

# The ICT sector in the CEE countries as a regional driver of growth





## Introduction

The digital economy and the Information and Communications Technology (ICT) sector in Central and Eastern Europe (CEE) has witnessed significant growth and transformation in recent years. This region, comprising of 11 countries<sup>1</sup>, has emerged as a hub for technological advancements, innovation, and digitalisation. The importance of the digital economy and ICT sector cannot be overstated. It plays a crucial role in driving economic growth, creating job opportunities, and enhancing the overall competitiveness of the region. With the increasing global demand for digital services and technologies, CEE has positioned itself as a significant player in the digital market.

With a population of almost 100 million CEE, the region accounts for 12.3 percent of EU GDP. The economic growth of the CEE countries participating in the initiative continues to grow despite recent crises. In the coming years, the region may close its gap to Western Europe in digital economy development.

In this report, information on the development of the digital economy in CEE countries is presented, based on relevant indicators and data, and taking into account regulations at both the national and EU levels. This document is intended not only to summarise the state of the digital economy in the countries discussed, but also to indicate possible directions of development of the ICT sector.

In the first chapter, basic indicators and data for individual countries, which will be key to understanding the current situation of the ICT sector in the region will be presented. The second chapter looks at what is driving the development of the digital economy in the region, including digital infrastructure, education, macroeconomic conditions and the business environment. In the third chapter, key areas that will affect the future of the digital economy, including cloud technologies, artificial intelligence and cybersecurity will be articulated. In the fourth and last chapter, we try to answer the question of what else may influence the development of the ICT sector in the CEE region in the coming years.

---

<sup>1</sup> This report will cover 11 CEE countries: Bulgaria, Croatia, Czechia, Estonia, Hungary, Lithuania, Latvia, Poland, Romania, Slovakia and Slovenia.

# Executive summary

- CEE countries have the resources and potential to strengthen and develop the ICT sector. This is evidenced by increasing Research and Development (R&D) expenditure, the growing number of investments in IT services, as well as the economic stability of these countries despite the recent crises. The ICT sector in the CEE countries is characterised by a rapid pace of development. This is visible in the permanent increase in the share of value added in GDP, new jobs, and the dynamics of international trade – exports of commercial ICT services in the CEE region have increased more than six-fold between 2005 and 2021.
- There are some areas in which the CEE region is already ahead of more developed economies in the EU – such as the share of employment in the ICT sector or a number of enterprises in ICT sector per 1000 inhabitants. On the other hand, ICT enterprises in Western Europe tend to have higher labour productivity with EUR 135,512 in value added per employee, compared to EUR 45,351 in the CEE region. Central and Eastern European countries record weaker results in digitisation of enterprises and individuals, such as e-commerce sales, cloud services and big data use and e-government activities of individuals.
- Dynamic changes in business environment accelerated the emergence of new trends that are going to affect digital economy in the future, such as artificial intelligence, cybersecurity and cloud technology. The impact of artificial intelligence will be felt more and more in the region. Both within the ICT sector and through the technologies produced by this sector. The cybersecurity sector may undergo particular development in the region in the near future due to the growing market demand as a result of the hybrid threat from Russia. Cloud technology on the other hand will be the foundation for further development of the former two phenomena.

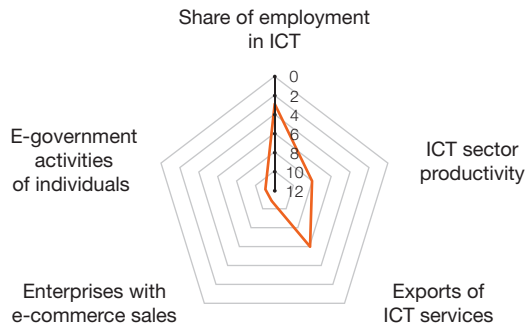


- Subsequently, further development of the ICT sector requires certain measures, among which are raising awareness of the digital economy and the conscious absorption of the emerging tools and technologies. CEE countries are also facing a shortage of skilled ICT specialists, caused by both a mismatch of educational offerings to meet today's world needs, as well as surging demand for digital experts (such as robotic engineers, operators and cybersecurity specialists).
- In that light, there is a need for cooperation between all CEE countries through the development of common priorities as well as coordination of activities at the regional level in the field of technology. The existence of umbrella organisations, such as the CEE Digital Coalition (an informal gathering of digital and advanced technologies industry organisations from Central Eastern Europe), aimed at uniting the voice of businesses in different countries is crucial for representing their common interests at the European and global levels, also in the light of upcoming elections to the European Parliament. Increased investments aimed at supporting start-ups, small and medium enterprises growth, but also creating a friendly business environment enticing global companies to invest in the region is desired. Furthermore, increased cooperation between public and private sectors is urged to better tailor solutions for actual business needs. Lastly, creating a balanced regulatory environment is crucial to ensure competitiveness and further development of the digital economy in the CEE region.

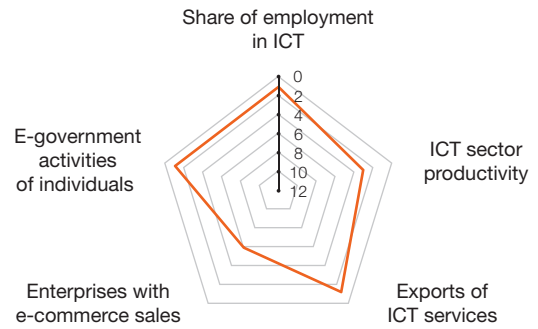
CEE Digital Coalition is an informal gathering of digital and advanced technologies industry organisations from Central Eastern Europe. The Coalition which includes 18 organisations from 11 countries was founded on the premise that CEE societies share cultural and historical heritage, tend to be in similar stages of digital progress, and have a common digital identity. Its establishment was marked by the signature of the “Warsaw Digital Declaration”, when 12 associated organisations joined forces and agreed to support both private and public sectors in creating innovative and safe digital environments in Europe.

# CEE countries snapshot

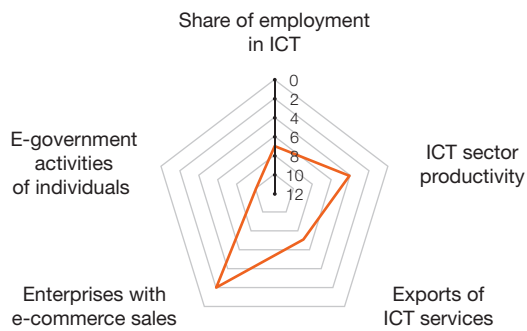
## Bulgaria



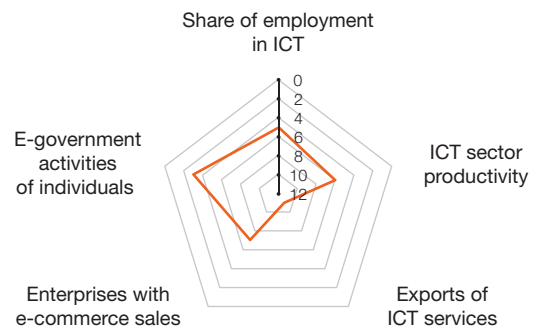
## Estonia



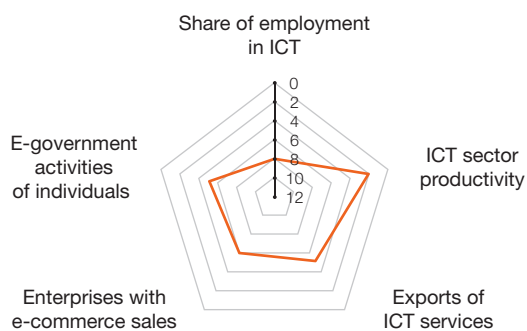
## Croatia



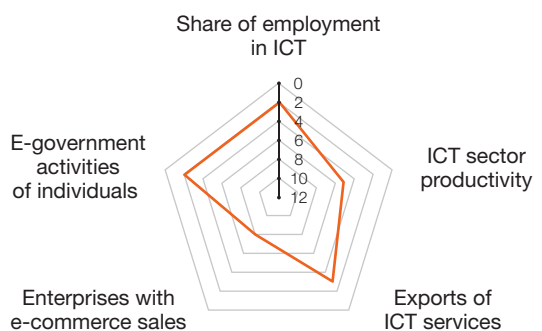
## Hungary



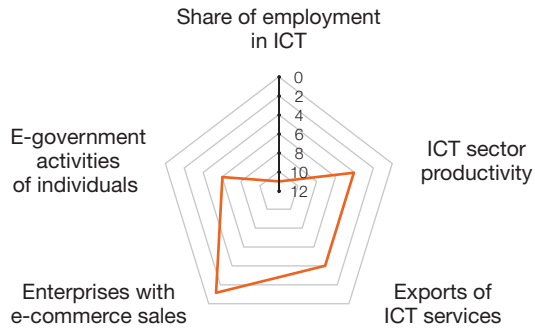
## Czechia



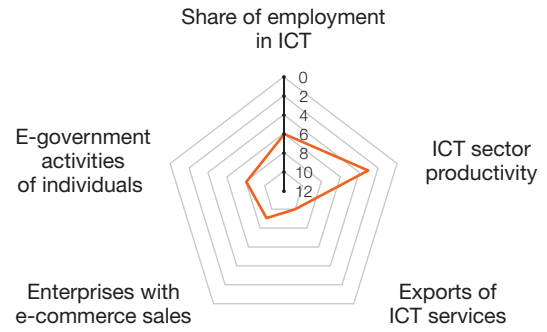
## Latvia



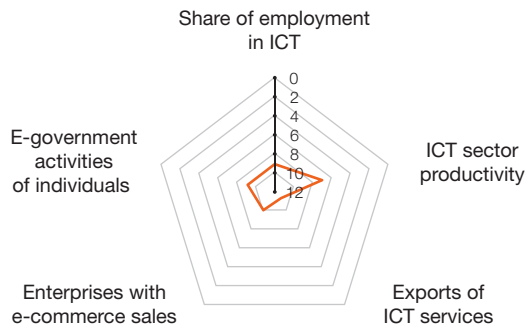
### Lithuania



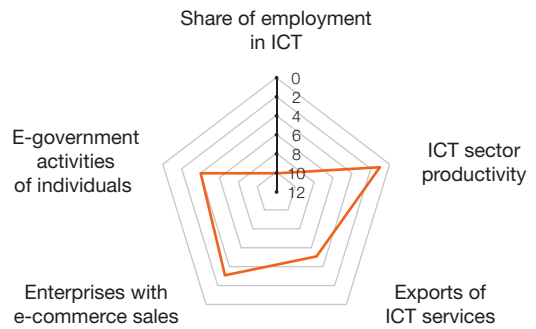
### Slovakia



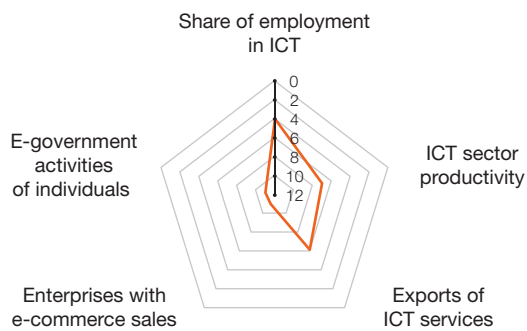
### Poland



### Slovenia



### Romania



Note: The charts above show each country's position analysed in this report. Each country is rated from 1 (highest) to 11 (lowest).

# Contents

Digital Economy in CEE: outlook	7
Digital Economy in CEE: drivers	13
Digital infrastructure	14
Education and talent upskilling	18
Macroeconomic environment	21
Business ecosystem	24
Digital economy in CEE: catalysts	27
Artificial Intelligence	28
Cloud technology	30
Cybersecurity	32
Digital economy in the CEE: what's next?	35
Country profiles	37



# Digital Economy in CEE: outlook





In this chapter, some basic data allow us to outline how the digital economy fares in Central and Eastern European countries in terms of basic categories and how these countries rank compared to Western European or other European Union countries. We will look at several basic indicators determining the situation of the digital economy in the region.

The digital economy encompasses all economic activities that rely on digital technologies, which includes the internet, mobile technology, and all types of digital communication and computing tools. This broad domain covers a wide range of sectors, from traditional fields like banking and retail transformed by online transactions, to recent domains such as e-commerce platforms, digital content production, and cloud computing services. At its core, the digital economy is characterised by its emphasis on data as a key resource, the widespread use of online platforms to connect producers and consumers, and the innovative application of technologies such as artificial intelligence and blockchain to enhance efficiency as well as creating new value.

In Central and Eastern European countries, the digital economy is rapidly evolving. It has been driven by the increasing digital literacy, infrastructure development, and supportive policies aimed at fostering

digital innovation and cross-border e-commerce within the region and beyond.

Whilst analysing the digital economy across the CEE region there are some indicators especially noteworthy. There are some areas in which the CEE region is already ahead of more developed economies in the EU — such as the share of employment in the ICT sector or the number of enterprises in the ICT sector per 1000 inhabitants. However, ICT enterprises in Western Europe tend to have higher productivity with EUR 135,512 in value added per employee, compared to EUR 45,351 in CEE. Central and Eastern European countries record weaker results in digitisation of enterprises and individuals and indicators such as e-commerce sales, cloud services and big data use and e-government activities of individuals (measured as internet interaction with public authorities in the last 12 months), which shows room for convergence.

## ICT sector development

	Central and Eastern Europe <sup>2</sup>	Western Europe <sup>3</sup>
Share of employment in ICT sector (2021)	<b>4.8%</b>	<b>4.1%</b>
Number of enterprises in ICT sector per 1000 inhabitants (2021)	<b>3.9</b>	<b>2.1</b>
Average value added per person employed, EUR (2021)	<b>45 351</b>	<b>135 512</b>
Share of ICT value added in total value added (2021)	<b>5.7%</b>	<b>6.3%</b>

<sup>2</sup> Central and Eastern Europe in this report covers 11 countries: Bulgaria, Croatia, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia.

<sup>3</sup> Western Europe in this report covers 14 countries: Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, Malta, Netherlands, Portugal, Spain, Sweden.

## Digitalisation of enterprises and individuals

	Central and Eastern Europe	Western Europe
Enterprises with e-commerce sales (2022)	21.9%	28.0%
Enterprises buying cloud computing services using Internet (2023)	39.7%	53.5%
ICT enterprises analysing big data (2020)	20.3%	29.9%
E-government activities of individuals — interaction with public authorities (2021)	56.6%	72.7%

Source: prepared by PwC based on Eurostat data.

## The Digital Economy and Society Index

The Digital Economy and Society Index (DESI) serves as a tool to oversee the digital performance across Europe and to monitor the advancement of European Union (EU) nations in terms of their digital competitiveness. Every year, it evaluates the digital connectivity, proficiency in digital skills, online engagement, and provision of digital public services within member states. This assessment aims to gauge the level of digitalisation in each member state and pinpoint areas that necessitate further investment and strategic action.

The Central and Eastern European (CEE) countries exhibit differing degrees of digitisation. According to the Digital Economy and Society Index (DESI)

for 2022, which assesses digitisation across four key categories and encompasses 33 indicators, only three out of the 11 CEE countries — Estonia, Slovenia, and Lithuania — surpass the EU average. The majority of these countries rank in the lower half of the index. Among the CEE countries, Estonia stands out as a leader in digitisation, particularly noted for its high-quality digital services in public administration.

The remaining countries are doing much worse — Slovenia is still in the middle of the pack, while as many as eight Central and Eastern European countries recorded a result below the EU average, which was 52.27 last year. Bulgaria and Romania deviate the most from the entire EU, with results of 37.67 and 30.58, respectively.

Chart 1. Countries' scores in the DESI 2022 ranking



Source: prepared by PwC based on European Commission data.

**Chart 2. Digital public services for businesses (DESI period 2023, data from 2022)**



Source: prepared by PwC based on European Commission data.

In the case of digital public services for businesses, it turns out that often highly developed countries, including those with highly developed digital economies, may not necessarily be leaders in this category. The “Digital public services for businesses” indicator is crucial for illustrating the digital economy in CEE countries as it reflects the efficiency, innovation capacity, and competitiveness of their digital infrastructures, directly impacting economic growth and digital transformation progress. The second indicator, i.e. SMEs with at least a basic level of digital intensity, will allow us to show how business adapts to the new digital environment.

Digital services for business look much better in smaller countries such as Estonia, Lithuania or even Latvia, which, also due to their much smaller scale, can more quickly and easily introduce innovative digitisation solutions for business. Estonia has been a leader in this area for years, although at the EU level it was second to both Finland and Ireland according to DESI 2023. It is worth noting that in the category checked by this indicator, such strong economies as France and Germany, which, due to their size, cannot implement digital solutions for business as quickly, were below the EU average.

The final three are closed by Poland, Croatia and Romania. It should be noted that Bulgaria, which usually closes the pond, was ranked exceptionally high in this category, just 3 points from the EU average. The digital environment is much more developed for business in Bulgaria than, for example, in Italy or the aforementioned France and Germany.

In analysing SMEs with at least a basic level of digital intensity in CEE, the data reveals a spectrum of digital adoption. Countries like Czechia, Slovenia and Estonia higher digital intensity, showcasing their advancements in integrating digital technologies within SMEs. However, other CEE nations such as Romania, Latvia, Hungary, and Bulgaria display lower percentages. This variation signals the diverse digital landscape across the CEE, highlighting areas of growth and the need for increased digital upskilling and infrastructure development to boost digital integration among SMEs in the region.

**Chart 3. SMEs with at least basic level of digital intensity, without financial sector (DESI period 2023, data from 2022)**



Source: Prepared by PwC based on European Commission data.

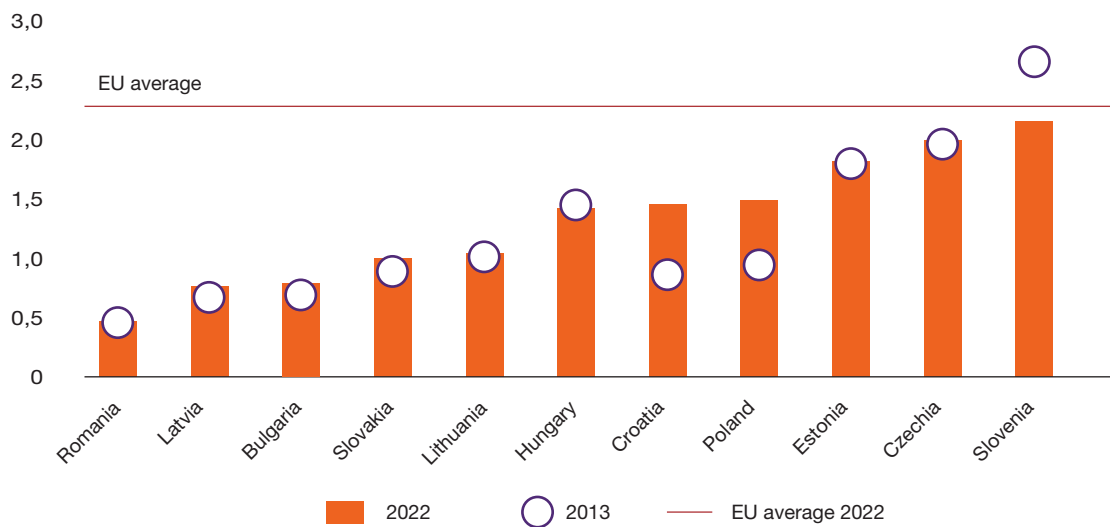
## Digital expenditures

The R&D expenditures shown below include business enterprise, government, higher education and private non-profit sectors. Below data including R&D spending as a percentage of GDP and in absolute terms as GERD by sector of performance is presented.

Among CEE countries, Slovenia has the highest percentage share of R&D expenditures in all expenditures, as high as 2.11% of GDP. On the other hand,

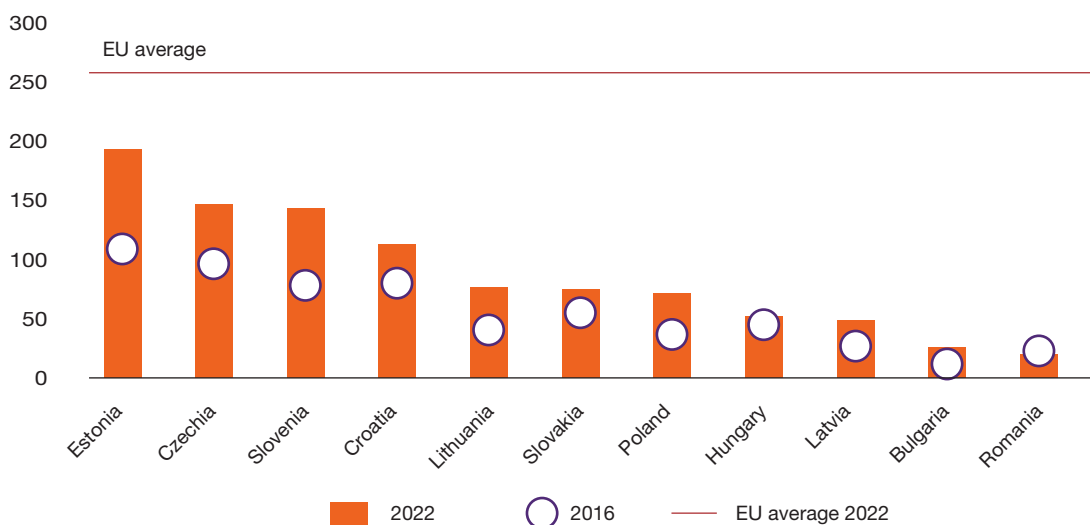
even Slovenia was below the EU average of 2.23% of GDP here. The country that allocates proportionally the most among the CEE countries was ranked 8th in the entire EU. Czechia and Estonia also stand out, allocating more than 1.5% of GDP. In the middle of the pack are Poland, Croatia and Hungary. Lithuania and Slovakia spend slightly less on R&D in percentage terms, whilst Bulgaria and Latvia spend the least. A clear outlier not only from the EU as a whole, but also from the CEE countries, is Romania, whose spending in 2022 was only 0.46% of GDP.

**Chart 4. Gross domestic expenditure on R&D (GERD) as a percentage of GDP**



Source: prepared by PwC based on Eurostat data.

**Chart 5. Total government budget allocation for R&D (EUR per capita)**



Source: prepared by PwC based on Eurostat data.

Taking into account data from the last five years, R&D spending is increasing in most CEE countries. However, this is not the case for Hungary and Romania, which deviate from this pattern. The data covering the period up to 2022 already shows that some countries had to revise their R&D spending after 2021 as a result of the crisis caused by the coronavirus pandemic.

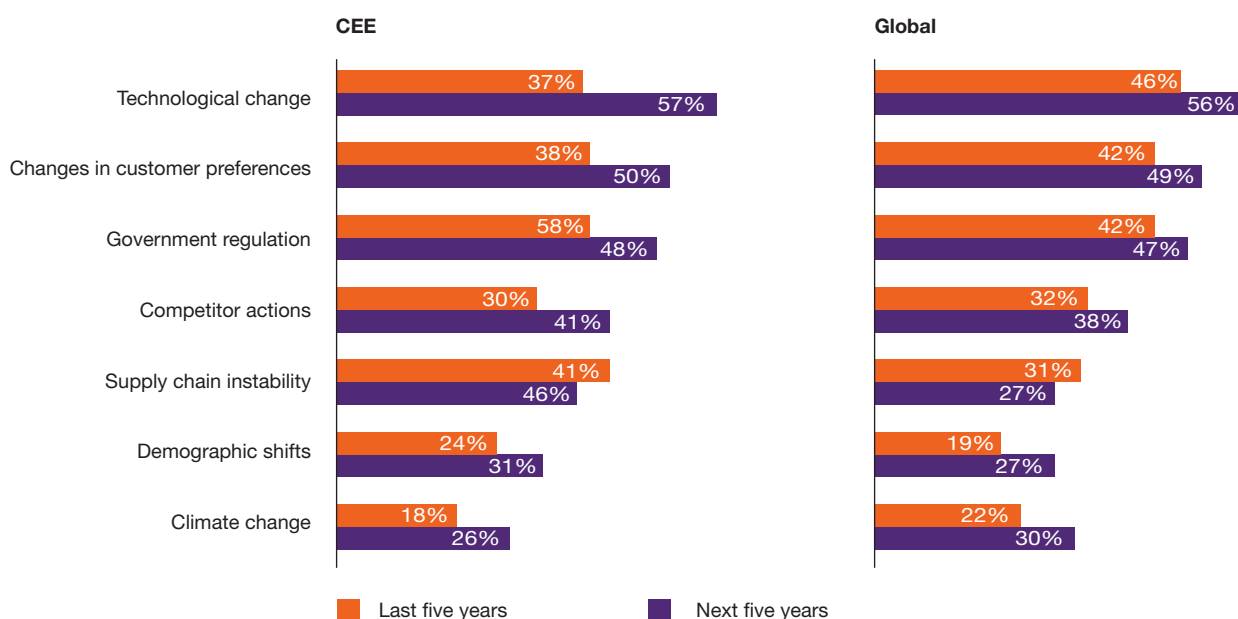
The numbers tell us how much money each person in Central and Eastern European countries effectively contributes to their nation's research and development (R&D) efforts through government budgets. Estonia is the front-runner, investing almost EUR 196 per person in R&D, which could mean that Estonians are quite serious about driving innovation. Czechia and Slovenia are close as each country spends around EUR 149 and EUR 145 per person, showing they are also keen on advancing in science and technology. Poland, Croatia, and Lithuania are close to the middle with each country spending between EUR 73 and EUR 115. At the other end, Romania, Bulgaria, and Latvia appear more cautious, with Romania's per-person spending is just under EUR 21. These figures give a peek into each country's investment in the future, with some clearly prioritising R&D more than others.

All cumulative government R&D allocation in the CEE countries has not even crossed the EUR 7.2 billion barrier. This is far too little to consider these countries as pioneers in such spending. CEE countries collectively spend less on these purposes than France, not to mention Germany, which allocates more than one third of what the entire European Union spends on R&D. In absolute terms, Poland spends the most — more than EUR 9.5 billion, while Latvia spends the least (EUR 290 million). While in terms of percentage of GDP the distance between the strongest EU economies and the CEE region is not so visible, in absolute terms one can already see the gap, which may result in an even greater widening of the distance in this area between the West and Central and Eastern Europe.

### Technological change as a driver of transformation

**The CEE business leaders predict technological change as the main driver of transformation in the next three years, with 57% of CEOs in the region indicating its importance.** It is a significant rise compared to how it was viewed over the last five years (37%). In the next chapter we describe pillars of digital economy development.

Chart 6. Drivers of transformation in the way companies create, deliver and capture values



Source: PwC, PwC's 27th Annual Global CEO Survey. Question: Please indicate the extent to which the following factors have driven/will drive changes to the way your company creates, delivers and captures value in the last five years/next three years. (Showing only 'to a large extent' and 'to a very large extent' responses).



# Digital Economy in CEE: drivers

In this part, the factors that drive or may drive the development of the digital economy in CEE countries are presented. The data and indicators presenting this information are divided into four parts: Digital infrastructure, Education and talent upskilling, Macroeconomic environment and Business ecosystem. One of the sections in this part is devoted to presenting The CEE Digital Coalition initiative.

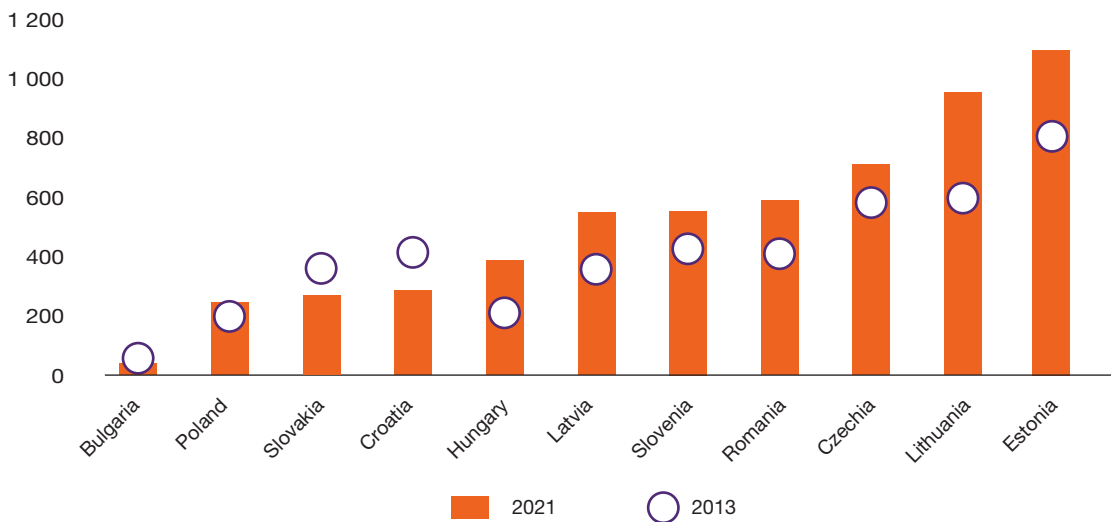


# Digital infrastructure

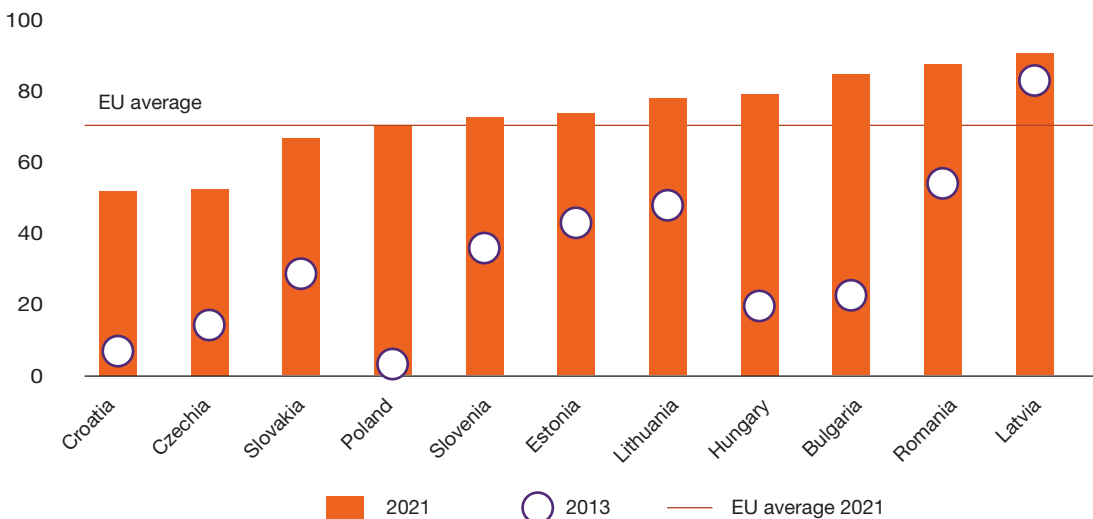
The digital infrastructure in Central and Eastern Europe (CEE) is on a strong growth trajectory, underscored by its increasing broadband penetration and the expansion of digital services. With investments flowing into high-speed internet, cloud computing, and data centres, the region is positioning itself as a key hub for digital innovation. The deployment of 5G networks is further enhancing connectivity, promising to revolutionise industries by enabling faster and more reliable services. This robust digital framework supports the CEE's vision to become a leading digital economy, attracting tech talent and fostering a vibrant startup ecosystem.

Below several indicators that illustrate how this infrastructure is currently developing are presented. The value of ICT infrastructure stocks shows the value of ICT equipment in the economy. While progress has been made, there is still a lot of work to be done to enhance digital infrastructure and promote innovation. As compared to the rest of the EU, CEE countries are lagging behind with regional leaders – Estonia and Lithuania being in 7th and 9th place respectively. There are some investment gaps compared to Western Europe and bridging this gap is essential for CEE countries to reach the level of more developed European nations.

**Chart 7. ICT infrastructure stocks in the economy (EUR per capita)**



**Chart 8. High-speed internet coverage (% of households)**



Source: Prepared by PwC based on Eurostat data.

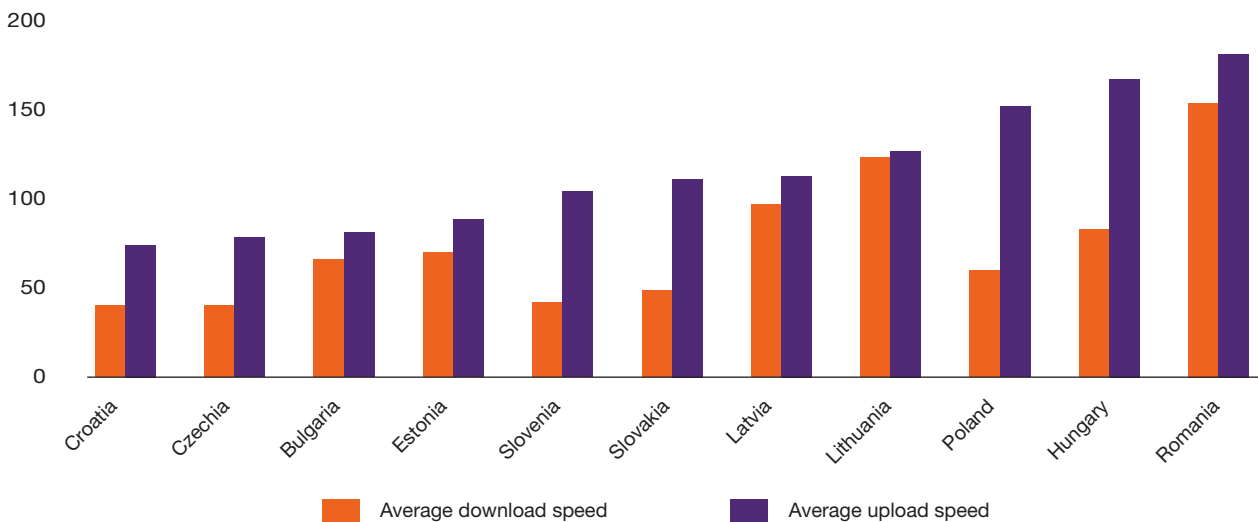
The data highlights varying levels of high-speed internet accessibility among Central and Eastern European (CEE) countries. Although the majority of analysed countries have higher coverage than EU average, there are still some countries lagging behind (i.e. Croatia, Czechia and Slovakia). These variations may stem from factors including infrastructure development, regulatory frameworks, and technological adoption rates. Overall, with the EU average at 70.2%, it is evident that there is a need for concerted efforts to ensure equitable high-speed internet coverage across all CEE nations. In 2021, the European Commission set a 2030 target of achieving gigabit connectivity in all EU households and 5G coverage for all populated areas. In terms of 5G coverage in 2022 only three CEE countries were above the EU average (Lithuania, Czechia and Croatia).

Among the CEE countries, Romania stands out with impressive download and upload speeds, ranking first in both categories. Hungary also showcases notable download speeds, ranking second.

However, other CEE nations such as Slovakia, Slovenia, Estonia, Bulgaria, Czechia and Croatia exhibit lower average speeds compared to Western European counterparts, indicating potential areas for improvement in internet infrastructure and connectivity.

Overall, while some CEE countries demonstrate competitive internet speeds, there is variability across the region, highlighting the need for continued investment in broadband infrastructure and technology to ensure equitable access and connectivity for all citizens. In contrast, Western European countries like France, Denmark, and the Netherlands lead in both download and upload speeds, reflecting advanced infrastructure and technological development. This discrepancy underscores the need for increased investment and infrastructure development in CEE countries to bridge the gap and ensure equitable access to fast and reliable internet services across the entire European Union.

**Chart 9. Internet speed in 2022 (Mbps)**



Source: Prepared by PwC based on Speedtest by Ookla Global Fixed and Mobile Network Performance Map.



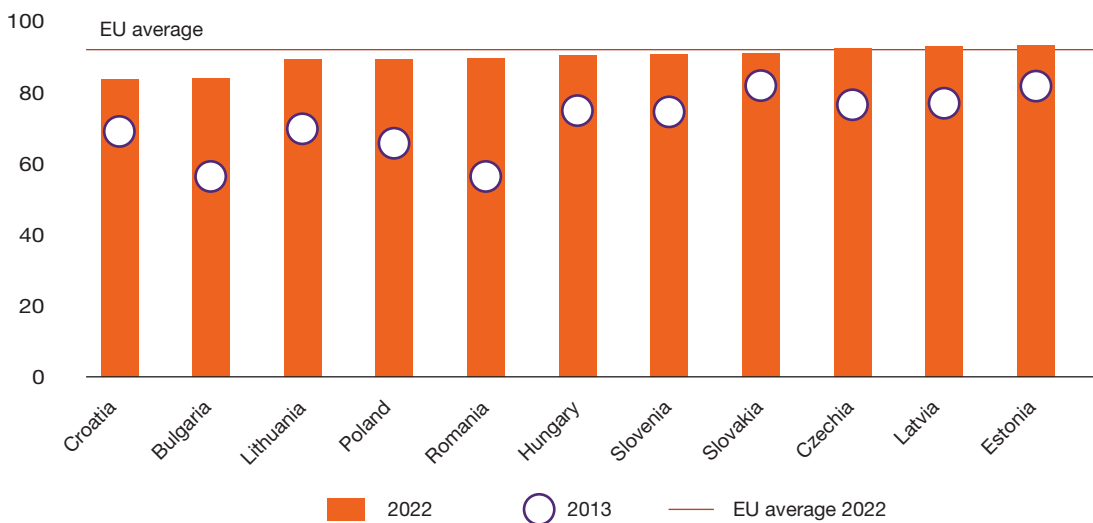
## Technology adoption

Another valuable indicator for measuring technology adoption in EU countries is the percentage of individuals using the internet. This indicator provides insight into the penetration of internet usage among the population, regardless of whether they access it through broadband or other means. It reflects the extent to which individuals are actively engaged with online platforms, services, and content, offering a broader perspective on digital inclusion and connectivity within a society. The second indicator that shows how countries adapt technology to develop the digital economy is interaction with public authorities in the last 12 months via the internet, showing availability of such services in each country.

CEE countries generally exhibit slightly lower internet usage rates compared to the EU average of 91.09%. While Hungary (89.7%), Romania (88.9%) and Poland (88.4%) fall below the EU average, others such as Czechia (91.6%), Latvia (92.2%) and Estonia (92.3%) are close to the average. This suggests that while internet adoption in CEE countries is generally robust, there are some disparities across the region.



Chart 10. Internet use (% of individuals)



Source: Prepared by PwC based on European Commission data.

Overall, while internet usage rates in CEE countries may vary, the region as a whole demonstrates a substantial level of digital engagement. **Efforts to further promote internet access and digital literacy can help bridge the gap and ensure equitable participation in the digital economy across the entire European Union.**

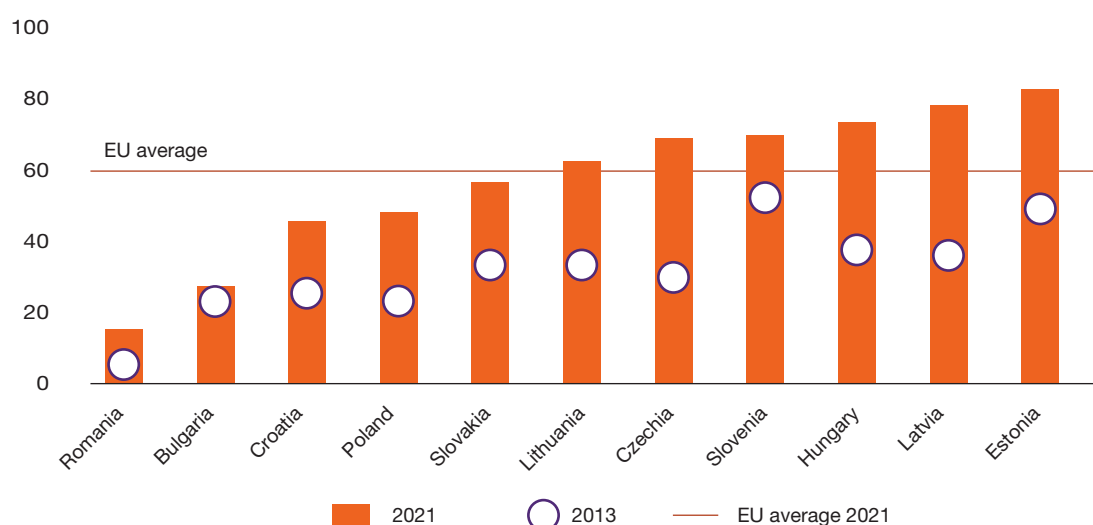
In terms of e-government activities of individuals via websites — interactions with public authorities via the internet in the last 12 months, there are some leaders such as Estonia, Latvia and Hungary significantly exceeding EU average, whereas Romania and Bulgaria are still lagging behind. Romania with one of the EU's least developed systems of online public services, has extensive internet infrastructure with one of the highest high-speed internet coverage in the CEE region. The pandemic has increased the pace of digitalisation in the region.

Another indicator, the DESI digital public services for citizens (share of administrative steps that can be done online for major life events for citizens) shows that CEE countries generally show lower scores in digital services for citizens compared to the EU average of 77.03 points. While Latvia (87.17), Estonia (94.04), and Lithuania (83.85) perform relatively well and are close to or above the EU

average, others such as Romania (47.58), Bulgaria (59.52), Poland (59.92) and Hungary (67.87) score below the average. This indicates disparities in the availability and accessibility of digital services across the region. Among CEE countries, Estonia stands out as a top performer with a high score of 94.04 points, indicating robust digital infrastructure and widespread availability of digital services for its citizens. Moreover, Latvia also performs well with a score of 87.17 points, demonstrating a strong commitment to digitalisation and technological advancement. On the other hand, countries like Poland, Romania, Bulgaria, and Hungary face challenges in providing comprehensive digital services to their citizens, scoring below the EU average. These countries may need to focus on improving digital infrastructure, enhancing digital literacy, and implementing policies to promote the adoption of digital technologies to bridge the gap with their Western European counterparts.

Overall, while some CEE countries excel in e-government services available for and used by citizens, there are notable disparities across the region. Efforts to address these disparities and promote digital inclusion and accessibility can contribute to the overall advancement of the digital economy and society in CEE countries.

**Chart 11. E-government activities of individuals via websites — internet use: interaction with public authorities in the last 12 months (% of individuals)**



Source: Prepared by PwC based on Eurostat data.



# Education and talent upskilling

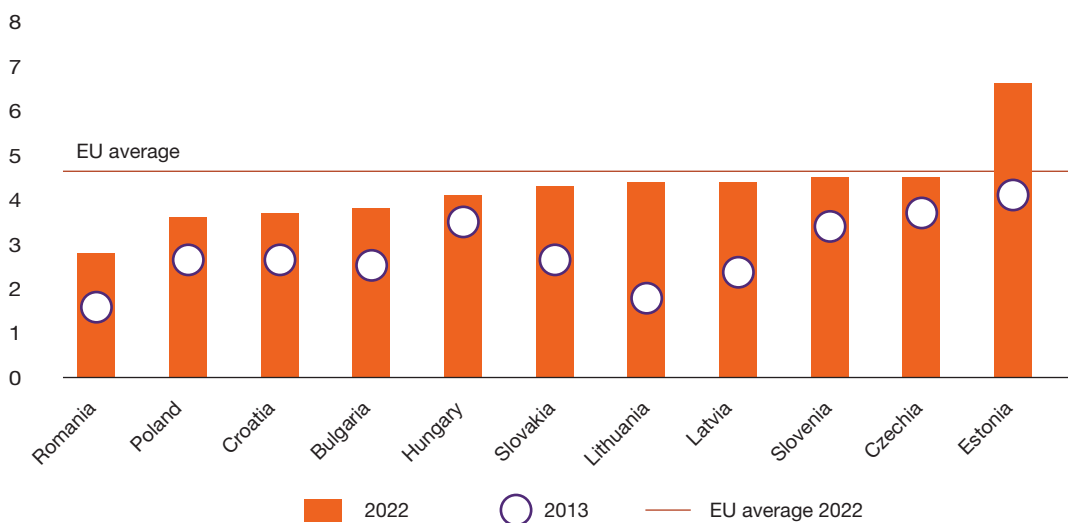
**Education and talent upskilling** in the ICT sector in the CEE is seeing a dynamic evolution, aimed at bridging the digital skills gap and propelling the workforce into the forefront of the global tech industry. With an acute focus on enhancing STEM education, coding skills, and advanced IT training, CEE countries are leveraging a mix of academic rigour and practical training programs. This comprehensive approach not only prepares individuals for the complexities of the tech world but also aligns with the region's strategic vision to emerge as a significant player in the international digital economy.

## ICT specialists

To stay competitive in the global technology race and advance its digital agenda, the European Union aims to boost the number of ICT specialists<sup>4</sup> in the workforce. Currently, there are 9.37 million ICT professionals in the EU, making up 4.6% of the total employment. The goal is to increase this figure to 20 million by 2030. However, achieving this target will require significant efforts, especially from the CEE countries. Except for Estonia, where the percentage of ICT specialists in employment stands at 6.6%, most CEE countries fall below the EU average, as depicted in Chart 12. While the deviation from the EU average is not significant in six CEE countries, significantly increasing the proportion of ICT specialists in the workforce poses a challenge that demands coordinated actions across various sectors: higher education and continuous learning, the job market, and collaboration with the private sector.

Closing the gap in the number of ICT specialists might pose a challenge, partly because there is a relatively low number of graduates in relevant fields. In CEE countries, the percentage of STEM (Science, Technology, Engineering, and Mathematics) students compared to the population is below the EU average. On average, in the countries analysed, only 17 out of 1000 people aged 20 to 29 have degrees in these subjects, which falls below the EU average. It is worth noting that STEM graduates are not solely destined to become IT specialists. Strategies aimed at fostering skills crucial for building a competitive economy in the near future stress the importance of STEM education. While Slovenia is edging closer to the EU average, some countries notably diverge from it. Hungary and Slovakia, in particular, have the lowest number of STEM graduates.

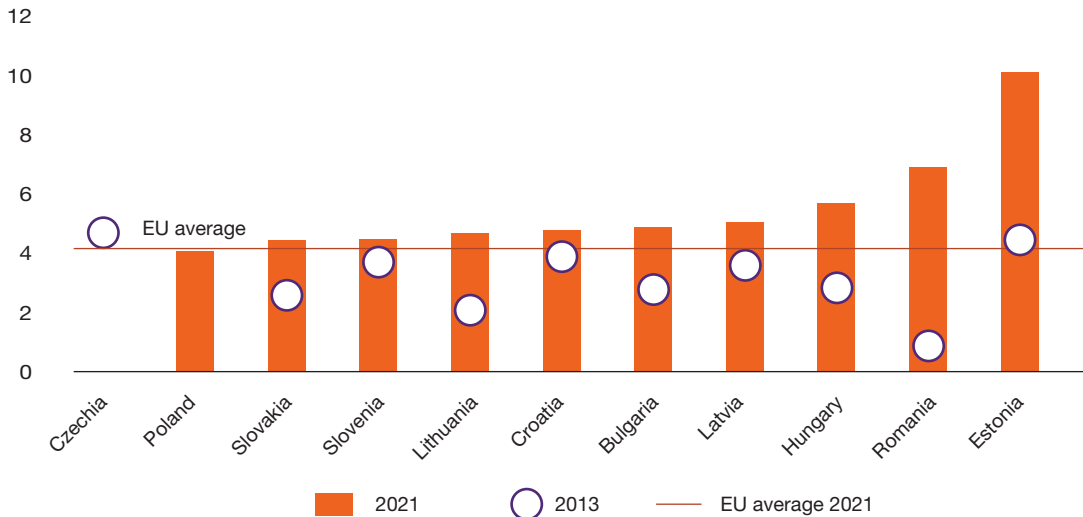
**Chart 12. ICT specialists in the total workforce (% of total workforce)**



Source: Prepared by PwC based on Eurostat data.

<sup>4</sup> Note: ICT specialists aggregate presented in Eurostat is based on different classification system (ISCO – International Standard Classification of Occupations) than the share of employment in ICT sector (based on NACE Rev. 2 classification), therefore numbers might differ between these two indicators.

**Chart 13. ICT graduates (% of graduates)**



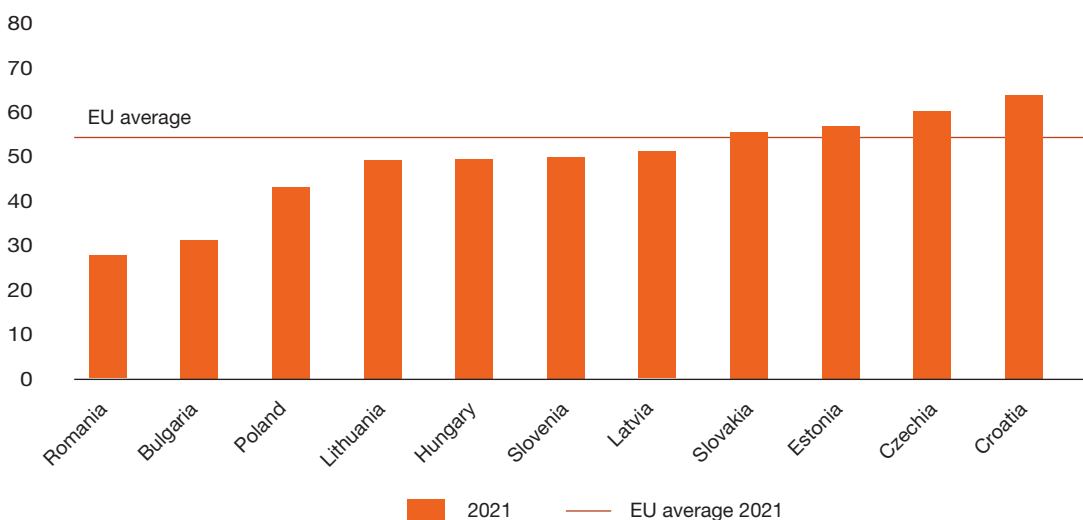
Source: Prepared by PwC based on European Commission data\* — data not available for Poland for 2022 and for Czechia for 2013.

In the context of ICT graduates as a percentage of all degree graduates, Estonia leads the CEE countries with a notable 10.1%, indicative of its strong emphasis on technology and digital education. Romania follows with 6.9%, while Hungary, Latvia and Bulgaria also show significant contributions at 5.7%, 5% and 4.9% respectively. These figures, surpassing the EU average of 4.2%, suggest that certain CEE nations are fostering substantial ICT talent, potentially driving digital innovation and growth in the region. Conversely, countries like Poland and Slovakia, at 4.1% and 4.4%, are closer to the EU average, indicating a more moderate integration of ICT education among total graduates.

**Basic digital skills in CEE countries**

At the level of social potential, two indicators show how particular nations acquire new digital skills. The first indicator conveys the percentage of that has basic digital skills. The second indicator is more important, primarily for business, as it shows basic skills in creating digital content, which allows us to present how societies are prepared for technological development and changes in the labour market.

**Chart 14. At least basic digital skills (% of all individuals aged 16-74)**



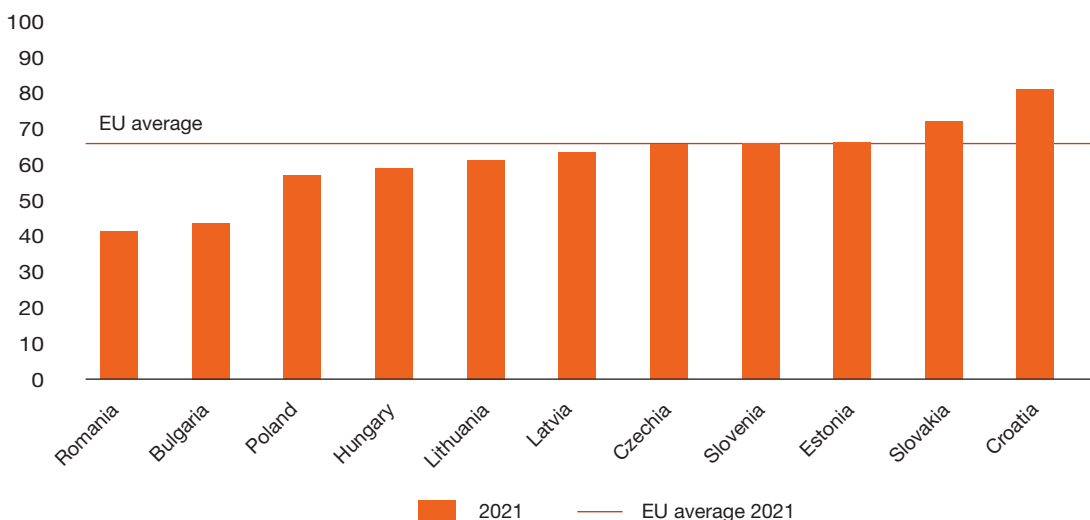
Source: Prepared by PwC based on European Commission data.



In the landscape of digital competencies across the CEE region, Croatia leads with 63.37% of individuals aged between 16 to 74 possessing at least the basic digital skills, outperforming the EU average of 53.92%. Czechia and Estonia follow closely, showing that a significant portion of their populations have foundational digital skills. Slovakia is also above the EU average, reflecting concerted efforts in digital upskilling. Towards the lower end of the scale, Poland, Bulgaria, and Romania have percentages below the EU benchmark, indicating potential areas for growth in digital education and skill development initiatives to enhance their digital economies.

Croatia exhibits a notable lead in digital content creation skills, with 81.25% of individuals aged between 16 to 74 are proficient in these abilities, significantly surpassing the EU average of 66.16%. Slovakia and Estonia also demonstrate strong performance in this area, suggesting a robust digital skill set among their populations. While most CEE countries levitate around or slightly below the EU average, Poland, Bulgaria, and Romania fall behind, highlighting opportunities for targeted digital skill-building initiatives to foster content creation competencies within these societies.

**Chart 15. At least basic digital content creation skills in 2021 (% of all individuals aged 16-74)**



Source: Prepared by PwC based on European Commission data.

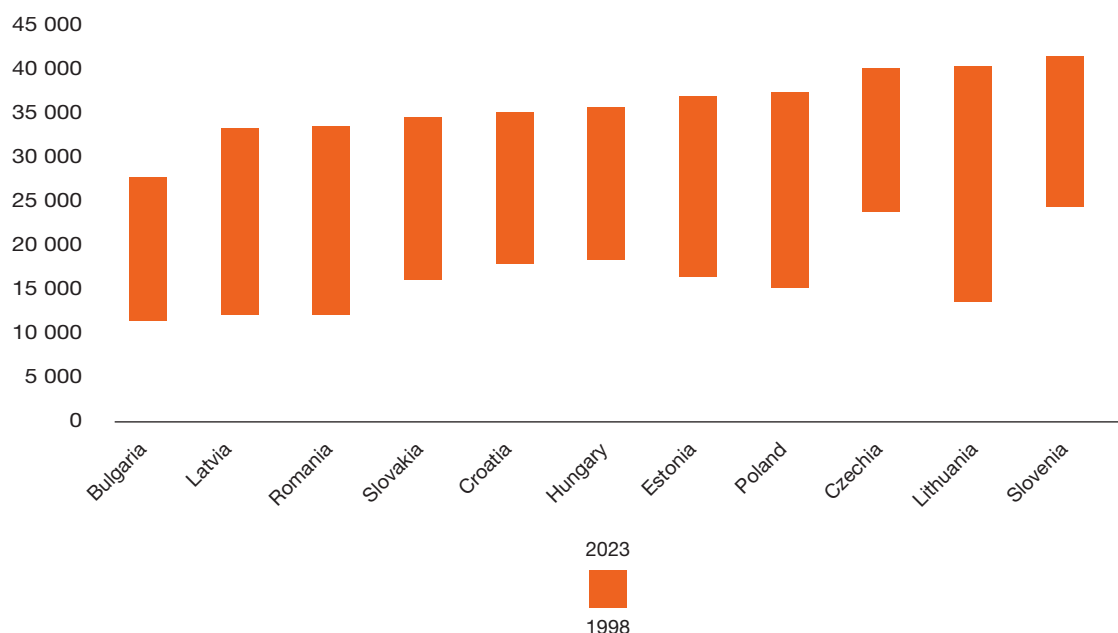
# Macroeconomic environment

Central and Eastern Europe is one of the most successful regions in terms of catching up to its Western counterparts in economic development. It is all the more important, given the importance of the favourable macroeconomic environment in providing conditions for the growth of the digital economy, e.g. increased spending on the ICT sector by businesses and individuals. On the other hand, the COVID-19 pandemic, despite having a detrimental impact on the economy, resulted in surging growth rates of the digital sector due to increased use of IT tools.

In the last 25 years, CEE countries have experienced surging economic growth rates with the pioneers being Lithuania, Latvia and Romania with 201.5%, 185.4% and 179.3% rise in real GDP per capita respectively. In comparison, over the same period, developed economies such as France or Germany have grown by only 24 and 30% respectively. In terms of the current state of development, Slovenia, Lithuania and Czechia are the leaders, while Bulgaria, Latvia and Romania performed relatively poorer.

Another measure showing the economic environment are labour costs, which — given their tendency to be relatively low — might entice companies to locate businesses in particular countries. This was one of the drivers of the growth of foreign direct investment in the CEE over the last three decades. Although competitive labour costs are still one of the drivers of the CEE region, their advantage is diminishing with the CEE region catching up with Western Europe. Yet still, Bulgaria, Romania, Hungary, Croatia, Latvia and Poland are among countries with the lowest labour costs in the EU. On the other hand, countries are doing more and more to decrease the importance of labour costs as their economic advantage and become more reliant on an advanced business environment. In that light, sustained economic growth will be more dependent on the adoption and proficient use of digital technologies, especially artificial intelligence (AI). It is particularly important to take actions in order to increase digitalisation of the society, e.g. at least through improving basic digital skills among individuals in the EU. More importantly, the EU needs a bigger pool of digital specialists to protect businesses and public services in Europe and to design cybersecurity solutions fit for the future<sup>5</sup>.

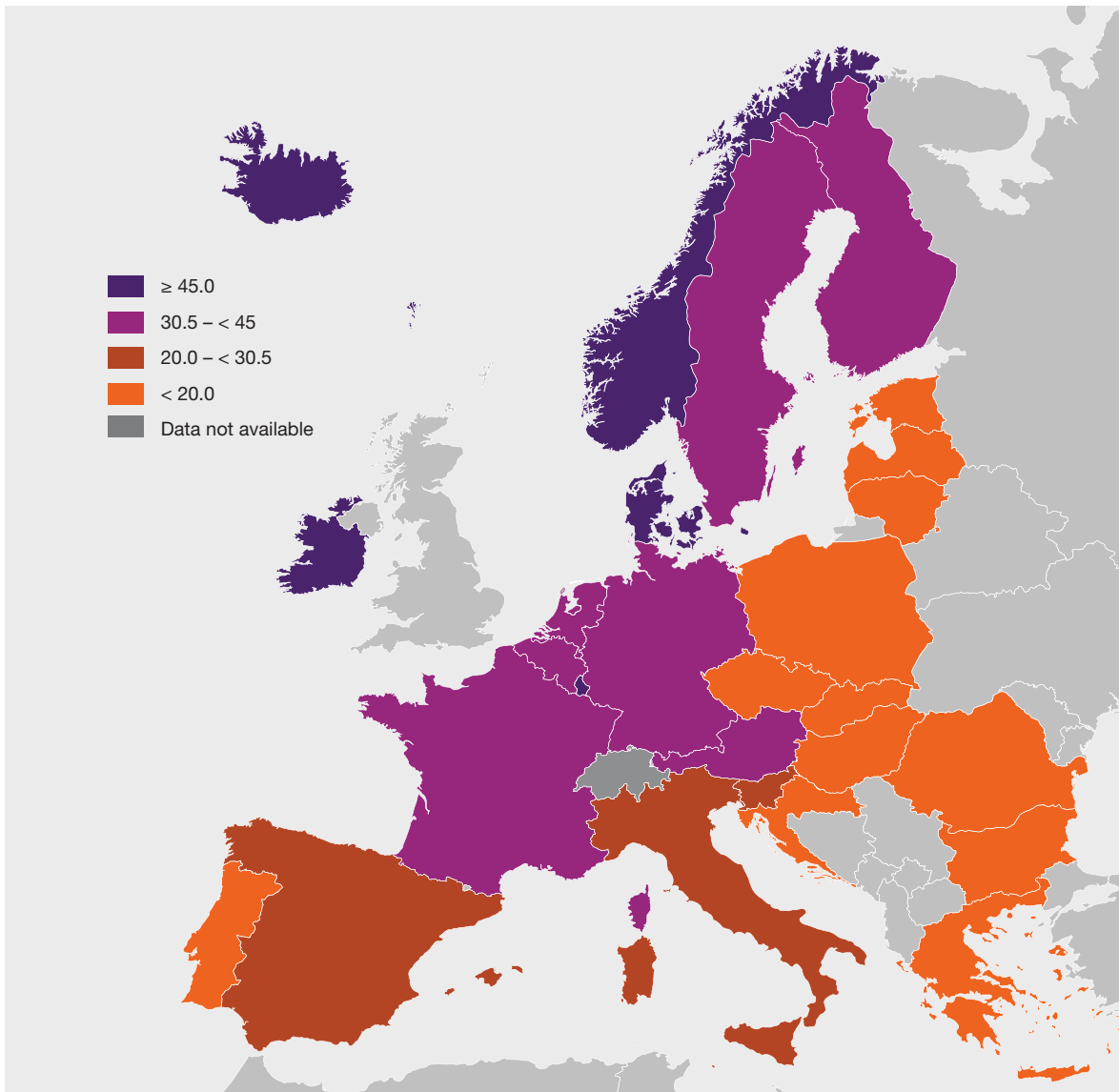
**Chart 16. Real GDP per capita in purchasing power parity (2017 international dollar)**



Source: Prepared by PwC based on European Commission data.

<sup>5</sup> European Commission, Digital Decade Cardinal Points, Report on the state of the Digital Decade 2023.

## Hourly labour costs in 2022 (in EUR, enterprises with 10 or more employees)



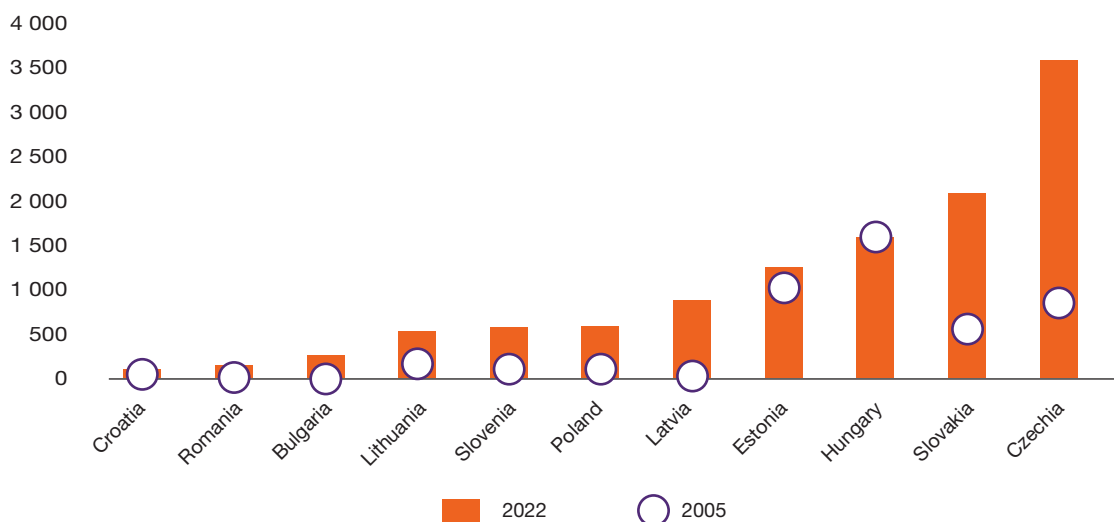
Source: Eurostat, Labour cost levels by NACE Rev. 2 activity.

Trade in ICT goods and services is another macroeconomic indicator showing the level of internationalisation and integration with external partners of the CEE countries. Only countries which trade intensively with the world and do not protect local vested interests can have access to technologies and capital necessary to invest in growth potential.

**The total value of ICT goods exports in 2022 reached USD 98.6 billion, up 185% from 2005 in Central and Eastern Europe** (exports of ICT goods in Western Europe has decreased by 9.5% during the same period, however it might be a result of relocation of manufacturing of ICT equipment activities to the CEE region as a result of lower labour costs). Czechia and Slovakia are the leaders of ICT goods exports per capita with very high computer, peripheral, communication and consumer electronic equipment manufacturing.



**Chart 17. Export of ICT goods per capita in 2005 and 2022 (USD)**

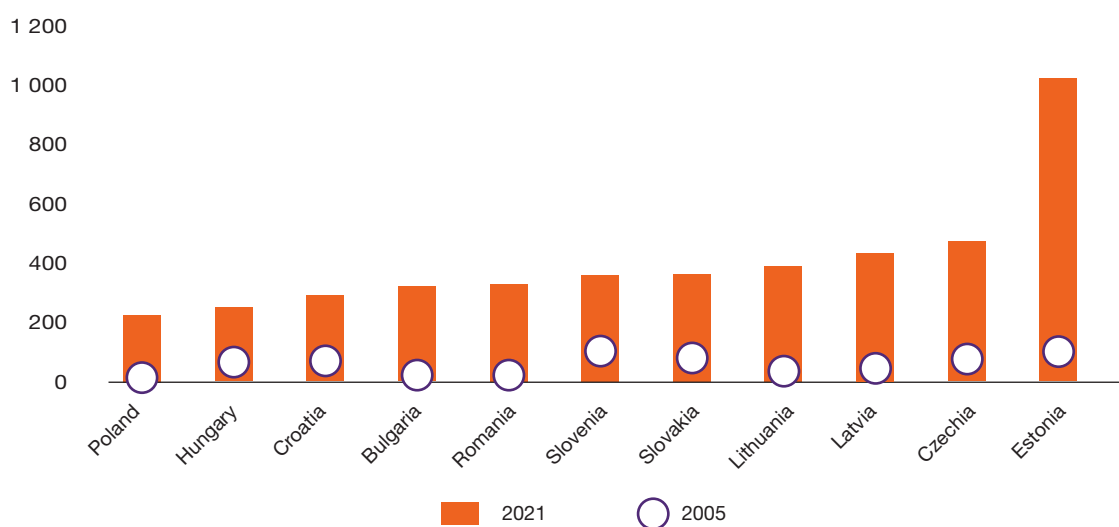


Source: UNCTAD Data Centre (Digital Economy indicators) and World Economic Outlook.

**Exports of commercial ICT services have increased in all CEE economies more than six-fold between 2005 and 2021** with Estonia being the leader in that regard (not only as a result of the extensive ICT sector in the country, but also because of its relatively low population). During the same period, Western European countries experienced three-fold increase. The differences between other CEE countries are not substantial which shows relatively high homogeneity in the group. As EBRD notices, ‘exports of commercial ICT services per capita tend to be higher in economies with less restrictive trade in services

(as measured by an OECD index) and higher levels of digitalisation (including better digital infrastructure and more sophisticated regulations governing the provision of digital solutions and the use of digital technology by firms and individuals)<sup>6</sup>. Indeed, Poland with the lowest value of exports of commercial services has the highest restrictions in the OECD Digital Services Trade Restrictiveness Index (DSTRI), especially in the infrastructure and connectivity pillars, Estonia on the other hand has the least restrictions in that regard among the CEE countries.

**Chart 18. Exports of commercial ICT services per capita in 2005 and 2021 (USD)**



Source: OECD-WTO Balanced Trade in Services (BaTIS) and IMF World Economic Outlook.

<sup>6</sup> EBRD, Transition Report 2023-24, <https://www.ebrd.com/news/publications/transition-report/transition-report-202324.html> [20.03.2024].

# Business ecosystem

**The CEE business ecosystem** presents a compelling mix of opportunities and resilience amid challenges. Its integration with the European Union, robust talent pool, and strategic initiatives to foster innovation and development continue to attract diverse investment activities, underscoring the region's potential as a vibrant hub for business and investment.

In the Index of Economic Freedom, all CEE countries enjoy a high rating. In the latest edition, Czechia was the highest ranked country with 70 points, followed by Bulgaria and Slovakia. All CEE countries recorded results well above average and were classified as 'moderately free'. Several aspects that illustrate the business climate in the digital economy are presented below.

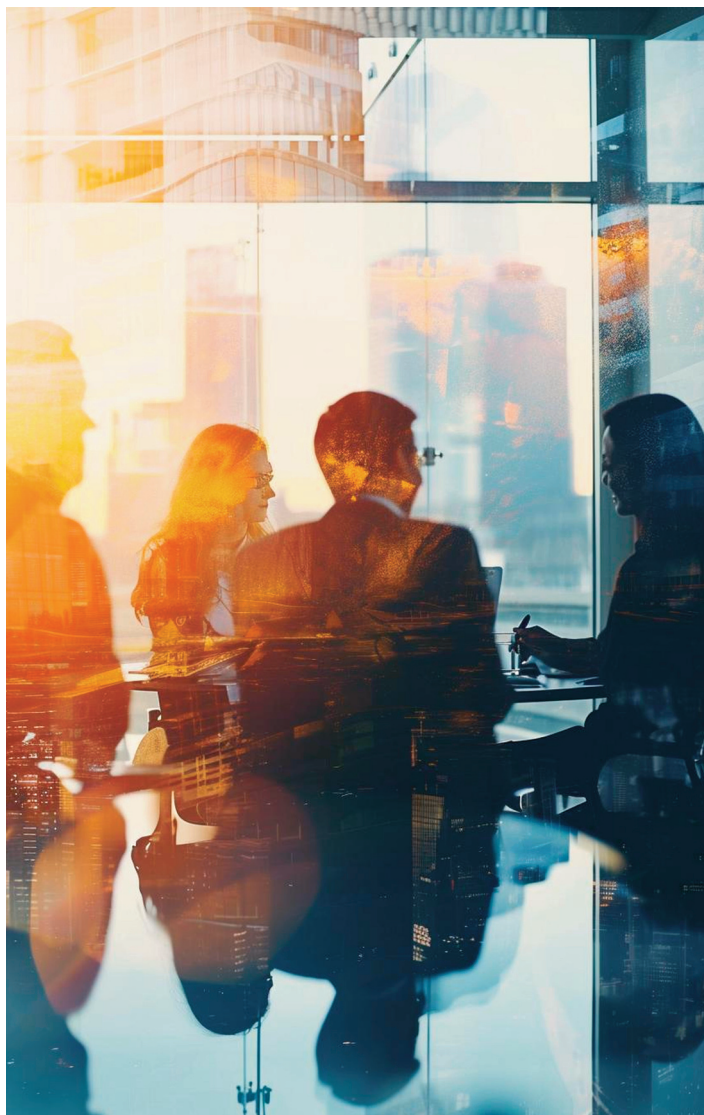
**Investment Activity:** The CEE region shows robust investment trends, with 77% of companies investing in business development. This includes a higher inclination towards product and service innovation compared to the broader European Union — 27% in CEE versus 24% in the EU. Despite facing challenges such as uncertain macroeconomic conditions, rising energy costs, and a shortage of skilled labour, the region's investment in enterprises closely aligns with that of the European Union and the United States.

**Private Equity (PE) and Venture Capital (VC) Growth:** PE investments in CEE have been on a steady rise, leveraging the region's high-quality, cost-effective labour force and its strategic position within the European Union. The VC ecosystem, in particular, has seen exponential growth since 2016, with funding levels surpassing many European counterparts. This surge is backed by the region's solid foundation for economic growth, a high percentage of engineering graduates, and a significant talent pool of developers.

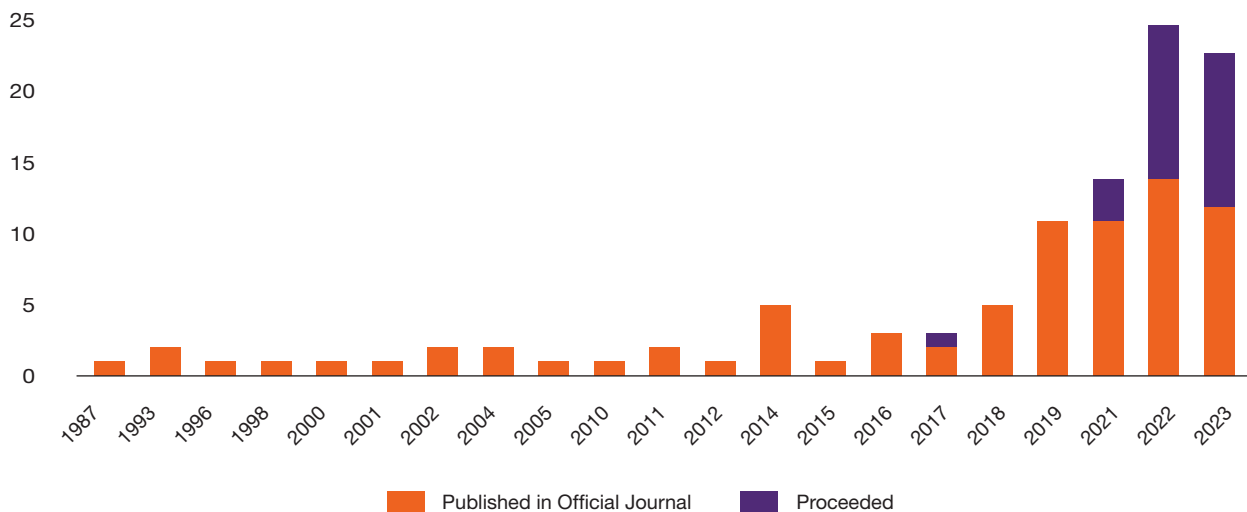
**Economic Indicators and Growth Prospects:** The CEE economies collectively had a GDP of EUR 2 trillion, showcasing a faster growth rate (about 3% from 2016 to 2021) compared to Western Europe. This growth is less volatile than other emerging markets, thanks to EU integration and legal certainty guaranteed by EU memberships. Five of the 11 CEE countries have adopted the euro, further stabilising the region's economic environment.

**Investment Volumes and Sector Trends:** The region's investment landscape remains diverse, with the Industrial and Logistics (I&L) sector leading, followed closely by retail and office sectors. Notably, domestic capital within CEE has been particularly active, demonstrating strong regional investment confidence.

**M&A Activity Amidst Geopolitical Challenges:** The geopolitical tensions, notably Russia's invasion of Ukraine, have intensified existing challenges in the investment scene, including supply chain disruptions and labour shortages. However, the CEE region continues to navigate these complexities, adapting to changing market conditions and maintaining a trajectory of recovery and growth.



**Chart 19. EU Legislations in the Digital Sector**



Source: PwC analysis based on Bruegel's Dataset on EU legislation for the digital world. Data as of 15th March 2024.



*The evolution of new trends in the digital economy has prompted discussions on the need for further regulatory interventions. As the multitude of norms can be a source of compliance costs for companies, creating a balanced regulatory environment is critical not only to accelerate development and facilitate activities of CEE companies engaged in innovating the EU's economy but also to attract investments from like-minded countries outside the EU. Cooperation between the policymakers and the private sector is crucial for ensuring the competitiveness of our region when regulating the rapidly growing ICT sector.*

**Michał Kanownik**, Initiator of CEE Digital Coalition & President of Digital Poland Association

The state of the digital economy in CEE countries can be also analysed through the prism of European digital legislation. Starting from 2018 a rise in a number of legislative acts adopted by the European Union can be observed in that area, with a further increase between 2021 and 2023. One of the most significant EU regulations concerning the development of the digital economy is the Digital Markets Act (DMA), which aims to ensure fair market conditions in the digital sector. The DMA primarily focuses on restraining the power of large digital platforms (referred to as 'gatekeepers') to prevent them from abusing their dominant market positions. It covers a wide range of digital services, including online search engines, social networks, cloud services, and online advertising services. Another important piece of legislation is the Digital Services Act (DSA), which complements the DMA by setting out regulations to protect EU citizens' fundamental rights online and to define measures to control the digital space. In addition to the DMA and DSA, the EU's more recent legislative initiatives also include the Data Act and the Artificial Intelligence Act (AI Act), both of which form part of the EU's broader strategy to foster a digital single market.

The above-mentioned examples of legislative initiatives are part of the comprehensive plan of the EU to build a secure digital economy of the future. Though the purpose of boosting innovation while improving data protection and consumer privacy is valid, the regional policy-makers should take into account the impact of their decisions on the dynamics within the digital markets of the EU. Adopting simple and flexible rules whilst reducing unnecessary obstacles will allow businesses to compete more effectively. New legislation should therefore empower digital communities and enable user safety. In this light, the appropriate functioning of umbrella organisations aimed at uniting the interests of different countries and representing their common demands on international agendas is crucial. One of them is the CEE Digital Coalition, an informal gathering of digital and advanced technologies industry organisations from Central and Eastern Europe, described below.

# CEE Digital Coalition

With the rapid advancements in digital transformation, the European Union has seen a rise in institutions aiming to unite and integrate its domestic ICT industry. One of these divers is the CEE Digital Coalition, ‘an informal gathering of digital and advanced technologies industry organisations from Central Eastern Europe’<sup>7</sup>. By bringing different stakeholders together, the Coalition focuses on facilitating and strengthening close business and governmental collaboration between the CEE countries in the digital sphere. In addition, members of the Coalition, which include 18 organisations from 11 countries, exchange spread knowledge about the contribution of the digital industry to the region’s economic and social growth.

The Coalition was initiated by the Digital Poland Association in September 2020. Its establishment was marked by the signature of the “Warsaw Digital Declaration”, when 12 associated organisations joined forces and agreed to support both private and public sectors in creating innovative and safe digital environments in Europe. The Coalition was founded on the premise that CEE societies share cultural and historical heritage, tend to be in similar stages of digital progress, and have a common digital identity.

## **The following areas are crucial to the CEE Digital Coalition in building digital capacities of the region:**

- digital competence;
- promotion of investments in advanced technologies;
- common access to the internet and digital services for citizens in the CEE region;
- cybersecurity and responsible data management;
- support and development of start-ups;
- support for digital transformation of small and medium enterprises;
- uniform and clear regulatory environment; and
- improvement of connectivity through 5G networks development.

The CEE Digital Coalition has been involved in various activities since its launch, including: issuing statements and opinions, connecting potential partners in the region, consulting regulatory changes, preparing joint project proposals for international funding schemes, raising awareness of good practices, digital potential and success stories in the CEE region. Furthermore, the Coalition organises conferences, educational workshops and webinars, amplifying voices of digitally-engaged leaders, experts and civil society representatives from the CEE region.

The CEE Digital Summit is the Coalition’s flagship event focused on gathering those involved in shaping the digital future of the CEE. Since 2020, the summit has served as a platform for exchanging ideas on the most pressing challenges and issues affecting digitalisation in the region, for example, the relevance of fact-checking and combating disinformation, ways to boost cybersecurity and digital resilience, and the impact of artificial intelligence on finance and banking. The fifth edition of the CEE Digital Summit is set to take place on October 17th 2024. It seems worth mentioning that during the summit, the Coalition presents the “CEE Digital Trident” award to an individual who has made a remarkable contribution to making Central Eastern Europe fit for the digital age. The first CEE Digital Trident award was presented in 2022 to Mykhailo Fedorov, Vice Prime Minister of Ukraine and Minister of Digital Transformation of Ukraine. In turn, in 2023, Mark Boris Andrijanič, former Minister of Digital Transformation of the Republic of Slovenia and Member of the Governing Board at the European Institute of Innovation and Technology, was named as the laureate of the award. Since 2022, the Coalition has organised two editions of CEE Education Digital Summit, a regional meeting dedicated to integrating key drivers from across the innovation and education communities. Through participating in the event, educators and representatives from EU institutions, public administration and digital companies, had an opportunity to network, share their views on current progress of education transformation and discuss crucial risks, opportunities and consequences of applying new technologies in teaching and learning.

<sup>7</sup> <https://ceedigital.org/about-us.html>



# Digital Economy in CEE: catalysts

This chapter is focused on analysing three main emerging trends that are set to transform dynamics of the technological landscape of CEE countries, namely, artificial intelligence, cloud and cybersecurity. As highlighted by several ICT associations surveyed in preparation of this report<sup>8</sup>, these three phenomena demonstrate the highest potential to shape the future of the region's digital economy. Each section begins with a brief introduction of a trend, followed by a detailed assessment of its current impact on different sectors of CEE. Then, we allow ourselves a look into the unknown, forecasting prospective changes in the regulatory environment, exploring the most pressing challenges ahead, and evaluating consequences of embracing these new technologies for the CEE region and the rest of the world.





# Artificial Intelligence

Amidst diminishing significance of traditional growth drivers, many pin their hopes on artificial intelligence (AI) as a source of sustained economic growth and increased productivity in CEE, Western Europe and globally. PwC estimates that AI could contribute up to as much as USD 15.7 trillion to the global economy by 2030<sup>9</sup>. Owing to its capacity to overcome the physical barriers of capital and labour, AI is regarded as a potential game-changer which can aid decision-makers, business executives and industry specialists in the current context of enormous challenges, e.g., aging population, insufficient R&D investments, regulatory-heavy environment, stagnant productivity, and talent shortages. Effective adoption of AI-based solutions presents the CEE region and the EU with a pivotal chance to enhance its economic competitiveness and address these challenges head-on. In order to succeed, local actors must work together in developing an AI-ready policy framework and creating a digital environment which favours transparency, openness and interoperability.



## Transformative capacity of AI

As AI algorithms continue to improve and data becomes more abundant, organisations across the CEE region attempt to integrate AI into various applications across different industries, including healthcare, agriculture, telecommunications, finance, manufacturing, education, media, energy and customer service<sup>10</sup>. In CEE and other European countries AI has already taken the burden off humans by automating computer coding, facilitating translations, assisting in decision-making and aiding in image processing, among many other things<sup>11</sup>.

Provided that the development of AI is supported by the necessary investments, training and education, it could substantially increase productivity in Europe by 11 to 37 percent by 2035<sup>12</sup>. Already at this stage it seems vital for decision-makers in CEE to consider the issue of digital inclusivity and evaluate potential impacts of AI on different segments of society.

Due to its enormous versatility, AI has the potential to affect other cutting-edge technologies. Transformative in several ICT sectors in the CEE region, AI-based solutions are being used to speed up automation processes, support enhanced data analytics, raise cyber security levels through improved threat detection and recovery, and enable predictive maintenance in ICT infrastructure<sup>13</sup>. Appropriately managed and combined with blockchain, cloud technology or robotics, AI can offer countless synergetic opportunities for businesses and decision-makers, reshaping industries and driving innovation. Importantly, due to its remarkable capacity to swiftly create new content (images, text, videos, and other media), Generative AI (genAI) emerges as one of the most impactful advances in AI. In accordance with PwC's 27th Annual Global CEO Survey, the majority of CEOs in the CEE region expect increases of at least 5% in the next year in terms of efficiencies in their own time at work thanks to genAI, while nearly half expects efficiencies in their employees' time<sup>14</sup>. GenAI is expected to change the way companies operate and deliver value, although its exact impact on different branches of the ICT sector still remains unsure. It is therefore of utmost importance to continue learning about its applications and capacities to prepare for the future.

<sup>8</sup> ICT associations participating in the survey: AAVIT — Association for Applied Research in IT (Czechia), ICT Association of Slovenia, part of Chamber of Commerce and Industry of Slovenia, INFOBALT — DigiTech Sector Association (Lithuania), IVSZ — Hungarian Association of Digital Companies, SAPIE — Slovak Alliance for Innovation Economy.

<sup>9</sup> PwC, PwC's Global Artificial Intelligence Study: Exploiting the AI Revolution <https://www.pwc.com/gx/en/issues/data-and-analytics/publications/artificial-intelligence-study.html> [09.03.2024].

<sup>10</sup> IVSZ — Hungarian Association of Digital Companies.

<sup>11</sup> European Commission, Use of artificial intelligence in enterprises

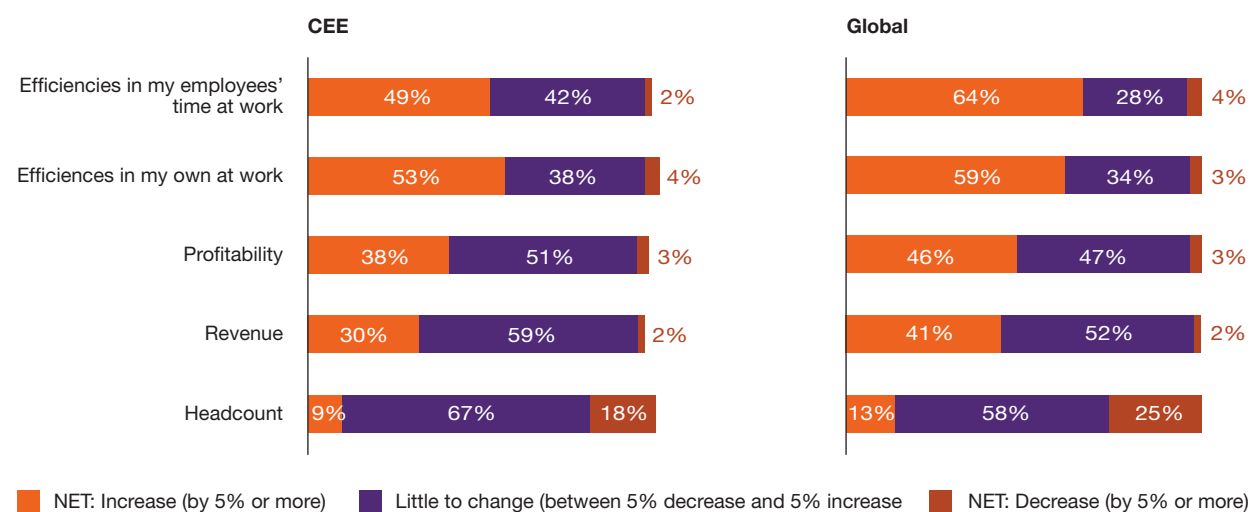
<sup>12</sup> Purdy, M. and Daugherty, P., Why AI is the future of growth <https://dl.icdst.org/pdfs/files2/2aea5d87070f0116f8aaa9f545530e47.pdf> [06.03.2024].

<sup>13</sup> IVSZ — Hungarian Association of Digital Companies.

<sup>14</sup> IPwC, PwC's 27th Annual Global CEO Survey — CEE Edition <https://www.pwc.com/c1/en/27th-annual-global-ceo-survey-cee-edition.html> [11.03.2024].

## Chart 20. Impact of Generative AI on companies in CEE

Question: To what extent will generative AI increase or decrease the following in your company in the next 12 months?



Source: PwC, PwC's 27th Annual Global CEO Survey. Question: To what extent will generative AI increase or decrease the following in your company in the next 12 months (Showing summary 'NET' Increase). Note: 'Don't know' is excluded.

## Challenges ahead

Despite major benefits deriving from its numerous applications, AI could also introduce new risks into the digital and physical landscape of CEE. Importantly, AI-based solutions are predicted to revolutionise employment, eliminating a considerable number of jobs in the process and forcing changes in job markets' structures. The results of a new IMF analysis suggest that nearly 40% of jobs globally (and 60% in advanced economies) are exposed to AI and could be affected by its spread in the near future<sup>15</sup>. In turn, according to OECD estimates, approximately 14% of occupations in OECD member states are prone to automation, with agriculture and manufacturing at the highest risk<sup>16</sup>. However, the various attempts to quantify the impact on employment should be regarded as speculative, considering that AI is expected to drive job creation and enable the workforce to focus on more meaningful and advanced activities. In addition, with the development of AI, a demand for well-compensated roles, such as data scientists and specialised engineers should also increase. Effective adjustments at multiple levels are essential, if CEE countries aim to capitalise on the economic potential of AI. This involves investments in reskilling, enhancing digital skills and literacy, and transparently informing the public about what lies ahead.

Sophistication, multifacetedness and wide applicability of AI create numerous challenges for national and regional authorities in CEE, including a range of ethical, trust

and legal considerations. Concerns are being raised about privacy and data protection (e.g. facial recognition), accountability of AI systems, their fairness and alleged discrimination, and other liability issues<sup>17</sup>. Reviewing different impacts and consequences of AI seems nearly impossible considering its complex nature. One of the key legislative initiatives aimed at setting AI norms in Europe is the ambitious EU AI Act. The first-ever legal framework on AI was formally adopted by the European Parliament on 13 March 2024<sup>18</sup>. Though progress is being made and the AI Act will be an important step towards strengthening digital standards in the region, its effects on innovativeness and competitiveness of local ICT sectors remain to be seen. According to the impact assessment prepared by the European Commission in 2021, the maximum compliance and administrative costs under Option 3, which encompasses high-risk AI applications, could reach from EUR 100 million to EUR 500 million by 2025, and up to EUR 3 billion under Option 4, which establishes mandatory requirements for all AI applications<sup>19</sup>. However, these cost assessments are solely estimates based on assumptions and should be regarded as such. Nevertheless, in order to be effective, the EU AI Act ought to be complemented by updated national plans and strategies, promoting the development of digital technologies such as AI. The stakes are high taking into account its transformative power and the effects on strategic sectors. Policy-makers, business executives and academia across the CEE region should work hand in hand to enable transnational exchange of information and continuous monitoring of changes in the AI landscape.

<sup>15</sup> IMF, Gen-AI: Artificial Intelligence and the Future of Work <https://www.imf.org/en/Publications/Staff-Discussion-Notes/Issues/2024/01/14/Gen-AI-Artificial-Intelligence-and-the-Future-of-Work-542379?cid=bl-com-SDNEA2024001> [10.03.2024].

<sup>16</sup> OECD, What happened to jobs at high risk of automation? [https://www.oecd-ilibrary.org/social-issues-migration-health/what-happened-to-jobs-at-high-risk-of-automation\\_10bc97f4-en](https://www.oecd-ilibrary.org/social-issues-migration-health/what-happened-to-jobs-at-high-risk-of-automation_10bc97f4-en) [07.03.2024].

<sup>17</sup> Survey among CEE Digital Coalition ICT associations.

<sup>18</sup> European Commission, AI Act <https://digital-strategy.ec.europa.eu/en/policies/regulatory-framework-ai> [09.03.2024].

<sup>19</sup> European Commission, Impact Assessment of the Regulation on Artificial Intelligence <https://digital-strategy.ec.europa.eu/en/library/impact-assessment-regulation-artificial-intelligence> [26.03.2024].

# Cloud technology

Cloud is offering business leaders and decision-makers unique opportunities to transform their organisations to be more agile, save costs and act faster — all at once. The rapid, wide spread of on-demand computing solutions (e.g., hardware, databases, software and storage) has changed the way both private and public actors operate, collaborate, communicate and grow. Due to its ability to accelerate digital transformation and economic development, the potential of the cloud is exponential and no industry or government in the CEE region can afford to miss it.



*Cloud solutions are the technological foundation of digitally advanced societies. Democratisation of technology, scalability, improved access to services and increased data security are only a handful of benefits that cloud brings to the table.*

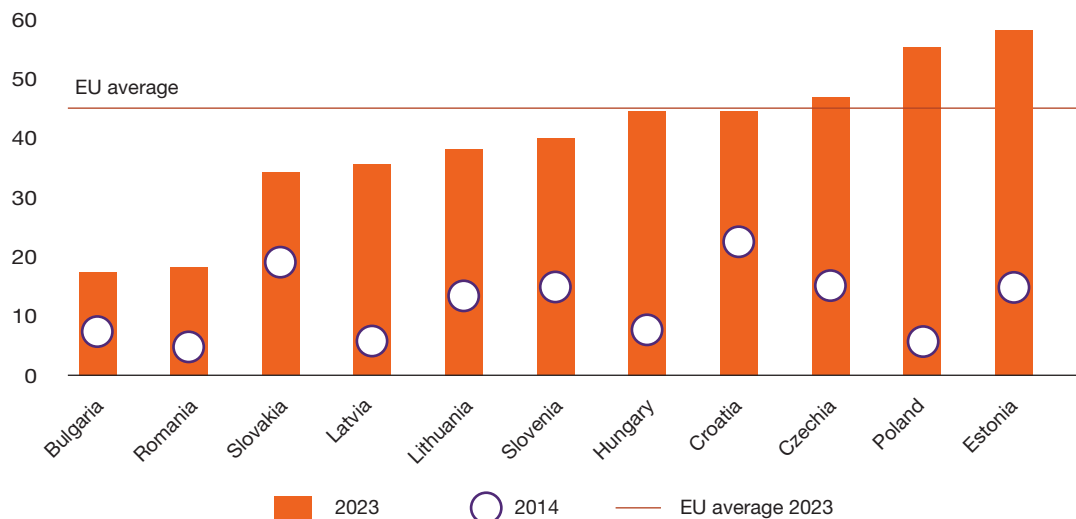
**Mariusz Chudy**

Partner, PwC CEE Cloud & Digital Leader

## Potential of cloud

Nowadays, data is commonly seen as one of the most valuable assets in the world. This should not come as a surprise considering the extent to which contemporary organisations rely on information in their day-to-day operations. For this reason, cloud solutions have recently seen a massive diffusion in all economic sectors. If implemented correctly, they allow users to access, store, process, and manage data more quickly and conveniently than ever before. Although in terms of cloud deployment CEE still lags behind European leaders, such as Finland, Sweden and Denmark, the usage of cloud in the region has risen substantially over the last years<sup>20</sup>. In particular, Poland, Hungary and Czechia recorded steep increases in numbers of enterprises purchasing cloud infrastructure and software applications between 2014 and 2023 (by 49.9, 36.8 and 32.1 percentage points respectively, as depicted in Chart 21). However, considerable improvements are needed in Bulgaria and Romania, specifically with regard to more sophisticated cloud solutions, as the two countries continue to be ranked at the end of the pack.

**Chart 21. Enterprises buying cloud computing services (% of enterprises)**



Source: Prepared by PwC based on Eurostat data.

<sup>20</sup> European Commission, Cloud computing — statistics on the use by enterprises [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Cloud\\_computing\\_-\\_statistics\\_on\\_the\\_use\\_by\\_enterprises](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Cloud_computing_-_statistics_on_the_use_by_enterprises) [06.03.2023].

Cloud facilitates working remotely, reduces operational costs, enhances internal processes and improves communication methods. Consequently, it has already contributed to modernising the public and private sectors in CEE countries by streamlining the delivery of diverse services. According to the report prepared by PwC, **35% of companies in the CEE region have integrated cloud into the majority or every sector of its operations, while 87% of those that do not currently use it, expect more than half of their activities to be moved to cloud within the next 2 years**<sup>21</sup>. This demonstrates that the majority of CEE business executives are aware that cloud is one of the key technologies shaping the future of the digital economy. Increased accessibility and use of cloud technology across the region is crucial to capitalise on the economic potential of data and improve the competitiveness of CEE.

### Future outlook

In view of the increasing significance and impact of cloud, the EU is intervening in the sector with growing intensity. One of the initiatives aimed at regulating the cloud and harmonising rules on data use is the Data Act. Implemented to complement the Data Governance Act, the cross-sectoral Data Act entered into force on 11 January 2024, and will become applicable in September 2025<sup>22</sup>. Among other things, the new measures will obligate cloud computing companies in the EU to facilitate provider switching. Although Brussels highlights the need to strengthen data security, EU officials understand the potential in leveraging the cloud's power<sup>23</sup>. Both regional and national decision-makers should fully realise that a supportive 'cloud-first' policy environment ought to maintain a balance between control and flexibility so as to not hinder the development of cloud and ICT sectors.

As mentioned in the previous section, new technologies possess the capacity to impact one another and create synergies that benefit stakeholders. This is certainly the case for cloud and AI, which when converged amplify each other's potential.

While cloud-based solutions offer flexible and accessible storage, AI algorithms can process large datasets, analyse them and interpret results. Together their capacity to extract insightful information that can help in optimisation, decision-making and cost saving is immense. In a similar manner, effective fusion of cloud and cybersecurity can equip IT and security teams with novel tools, improving security analytics, data protection and cyber threat detection. Exact trajectories that will shape the technological landscape are unknown. Nonetheless, it is up to business executives and decision-makers in the CEE region to create a digital ecosystem, where exchange of knowledge and best practices flourishes so that local organisations anticipate change, take advantage of innovative solutions and discover new ways business is done.

In order to take advantage of groundbreaking technologies, such as cloud, ICT sectors require access to specialists trained in application of novel IT solutions. As the shortage of technical skills among the workforce and insufficient investments in R&D can inhibit the adoption of new technologies, CEE leaders should address these pressing issues immediately<sup>24</sup>. It is recommended that governments, academia and business across the region work together to ensure that education systems are fit for building a competitive economy in the future. This requires the following actions:

- improving advanced technical competences among students;
- implementing scholarship schemes for promising scientists;
- investing in modernisation of STEM graduate programmes; and
- enabling wide access to reskilling and upskilling training courses.

ICT associations in the region are aware of the costs, effort and coordination such actions require. However they must be urgently taken, if CEE is to stand a chance in the ongoing digital race.

<sup>21</sup> PwC, Cloud in business, leaders see value [https://www.pwc.pl/pl/pdf-nf/2023/PwC\\_Chmura\\_w\\_biznesie\\_liderzy\\_widza\\_wartosc\\_2023.pdf](https://www.pwc.pl/pl/pdf-nf/2023/PwC_Chmura_w_biznesie_liderzy_widza_wartosc_2023.pdf) [02.03.2024].

<sup>22</sup> European Commission, Data Act <https://digital-strategy.ec.europa.eu/en/policies/data-act> [01.03.2024].

<sup>23</sup> European Commission, Cloud computing <https://digital-strategy.ec.europa.eu/en/policies/cloud-computing> [02.03.2024].

<sup>24</sup> IVSZ — Hungarian Association of Digital Companies.



# Cybersecurity

In recent years, the Central and Eastern European countries have experienced a rapid evolution of the cybersecurity landscape. With intensification of hacker attacks and emergence of novel forms of cyberthreats, the environment became riskier and more difficult for both public and private actors to navigate.

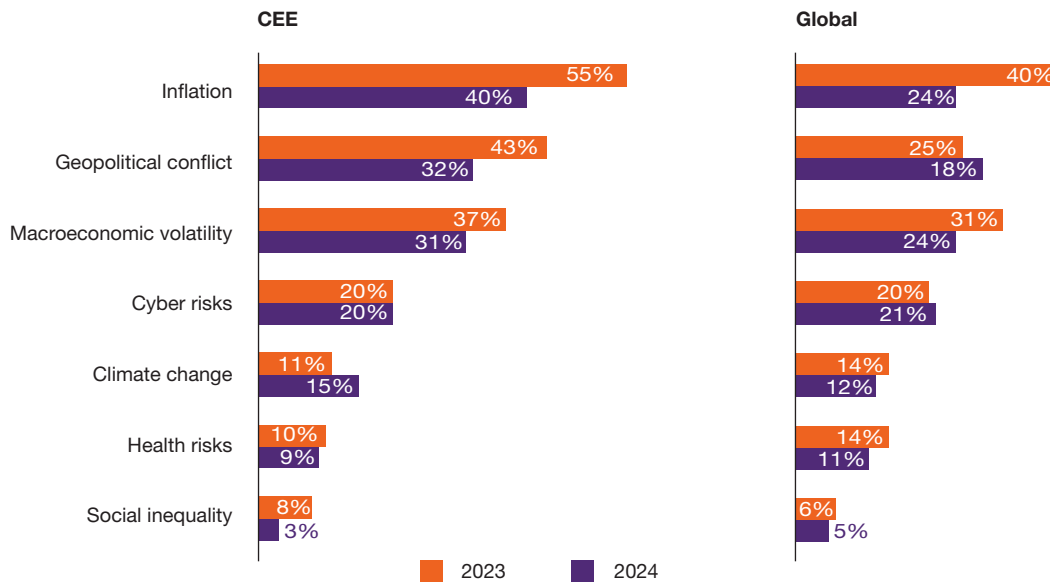
Increasing value of online data forced organisations to redefine their approach to cybersecurity, and allocate resources to development of cyber defence strategies and mechanisms. The situation was further exacerbated by the geopolitical tensions in the region which shifted stakeholders attention to the significance of cybersecurity capacity-building, e.g., intrusion detection, software vulnerability and data encryption. ICT Associations across CEE region have long recognised cybersecurity as one of the main trends that might affect the digital economy in the future<sup>25</sup>. Those that do not adapt to new circumstances may not only face severe disruptions, financial losses and reputation damage, but also miss out on the potential opportunities arising from the new digital context.

## Digital threats

Even though CEE is a digitally diverse region, cybersecurity tends to be high on the agenda of local decision-makers and business leaders aware that increased expenditure on cybersecurity is crucial to ensure a safe, stable and booming economy. According to PwC's 27th Annual Global CEO Survey results, cyber risk rated fourth top concern for CEOs in CEE (behind inflation, geopolitical risks and macro-economic volatility) and third globally<sup>26</sup>. It seems worth adding that in the previous survey editions, cyber risks were classified as more pressing according to CEE executives. However, they were outranked by geopolitical conflict, which in its current form also incorporates comprehensive cyberwarfare practices.

**Chart 22. Exposure of companies in CEE and the world to key threats**

Question: How exposed do you believe your company will be to the following key threats in the next 12 months?



Source: PwC, PwC's 27th Annual Global CEO Survey. Question: How exposed do you believe your company will be to the following key threats in the next 12 months? (Showing only 'highly exposed' and 'extremely exposed' responses).

Note: Exposure is defined as probability of significant financial loss.

<sup>25</sup> ICT Association of Slovenia, part of Chamber of Commerce and Industry of Slovenia, INFOBALT.

<sup>26</sup> PwC, PwC's 27th Annual Global CEO Survey – CEE Edition <https://www.pwc.com/c1/en/27th-annual-global-ceo-survey-cee-edition.html> [05.03.2024].

The significance of digital resilience in CEE is associated with the growing sophistication, innovation and number of cyber-attacks<sup>27</sup>. In February 2024, Poland, one of the most targeted countries for cyber-attacks globally, recorded more than 1000 cyber-attacks on organisations weekly<sup>28</sup>. Deep fakes, misinformation, denial-of-service attacks, social engineering threats, phishing and supply chain attacks are examples of cyberthreats that CEE security teams are forced to deal with on a daily basis. Nonetheless, ransomware attacks targeting essential services, public institutions and international companies remain the most serious threat in Europe according to the tenth edition of the ENISA Threat Landscape report<sup>29</sup>.

The invasion of Ukraine has, among other things, directed global and regional focus to cybersecurity<sup>30</sup>. From the beginning of the war, governmental institutions, critical infrastructure and key companies in the CEE have been targeted in cyberspace. Countries supporting the Ukrainian cause have been subject to intensified malicious disruption attempts by the Kremlin, provoking policymakers to evaluate vulnerabilities, establish appropriate cybersecurity standards and invest in digital infrastructure.

Indeed, it is a role of governments and international organisations to set norms and directions for enhancing cybersecurity practices in the region. At the national level, CEE authorities adopted long-term cybersecurity plans, prioritising capacity-building and updating public spending on the digital transformation. Their overall aim is to reduce exposure to cyberattacks through implementing essential improvements to their digital capacities and identifying key areas for cyber investments.

The EU's cybersecurity strategy recognises that strengthening the cybersecurity sector as essential to the region's economy<sup>31</sup>. In the process, Brussels has recently implemented new security regulations, most notably, the NIS2 (Network and Information Systems 2) Directive<sup>32</sup>. The updated version of NIS expands the scope of the cybersecurity rules to new sectors and entities, obliging them to comply with novel security and notification requirements. Other legislation procedures are pending. The question remains, however, whether current legislation efforts are adequate and sufficient up against increasingly dangerous cyberthreats, and if the costs of compliance to the new legal requirements will create barriers to SMEs<sup>33</sup>. Ensuring legislative clarity and lowering compliance expenses should be central to developing the region's regulatory environment.



*Due to growing interdependencies, critical infrastructure has been embracing more and more areas. Once it used to be bridges and buildings, but now, it is covering ICT systems and apart from usual sectors like healthcare, energy or finance, also new ones like agriculture, chemical and electromechanical sectors are added. Hence the growing importance of cybersecurity. Current national and regional legislative efforts must be aimed at mobilising key actors to ensure that their operations are secured and businesses are ready for threats of the future.*

**Karol Okoński**, Director, PwC CEE Leader for Cybersecurity in Public Sector

<sup>27</sup> Europol, Spotlight Report: Cyber-attacks: the apex of crime-as-a-service <https://www.europol.europa.eu/publication-events/main-reports/cyber-attacks-apex-of-crime-service-iocta-2023> [07.03.2024].

<sup>28</sup> International Trade Administration, Poland ICT the most cyber attacked country in the world <https://www.trade.gov/market-intelligence/poland-ict-most-cyber-attacked-country-world#:~:text=According%20to%20Polish%20Cyberspace%20Defense,of%20Ukraine%20in%20February%202022> [06.03.2024].

<sup>29</sup> ENISA, Threat Landscape 2022 <https://www.enisa.europa.eu/publications/enisa-threat-landscape-2022> [07.03.2024].

<sup>30</sup> European Parliament, The role of cyber in the Russian war against Ukraine: Its impact and the consequences for the future of armed conflict [https://www.europarl.europa.eu/thinktank/en/document/EXPO\\_BRI\(2023\)702594](https://www.europarl.europa.eu/thinktank/en/document/EXPO_BRI(2023)702594) [09.03.2024].

<sup>31</sup> European Commission, The EU's Cybersecurity Strategy for the Digital Decade <https://digital-strategy.ec.europa.eu/en/library/eus-cybersecurity-strategy-digital-decade-0> [07.03.2024].

<sup>32</sup> European Commission, Directive on measures for a high common level of cybersecurity across the Union (NIS2 Directive) <https://digital-strategy.ec.europa.eu/en/policies/nis2-directive> [04.03.2024].

<sup>33</sup> Interview with PwC expert in Cybersecurity.

## Cyber opportunities

As the CEE governments continue to improve protection of critical infrastructure and counter disinformation, businesses enhance the safety of their operations and ensure security of their clients' information. The demand for cybersecurity capacity-building in CEE is predicted to increase in the near future and companies that provide cybersecurity services, such as data authentication and intrusion detection, are poised for growth<sup>34</sup>. Interestingly, many experts perceive cybersecurity as a potential business driver rather than a necessary expense<sup>35</sup>. They approach cyber as a facilitator of uninterrupted business operations, a useful tool reducing financial impact of a breach or intrusion, and a source of knowledge and increased business trust.

In the face of regulatory challenges, high costs of in-house cybersecurity and scarcity of talent, many CEE security leaders will choose outsourcing and turn to security consulting providers. Since Europe currently lacks a universal certification system for verifying individual cybersecurity solutions, large global players that dominate the market are at an advantage due to their strong reputation and brand recognition<sup>36</sup>. Moreover, by offering a complete range

of services, they are in a better position to scale, attract customers and gain competitive advantage by employing new technologies (i.e., genAI and blockchain) in their operations<sup>37</sup>.

In turn, governments across the CEE region will aim to develop cybersecurity solutions locally in order to reduce potential dependency risks. Above all, they will aim to build self-sustaining digital resilience in the spheres of military (e.g. encryption algorithms) and critical infrastructure<sup>38</sup>. This could mean increased business and financing opportunities for cybersecurity organisations and startups across the region, the need for which has been voiced in the past by the ICT CEE associations<sup>39</sup>. Close cooperation with the private sector stakeholders ought to be imperative for decision-makers across CEE to allow for combining know-how, resources and technologies to enhance regional cybersecurity against increasingly dangerous state and non-state threats. This, however, should be accompanied by promoting cybersecurity awareness and education initiatives, and investing in research. Simultaneously, the focus of national and regional decision-makers should lie in the introduction of balanced, timely and harmonised regulations that support the development of ICT sectors.

---

<sup>34</sup> IVSZ — Hungarian Association of Digital Companies.

<sup>35</sup> PwC, Cybersecurity becoming increasingly important for value creation <https://www.pwc.nl/en/topics/blogs/cybersecurity-becoming-increasingly-important-for-value-creation.html> [13.03.2024].

<sup>36</sup> Forrester, The Cybersecurity Consulting Services Landscape In Europe [09.03.2024].

<sup>37</sup> Interview with PwC expert in cybersecurity.

<sup>38</sup> Interview with PwC expert in cybersecurity.

<sup>39</sup> IVSZ — Hungarian Association of Digital Companies.



# Digital Economy in CEE: what's next?





# Digital economy in the CEE: what's next?

Over the last three decades, CEE has proven its economic potential, competitiveness and digital capacities. Entrepreneurial mindset, digital optimism, technological literacy, a wide pool of talented IT specialists, robust infrastructure and a resilient business ecosystem are some of the key factors accelerating the growth of local ICT sectors and digital transformation in the region. To take advantage of emerging technologies, CEE should focus on building upon its strengths, while addressing key shortcomings and areas for improvement.

The CEE business ecosystem presents a compelling mix of opportunities and resilience amid challenges. Its integration with the European Union, robust talent pool, and strategic initiatives to foster innovation and development continue to attract diverse investment activities, underscoring the region's potential as a vibrant hub for business and investment. The CEE region's competitiveness is reflected in surging inward foreign direct investment in information and communication sector (up by 69.5% between 2013 and 2022), a six-fold increase in exports of commercial ICT services between 2005 and 2021, as well as nearly two-fold increase in exports of ICT goods between 2002 and 2022.

On the other hand, among areas for improvement, a need for further upskilling of ICT specialists and increased investment in digital infrastructure are observed. As experts mention, allocating resources to education and training initiatives is crucial for bridging the digital skills gap and cultivating a proficient workforce in the ICT sector. These efforts encompass strengthening STEM (science, technology, engineering, and mathematics) education, offering specialised training in fields such as software development and data science, and facilitating lifelong learning and upskilling opportunities for current employees. Additionally, prioritising investment in ICT-related research and development can foster innovation and propel technological progress across the CEE region. This involves supporting research institutions, universities, and forward-thinking startups engaged in cutting-edge projects, while also fostering collaboration between academia, industry, and government.

There are the observed trends that are going to affect the digital economy in the future, in areas such as artificial intelligence, cybersecurity, and cloud technology. The impact of artificial intelligence will be felt more and more in the region. Both within the ICT sector and through the technologies produced by this sector. The cybersecurity sector may undergo particular development in the region in the near future due to the growing market demand as a result of the hybrid threat from Russia. The Russian invasion of Ukraine has further highlighted the importance of cybersecurity and prompted policy-makers to evaluate vulnerabilities and invest in digital infrastructure. But the increasing importance of cybersecurity is also related to the rise of new technologies, sharing information online, online payments, and e-commerce. Cloud technology on the other hand will be the foundation for further development of the former two phenomena. It is crucial for improving competitiveness and effectiveness of internal processes. The majority of CEE countries are still below the EU average in terms of cloud computing services use and among these buying cloud services, deployment is rather basic, so there is room for improvement.

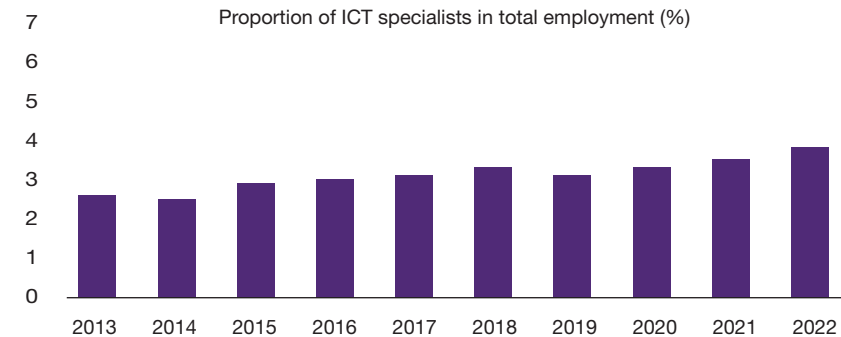
To face these challenges and to enhance competitiveness and foster innovation there is a need for increase in resources allocated towards innovation, supporting startups, as well as simplifying access to funding. What is more, ensuring regulatory clarity, promoting digital technology adoption, encouraging openness and interoperability in digital ecosystems and strengthening strategic partnerships between CEE countries are crucial for maintaining competitiveness and building up a stronger position of the region in the European and global ICT market.

# Country profiles



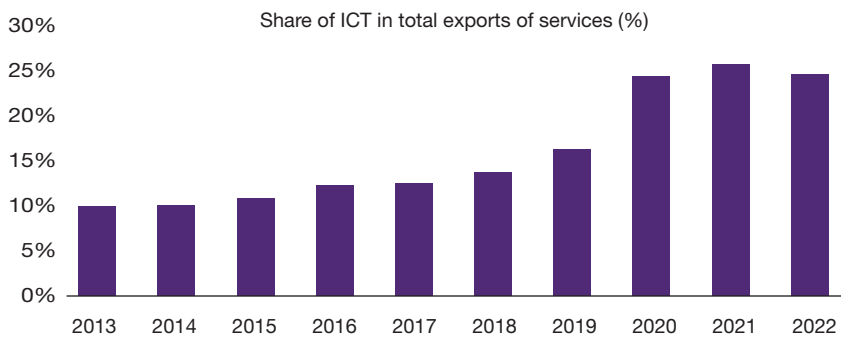
# Country profiles

## Bulgaria



13 821.2

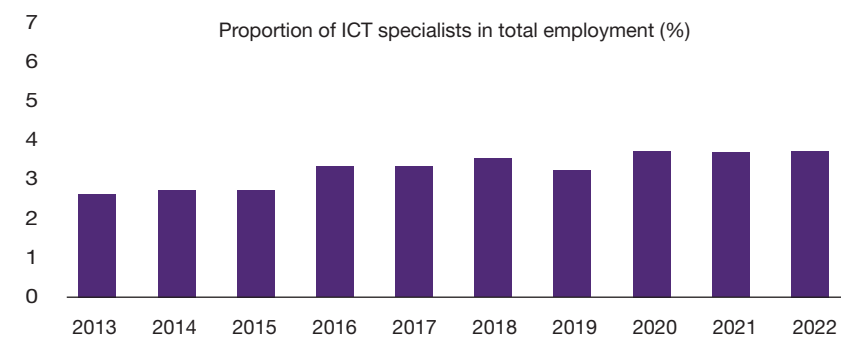
GDP per capita in 2022 (USD)



37.67

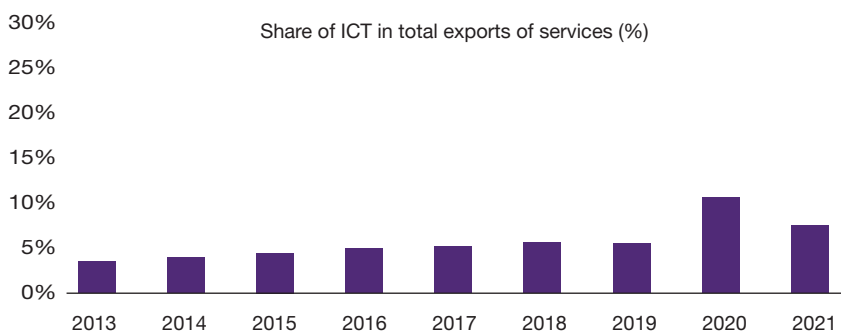
DESI score 2022 (100=best)

## Croatia



18 305.0

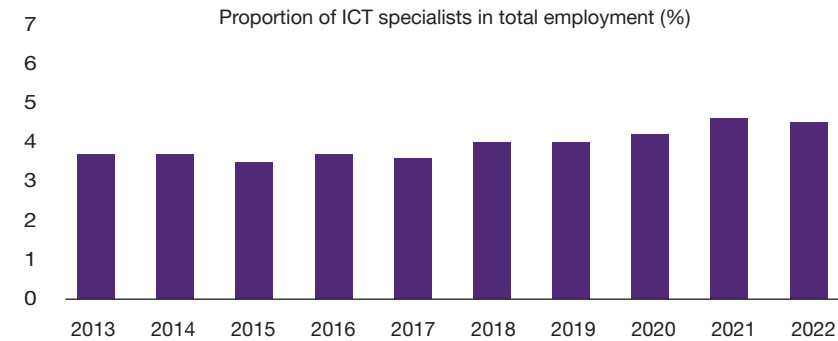
GDP per capita in 2022 (USD)



47.55

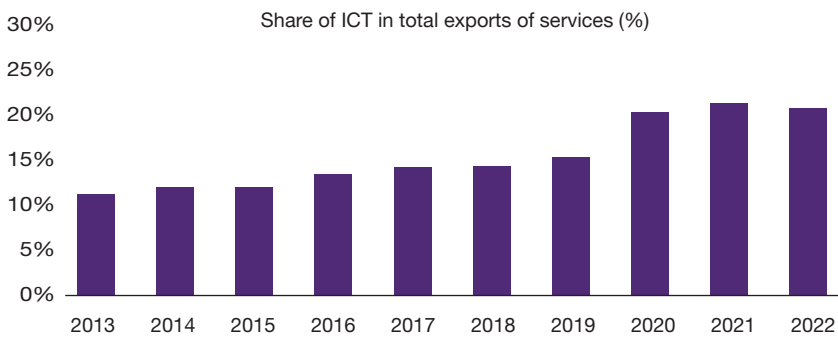
DESI score 2022 (100=best)

## Czechia



26 832.3

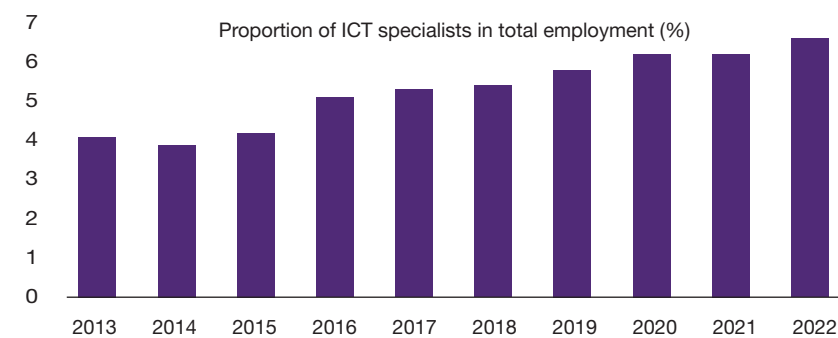
GDP per capita in 2022 (USD)



49.14

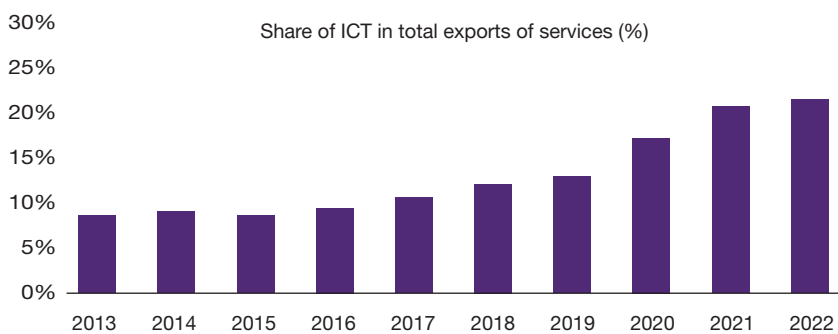
DESI score 2022 (100=best)

## Estonia



28 136.3

GDP per capita in 2022 (USD)

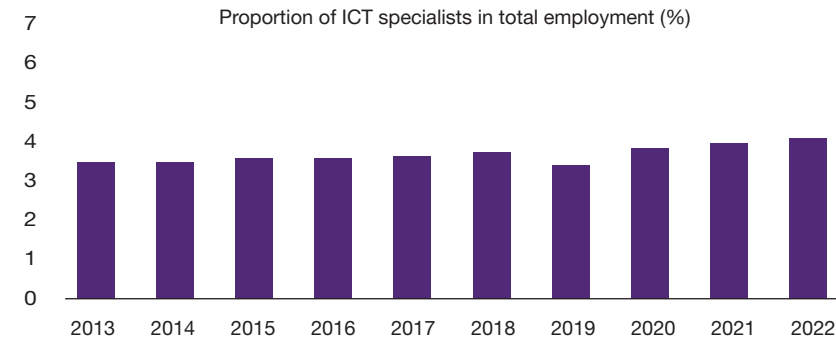


56.51

DESI score 2022 (100=best)

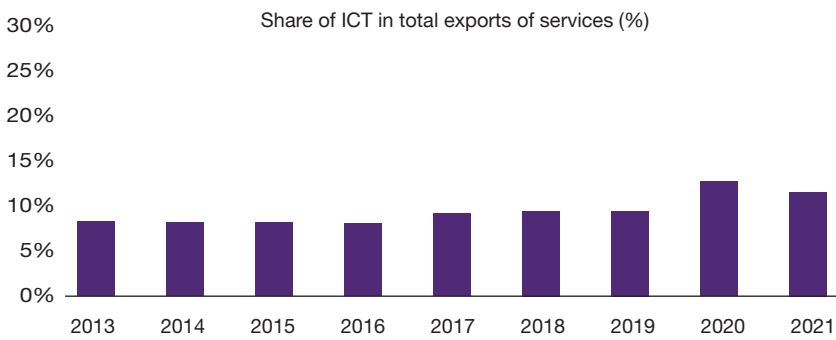


## Hungary



18 579.1

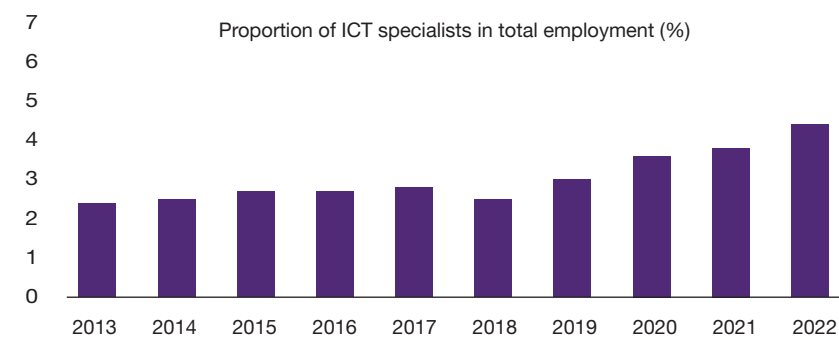
GDP per capita in 2022 (USD)



43.76

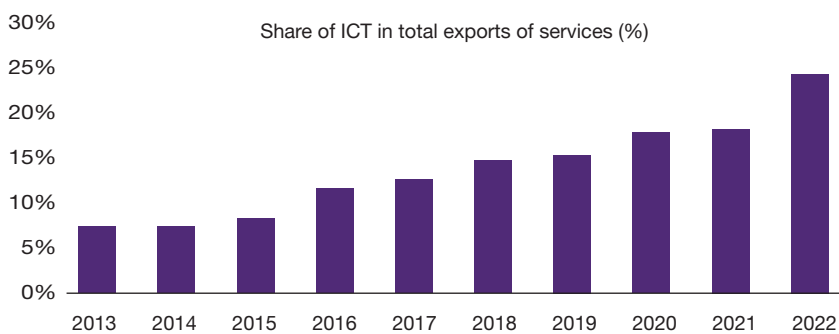
DESI score 2022 (100=best)

## Latvia



21 946.9

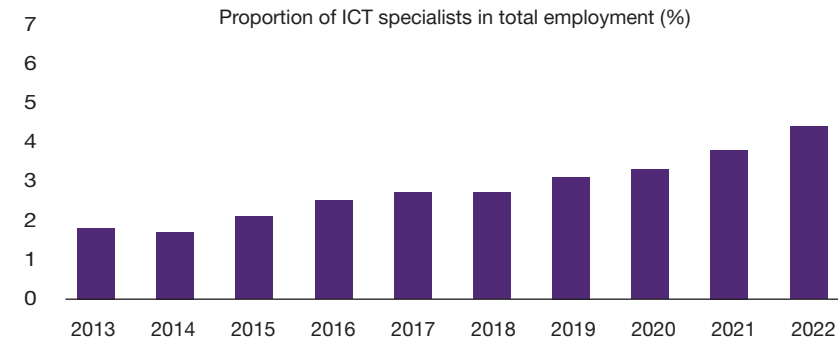
GDP per capita in 2022 (USD)



49.71

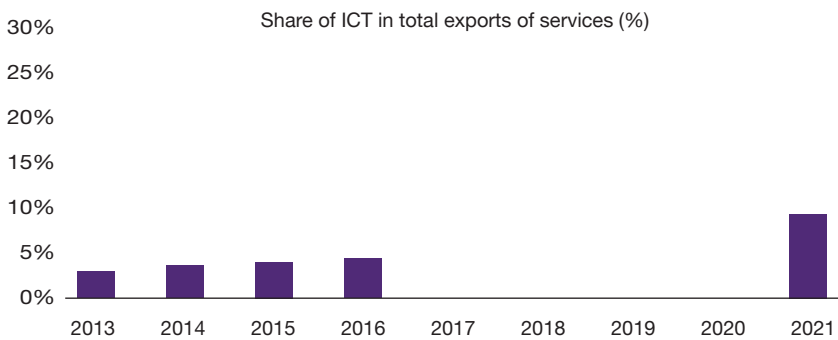
DESI score 2022 (100=best)

## Lithuania



24 988.7

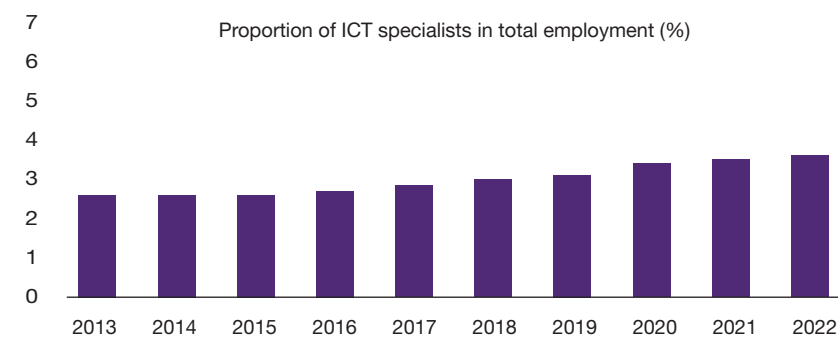
GDP per capita in 2022 (USD)



52.71

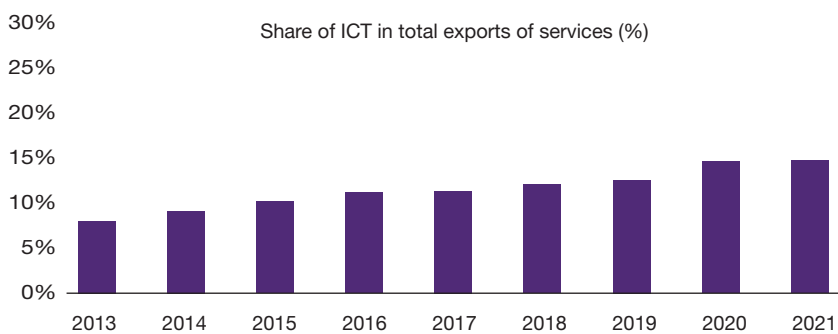
DESI score 2022 (100=best)

## Poland



18 342.7

GDP per capita in 2022 (USD)

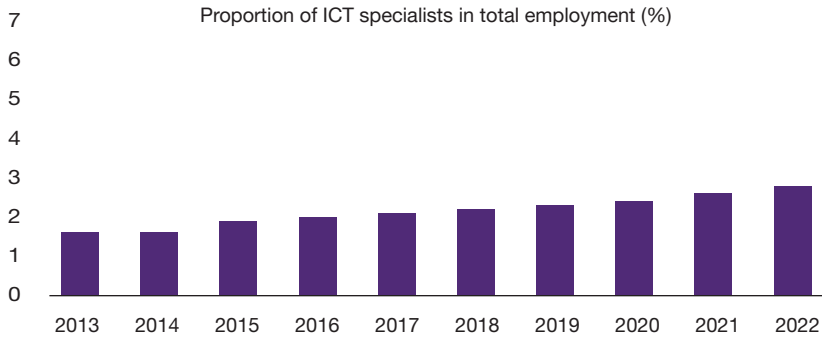


40.55

DESI score 2022 (100=best)

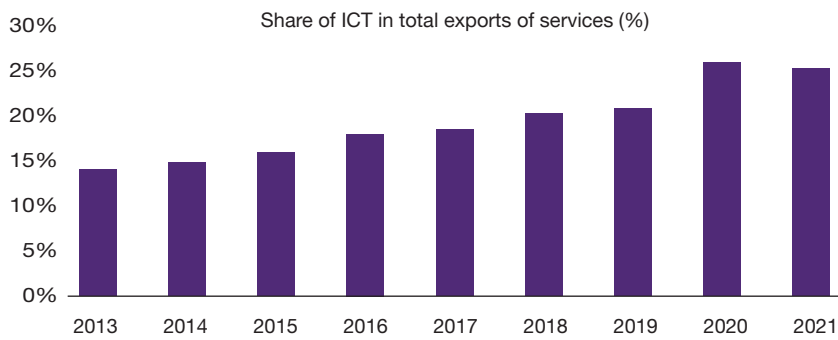
## Romania

---



15 821.1

GDP per capita in 2022 (USD)

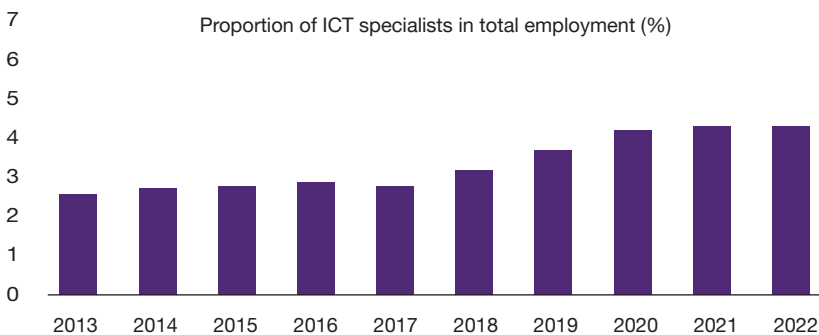


30.58

DESI score 2022 (100=best)

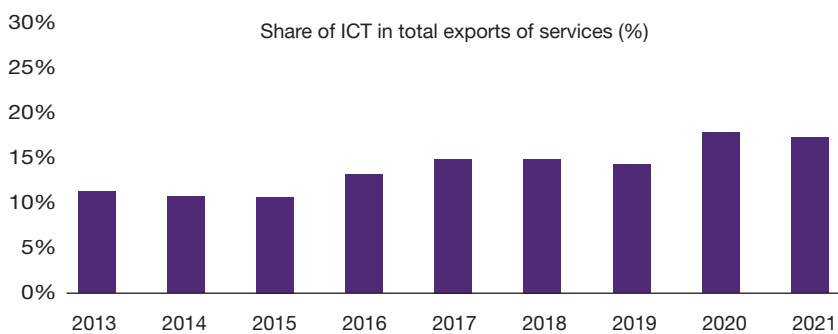
## Slovakia

---



21 263.2

GDP per capita in 2022 (USD)

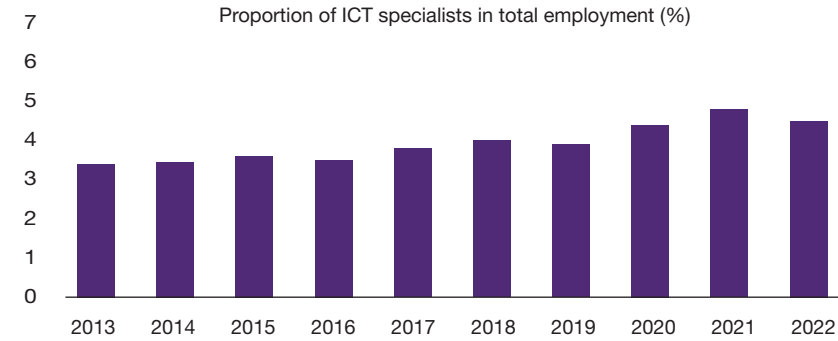


43.45

DESI score 2022 (100=best)

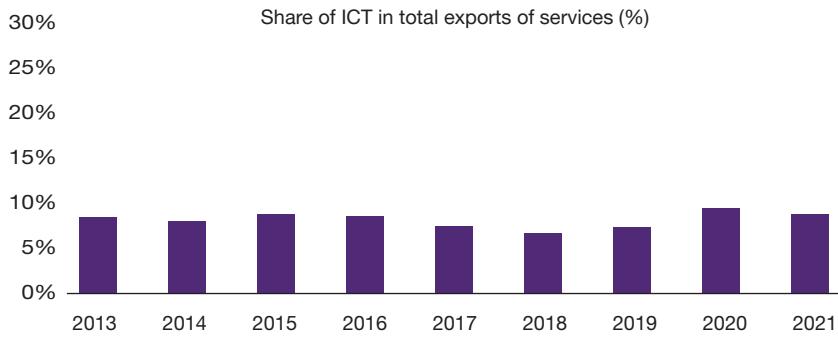
## Slovenia

---



28 526.6

GDP per capita in 2022 (USD)



53.37

DESI score 2022 (100=best)

Sources: Proportion of ICT specialists in total employment – Eurostat, Employed ICT specialists – total;  
Share of ICT in total exports of services – Eurostat, International Trade in Services;  
GDP per capita – IMF World Economic Outlook – October 2023;  
DESI score 2022 – European Commission, The Digital Economy and Society Index (DESI).



# This report was prepared by the Public Sector & Economics team, PwC Poland

## About us:

---

We are a team experienced in comprehensive economic consulting. The range of services we offer includes the development of economic, socio-economic and impact assessment analyses for both private and public sector clients.

## Authors:

---

**Dionizy Smoleń**, PhD, Partner

**Paweł Oleszczuk**, PhD, Vice Director

**Julia Otwinowska**, Senior Associate

**Przemysław Kurlandt**, Associate

## Contributions:

---

We would like to acknowledge the contribution of the ICT associations that participated in the survey on development of the ICT sector in the CEE region:

**AAVIT** — Association for Applied Research in IT (Czechia)

**ICT Association of Slovenia**, part of Chamber of Commerce and Industry of Slovenia

**INFOBALT** — DigiTech Sector Association (Lithuania)

**IVSZ** — Hungarian Association of Digital Companies

**SAPIE** — Slovak Alliance for Innovation Economy



[www.ceedigital.org](http://www.ceedigital.org)