From digital investment to economic performance: insights from EU25 economies

Review of Accounting and Finance

Andrej Privara, Róbert Mészáros and Najib Rahman Rahmat
Department of Economics, University of Economics in Bratislava, Bratislava, Slovakia

Received 6 February 2025
Revised 8 May 2025
Accepted 15 May 2025

Abstract

Purpose – The purpose of this study is to examine the impact of digitization on selected productivity and efficiency indicators in EU25 countries. This research focuses on the relationship between digitization, labor productivity and capital efficiency, aiming to provide insights into how digital adoption influences economic performance.

Design/methodology/approach – This study uses a panel data regression analysis using data from Eurostat for the period 2017–2020. Two econometric models are developed: the first assesses the effect of digitization on nominal unit labor costs based on hours worked, while the second evaluates its impact on gross value added per unit of net fixed assets. The analysis applies fixed effects and random effects models to estimate the significance of digitization proxies.

Findings – The results of this study indicate that the provision of portable digital devices to employees has a positive effect on capital productivity while reducing labor costs. However, a higher share of enterprises providing internet access to employees negatively impacts gross value added per unit of net fixed assets, suggesting that digital infrastructure alone is insufficient without complementary digital skills.

Research limitations/implications – Limitations include data availability constraints for advanced digital technologies such as artificial intelligence and the Internet of Things. Future research should incorporate firm-level data to refine the analysis.

Practical implications – The findings of this study highlight the need for policy interventions to support digital literacy and infrastructure integration to maximize the benefits of digitization on productivity.

Originality/value – This study contributes to the literature by providing a cross-country comparison of digitization's effects on productivity and efficiency indicators within the EU25 framework, closing existing research gaps with robust panel data analysis.

Keywords Digital economy, Productivity, Efficiency, Digitization, EU25, Panel data analysis

Paper type Research paper

The publication was co-financed by the European Union under the Horizon Europe Framework Program (HORIZON-MSCA-2021-SE-01–1); Project number: 101086381; Project title: Overcoming Digital Divide in Europe and Southeast Asia; VEGA research project number 1/0068/24: "Socio-economic challenges of the Slovak migration policy in the context of the labor market situation"; and VEGA research project number 1/0156/24: "Circular migration of highly skilled labor in EU countries: a challenge for migration policies."

Funding: This research was funded by Young Researcher Project A-24-101/0013-00 'Navigácia v nových horizontoch: Hodnotenie sociálno-ekonomických dopadov digitalizácie na súčasné migračné vzorce.

Review of Accounting and Finance
Emerald Publishing Limited
1475-7702
DOI 10.1108/RAF-02-2025-0049

1. Introduction

The impact of digitization on productivity and efficiency indicators has become a critical topic in modern economic and business research. The integration of digital technologies such as artificial intelligence (AI), the Internet of Things (IoT), big data analytics and automation has reshaped how enterprises operate, produce and compete across industries (Boris *et al.*, 2018; Pianta *et al.*, 2020). The digital transformation of businesses is now widely recognized as a key driver of economic growth, efficiency improvements and cost reductions. Existing studies highlight the significance of digital adoption in improving production processes, optimizing business strategies and facilitating data-driven decision-making (Mortal and Schill, 2018). The digital economy is rapidly transforming traditional industries, particularly within the European Union (EU), where economic shifts have driven companies toward digitalization to maintain competitiveness (Hadad, 2017; Gavrila and Ancillo, 2021).

Despite widespread recognition of digitization's transformative potential, existing research is fragmented and often limited in scope. Many studies focus on specific aspects of digitalization, such as labor productivity (Metlyakhin *et al.*, 2020; Liu *et al.*, 2022), automation (Horvat *et al.*, 2019) or digital infrastructure (Polozova *et al.*, 2021). However, these studies tend to analyze digital transformation at the firm level or within single-country contexts, overlooking broader cross-national patterns. Additionally, research on digitization's impact on efficiency indicators remains insufficient, particularly regarding its effects on unit labor costs (ULCs) and capital productivity. Existing literature also lacks robust quantitative panel data analysis that systematically examines the relationship between digitization and key economic indicators across multiple EU nations. This gap raises the central research question of this study: What is the impact of digitization on selected productivity and efficiency indicators in EU25 countries?

Addressing this research question is crucial because understanding the role of digital transformation in economic efficiency can offer valuable insights for policymakers, businesses and researchers. The EU25 provides a unique context for studying digitization, as its member states vary in digital adoption levels, industrial structures and economic policies (Přívara, 2024). By investigating these cross-national dynamics, this study provides empirical evidence that goes beyond country- or industry-specific cases, offering a broader understanding of how digital adoption influences productivity. The importance of digital transformation has been further highlighted by the COVID-19 pandemic, which accelerated the need for digital tools to sustain business operations (Gavrila and Ancillo, 2021). Therefore, this study not only contributes to ongoing academic discussions but also holds practical implications for governments and organizations seeking to enhance productivity through digital investments.

This research extends the theoretical understanding of digitization's economic impact by integrating perspectives from institutional theory and economic efficiency models. While institutional theory explains how organizations adapt to technological changes based on external pressures, this study demonstrates how digital adoption translates into measurable productivity and efficiency improvements (Sabbagh *et al.*, 2013; Zaric and Bozhovic, 2021; Bai *et al.*, 2023; Koraus *et al.*, 2015; Kusá *et al.*, 2023). By using panel data regression, the study empirically validates theoretical claims about digitization's role in shaping production efficiency, contributing to a more nuanced understanding of digital transformation in varying institutional contexts.

This study advances knowledge by bridging gaps in the literature regarding cross-country digital adoption and its macroeconomic effects. Prior research has largely examined firm-level productivity, while this study shifts the focus to national productivity and efficiency indicators, allowing for broader generalizations (Cette *et al.*, 2021; Metlyakhin *et al.*, 2020; Duong, 2023; Dobrovič and Koraus, 2015; Moravcikova *et al.*, 2019). Furthermore, by incorporating multiple digitalization proxies, such as portable device adoption and digital infrastructure, the research offers a more comprehensive analysis than studies that focus solely on a single digital metric.

The findings of this study have practical implications for policymakers, businesses and economic planners. The results highlight the importance of investing in portable digital tools and ensuring that digital literacy programs accompany infrastructure investments. Additionally, the study challenges the assumption that mere internet access automatically improves productivity, emphasizing the need for effective integration of digital technologies into business processes. Policymakers should, therefore, focus on strategies that promote digital competency and technological adaptation across different industries, ensuring that digitalization leads to tangible economic benefits.

2. Literature review

In the modern world, Information and Communication Technology (ICT) influences all areas of economic activity, including businesses, government and society. Although ICT was initially expensive and inaccessible to many, rapid technological advancements have significantly reduced costs and improved accessibility for a broader audience.

In the context of this study, digitization is defined as "the social transformation triggered by the massive adoption of digital technologies to generate, process, share, and transact information" (Katz *et al.*, 2014). Pearce-Moses (2005) describes digitization as the process of converting analog materials into binary electronic formats, primarily for computer storage and use. Trzaska *et al.* (2021) define it as making information digitally available and accessible, while also distinguishing digitalization as the automation of processes through digital solutions. Similarly, Nasiri *et al.* (2020) argue that digitalization serves as a critical tool for performance development in businesses.

Several studies highlight that digital transformation in the private sector significantly contributes to economic development and productivity growth (Blinova *et al.*, 2021; Bonci *et al.*, 2022; Kuzmina *et al.*, 2021; Szopa and Cyplik, 2020; Li *et al.*, 2022; Liu *et al.*, 2022; Belas *et al.*, 2025). Duasa and Ramadan (2019) examined digital transformation's impact on economic growth in Malaysia and the Philippines, finding long-term positive effects. However, in the short run, digitization's benefits were unevenly distributed because of the digital divide, which hindered accessibility and network connectivity. Digitization impacts businesses through multiple channels, including human capital (Blizkiy *et al.*, 2021; Bonci *et al.*, 2022; Konovalova *et al.*, 2021; Tolstykh *et al.*, 2017), labor productivity (Aly, 2022), finance (Liu *et al.*, 2022), technological innovation (Liu *et al.*, 2022) and risk reduction (Liu *et al.*, 2022; López-Felices *et al.*, 2023; Břečka and Koraus, 2016; Vrtana and Gogolova, 2019).

Blizkiy *et al.* (2021) examined the effect of digital transformation on human capital, concluding that digitization enhances workforce efficiency by integrating technological, digital, political, educational and socio-economic factors. Liu *et al.* (2022) studied the mechanisms of digital transformation on Chinese enterprises, revealing a positive impact on firm development, especially in inland regions. However, they also noted that economic policy uncertainty weakens the benefits of digital transformation. Similarly, Industry 4.0, introduced in Germany in 2011, aims to transform industrial manufacturing through digitalization and emerging technologies (Bidnur, 2020; Le *et al.*, 2023; Gombár *et al.*, 2022; Vrtana and Krizanova, 2020).

Key technologies such as the IoT, Big Data, Cloud Computing, digital twins and additive manufacturing have played a crucial role in improving productivity and operational performance (Turkyilmaz *et al.*, 2021). However, despite recognizing these technological advances, research directly linking advanced digital technologies, specifically IoT and AI, with productivity outcomes remains relatively under-explored. This gap highlights a need for deeper investigation into how such technologies concretely influence productivity across various economic contexts.

Despite these advancements, research linking digitization to productivity remains inconclusive. Some scholars suggest that digitalization does not necessarily lead to productivity growth, even with rising investments in technology (Gebauer *et al.*, 2020; Kohtamäki *et al.*, 2020; Pinsonneault and Rivard, 1998). However, Cette *et al.* (2021) found that using ICT specialists and adopting digital technologies increased labor productivity by 23% and total factor productivity by 17% in French firms. This finding emphasizes the critical role of digital skills development, suggesting that productivity gains from digitization significantly depend on workforce competence and the effective integration of digital tools into organizational practices. Such a perspective helps interpret scenarios where enhanced internet access alone yields negative or neutral productivity effects because of insufficient digital skills or inadequate integration strategies.

Horvat *et al.* (2019) analyzed the impact of automation and digitalization on manufacturing productivity in early-stage Industry 4.0 adoption. Their findings showed a statistically significant and positive effect on labor productivity. Similar studies found that companies leveraging digital tools reported higher productivity and firm growth (Clarke *et al.*, 2015; Diaz Tautiva *et al.*, 2023; Koraus *et al.*, 2019; Vrtana and Krizanova, 2018). In Russia, Metlyakhin *et al.* (2020) examined key digitalization factors affecting labor productivity, emphasizing their regional significance. Aly (2022) investigated the relationship between digital transformation, economic development and productivity growth in developing economies, confirming a strong positive correlation between digitalization and labor market performance. Additionally, Cheng *et al.* (2022) measured enterprise performance through Return on Assets and Return on Sales, linking them to digital transformation efforts.

Several studies have also examined digitization's impact on labor markets using the Digital Economy and Society Index (DESI) across EU countries (Shahnazi, 2021; Kovács *et al.*, 2022; Crisan *et al.*, 2023; Skare *et al.*, 2023; Santos-Arteaga *et al.*, 2023). Başol and Yalçın (2021) investigated DESI's effect on labor market insecurity, long-term unemployment, employment rate and personal earnings, concluding that higher DESI scores correlate with improved labor market indicators in 23 EU countries. Similarly, Polozova *et al.* (2021) explored the relationship between digitization, productivity and competitiveness in EU member states, emphasizing the link between digital and human development through DESI and the Human Development Index. Ghazy *et al.* (2022) applied panel data methods to examine digitization's impact on entrepreneurship in EU27, confirming a positive relationship between digitalization and business growth.

Although the literature establishes a clear connection between digitization and productivity, several gaps remain unaddressed. Most studies fail to use panel data regression models, making their findings less generalizable across multiple EU nations. Existing research mainly relies on cross-sectional data or case studies, limiting the understanding of long-term trends in digital transformation. Additionally, many studies analyze single countries or industries, without providing a comparative perspective on digital adoption and economic efficiency. To address these gaps, this study investigates the impact of digitization on productivity and efficiency indicators across EU25 countries using panel data regression models.

This research advances the literature by offering a cross-country comparative analysis of digital transformation's economic effects. The findings provide valuable insights for policymakers, businesses and researchers, helping them design data-driven strategies to enhance productivity and efficiency through digital adoption. Integrating longitudinal data and robust econometric modeling, this study contributes to a more comprehensive understanding of digitization's role in economic performance across the EU.

3. Methodology

This study adopts an exploratory research approach to assess the impact of digitization on selected productivity and efficiency indicators in EU25 countries, excluding Cyprus and Malta because of data availability constraints. The research examines the relationship between digitization, productivity and efficiency, focusing on how digital adoption influences economic performance.

A panel data regression analysis is applied, using data sets from Eurostat and the European Commission's Digital Agenda.

Two dependent variables are used to measure productivity and efficiency: nominal ULCs based on hours worked, which captures labor cost efficiency, reflecting changes in the average cost of labor per unit of output produced, and gross value added (GVA) per unit of net fixed assets, representing capital productivity, indicating how efficiently firms use their capital assets to generate value. Digitization indicators are derived from Eurostat and supported by literature, measuring the percentage of enterprises providing portable devices to employees (Pistoia *et al.*, 2015), the percentage of enterprises offering ICT training to employees (Greenan *et al.*, 2020; Billert *et al.*, 2020) and the percentage of enterprises where employees have internet access (Borowiecki *et al.*, 2021). These proxy variables were selected because of the limited availability of detailed, firm-level data on advanced digital technologies such as AI, VR and IoT, as highlighted in existing literature.

To account for additional factors influencing productivity and efficiency, this study includes several control variables. These are research and development (R&D) expenditure (Aden Dirir, 2023; Owalla *et al.*, 2022), total employment levels as a measure of labor force engagement, the percentage of the population aged 15–64 years with tertiary education (Levy and Murnane, 2003; Ding *et al.*, 2024; Hanushek *et al.*, 2022) and enterprises using DSL or fixed broadband connections, reflecting the level of digital infrastructure (Varian *et al.*, 2002).

This study examines the period from 2017 to 2020 and involves a sample of 100 observations from EU25 countries. The econometric models are estimated using Stata software, a statistical package widely used for panel data regression analysis, which provides robust tools for managing data, performing regression analyses and addressing issues such as heteroskedasticity. The first model assesses the impact of digitization on nominal ULCs, reflecting how digital adoption affects labor cost efficiency. The second model evaluates the impact of digitization on GVA per unit of net fixed assets, providing insights into how digitalization influences capital productivity. The selection of these econometric models was motivated by their ability to capture dynamic changes and to control for unobserved heterogeneity across countries and over time, offering a clear understanding of digitization's impact on economic efficiency.

Econometric Model 1:

$\mathrm{ULC}_{\mathrm{it}}$ is represented by indicator nominal ULC based on hours worked (% change on previous period) acquired from Eurostat data set in period 2017–2020:

$$ULC_{it} = c + \beta 1 Epd_{it} + \beta 2 Eict_{it} + \beta 3 Ia_{it} + \beta 4 RD_{it} + \beta 5 Pop_{it} + \beta 6 Emp_{it} + \beta 7 Con_{it} + v_{it}$$

Econometric Model 2:

GVA per unit of net fixed assets is represented by data from Eurostat for the same period (2017–2020):

$$GVA_{it} = c + \beta 1Epd_{it} + \beta 2Eict_{it} + \beta 3Ia_{it} + \beta 4RD_{it} + \beta 5Pop_{it} + \beta 6Emp_{it} + \beta 7Con_{it} + v_{it}$$

$i = 1, \ldots, N$ – represents selected EU states;
$t = 1, \ldots., T$ – represents observed period from 2017 to 2020;

Epd_{it} – variable for share of enterprises which provide portable devices to some employees;
$Eict_{it}$ – variable for share of enterprises which provide ICT training to employees;
Ia_{it} – variable for share of enterprises where people used have access to the internet;
RD_{it} – explanatory variable for research and development expenditure;
Emp_{it} – explanatory variable for persons in employment;
Pop_{it} – explanatory variable for population by educational attainment level and age 15–64 years;
Con_{it} – explanatory variable for type of connections to the internet (digital infrastructure quality);
v_{it} – unobserved error term which include also country-specific error; and
C – the constant.

Regarding research limitations, this study suffers from the limited availability of detailed longitudinal data describing the penetration and impact of advanced digital technologies such as AI, VR, cloud storage, IoT and Big Data within EU countries. Consequently, the analysis uses three widely recognized proxy variables (portable devices, internet access and ICT training) identified from the literature. Another methodological limitation is the presence of heteroskedasticity detected through the Breusch–Pagan test. Although addressed by applying a logarithmic transformation to dependent variables, residual heteroskedasticity indicates a potential need for additional model refinement or alternative estimation techniques, such as robust standard errors or alternative econometric specifications, to further improve result reliability.

4. Results

Descriptive characteristics of both models show for each dependent and explanatory variables number of observations, mean, standard deviation as well as minimum and maximum values.

According to data depicted in Table 1, we see variables used in Model 1. There are 7 explanatory variables, 1 dependent variable and 100 observations.

Regarding the results from the summary statistics presented in Table 2, we observe that the econometric Model 2 includes 7 explanatory variables, 1 dependent variable and 100 observations.

In terms of the study's scope, productivity and cost efficiency indicators are estimated using GVA per unit of net fixed assets and nominal ULC based on hours worked (percentage change from the previous period). To analyze the influence of digitization on productivity and efficiency indicators, we use a panel data regression analysis. This econometric approach allows us to track multiple entities (countries) across time, enhancing the precision of our findings by controlling for unobserved heterogeneity (Geweke *et al.*, 2006; Hasnaoui, 2024).

To enhance readability and understanding for the reader, the econometric equations are presented in a simplified manner:

Model 1 (labor cost efficiency):

Table 1. Summary statistics from Stata – Model 1 – nominal unit labor cost based on hours worked

Variable	Observation	Mean	SD	Minimum	Maximum
Nominal unit labor cost based on hours worked	100	3.24	2.959491	−8.4	9.6
Enterprises which provide portable devices to some employees	100	73.719	11.91621	45	98.2
Enterprises where people employed have access to the internet	100	96.964	4.02137	81.4	100
Enterprises which provide ICT training to employees	100	21.31208	8.453198	4.4337	37.5139
Research and development expenditure	100	1.74	0.8696232	0.47	3.49
Persons in employment	100	1.048	2.015018	−4.5	7.2
The population that has achieved tertiary education and is aged 15–64 years	100	29.625	7.092525	15.3	42.8
Enterprise using DSL of fixed broadband connection to internet (level of digital infrastructure)	100	91.986	5.719063	78.5	100

Source(s): Own calculated results from Stata 17

Table 2. Summary statistics from Stata – Model 2 – capital productivity

Variable	Observation	Mean	SD	Minimum	Maximum
Gross value added per unit of net fixed assets	100	102.318	7.15579	84.802	127.022
Enterprises which provide portable devices to some employees	100	73.719	11.91621	45	98.2
Enterprises where people employed have access to the internet	100	96.964	4.02137	81.4	100
Enterprises which provide ICT training to employees	100	21.3120	8.453198	4.4337	37.5139
Research and development expenditure	100	1.74	0.8696232	0.47	3.49
Persons in employment	100	1.048	2.015018	−4.5	7.2
The population that has achieved tertiary education and is aged 15–64 years	100	29.625	7.092525	15.3	42.8
Enterprise using DSL or fixed broadband connection to internet (level of digital infrastructure)	100	91.986	5.719063	78.5	100

Source(s): Own calculated results from Stata 17

Change in labor costs = constant + portable devices + ICT training + internet access + R&D + tertiary education + employment + internet connectivity quality + error term.

Model 2 (capital productivity):

Capital productivity = constant + portable devices + ICT training + internet access + R&D + tertiary education + employment + internet connectivity quality + error term.

To illustrate practical implications, consider a hypothetical scenario where an EU country increases portable device provision by 10%. Based on the results, this would lead to an approximate 0.5% reduction in labor costs and about a 2.2% improvement in capital productivity, clearly emphasizing the potential economic benefits of targeted digital adoption.

The dependent variable in the first model is the nominal ULC based on hours worked, while in the second model, it is the GVA per unit of net fixed assets. The independent variables measuring digitization incorporated in both models include the percentage share of enterprises providing portable devices to employees (Pistoia *et al.*, 2015), enterprises where employees have internet access and the share of enterprises providing training to employees for developing or upgrading their ICT skills (Greenan and Messe, 2018; Blázquez-Resino *et al.*, 2020; Billert *et al.*, 2020; Mirza *et al.*, 2024).

Additionally, we include control variables from Table 1, such as research and development expenditure, the proportion of the population aged 15–64 years with tertiary education (Autor *et al.*, 2003; Ding *et al.*, 2024; Hanushek and Woessmann, 2008; Owalla *et al.*, 2022) and enterprises using DSL or fixed broadband connections to the internet (Varian *et al.*, 2002).

This study covers the period from 2017 to 2020 and examines EU-25 countries, incorporating a total of 100 observations using two econometric models. The panel data regression models were estimated using Stata software.

Equation for Model 1 is following:

$$\mathrm{ULC}_{\mathrm{it}} = c + \beta 1 Epd_{it} + \beta 2 Eict_{it} + \beta 3 Ia_{it} + \beta 4 RD_{it} + \beta 5 Pop_{it} + \beta 6 Con_{it} + v_{it}$$

Equation for Model 2 is following:

$$GVA_{it} = c + \beta 1 Epd_{it} + \beta 2 Eict_{it} + \beta 3 Ia_{it} + \beta 4 RD_{it} + \beta 5 Pop_{it} + \beta 6 Con_{it} + v_{it}$$

In this study, we considered three possible panel data models: Pooled OLS, Fixed Effects and Random Effects. After performing the Breusch–Pagan test to check for heteroskedasticity, we found that it was present in the model. To address this issue, we attempted to identify its source and applied a logarithmic transformation to the dependent variable, which proved effective in mitigating heteroskedasticity.

We also examined multicollinearity in both models using the variance inflation factor (VIF) test. The first model yielded a mean VIF value of 2.00, while the second model showed a value of 1.94. Typically, a VIF value of 1 indicates no multicollinearity, whereas values exceeding 5 or 10 suggest high multicollinearity, which can distort regression results (Deanna and Schreiber, 2018). Therefore, a mean VIF of 2.00 is generally not a concern, indicating that multicollinearity is present but unlikely to significantly impact the model's reliability (Frost, 2019).

For both models, we conducted the Hausman test to compare the appropriateness of the Random Effects and Fixed Effects methods. In Model 1, which examines the impact of digitization on labor productivity, the test results (Prob < 0.05) indicated that the Fixed Effects method was the more suitable choice. Conversely, in Model 2, which assesses the impact of digitization on capital productivity, the Random Effects method was found to be the better fit. Both models have strongly balanced panels.

Table 3 shows results calculated in Stata for Model 1. Hausman test for comparing appropriateness of random effects and fixed effects methods showed better fitness for fixed effects. According to results from panel data regression, there are two significant variables, share of enterprises providing portable devices to some employees and persons in employment. Both explanatory variables have negative impact on dependent variable in this model.

Table 4 shows results calculated in Stata for Model 2. Hausman test for comparing appropriateness of random effects and fixed effects methods showed better fitness for

Table 3. Comparison of results from OLS, FE, RE and FE-ROBUST in Model 1

Variables	(1) OLS	(2) FE	(3) RE
Enterprises_providing_portable_d	−0.0504** (0.0243)	−0.0504** (0.0221)	−0.00250 (0.00923)
Internet_access_of_employees	0.0391 (0.0822)	0.0391 (0.0668)	0.0106 (0.0301)
E_provided_ICT_training	−0.0206 (0.0243)	−0.0206 (0.0358)	−0.00911 (0.0176)
R&D_expenditure	0.619 (0.507)	0.619 (0.931)	−0.161 (0.151)
Employees	−0.211*** (0.0554)	−0.211*** (0.0574)	−0.146*** (0.0431)
Education	−0.0392** (0.0185)	−0.0392 (0.0299)	−0.00308 (0.0141)
Type_of_connection	−0.0545 (0.0424)	−0.0545 (0.0409)	−0.0261 (0.0205)
Constant	6.701 (10.51)	6.701 (7.159)	3.326 (2.629)
Observations	90	90	90
R^2	0.336	0.336	0.336
Number of ID	25	25	25

Note(s): Standard errors in parentheses: ***$p < 0.01$, **$p < 0.05$ and *$p < 0.1$
Source(s): Own calculated results from Stata 17

Table 4. Comparison of results from OLS, FE, RE and FE-ROBUST in Model 2

Variables	(1) OLS	(2) FE	(3) RE
Enterprises_providing_portable_d	0.249*** (0.0606)	0.203** (0.0984)	0.224*** (0.0742)
Internet_access_of_employees	−0.509*** (0.187)	−0.410 (0.297)	−0.444** (0.224)
E_provided_ICT_training	−0.166 (0.109)	−0.0607 (0.170)	−0.123 (0.130)
R&D_expenditure	−0.321 (0.918)	4.670 (4.174)	−0.165 (1.446)
Employees	−1.904*** (0.280)	−1.691*** (0.229)	−1.873*** (0.181)
Education	0.272*** (0.0873)	0.364** (0.145)	0.297*** (0.107)
Type_of_connection	−0.0286 (0.138)	−0.0242 (0.168)	−0.0619 (0.141)
Constant	134.0*** (15.78)	113.4*** (29.87)	130.7*** (20.19)
Observations	100	100	100
R^2	0.484	0.657	
Number of ID		25	25

Note(s): Standard errors in parentheses: ***$p < 0.01$, **$p < 0.05$ and *$p < 0.1$
Source(s): Own calculated results from Stata 17

random effects. Analysis identifies four significant variables in this model. Indicator “share of enterprises providing portable devices to some employees” is highly significant at 1% level as well as “persons in employment” and indicator “the population that has achieved tertiary education and is aged 15–64 years.” Variable “enterprises where people employed have access to the internet” is significant at 5% level.

For Model 1, according to Table 5, we acquired the following results:

- A 1% change in share of enterprises providing portable devices to some employees leads to decrease in nominal ULC based on hours worked by 0.05%.
- A 1% change of persons in employment leads to decrease in nominal ULC based on hours worked by 0.21%.

For Model 2, related to Table 5, we obtained the following results:

Table 5. Results from Models 1 (FE) and 2 (RE)

Variables	FE	RE
Enterprises_providing_portable_d (Standard error)	−0.0504** (0.0221)	0.224*** (0.0742)
Internet_access_of_employees (Standard error)	0.0391 (0.0668)	−0.444** (0.224)
E_provided_ICT_training (Standard error)	−0.0206 (0.0358)	−0.123 (0.130)
R&D expenditure (Standard error)	0.619 (0.931)	−0.165 (1.446)
Employees (Standard error)	−0.211*** (0.0574)	−1.873*** (0.181)
Education (Standard error)	−0.0392 (0.0299)	0.297*** (0.107)
Type of connection (Standard error)	−0.0545 (0.0409)	−0.0619 (0.141)
Constant (Standard error)	6.701 (7.159)	130.7*** (20.19)
Observations	90	100
R^2	0.336	
Number of ID	25	25

Note(s): Standard errors in parentheses: ***$p < 0.01$, **$p < 0.05$ and *$p < 0.1$
Source(s): Own calculated results from Stata 17

- A 1% change in share of enterprises providing portable devices to some employees leads to increase in GVA per unit of net fixed assets by 0.22%.
- A 1% change share of enterprises where people employed have access to the internet lead to decrease in GVA per unit of net fixed assets by 0.44%.
- A 1% change in persons in employment leads to decrease in GVA per unit of net fixed assets by 1.87%.

5. Discussion and limitation

This study aimed to analyze the impact of digitization on selected productivity and efficiency indicators in EU25 member states. The results from panel data regression analysis reveal notable insights into how digital adoption affects labor and capital productivity. In Model 1, which examines the effect of digitization on labor cost efficiency, we find that an increase in the share of enterprises providing portable devices to employees is associated with a slight reduction in nominal ULC based on hours worked, indicating that mobile technology adoption contributes to efficiency improvements. Similarly, an increase in employment levels is linked to lower labor costs, suggesting that higher employment may allow firms to achieve greater economies of scale, reducing cost pressures.

For Model 2, which assesses the relationship between digitization and capital productivity, we observe that the provision of portable devices to employees positively impacts GVA per unit of net fixed assets, reinforcing the argument that mobile technology supports productivity gains. However, an increase in enterprises offering internet access to employees is associated with a decline in GVA per unit of net fixed assets. This result suggests that while internet access is a fundamental aspect of digital transformation, its mere availability does not guarantee productivity improvements. Without proper digital literacy or integration into business processes, internet access alone may not lead to efficiency gains and, in some cases, could even contribute to inefficiencies. Furthermore, an increase in employment levels is negatively associated with capital productivity, which may reflect the challenges of optimizing labor-intensive processes in the face of digital transformation.

Our findings align with previous research, such as Cette *et al.* (2021), who found that providing ICT tools to employees enhances productivity, albeit at varying levels of significance. While our study identifies a relatively modest effect of portable devices on labor cost reductions, it supports the broader notion that digital tools facilitate efficiency gains. Similarly, Metlyakhin *et al.* (2020) highlighted the limited role of internet access in driving productivity improvements, a result that is also reflected in our study. Their findings suggest that while digital connectivity is a necessary condition for modernization, its impact depends on how effectively firms integrate digital solutions into their workflows.

While our results confirm some widely held assumptions about the positive effects of digitization on productivity, they also reveal unexpected findings. Notably, internet access alone appears to have a negative impact on capital productivity, implying that businesses may require complementary investments in digital skills, training or management strategies to fully capitalize on digital infrastructure. Furthermore, our study finds that enterprises using DSL or fixed broadband connections – an indicator of digital infrastructure quality – do not significantly impact any model, suggesting that the quality and application of digital tools matter more than mere connectivity.

Several limitations must be acknowledged. First, the availability of long-term data on advanced digital technologies such as AI, virtual reality, cloud storage and the IoT in EU countries remains limited. As a result, we relied on three proxy variables – portable devices, ICT training and internet access – to capture the effects of digitization. Future studies should incorporate more granular firm-level data to provide deeper insights into how different digital technologies contribute to productivity and efficiency. Additionally, the presence of heteroskedasticity in our models, despite our efforts to address it through a logarithmic transformation, suggests that further refinements in model specification may be necessary. Alternative estimation techniques, such as robust standard errors or instrumental variable approaches, could be explored to improve the robustness of results.

Going forward, future research could extend this study by refining the measurement of digitization and exploring its effects on other economic indicators, such as total factor productivity or innovation capacity. Moreover, addressing potential endogeneity concerns by using firm-specific data sets or conducting case studies could enhance the validity of findings. By broadening the scope of digital transformation research beyond labor and capital productivity, future studies can provide more comprehensive insights into the evolving role of digital adoption in economic performance.

6. Implications

The findings of this study carry significant implications for policymakers, business leaders and economic researchers seeking to leverage digitization for productivity improvements. The results highlight that providing employees with portable digital devices can contribute to enhanced labor cost efficiency and capital productivity, highlighting the importance of enterprise-driven digital adoption. However, the finding that increased internet access within enterprises does not necessarily translate into higher productivity suggests that merely expanding digital infrastructure is insufficient. Instead, businesses must integrate digital tools effectively into their workflows and ensure that employees possess the necessary skills to use these technologies productively.

From a policy perspective, these results suggest that governments should not only focus on expanding digital infrastructure but also invest in digital literacy programs and workforce training initiatives. Providing internet access alone does not guarantee productivity gains; rather, employees must be equipped with the necessary digital competencies to take advantage of the technologies available to them. Policymakers should consider targeted interventions, such as incentives for firms to provide ICT training and tax benefits for businesses investing in digital tools that enhance operational efficiency. Additionally, policies should emphasize the adoption of digital strategies that align with specific industry needs, ensuring that digital transformation is not just a blanket initiative but one that is carefully adapted to different economic sectors.

For business leaders, the results emphasize the importance of strategic digital integration. Enterprises should recognize that merely equipping employees with digital tools is not enough; they must also foster an environment where digital adoption is accompanied by skills development and operational restructuring. Companies investing in portable devices should complement this initiative with training programs that enable employees to use these tools efficiently. Furthermore, firms should reassess their reliance on internet access as a standalone driver of productivity and focus instead on developing comprehensive digital strategies that enhance business operations.

In terms of academic and research implications, this study contributes to the growing body of literature on the economic effects of digitization by providing cross-country empirical evidence using panel data regression analysis. The results highlight the need for future research to explore how specific digital adoption strategies – beyond infrastructure expansion – affect productivity across different industries and firm sizes. Additionally, researchers should further investigate the conditions under which internet access positively or negatively influences productivity, particularly in the context of firm-specific capabilities, management practices and industry characteristics.

7. Conclusion

This study aimed to assess the impact of digitization on productivity and efficiency indicators in EU25 member states. The primary research question investigated how digitization influences selected economic indicators, specifically labor cost efficiency and capital productivity. To address this question, we examined the effects of digital adoption on nominal ULCs based on hours worked (Model 1) and GVA per unit of net fixed assets (Model 2).

The results from panel data regression analysis reveal several key findings. In Model 1, which explores the impact of digitization on labor cost efficiency, we find that an increase in the share of enterprises providing portable devices to employees is associated with a reduction in nominal ULCs, suggesting that mobile technology adoption contributes to cost efficiency. Additionally, an increase in employment levels also leads to a decline in nominal ULCs, likely because of economies of scale. In Model 2, which examines the effect of digitization on capital productivity, the provision of portable devices to employees is positively associated with GVA per unit of net fixed assets, reinforcing the notion that digital tools can enhance productivity. However, we also find that an increase in enterprises where employees have internet access correlates with a decline in capital productivity. This result suggests that internet access alone is insufficient to drive productivity improvements and must be complemented by appropriate digital skills and integration strategies. Moreover, employment growth negatively affects capital productivity, potentially highlighting the challenges associated with managing a growing workforce in an increasingly digitalized environment.

This study contributes to the literature by offering cross-country comparative insights and a longitudinal perspective on the impact of digitization on economic performance. By using three proxies for digitization – portable devices, ICT training and internet access – our research provides empirical evidence on the role of digital transformation in shaping labor and capital productivity. Additionally, our findings reveal unexpected results, particularly the lack of significance of internet access in Model 1 and the non-significance of enterprises using DSL or fixed broadband connections in both models, despite these being widely used as indicators of digital infrastructure quality in prior research.

Based on these findings, we suggest that policymakers and enterprises prioritize strategic digital investments to enhance productivity. Encouraging businesses to invest in portable digital tools could be facilitated through targeted tax incentives, subsidies or grants aimed at increasing digital mobility within the workforce. Furthermore, the negative impact of internet access on capital productivity suggests that simply providing digital infrastructure is insufficient without the necessary workforce skills to use it effectively. Policymakers should focus on digital literacy programs, professional training initiatives and the integration of digital tools into business processes to ensure that investments in digitization translate into tangible productivity gains. Expanding internet access without accompanying digital training may not yield the expected benefits, emphasizing the need for a more comprehensive approach to digital transformation.

References

Aden Dirir, S. (2023), “The potential of macroeconomic factors in shaping the landscape of technological development: a testimonial from upper-middle-income countries”, *Business, Management and Economics Engineering*, Vol. 21 No. 1, pp. 84-105.

Autor, D.H., Levy, F. and Murnane, R.J. (2003), “The skill content of recent technological change: an empirical exploration”, *The Quarterly Journal of Economics*, Vol. 118 No. 4, pp. 1279-1333.

Bai, T., Xu, D., Yang, Q., Piroska, V.D., Dávid, L.D. and Zhu, K. (2023), “Paths to low-carbon development in China: the role of government environmental target constraints”, *Oeconomia Copernicana*, Vol. 14 No. 4, pp. 1139-1173.

Başol, O. and Yalçın, E.C. (2021), “How does the digital economy and society index (DESI) affect labor market indicators in EU countries”, *Human Systems Management*, Vol. 40 No. 4, pp. 503-512.

Belas, J., Kliestik, T., Dvorsky, J. and Streimikiene, D. (2025), “Exploring gender-based disparities in the digital transformation and sustainable development of SMEs in V4 countries”, *Journal of Innovation and Knowledge*, Vol. 10 No. 2, p. 100681.

Bidnur, C.V. (2020), “A study on industry 4.0 concept”, *International Journal of Engineering Research*, Vol. 9 No. 4, pp. 613-618.

Billert, M.S., Weinert, T. and Janson, A. (2020), “Co-Creation durch peers im digitalen lernen – wie plattformen und chatbots die partizipation bei der lernmaterialerstellung begleiten können”, *HMD Praxis Der Wirtschaftsinformatik*, Vol. 57 No. 4, pp. 722-743.

Blinova, U.Y., Rozhkova, N.K. and Sultanguzhieva, A.Z. (2021), “Methodology of analysing the effectiveness of activities in the conditions of the digital economy”, in *Socio-Economic Systems: Paradigms for the Future*, Springer, Cham, pp. 1789-1798.

Bonci, A., Stadnicka, D. and Longhi, S. (2022), “The overall labour effectiveness to improve competitiveness and productivity in Human-Centered manufacturing”, *in International Scientific-Technical Conference MANUFACTURING*, Springer, Cham, pp. 144-155.

Boris, O.A., Timoshenko, P.N., Tadtaev, D.M. and Rebiy, E.Y. (2018), “Integrated innovation and investment policy As the factor of A balanced development of the new economy”, *Quality-Access to Success*, Vol. 19.

Borowiecki, M., *et al* (2021), “The impact of digitalisation on productivity: Firm-level evidence from The Netherlands”, *OECD Economics Department Working Papers*, No. 1680, OECD Publishing, Paris.

Břečka, S. and Koraus, A. (2016), “Innovation and innovation management in the tourism industry in the context of globalization”, *in Globalization and Its Socio-Economic Consequences, 16th International Scientific Conference Proceedings*, pp. 261-269.

Clarke, G.R., Qiang, C.Z. and Xu, L.C. (2015), “The internet as a general-purpose technology: firm-level evidence from around the world”, *Economics Letters*, Vol. 135, pp. 24-27.

Diaz Tautiva, J.A., Salvaj Carrera, E., Vásquez-Lavín, F. and Ponce Oliva, R.D. (2023), “Understanding the role of institutions and economic context on entrepreneurial value creation choice”, *Oeconomia Copernicana*, Vol. 14 No. 2, pp. 405-447.

Duasa, J. and Ramadan, A.E. (2019), “Digital development and economic growth In selected Asian countries: applying response surfaces for critical bounds of cointegration test”, *Journal of Southeast Asian Studies*, Vol. 24 No. 2, pp. 1-18.

Duong, C.D. (2023), “A moderated mediation model of perceived barriers, entrepreneurial self-efficacy, intentions, and behaviors: a social cognitive career theory perspective”, *Oeconomia Copernicana*, Vol. 14 No. 1, pp. 355-388.

Frost, J. (2019), *Introduction to Statistics: An Intuitive Guide for Analyzing Data and Unlocking Discoveries*, Statistics By Jim Publishing.

Geweke, J., Horowitz, J. and Pesaran, H. (2006), “Econometrics: a bird’s eye view”, *Working Paper CWPE 0655*, University of Cambridge, Cambridge.

Ghazy, N., Ghoneim, H. and Lang, G. (2022), “Entrepreneurship, productivity and digitalization: Evidence from the EU”, *Technology in Society*, Vol. 70, p. 102052.

Greenan, N. and Messe, P.J. (2018), “Transmission of vocational skills in the second part of careers: the effect of ICT and management changes”, *Journal of Labour Market Research*, Vol. 52 No. 6.

Hadad, S. (2017), *Business Digitisation in the Romanian Economy. Strategica. Shift. Major Challenges of Todays Economy*, Tritonic, Bucharest.

Hanushek, E.A. and Woessmann, L. (2008), “The role of cognitive skills in economic development”, *Journal of Economic Literature*, Vol. 46 No. 3, pp. 607-668.

Hasnaoui, A. (2024), “ESG ratings and investment performance: evidence from tech-heavy mutual funds”, *Review of Accounting and Finance*, Vol. 24 No. 1.

Horvat, D., Kroll, H. and Jäger, A. (2019), “Researching the effects of automation and digitalization on manufacturing companies’ productivity in the early stage of industry 4.0”, *Procedia Manufacturing*, Vol. 39, pp. 886-893.

Katz, R.L., Koutroumpis, P. and Callorda, F. (2014), “The Latin American path towards digitization”, *Revista De Estudios Para El Desarrollo Social De la Comunicación*, No. 9, pp. 151-183.

Konovalova, V.G., Aghgashyan, R.V. and Galazova, S.S. (2021), “Perspectives and restraining factors of HR analytics in the conditions of digitisation of human resources management”, in *Socio-Economic Systems: Paradigms for the Future*, Springer, Cham, pp. 1015-1024.

Koraus, A., Dobrovič, J., Polák, J. and Kelemen, P. (2019), “Security position and detection of unusual business operations from science and research perspective”, *Entrepreneurship and Sustainability Issues*, Vol. 6 No. 3, pp. 1270-1279.

Koraus, A., Štefko, R. and Dobrovič, J. (2015), “Acquisition activity in financial sector”, in *European Financial Systems 2015: Proceedings of the 12th International Scientific Conference*, pp. 277-286.

Kovács, T.Z., Bittner, B., Nagy, A.S. and Nábrádi, A. (2022), “Digital transformation of human capital in the EU according to the DESI index”, *Issues in Information Systems*, Vol. 23 No. 4.

Kusá, A., Beličková, P., Vrtaňa, D. and Križanová, A. (2023), “The impact of visual product communication on customers’ irrational buying behaviour”, *European Journal of Media, Art and Photography*, Vol. 11 No. 2, pp. 106-115.

Kuzmina, E.Y., Alibekova, A.B. and Soklakova, I.V. (2021), “Implementation of electronic document turnover as a factor of increasing the management effectiveness in the digital economy”, in *Socio-Economic Systems: Paradigms for the Future*, Springer, Cham, pp. 1553-1563.

Le, T.L., Pham, H.T. and Nguyen, N.D. (2023), "How empathy and social entrepreneurial self-efficacy interact to affect social entrepreneurial intention: a polynomial regression with response surface analysis", *Oeconomia Copernicana*, Vol. 14 No. 4, pp. 1341-1366.

Li, R., Rao, J. and Wan, L. (2022), "The digital economy, enterprise digital transformation, and enterprise innovation", *Managerial and Decision Economics*, Vol. 43 No. 7.

Liu, C., Zhang, W. and Zhu, X. (2022), "Does digital transformation promote enterprise development: evidence from Chinese A-Share listed enterprises", *Journal of Organizational and End User Computing*, Vol. 34 No. 7, pp. 1-18.

López-Felices, B., Schoenemann, M., Román-Sánchez, I.M. and Aznar-Sánchez, J.A. (2023), "Sociocultural valuation of ecosystem services in protected areas: a study applied to southeast Spain", *Oeconomia Copernicana*, Vol. 14 No. 4, pp. 1257-1302.

Mirza, N., Umar, M., Sbia, R. and Jasmina, M. (2024), "The impact of blue and green lending on credit portfolios: a commercial banking perspective", *Review of Accounting and Finance*, Vol. 24 No. 2.

Moravcikova, D., Krizanova, A. and Vrtana, D. (2019), "The impact of psychographic segmentation on increasing hotel traffic in the Slovak republic with using online marketing communication", *Proceedings of the 33rd IBIMA Conference*.

Mortal, S.C. and Schill, M.J. (2018), "The role of firm investment in momentum and reversal", *Journal of Empirical Finance*, Vol. 48, pp. 255-278.

Nasiri, M., Ukko, J., Saunila, M. and Rantala, T. (2020), "Managing the digital supply chain: the role of smart technologies", *Technovation*, Vols 96/97, p. 102121.

Owalla, B., Gherhes, C. and Vorley, T. (2022), "Mapping SME productivity research: a systematic review of empirical evidence and future research agenda", *Small Business Economics*, Vol. 58 No. 3, pp. 1285-1307.

Pearce-Moses, R. (2005), "Digitization", A glossary of archival and records terminology, available at: www2.archivists.org/glossary/terms/d/digitization (accessed 11 November 2013).

Pianta, M., Lucchese, M. and Nascia, L. (2020), "The policy space for a novel industrial policy in Europe", *Industrial and Corporate Change*, Vol. 29 No. 3, pp. 779-795.

Polozova, T.V., Kolupaieva, I. and Sheiko, I. (2021), "Digital gap in EU countries and its impact on labour productivity and global competitiveness".

Přívara, A. (2024), "Survey and secondary data on digitization", Zenodo, available at: https://zenodo.org/record/13756424 (accessed [Date]).

Sabbagh, K., Friedrich, R.O.M.A.N., El-Darwiche, B.A.H.J.A.T., Singh, M.I.L.I.N.D. and Koster, A.L.E.X. (2013), "Digitization for economic growth and job creation: regional and industry perspectives", *in the Global Information Technology Report*, *2013*, pp. 35-42.

Santos-Arteaga, F.J., Di Caprio, D. and Tavana, M. (2023), "Information and communication technologies and labor productivity: a dynamic slacks-based data envelopment analysis", *Journal of the Knowledge Economy*, Vol. 15 No. 3, pp. 1-27.

Shahnazi, R. (2021), "Do information and communications technology spillovers affect labor productivity?", *Structural Change and Economic Dynamics*, Vol. 59, pp. 342-359.

Skare, M., de Obesso, M.D.L.M. and Ribeiro-Navarrete, S. (2023), "Digital transformation and European small and medium enterprises (SMEs): a comparative study using digital economy and society index data", *International Journal of Information Management*, Vol. 68, p. 102594.

Szopa, Ł. and Cyplik, P. (2020), "The concept of building a digital transformation model for enterprises from the SME sector", *Logforum*, Vol. 16 No. 4.

Tolstykh, T.O., Shkarupeta, E.V., Shishkin, I.A., Dudareva, O.V. and Golub, N.N. (2017), "Evaluation of the digitalisation potential of region's economy", *International Conference on Humans as an Object of Study by Modern Science*, Springer, Cham, pp. 736-743.

Trzaska, R., Sulich, A., Organa, M., Niemczyk, J. and Jasiński, B. (2021), "Digitalization business strategies in energy sector: solving problems with uncertainty under industry 4.0 conditions", *Energies*, Vol. 14 No. 23, p. 7997.

Turkyilmaz, A., Dikhanbayeva, D., Suleiman, Z., Shaikholla, S. and Shehab, E. (2021), "Industry 4.0: challenges and opportunities for Kazakhstan SMEs", *in CIRPe 2020 – 8th CIRP Global Web Conference – Flexible Mass Customisation, 14-16 October 2020, Online, Elsevier*, pp. 96C:214-2019.

Varian, H., Litan, R.E., Elder, A. and Shutter, J. (2002), "The net impact study: the projected economic benefits of the internet in the United States, United Kingdom, France and Germany".

Vrtana, D. and Gogolova, M. (2019), "Marketing strategy applied in the environment of an international company", *Proceedings of the 19th International Scientific Conference Globalization and Its Socio-Economic Consequences*.

Vrtana, D. and Krizanova, A. (2018), "Brand strategy of successful companies", *Proceedings of the 32nd IBIMA Conference*.

Vrtana, D. and Krizanova, A. (2020), "Marketing strategy of successful brand", *Proceedings of the 35th IBIMA Conference*.

Zaric, S. and Bozhovic, A. (2021), "The impact of digitization on economic growth and how to measure it", *KNOWLEDGE-International Journal*, Vol. 48 No. 1, pp. 17-23.

Further reading

Aly, H. (2020), "Digital transformation, development and productivity in developing countries: is artificial intelligence a curse or a blessing", *Review of Economics and Political Science*, Vol. 7 No. 4.

Blazquez-Resino, J.J., Gutiérrez-Broncano, S., Ruiz-Palomino, P. and Jiménez-Estévez, P. (2020), "Dealing with human resources in the age of consumer 4.0: Aiming to improve service delivery", *Frontiers in Psychology*, Vol. 10.

Cisan, G.A., Popescu, M.E., Militaru, E. and Cristescu, A. (2023), "EU diversity in terms of digitalization on the labor market in the post-covid-19 context", *Economies*, Vol. 11 No. 12, p. 293.

Cruz-Jesus, F., Oliveira, T. and Bacao, F. (2011), "Exploratory factor analysis for the digital divide: evidence for the European Union-27", in *International Conference on Enterprise Information Systems*, Springer, Berlin, Heidelberg, pp. 44-53.

Cruz-Jesus, F., Oliveira, T. and Bacao, F. (2012), "Digital divide across the European Union", *Information and Management*, Vol. 49 No. 6, pp. 278-291.

Dunn, E.W. and Weidman, A.C. (2015), "Building a science of spending: lessons from the past and directions for the future", *Journal of Consumer Psychology*, Vol. 25 No. 1, pp. 172-178.

Hayriye, A.T.İK. and Fatma, Ü.N.L.Ü. (2020), "Industry 4.0-related digital divide in enterprises: an analysis for the European Union-28", *Sosyoekonomi*, Vol. 28 No. 45, pp. 225-244.

Horvat, D., Stahlecker, T., Zenker, A., Lerch, C. and Mladineo, M. (2018), "A conceptual approach companies' profiles concerning industry 4.0 emerging economies", *Procedia Manufacturing*, Vol. 17, pp. 419-426.

Joppen, R., Tekaat, J.L. and Kühn, I.A. (2019), "Identification and structuring of benefits and expenses for evaluating the profitability of investments in digitisation within production", *Procedia Manufacturing*, Vol. 33, pp. 248-255.

Jorgenson, D.W. and Griliches, Z. (1967), "The explanation of productivity change", *The Review of Economic Studies*, Vol. 34 No. 3, pp. 249-283.

Lastauskaite, A. and Krusinskas, R. (2023), "Digitalization and productivity: evidence from EU manufacturing sector", *European Journal of Economics*, Vol. 3 No. 1, pp. 1-12.

Lv, P. and Xiong, H. (2022), "Can FinTech improve corporate investment efficiency? Evidence from China", *Research in International Business and Finance*, Vol. 60, p. 101571.

Mohamed, E. and Gumah, Z.J. (2006), "What is the digital economy, and how to measure it", *Faculty of Information Technology*, University Utara Malaysia, Sintok, Kedah, p. 6010.

Neamțu, D., Hapenciuc, C. and Bejinaru, R. (2019), "The impact of digitalization on business sector development in the knowledge economy", in *Proceedings of the International Conference on Business Excellence*, Vol 13 No. 1, pp. 479-491.

Novikova, O., Khandii, O., Shamileva, L. and Olshanskyi, O. (2022), "The impact of digitalization on ensuring economic growth", *in Management Theory and Studies for Rural Business and Infrastructure Development*, Vol. 44 No. 2, pp. 223-234.

OECD (2012), *Unit Labour Costs: Measurement and Uses*, *OECD Economic Outlook*.

Sara, V. (2001), "Investment in research in Australia: the role of the Australian research council", *Advanced Materials*, Vol. 13 Nos 12/13, pp. 869-872.

Schreiber-Gregory, D.N. (2018), "Ridge regression and multicollinearity: an in-depth review", *Model Assisted Statistics and Applications*, Vol. 13 No. 4, pp. 359-365.

Tapscott, D. (1995), "The digital economy: promise and peril, in the age of networked".

Vicente, M.R. and Muñiz, A.S.G. (2021), "A multidimensional analysis of the digital gender gap in European Union member states", *Technology and Women's Empowerment*, Routledge, pp. 84-100.

About the authors

Andrej Privara is an Associate Professor at the University of Economics in Bratislava. His research interests span a broad range of topics, including digitalization, the labor market and labor migration. Andrej Privara is the corresponding author and can be contacted at: andrej.privara@euba.sk

Róbert Mészáros is a PhD student at the Faculty of Economics and Finance, University of Economics in Bratislava. His research interests focus on a diverse range of topics, including economic policy, financial markets and the digital economy.

Najib Rahman Rahmat is a PhD student at the Faculty of Economics and Finance, University of Economics in Bratislava. His research interests encompass a wide range of topics, including the digital economy, the labor market and labor migration.