Piotr Wiśniewski

Nicolaus Copernicus University in Toruń
e-mail: psw@umk.pl
ORCID: 0000-0002-2263-4851

DOI: 10.15290/oes.2025.03.121.06

EXPLORING THE LINK BETWEEN ICTS UTILISATION AND LABOUR PRODUCTIVITY ACROSS THE EUROPEAN UNION

Summary

Purpose | This study aims to determine the effect of ICTs utilisation on labour productivity. It compares how different aspects of the digital economy affect productivity in two groups of countries within the European Union – the developed ("the Old Europe") and the developing ("the New Europe").

Research method | In this study, random forest regression was used on two groups of countries within the European Union.

Results | The utilisation of ICTs between the two parts of the European Union is significantly different. Two independent random forests show that the most influential variables in "the Old Europe" are the least influential in "the New Europe," and vice versa. This showcases that the theory of the national ecosystem is correct. There is no universal way in which ICT adaptation influences productivity.

Originality/value/implications/recommendations | This study reveals differences within the interconnected economy of the European Union. It shows that even in the case of widespread and accessible technologies, there are meaningful differences in their adaptation based on national ecosystems and regional factors. The findings should serve as a basis for future research on the institutional and regional factors influencing differences in ICT adaptation and utilisation.

Keywords: digital economy, productivity, ICT, digital divide

JEL classification: O33, O43, O47

1. Introduction

Economic history encompasses four major technological revolutions, each of which has significantly disrupted the economy and society [Śledziewska, Włoch, 2020]. The world has already passed through the Third Industrial Revolution (the Digital Revolution) and is now in the early aftermath of the Fourth Industrial Revolution. Current debates surrounding the fourth revolution primarily highlight its economic benefits and technological advancements. One of the anticipated outcomes is an increase in labour productivity.

ICT (Information and Communications Technology**)** adaption, since the 1990s, has led to enormous productivity gains. ICTs was seen as an opportunity to accelerate the growth rate of the country and allowed developing countries to catch up to the developed ones. Programs and strategies related to the technological development are widespread among different countries. Some of them were lunched in Germany [Federal Ministry for Economic Affairs and Climate Action, 2019], Japan [Council for Science, Technology and Innovation, 2015], Australia [Department of Industry, Science and Resources, 2021], the UK [Foresight, 2013], and the US [Subcommittee on Advanced Manufacturing Committee on Technology, 2022]. These programs are usually related to industry but also take into consideration the development of digital skills and digital inclusions. Examples of these include: the DIGCOMP Project by European Commission, the Krumsvik model (Norway), the TPACK model by the USA [Mishra and Koehler, 2006], the JISC model by the UK, the ISTE Standards by the USA, and the P21 model by the USA [Choudhary, Bansal, 2022].

There is a strong relation between societal and technological change. Technological advances are determined and determine societal changes [Vannoy, Palvia, 2010]. Empirical research showcases that physical localisation of a company may influence ICT adoption. Companies in the Netherlands, Sweden, Norway and Iceland on average adapted ICT better than companies in France. Multiple factors beside level of development influence ICT adaptation [Holl, Rama, 2023].

The impact of ICT utilisation on labour productivity and economic growth remains ambiguous. The existing literature showcases that there are significant

differences between the developed and developing countries in terms of benefits from digitalisation [Aissaoui, 2022; Gomułka, 2021]. Moreover, there are significant differences in how various types of ICTs affect labour productivity [Duso and Schiersch, 2025].

The aim of this research is to determine whether there are differences in the impact of ICTs on labour productivity between two groups of some European Union countries: those that joined before 2004 (referred to as "the Old Europe") and those that joined in 2004 or later ("the New Europe"). If such differences exist, it would suggest that the effects of digital transformation are dependent on country-specific characteristics and cannot be considered universal.

To investigate this, two random forest regressions were conducted. Both models include the same variables, but one will focus on "the New Europe" countries and the other on "the Old Europe." This approach enables a comparison of the aspects of the digital economy that influence productivity within each group.

2. Literature review

Economic growth in a country may result from changes in ICT capital, physical capital, or improvements in efficiency. Prior to around 2010, changes in ICT capital had the greatest influence on labour productivity; however, since then, its impact has been significantly weakened [Fulgenzi et al., 2024; Mas et al., 2025; Byrn, Corrado, 2016]. Changes in ICT capital require a corresponding increase in human capital, in the form of knowledge and skills [Giebel, Lammers, 2025].

Paunov and Rollo [2016] conducted research on knowledge spillovers in 50,013 firms from 117 developing and emerging countries. According to their results, firm performance did not depend on their own ICT investments, but on their environment. The Internet provided larger benefits to "... firms located in smaller agglomerations, to single-plant establishments and to non-exporters. These firms commonly engage less in innovation and consequently Internet-enabled knowledge spillovers can serve the 'democratization of innovation'" [Paunov, Rollo, 2016]. Positive impacts on these companies included increased productivity, investments in equipment, and patents.

Bauer [2018] publication highlights the role of ICTs' effects on the productivity of capital, labour, and information. It is described as a coordination technology that allows for an increase and improvement in the division of labour and the relocation of work. The results are not unambiguous. Depending on the implementation, these technologies can increase or decrease inequality and productivity among different groups. In the USA, manufacturing labour productivity significantly increased due to ICTs (in 1980, 25 workers were required to produce 1 million dollars of output, whereas in 2015 it was only 5). Other countries report a lower level of ICTs' impact on productivity.

One of the hypotheses explaining the slow growth of productivity during the periods of intense technological change and differences between countries states that: "...ICT requires investments in other assets, especially intangibles. To be productive, ICT requires not only investments in IT, data and communications, hardware and software, but also changes in the qualifications of human resources and their way of work, changes in the organisational structures of companies, and investment in R&D, process and product innovations" [Mas et al., 2025]. An increase in productivity, including labour productivity, requires not only access to technology but also human capital.

Differences in labour productivity among societies may be characterised as a digital divide between them and difference in adaptation of ICTs by individuals. This process in visible not only in workplace, but also earlier in school environment [Soga et al., 2024] and in the everyday use of technology in financial transactions [Saka et al., 2022] [Ivanov et al. 2023]. To fully utilise ICT, there is a need for public policies that involve not only investment in digitalisation but also in public infrastructure and in the development of digital skills [Amador, Silva, 2025].

The difference in development of digital markets between countries prevails [Hawash, Lang, 2020; Peji, 2014], but the difference in terms of infrastructure is getting smaller [Sharp, 2024].

There is a structural change on the market in form of the fragmentation of the workforce [Salahuddin et al., 2015]. ICTs are a part of both high and low paying jobs [Bauer, 2018]. Tasks within jobs are increasingly complex, non-repetitive,

and non-routine. Employees are expected to adopt a lifelong learning perspective and to continuously enhance their skills [Giebel, Lammers, 2025]. This gave rise to next generation users that utilise technology to seek solutions in a different aspect of both work and private life [Dutton, Blank, 2014]. Creation of solutions empowered by technology led to an increase in productivity. The downside is that to effectively utilise individual skills and talents, it is necessary to make the effective use of ICTs. This may decrease the potential productivity due to removing individuals who are highly competent and innovative in their jobs but may be excluded due to the lack of ICT-related skills. This showcases the difference between individuals in the ability to apply knowledge in the employment context in relation to the technology [Baker et al., 2020]. This process has two main implications for labour productivity. The first one is that a portion of the workforce will experience a decrease in productivity due to the lack of ICT-related skills or adaptability. The second one is that "the next generation users" may increase productivity by not only using the existing tool but by effectively creating technology-empowered solutions and processes.

The effective use of technology allows to build high value, scalable and high-growth propositions for the market. This creates a strong divide between businesses, due to network effect. Companies that utilised ICTs earlier may build strong barriers of entrance for newer companies [Sussan, Acs, 2017]. One of the propositions for countering this is to locally found digital entrepreneurships. This creates a set of challenges for governance in terms of how culture, legal system and economic development influence digital ecosystem. [Ren, Lin, 2024]. So far, these ideas have not been effective. The digital gap between developing and developed countries is widening [United Nations, 2023].

There are significant differences between companies in their approach to obtaining and utilising technology. The influence of digitalisation on labour productivity depends on how individual enterprises operate and how technology (for example, ICT) is perceived in relation to company strategy and the human element.

The individual company innovation capability is dependent on three factors: technology, human capital and organisational/relational aspects. The first one is related to obtaining or accessing existing infrastructure understood as

devices or software. The significant aspect of human capital involves ICT expertise of the staff, access to external ICT consultancy and training. In case of organisational/relational factors, these include company ambition for growth, digital strategies and cooperation with suppliers. The cooperation with universities or research centres was not significantly important for companies [Romero, Mammadov, 2024]. The availability of ICT experts and consultants has a lesser impact on digital innovation in microenterprises, which, instead, rely on collaborations with suppliers, universities, and research institutions. They utilise these external networks more effectively than larger firms. Furthermore, ICT expertise in microenterprises is often informal, yet it exerts a greater influence compared to SMEs. This suggests that the digital divide, concerning access to resources, is less critical than the capacity to utilise them efficiently. Given the widespread availability of online courses, user communities, and open-source tools, microenterprises prioritise external partnerships over developing in-house infrastructure to foster innovation.

Microenterprises need less specific knowledge resources. They utilise whatever is available. SME creates digital innovation by hiring ICT experts, contracting external consultants, and implementing training activities within the company. SME are more focused and require more higher staff and management involved [Nogler, Nogler, 2015; Romero, Mammadov, 2024]. This means that building external resources of microenterprises may help with this type of innovative enterprises.

Divergence between companies arises only when companies build their absorptive capacities. They need to absorb and use the existing resources. The problem regards the ability to use and utilise technology, not the access to it [Paunov, Rollo, 2016]. On the market there is still great demand for ICT-based skills that is larger than current supply [Arbeláez-Rendón et al., 2023]. The presented situation may be permanent in foreseeable future due to market's mechanisms and the role of ICT in business setting. The whole dynamic system is dependent on the environment that its operating in [Bauer, 2018].

Institutional order and policies on the central and regional levels are of great importance for both individuals and entrepreneurs [Sharma et al., 2016]. In economic sense, there are two facets of this: the impact of digitisation on

economic growth and factors influencing a different level of digitisation between countries.

The most important aspect of digitisation is the national ecosystem that is build from three constructs: environmental, technological and organisational. Digitisation is influenced by degree of globalisation, institutional order and ICT accessibility. Institutions are basis for country ability to minimise the digital divide [Tolba, 2022]. The development of ICT programs should be highly regionalised. Establishing such programs should involve taking into consideration the composition of employment and institutional order [Baker et al., 2020].

The high-income countries benefit the most from the cost reduction associated with ICT use. The globalisation process forces companies to adapt to new, global environment. Due to this, working towards enhancing the technological capabilities and ICT investment within countries is a key issue [Rodriguez-Crespo et al., 2019].

The analysis of access to the Internet should be compatible with the socio-economic factors analysis. Digital economy has micro- and macro- impact on society and economy as a whole [Baker et al., 2020]. The increase of digital inclusion creates positive externalities. It also allows greater exchange of knowledge [Baker et al., 2020]. At the same time, there is an issue with building social capital and societal challenges that are beyond the scope of economic analysis.

Development of ICTs and digital economy may influence productivity in different way depending on country ecosystem. Productivity was used in this research rather than economic growth due to fact that ICTs impact is the most visible in terms of individual work and business performance.

3. Methods and results

Different aspects of the digital economy are strongly interdependent, which results in the problem of collinearity among variables. In this case, many regression models are not the best tool for the analysis. Due to this fact,

a random forest which is more resilient to collinearity between variables was used [Mentch, Zhou, 2020]. "Random forest regression, grounded in decision tree-based learning, offers a personalised regression model with enhanced explanatory power, making it highly suitable for real-world data sets" [He, Wu, Fan, 2024].

Table 1 provide set of 9 independent variables (labelled as "x") and 1 dependent variable (labelled as "y"). These variables reflect an ecosystem approach to the impact of ICT on labour productivity and society. Gross fixed capital formation, the number of employed ICT specialists, and enterprises engaged in online orders and e-commerce are more direct indicators. Companies that implement various ICT solutions may increase their employees' productivity. Variables related to individual actions, such as e-banking, internet use, or participation in social networks, reflect the general population's immersion in technology and the broader national ecosystem. This is especially important concerning the presence of next-generation users and the ability of individual employees to utilise ICT within their jobs.

TABLE 1
Variable labels and descriptions

Variable	Description
x 1	Charges for the use of intellectual property
x 2	Individuals using the Internet for Internet banking
x 3	Individuals using the Internet for participating in social networks
x 4	Enterprises having received orders online (at least 1%)
x 5	Share of enterprises' turnover on e-commerce
x 6	Internet use by individuals
x 7	Employed ICT specialists
x 8	Broadband Internet coverage by technology
x 9	Gross fixed capital formation
y	Labour productivity and unit labour costs

Source: the authors' own work.

The sources of data are: World Bank [World Bank, 2025] (variable x1) and Eurostat [Eurostat, 2025] (rest of variables). Data was collected for 26 countries that were split to represent "the Old" and "the New" Europe between 2013 and 2023. Luxembourg was omitted from the research due to a lack of comparable data for the analysed time frame.

The "New Europe" countries include Bulgaria, Croatia, Cyprus, Czechia, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Slovenia. These are countries that joined European Union in 2004 or later.

The "Old Europe" countries include Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain and Sweden. These countries were part of European Union before 2004.

Table 2 and Table 3 provide descriptive statistic of the variables for these two groups.

TABLE 2
Descriptive statistics of the "New Europe" variables

Variable	N	Mean	S.D	Min	Median	Max
x 1	143	79000000000	935000000	31000000	398000000	4660000000
x 2	143	46.92021	22.00746	4.16	49.8	84.89
x 3	143	57.70441	11.2756	33.42	58.97	82.56
x 4	143	16.21007	6.642051	4.76	15.24	31.97
x 5	143	13.99255	6.79665	2.69	13.11	31.75
x 6	143	79.4135	9.55942	49.76	80.45	93.2
x 7	143	3.55524	0.97451	1.6	3.5	6.7
x 8	143	42.29371	28.17182	0	42.4	100
x 9	143	24371.3021	27635.15	1406	10664.7	134605.5
y	143	119.22248	12.24011	100.812	117.291	158.196

Source: the authors' own work.

The presented statistics showcases significant differences in data between two groups in terms of digital economy variables and productivity.

TABLE 3
Descriptive statistics of the "Old Europe" variables

Variable	N	Mean	S.D	Min	Median	Max
x 1	143	15500000000	28000000000	247000000	4510000000	153000000000
x 2	143	62.90969	21.92646	10.72	62.78	96.22
x 3	143	58.56094	12.44097	31.63	58.61	91.02
x 4	143	20.91738	7.816492	4.95	19.56	38.4
x 5	143	18.68682	7.943221	1.58	17.71	43.95
x 6	143	86.86797	9.697994	58.46	90.28	99.15
x 7	143	4.623077	1.473699	1.6	4,.5	8.7
x 8	143	49.16993	30.99043	0	48.7	96.9
x 9	143	197300.3	205181.4	19572.4	111457.3	899880
y	143	107.0631	13.72354	83.774	105.005	178.35

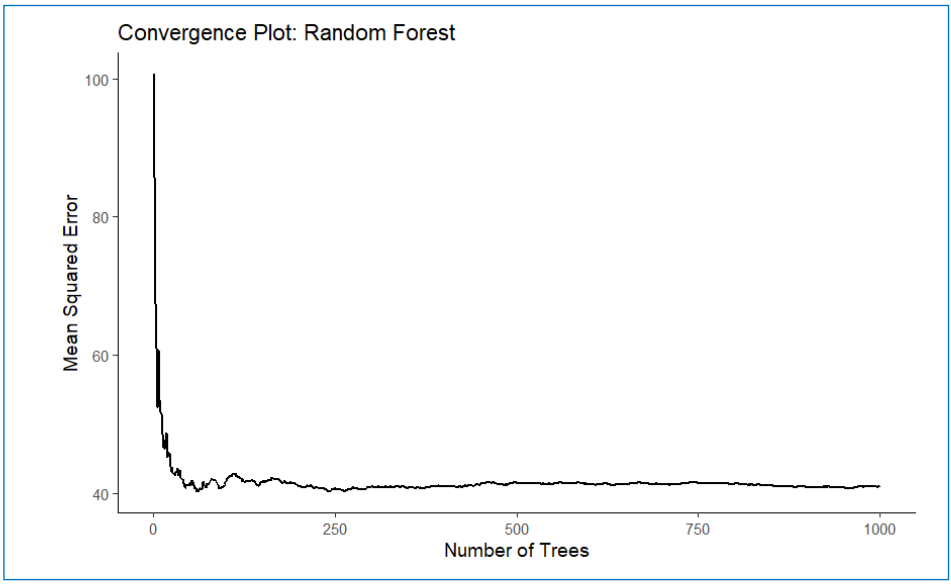
Source: the authors' own work.

In the case of "the New Europe" countries, the Random Forest regression resulted in 73.13% of the variation being explained by the response variable, with the mean of squared residuals being 39.98. In the "Old Europe", countries, 84.65% of the variation was explained by the response variable, with the mean of squared residuals being 28.69.

Charts 1 and 2 display the convergence plots of the random forest model for the New Europe and the Old Europe. The horizontal axis represents the number of decision trees, while the vertical axis displays the Mean Squared Error (MSE). In this study, 1000 samples were used. Increasing the number of decision trees does not result in overfitting. In Chart 1, when the number of decision trees exceeds approximately 100, the MSE stabilises and the regression results tend to converge [He, Wu, Fan, 2024].

CHART 1

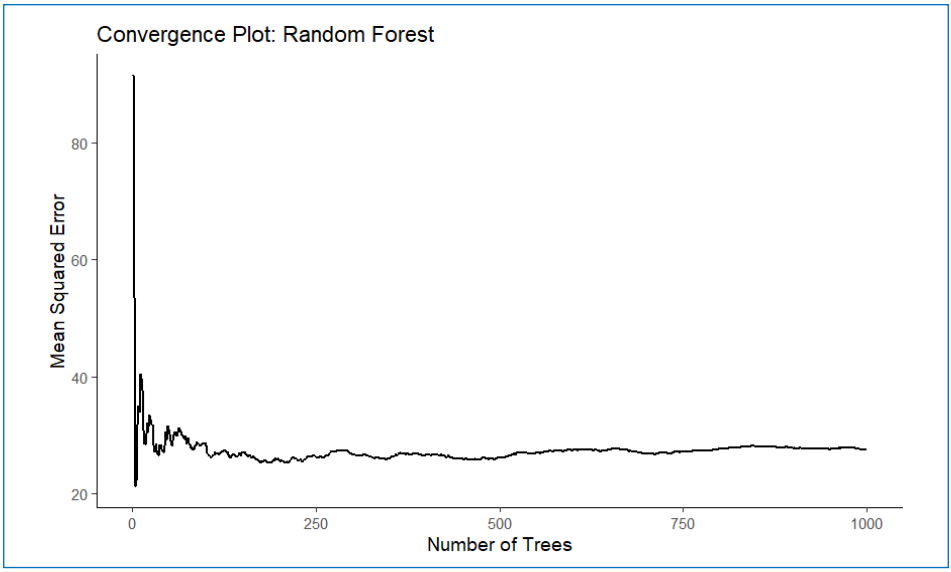
Convergence plot of the random forest model for "the New Europe"



Source: the authors' own work.

CHART 2

Convergence plot of the random forest model for "the Old Europe"



Source: the authors' own work.

Chart 2 presents initial fluctuations in the MSE curve due to the instability of predictions from the first few trees. As the number of decision trees increases, the mean squared error gradually stabilises, consistent with the Law of Large Numbers.

Table 4 presents the results of random forest. In "the Old Europe" definitely most influential determinant were charges for the use of intellectual property (×1). The second most influential determinant was share of enterprises' turnover on e-commerce (×5). The least influential determinants were: Individuals using the Internet for Internet banking (×2) and Individuals using the Internet for participating in social networks (×3)

In case of "the New Europe", the most influential determinant were individuals using the Internet for participating in social networks (×3) and individuals using the Internet for Internet banking (×2). The least influential determinants were charges for the use of intellectual property (×1) and share of enterprises' turnover on e-commerce (×5).

TABLE 4
Variable importance plot

Variable	IncNodePurity	
	Old Europe	New Europe
x 1	9494.9583	1417.768
x 2	733.2540	3294.188
x 3	522.2773	3660.799
x 4	3079.3555	1709.527
x 5	6729.6051	1166.895
x 6	1218.0102	2584.273
x 7	2112.9414	1405.637
x 8	953.0453	2753.421
x 9	976.4164	2728.385

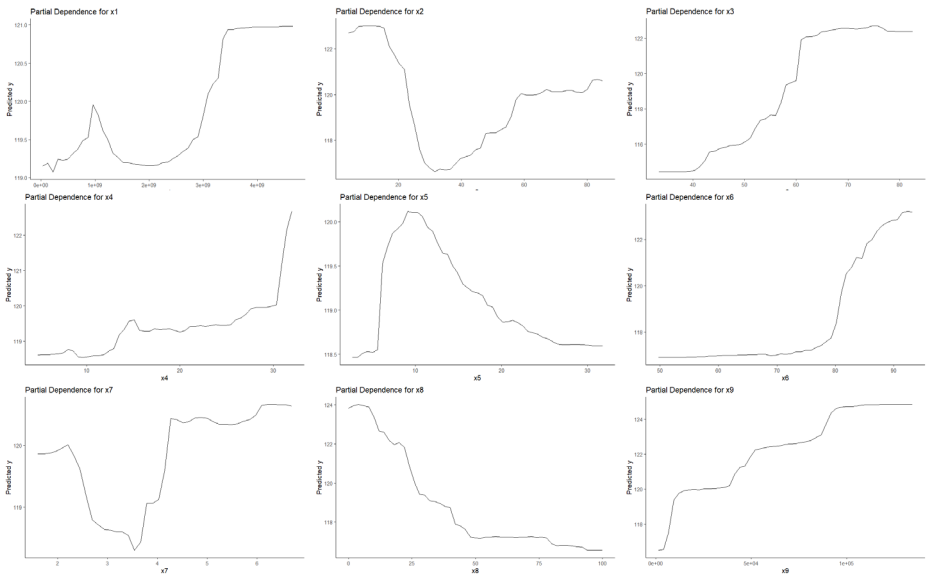
Source: the authors' own work.

This demonstrates that the variables determining the utilisation of ICTs between the two parts of the European Union are significantly different. Two independent random forests show that the most influential variables in "the Old Europe" are the least influential in "the New Europe", and vice versa. This showcases that theory of national ecosystem is right. There is no universal impact of ICTs adaptation on productivity.

Chart 3 and 4 depicts partial dependence plots for the determinants of "the New Europe" and "the Old Europe". In case of "the New Europe", individuals using the Internet for participating in social networks (×3) exhibits a positive impact on the productivity of labour. At the same time individuals using the Internet for Internet banking (×2) displays dynamic interaction with productivity of labour. It results in negative impact to at the lower values and then strong positive one.

CHART 3

Partial dependence plots for the determinants for "the New Europe"



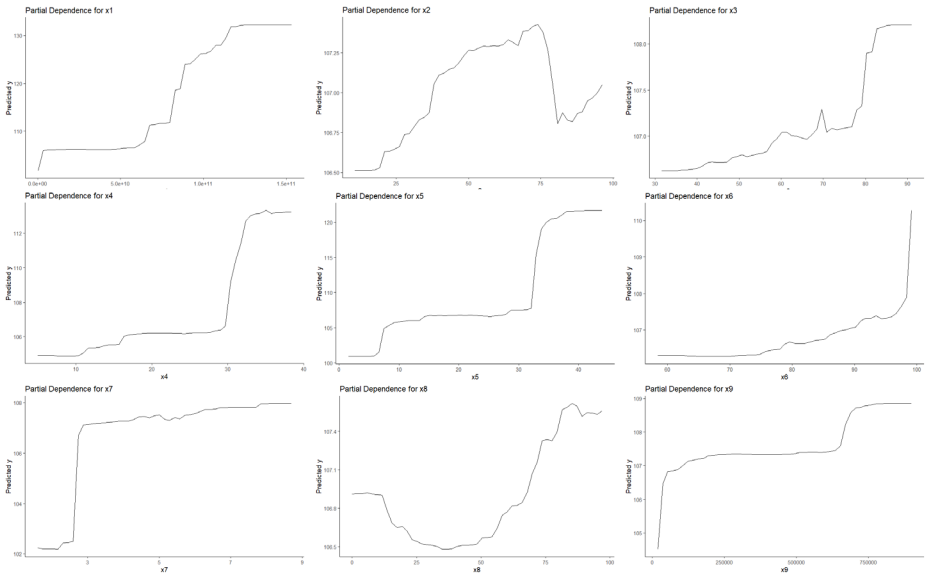
Source: the authors' own work.

In case of "the Old Europe", charges for the use of intellectual property (×1) exhibits a positive impact on the productivity of labour. The same is true about

share of enterprises' turnover on e-commerce (×5) impacting productivity of labour. In both cases the variables change in a stepwise manner.

CHART 4

Partial dependence plots for the determinants for "the Old Europe"



Source: the authors' own work.

The presented results highlighted significant differences in the effect of different variables on labour productivity. This showcases that adaptation of ICTs and its effect on economy and labour markets is nuanced and require deep understanding of the mechanisms behind it.

5. Conclusions

There are significant differences in how the digital economy affects productivity. In the interconnected economy of the European Union, these differences are most likely caused by the institutional characteristics of individual countries. This includes both formal and informal institutions, as well as differences in approaches to ICTs. These findings suggest practical implications.

Firstly, the return on investment in ICTs depends on their utilisation and adaptation, which in turn are influenced by regional characteristics. Companies operating in different regions should consider that the same investment may yield significantly different outcomes.

Secondly, policies related to the digital economy should consider the unique characteristics of each region. Technology and processes that are needed for Economy 4.0 are already existing. Implementation of the Economy 4.0 is already finished. Currently countries within European Union need to include digital inclusion and alignment with regional characteristics and needs in its further development. Technology and society influence and shape each other. Social and economic policies need to take into consideration technological landscape.

Future research should focus on the socioeconomic analysis of different aspects of the digital economy. This study demonstrates that access to the same technologies can lead to different outcomes depending on regional characteristics. Although this research uses aggregated variables, the mechanisms involved are more complex and require further investigation at the micro-, meso-, and macro-levels, as well as research into the relationships between these levels.

References

Aissaoui N., 2022, *The Digital Divide: a Literature Review and Some Directions for Future Research in Light of COVID-19*, "Global Knowledge, Memory and Communication" vol. 71(8–9), pp. 686–708, DOI: 10.1108/GKMC-06-2020-0075.

Amador J., Silva C., 2025, *The Impact of ICT Adoption on Productivity: Evidence from Portuguese Firm-level Data*, "Empirica", DOI: 10.1007/s10663-0025-09652-4.

Arbeláez-Rendón M., Giraldo D.P., Lotero L., 2023, *Influence of Digital Divide in the Entrepreneurial Motor of a Digital Economy: a System Dynamics Approach*, "Journal of Open Innovation: Technology, Market, and Complexity", DOI: 10.1016/j.joitmc.2023.100046.

Baker N.B., Boustany M.S., Khater M., Haddad C., 2020, *Measuring the Indirect Effect of the Internet on the Relationship between Human Capital and Labor Productivity*, "International Review of Applied Economics", pp. 821–838. DOI: 10.1080/02692171.2020.1792421.

Bauer J.M., 2018, *The Internet and Income Inequality: Socio-economic Challenges in a Hyperconnected Society*, "Telecommunications Policy", pp. 333–343, DOI: 10.1016/j.telpol.2017.05.009.

Byrne D., Corrado C., 2016, *ICT Prices and ICT Services: What Do They Tell us about Productivity and Technology?*, "Finance and Economics Discussion Series", DOI: 10.17016/FEDS.2017.015r1.

Choudhary H., Bansal N., 2022, *Addressing Digital Divide through Digital Literacy Training Programs: A Systematic Literature Review*, "Digital Education Review", pp. 224–248, DOI: 10.1344/der.2022.41.224-248.

Council for Science, Technology and Innovation, 2015, *Society 5.0*, https://www8.cao.go.jp/cstp/english/society5_0/index.html [date of access: 1.04.2025].

Department of Industry, Science and Resources, 2021, *Industry 4.0 Testlabs in Australia report*, https://www.industry.gov.au/publications/industry-40-testlabs-australia-report [date of access: 2.04.2025].

Duso T., Schiersch A., 2024, *Let's Switch to the Cloud: Cloud Usage and Its Effect on Labor Productivity*, "Information Economics and Policy", DOI: 10.1016/j.infoecopol.2025.101130.

Dutton W.H., Blank G., 2014, *The Emergence of Next Generation Internet Users*, "International Economics and Economic Policy", pp. 29–47, DOI: 10.1007/s10368-013-0245-8.

Eurostat, 2025, *Eurostat*, https://ec.europa.eu/eurostat/data/database [date of access: 2.04.2025].

Federal Ministry for Economic Affairs and Climate Action, 2019, *2030 Vision for Industrie 4.0*, Federal Ministry for Economic Affairs and Energy.

Foresight, 2013, *The Future of Manufacturing: A new Era of Opportunity and Challenge for the UK Project Report*, Foresight, https://www.gov.uk/government/publications/future-of-manufacturing [date of access: 2.04.2025].

Fulgenzi R., Gitto S., Mancuso P., 2024, *Information and Communication Technology and Labour Productivity Growth: a Production-frontier Approach*, "Annals of Operations Research", pp. 123–156, DOI: 10.1007/s10479-024-05818-8.

Giebel M., Lammers A., 2025, *The Impact of a New Workplace Technology on Employees*, „Oxford Bulletin of Economics and Statistics", DOI: 10.1111/obes.12674.

Gomułka S., 2021, *Transformacja i rozwój*, Warszawa: Wydawnictwo Naukowe PWN.

Hawash R., Lang G., 2019, *Does the Digital Gap Matter? Estimating the Impact of ICT on Productivity in Developing Countries*, "Eurasian Economic Review", pp. 189–209, DOI: 10.1007/s40822-019-00133-1.

He Y., Wu C., Fan Y., 2024, *Exploring the Drivers of Local Government Budget Coordination: A Random Forest Regression Analysis*, "International Review of Economics and Finance", pp. 1104–1113, DOI: /10.1016/j.iref.2024.04.004.

Holl A., Rama R., 2024, *Spatial Patterns and Drivers of SME Digitalisation*, "Journal of the Knowledge Economy", pp. 5625–5649, DOI: 10.1007/s13132-023-01257-1

Ivanov V., Lvova N., Saksonova S., Lyukevich I., 2023, *Digital Accessibility in the Context of Preference for Financial Services*, "St Petersburg University Journal of Economic Studies", pp. 179–197, DOI: spbu05.2023.202.

Mas M., Pérez F., Pilat D., 2025, *Productivity*, *Technology and Intangible Assets*, "SERIEs", DOI: 10.1007/s13209-025-00310-3.

Mentch L., Zhou S., 2020, *Randomization as Regularization: A Degrees of Freedom Explanation for Random Forest Success*, "Journal of Machine Learning Research", pp. 1–36. DOI: 10.48550/arXiv.1911.00190.

Nogler S.J., Nogler G.E., 2014, *CPAs*, *Librarians*, *and the Digital Divide*,*"The Journal of Corporate Accounting & Finance"*, pp. 63–67, DOI:10.1002/jcaf.22021.

Paunov C., Rollo V., 2016, *Has the Internet Fostered Inclusive Innovation in the Developing World?*, "World Development", pp. 587–609, DOI: 10.1016/j.worlddev.2015.10.029.

Ren C., Lin X., 2023, *Research on Digital Spillover Effect of Internet Enterprises – an Exploratory Study Based on Grounded Theory*, "Applied Economics", pp. 4776–4790, DOI: 10.1080/00036846.2023.2216439.

Rodriguez-Crespo E., Billon M., Marco R., 2019, *Impacts of Internet Use on Trade: New Evidence for Developed and Developing Countries*, "Emerging Markets Finance and Trade", pp. 3017–3032, DOI: 10.1080/1540496X.2019.1676225.

Romero I., Mammadov H., 2024, *Digital Transformation of Small and Medium-Sized Enterprises as an Innovation Process: A Holistic Study of its Determinants*, "Journal of the Knowledge Economy", DOI: 10.1007/s13132-024-02217-z.

Saka O., Eichengreen B., Aksoy C.G., 2022, *Epidemic Exposure*, *Financial Technology*, *and the Digital Divide*, "Journal of Money, Credit and Banking", DOI: /10.1111/jmcb.12945.

Salahuddin M., Tisdell C., Burton L., Alam K., 2015, *Social Capital Formation*, *Internet Usage and Economic Growth in Australia: Evidence from Time Series Data*, "International Journal of Economics and Financial Issues", pp. 942–953.

Sharma R., Fantin A.-R., Prabhu N., Guan C., Dattakumar A., 2016, *Digital Literacy and Knowledge Societies: A Grounded Theory Investigation of Sustainable Development*, "Telecommunications Policy", pp. 628–643, DOI: 10.1016/j.telpol.2016.05.003.

Sharp M., 2024, *Revisiting the Measurement of Digital Inclusion*, "The World Bank Research Observer", pp. 289–318, DOI: 10.1093/wbro/lkad007.

Soga L.R., Bolade-Ogunfodun Y., De Amicis A., 2024, *Exploring Flexible Working Practices and the Digital Divide in a Post-lockdown Era*, "European Journal of Management and Business Economics", pp. 445–465, DOI: 10.1108/EJMBE-08-2023-0247.

Subcommittee on Advanced Manufacturing Committee on Technology, 2022, *National Strategy For Advanced Manufacturing*, National Science And Technology Council.

Sussan F., Acs Z.J., 2017, *The Digital Entrepreneurial Ecosystem*, "Small Business Economics", pp. 55–73, DOI: 10.1007/s11187-017-9867-5.

Tolba A., Karadeniz E., Boutaleb F., Bouhaddioui C., Menipaz E., Pereira F., Bueno Y., Alsaeed M., Schøtt T., 2022, *Exports during the Pandemic: Enhanced by Digitalization*, "Small Enterprise Research", pp. 308–327, DOI: /10.1080/13215906.2022.2141846.

United Nations, 2023, *Widening Digital Gap between Developed*, *Developing States Threatening to Exclude World's Poorest from Next Industrial Revolution*, *Speakers Tell Second Committee*, https://press.un.org/en/2023/gaef3587.doc.htm [date of access: 2.04.2025].

World Bank, 2025, *World Bank*, https://databank.worldbank.org [date of access: 2.04.2025].