 16, Issue 2, 2024
ISSN: 1804-1299 (Print), 1805-353X (Online)
www.emijournal.cz

advancements in the fastest way and collecting examples of good practices, serving as inspiration for sectors, where automatisation and digitalisation processes have not started yet. Expected are differences, especially between the manufacturing and non-manufacturing sectors of the Czech economy, which is a place for public policies fostering the adoption and implementation of innovative solutions, promoting productivity and innovation capacities (Dvouletý et al., 2022; Květoň and Horák, 2023).

5 References

Alsufyani, N., & Gill, A. Q. (2022). Digitalisation performance assessment: A systematic review. Technology in Society, 68, 101894.

Aravantinos, E., Petre, K., Katsianis, D., & Varoutas, D. (2021). Determinants of FTTH tariffs evolution in EU: A panel data analysis. Telecommunications Policy, 45(10), 102218.

Balagopal, B. (2021). Innovations in digital technology and creative destruction in the music industry. International Journal of Indian Culture and Business Management, 24(3), 303-318.

Braxton, J. C., & Taska, B. (2023). Technological change and the consequences of job loss. American Economic Review, 113(2), 279-316.

Burešová, K. (2023). V Česku pracuje 111 robotů na 10 tisíc zaměstnanců. Statistika&My, 13(4), 12-13.

Colombari, R., Geuna, A., Helper, S., Martins, R., Paolucci, E., Ricci, R., & Seamans, R. (2023). The interplay between data-driven decision-making and digitalization: A firm-level survey of the Italian and US automotive industries. International Journal of Production Economics, 255, 108718.

Czech Statistical Office. (2024a). ICT usage in the Business Sector, available from: https://www.czso.cz/csu/czso/podnikatelsky_sektor.

Czech Statistical Office. (2024b). ICT Infrastructure, available from: https://www.czso.cz/csu/czso/telekomunikacni_a_internetova_infrastruktura

Czech Statistical Office. (2024c). Gross domestic product and gross value added – year-on-year real growth rate, seasonally adjusted, available from: https://www.czso.cz/csu/czso/ari/gdp-resources-and-uses-3rd-quarter-of-2023

Czech Statistical Office. (2024d). Labour Force Survey: Time series of basic indicators, available from: https://www.czso.cz/csu/czso/zam_ts

Czech Statistical Office. (2024e). Internet usage: individuals, available from: https://www.czso.cz/csu/czso/2-pouzivani-internetu-jednotlivci-qstqqa4xi2

Chen, Y., Li, J., & Zhang, J. (2022). Digitalisation, data-driven dynamic capabilities and responsible innovation: An empirical study of SMEs in China. Asia pacific journal of management, 2022, 1-41.

Daud, S. N. M., & Ahmad, A. H. (2023). Financial inclusion, economic growth and the role of digital technology. Finance Research Letters, 53(C), 103602.

Drmola, J., Kasl, F., Loutocký, P., Mareš, M., Pitner, T., & Vostoupal, J. (2021, August). The matter of cybersecurity expert workforce scarcity in the Czech Republic and its alleviation through the proposed qualifications framework. In Proceedings of the 16th International Conference on Availability, Reliability and Security (pp. 1-6).

Dvorak, J., Komarkova, L., & Stehlik, L. (2021). The effect of the COVID-19 crisis on the perception of digitisation in the purchasing process: customers and retailers perspective. Journal of Entrepreneurship in Emerging Economies, 13(4), 628-647.

Dvouletý, O. (2019). Development of entrepreneurial activity in the Czech Republic over the years 2005–2017. Journal of Open Innovation: Technology, Market, and Complexity, 5(3), 38.

Dvouletý, O., Blažková, I., Ratinger, T., Agyemang, S. A., & Čadil, V. (2022). Experience with the application of quantitative (counterfactual) methods for evaluating the economic impacts of the business research and development (R&D) support in the Czech Republic. Economics Management Innovation, 14(2), 21-27.

European Commission. (2024). Digital Economy and Society Index, available from: https://digital-decade-desi.digital-strategy.ec.europa.eu/datasets/desi-2022/indicators

Paper received: 6.5.2024 Paper revised:15.7.2024 Paper accepted:19.7.2024

Evangelista, R., Guerrieri, P., & Meliciani, V. (2014). The economic impact of digital technologies in Europe. Economics of Innovation and new technology, 23(8), 802-824.

Guo, B., Wang, Y., Zhang, H., Liang, C., Feng, Y., & Hu, F. (2023). Impact of the digital economy on high-quality urban economic development: Evidence from Chinese cities. Economic Modelling, 120, 106194.

Jung, J., Wang, Y., & Sanchez Barrioluengo, M. (2024). A scoping review on graduate employability in an era of 'Technological Unemployment'. Higher Education Research & Development, 43(3), 542-562.

Krkoska, L. (2001). Assessing macroeconomic vulnerability in central Europe. Post-Communist Economies, 13(1), 41-55.

Květoň, V., & Horák, P. (2023). Firms' supply chain integration, R&D collaboration, and impact on competitiveness: Evidence from Czechia. Journal of the Knowledge Economy, 1-24.

Li, Y., Dai, J., & Cui, L. (2020). The impact of digital technologies on economic and environmental performance in the context of industry 4.0: A moderated mediation model. International Journal of Production Economics, 229, 107777.

Lu, V. N., Wirtz, J., Kunz, W. H., Paluch, S., Gruber, T., Martins, A., & Patterson, P. G. (2020). Service robots, customers and service employees: what can we learn from the academic literature and where are the gaps?. Journal of Service Theory and Practice, 30(3), 361-391.

Markhaichuk, M., & Panshin, I. (2020). The Role of Digital Competence in the Impact of Digitalization on Labor Productivity. Education Excellence and Innovation Management: a 2025 Vision to Sustain Economic Development During Global Challenges, 6632-6641.

Mattsson, P., & Reshid, A. (2023). Productivity divergence and the role of digitalisation. Economic Analysis and Policy, 79, 942-966.

Mejia, S. (2023). The normative and cultural dimension of work: Technological unemployment as a cultural threat to a meaningful life. Journal of Business Ethics, 185(4), 847-864.

Mikeska, M., & Urbánek, T. (2020). The development of the labor market of Czech small and medium-sized enterprises: Toward the digital economy. Change Management, 20(2), 21-37.

OECD. (2022). The OECD Going Digital Measurement Roadmap, OECD Publishing, Paris, France, available from: https://doi.org/10.1787/bd10100f-en-

Pělucha, M. (2019). Smart villages and investments to public services and ICT infrastructure: case of the Czech rural development program 2007–2013. European Countryside, 11(4), 584-598.

Pisár, P., Priščáková, S., Špaček, D., & Nemec, J. (2022). Digitization as a tool of e-government in selected public services of the state: international comparison of Slovakia and the Czech Republic. Administratie si Management Public, 39, 111-132.

Pollák, F., Vavrek, R., Váchal, J., Markovič, P., & Konečný, M. (2021). Analysis of digital customer communities in terms of their interactions during the first wave of the COVID-19 pandemic. Management & Marketing, 16(2), 134-151.

Petrová, K. (2022). The impact of digital technologies on neoclassical labour market. Danube, 13(4), 318-330.

Rybanská, I. L., & Čada, K. (2024). The Power of the Powerless: Constructions of Self-Employment in Czechia. Social Inclusion, 12, 7820.

Sachs, L. (2012). Applied statistics: a handbook of techniques. Springer Science & Business Media, Cham, Switzerland.

Solomon, E. M., & van Klyton, A. (2020). The impact of digital technology usage on economic growth in Africa. Utilities policy, 67, 101104.

United Nations. (2024). United Nations E-Government Survey: E-Participation Index, E-Government Development Index Human Capital Index, available from: https://publicadministration.un.org/egovkb/en-us/Data-Center

Vokoun, M., & Dvouletý, O. (2022). International, national and sectoral determinants of innovation: evolutionary perspective from the Czech, German, Hungarian and Slovak community innovation

Paper received: 6.5.2024 Paper revised:15.7.2024 Paper accepted:19.7.2024

EMI, Vol. 16, Issue 2, 2024
ISSN: 1804-1299 (Print), 1805-353X (Online)
www.emijournal.cz

survey data. Innovation: The European Journal of Social Science Research, 1-41 (ahead of print), https://doi.org/10.1080/13511610.2022.2158309.

Wang, P., & Cen, C. (2024). Does digital economy development promote innovation efficiency? A spatial econometric approach for Chinese regions. Technology Analysis & Strategic Management, 36(5), 931-945.

Woźniak-Jęchorek, B., & Kuźmar, S. (2023). Income Inequalities in the accelerating digital era: Evidence from EU Countries and COVID-time. Panoeconomicus, 70(4), 551-572.

Zubíková, A., & Smolák, P. (2022). Macroeconomic impacts of the COVID-19 pandemic in the Czech Republic in the period of 2020-2021. International Journal of Economic Sciences, 11(1), 117-145.

Paper received: 6.5.2024 Paper revised:15.7.2024 Paper accepted:19.7.2024