Digitalisation of Poland's post-COVID economy – how to make the best use of the EU Recovery Fund?

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Acronyms

AI – Artificial Intelligence

CEE – Central and Eastern European (countries)

DESI – Digital Economy and Society Index

EC – European Commission

EP – European Parliament

ERP – Enterprise Resource Planning

EU – European Union

EUR – Euro

FDI – Foreign Direct Investment

FTTH/B – Fibre to Home/Business

GDP – Gross Domestic Product

GVC – Global Value Chains

ICT – Information and Communication Technology

KPO – National Reconstruction Plan

MFF – Multiannual Financial Framework

MS – Member States

NMS – New Member States

OECD – Organisation for Economic Cooperation and Development

PZIP – National Integrated Informatisation Programme

RES – Renewable Energy Sources

SMEs – Small and Medium-sized Enterprises

SRD – Strategy for Responsible Development

Introduction: drivers of growth in the Polish economy and the potential role of digitalisation

Poland has experienced remarkable gross domestic product (GDP) growth over the last three decades, since the beginning of its transformation to a market economy. Cumulative growth in real GDP since 1990 stands at approximately 213% (4.2% year-over-year annualised[1]). However, a large part of this boost occurred in the early transition years and is due to improvements in the efficiency of factor allocation, further strengthened by European Union (EU) accession in 2004 and trade liberalisation thanks to processes that had already started in the early 1990s. Growth processes were strengthened by the parallel processes of globalisation that materialised in Poland and other Central and Eastern European (CEE) countries in the offshoring of the production processes in the EU-15 to the New Member States (NMS). These newly fragmented production processes have benefited from the proximity of the NMS, low trading barriers, and competitive production costs driven by low hourly labour costs (e.g., Havlik [2005] shows that unit labour costs[2] wage were at 44% of the Austrian level in Poland in 2003). This, together with a large inflow of foreign direct investment (FDI), determined the Polish growth model based on exports. According to Hagemejer (2018), approximately half of all economic growth in Poland during 1995-2009 was driven by exports. At least 60% of all Polish exports over that time were exports of intermediate products used later in further production processes in other countries (mainly other European countries) and therefore were generated within newly formed global value chains (GVC). While exports of services have also been growing steadily in recent years, with the road transportation sector leading the way, the bulk of the export-driven growth is generated from manufacturing and manufacturing-supporting services.

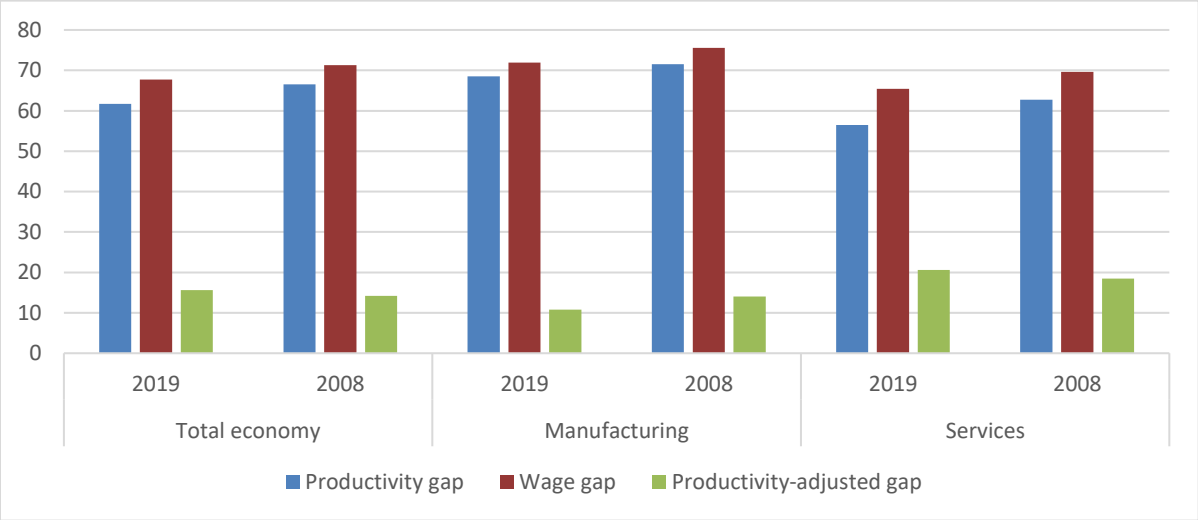
The global financial crisis has led to a universal halt in globalisation processes, and the persistent low demand in the EU-15 has led to a deterioration of the sources of external demand for the Polish economy. However, remarkably, as shown by Rozkrut (2020), the contribution of exports to the growth rate of Poland remained high as late as until 2018. The slowdown was apparent by 2019, mainly in manufacturing, while the 2020 negative growth effects until the second quarter of 2020 were mainly driven by the drop in export demand (*ibidem*). However, in the pre-COVID economy, exports were still a major growth driver with exporting enterprises being on average larger, more productive, and more capital-intensive than their non-exporting counterparts (see Hagemejer and Kolasa [2011] as well as Szpunar and Hagemejer [2019]).

The analysis of relative wages points to a persistent large difference in the level of wages between the EU-15 and Poland. We base our comparisons on hourly labour costs where methodological difficulties prevent us from comparison on a longer time period. However, in 2008, the Polish hourly wage expressed in euro (EUR) was 71.3% lower than the average in the EU, and while there has been some relative wage growth, by 2019, this gap had decreased to 67.7% (i.e., a roughly three times lower wage in Poland relative to the EU-15, see Figure 1). It has to be noted that while the wage should in principle follow labour productivity[3], the growth rate of

[1] World Bank's World Development Indicators Database.
[2] Unit labour cost can be expressed as the labour cost per unit of output which is equivalent to hourly labour cost divided by labour productivity. Hence, unit labour cost is the productivity-adjusted wage level.
[3] We consider labour productivity to be the value added per hour worked.

productivity was faster. This can be attributed, at least partially, to the desire to maintain cost-competitiveness as well as to a number of other factors, such as the declining labour share and the increasing wage inequality that are present in many countries (however, in Poland, the decoupling of wages and productivity is particularly strong – see, e.g., OECD, 2018). The difference in unit labour costs is currently much lower than indicated by the pre-accession literature the difference in unit-labour costs (productivity-adjusted wage gap) between Poland and the EU-15 stood at roughly 15% in 2008. Due to somewhat faster productivity growth in services than manufacturing, relative unit labour costs in services have gone down over time. In manufacturing, the cost-competitiveness advantage against the EU-15 has deteriorated since 2008 (the gap in the productivity-adjusted wage gap to the EU-15 has fallen from 14% in 2008 to 10% in 2019)[4].

Figure 1 Productivity gap, wage, and unit-labour cost: Poland (% deviation from the EU-15 level)



Source: own computation using Eurostat data

What does this tell us about the prospects for post-COVID economic growth in Poland? The cost-competitiveness of manufacturing is deteriorating due to ongoing wage growth supported by diminishing supply in the labour market. At the same time, productivity growth in manufacturing is lagging behind that of services as large productivity gains from the opening of the economy and real convergence have been largely exhausted. In the post--COVID era, we can expect changes in the form of the functioning of the global economy. On one hand, there may be some degree of reshoring and increasing redundancies in suppliers in value chains. This can lead to additional gains for NMS driven by their 'traditional' comparative advantages – low labour costs and proximity to European markets. To reap the potential benefits, it is important to continue to support productivity growth in manufacturing. On the other hand, ongoing digitalisation will strengthen cross-border trade in services not requiring a physical presence. In Poland, it could be advisable

[4] It has to be noted that expressing the above values in productivity reduces the observed wage gap to around 42% in 2019 but has no bearing on the calculation of the unit labour cost. However, we strongly believe that since we are comparing these numbers in the context of firm costs rather than real consumer incomes, the comparison in market exchange rates seems more appropriate.

to increase the degree of internationalisation of the services sector, in particular for small and medium-sized enterprises (SMEs). This structural change should be facilitated by factors that support the efficient allocation of resources, reduce transaction costs, and improve innovativeness.

One of the most important sources of economic growth in general and productivity growth in particular is the information and communication technology (ICT) intensity of economic activity. Economic literature on this subject is ample (see, e.g., Draca et al. [2009] for a comprehensive review of earlier evidence and OECD [2004] for a multi-country study), with firm-level empirical studies pointing to more pronounced evidence of ICT-driven productivity growth that stems from the country-level and sectoral studies underlining ICT-driven improvements in firm organisation. Newer evidence (Gal et al., 2019; Corrado et al., 2017) points to stronger productivity effects of digitalisation in manufacturing and more routine economic activities as well as complementarities between ICT and other forms of capital (e.g., human capital and intangible capital, among others). Poland's revealed comparative advantages are still mostly in routine tasks (see, e.g., Lewandowski and Hardy, 2018). Since March 2020, when the restrictions resulting from the COVID-19 pandemic were felt the strongest, many enterprises and public entities were forced to conduct accelerated digitisation processes. The situation intensified the already existing trend of transferring to remote communication or work. It is estimated that around 56% of enterprises introduced remote work through September 2020 (Obserwatorium.biz, 2020), while the percentage of the work force that works from home on a regular basis increased from 7% in 'normal' times to roughly 20% in 2020, (as of October 2020, data from an online labour force survey, Diagnoza.plus [2020], with 51% of the labour force at least intermittently working from home in April 2020). Moreover, it also forced digitisation in the area of transactions as well as led to a considerable boost in the demand for e-government services.

But what exactly can be understood by the process of digitalisation and how is it different from digitisation and digital transformation? While digitisation predominantly concerns internal optimisation, the automation of processes, and converting something non-digital into digital and typically results in cost reductions (Brynosofisson and McAfee, 2014), digitalisation is a far broader term describing a change of the entire work and production ecosystem. In Gartner's IT glossary, digitalisation is 'the use of digital technologies to change a business model and provide new revenue and value-producing opportunities; it is the process of moving to a digital business'[5]. Hence, it goes beyond the usage of software and hardware to introduce a deeper evolution of work. Digital transformation goes even further as it involves a cultural change in the implementation of digitalised processes. It requires people as much as it requires technology (Nadkarni and Prügl, 2020). Although these three concepts describe different processes, in the context of this report they will be very much interlinked, although our main focus is related to the concept of the country's overall digitalisation.

In this report, we show that the level of digitalisation of the Polish economy as a whole is behind European benchmarks and that it is insufficient. This has two dimensions – one is the overall low digital literacy of Polish society and the low demand for digital services, while the other is the

[5] https://www.gartner.com/en/information-technology/glossary/digitalization, accessed 25.11.2020.

insufficient digitalisation of business activities which stems from inefficient programmes and incentives in this respect. These dimensions overlap – human capital deficiencies reduce the benefits from digitalisation efforts on the part of enterprises while digitalisation itself is performed in an inefficient way. We analyse digitisation in several sectoral dimensions to understand the challenges facing specific segments of the Polish economy. We show that the deficiencies in digitalisation are uneven: small firms are lagging behind large firms, while manufacturing firms use existing digital solutions in inefficient ways, lacking integration and strategic vision. Given the existing empirical evidence, improvements in these areas can positively contribute to the costs of running a business and to the way a business is organised as well as improve the allocative efficiency. Improving the degree of the use of digital technology in manufacturing can contribute to maintaining the cost-competitiveness of the sector while digital process innovations can shift it towards non-price competitiveness. Improvements in the digitisation (and digitalisation) of the services sector will help with consumer outreach and facilitate entering foreign markets, in particular for small firms. Last but not least, in light of the identified list of needed improvements, we comment on the potential use of the EU Recovery Fund which was agreed in July 2020 to mitigate the social and economic damage of the COVID-19 pandemic in EU MS. Thanks to this earmarked budget, the European Commission (EC) will be able to borrow EUR 750 billion from capital markets and redistribute it among MS as grants and loans between 2021 and 2027.

Overall level of digitisation of the Polish economy

In this section of the report, we present a short assessment of the overall state of digitalisation in Poland. We largely base this assessment on the 2020 edition of the Digital Economy and Society Index (DESI, EC [2020a] as well as the accompanying indicator database) which provides an up-to-date set of indicators on digitalisation and digital transformation for EU MS in a way that allows them to be compared across countries and across time. Moreover, an analysis of Eurostat data allows for the identification of priority areas of the digital economy in the MS that require specific actions and investments. The DESI report describes 37 indicators that fall into five main categories: connectivity; human capital; use of internet; integration of digital technology; and digital public services. We are interested not only in the actual levels of the analysed indicators and their distance from the EU averages, but more importantly, we assess if there is a catching up process with the EU and whether the distance to the frontier countries is reduced over time.

The main ranking of DESI in 2020 shows Poland ranked 23rd out of 28 EU MS[6], which places it below the EU average (the higher the DESI score, the more advanced is the state of the digital economy and society), with only Bulgaria, Romania, and Cyprus of the NMS scoring worse than Poland, as well as Greece and Italy. Therefore, it may be argued that Poland is among the least advanced countries in Europe with respect to the degree of digitisation. What is worse, most of the relevant indicators show that the gap with the rest of the EU is widening. Poland has not managed to improve its ranking during 2015-2020 despite the fact that at least in 2015-2018 Poland experienced fast economic growth. What is more worrying is that the distance to the EU

[6] The United Kingdom is included in the 2020 edition of the DESI.

frontier (expressed as either the country with the maximum score or the average of the three top-performing countries) has increased substantially. While there has been an improvement of the DESI score by a substantial amount in Poland over the period of 2015-2020, this was not the result of an improvement in relative terms but rather the result of a general trend visible almost everywhere in Europe. The only visible improvement is the reduction in the distance to the NMS frontrunner – Estonia, but the distance to this country remains substantial.

Table 1 Poland's digital performance according to the DESI

	2020	2015	2010-2015 change
Poland's score	45.0	31.3	13.7
Poland's rank	23	23	0
Distance to EU average	8.5	8.2	0.3
Distance to EU maximum	72.3	57.0	15.3
Distance to EU frontier	21.1	19.7	1.4
Distance to CEE maximum	16.1	17.4	-1.3

Source: own elaboration of DESI indicators; EU frontier is the average for the three countries with the best score.

Low DESI scores result from all its components being below the EU average. The assessment of connectivity was relatively the best across all five analysed components and placed Poland 5th in the EU; the rankings of the remaining indicators were human capital (22), use of internet services (23), integration of digital technology (25), and digital public services (20). It is important to note that a significant improvement in the ranking in 2015 was achieved only in the connectivity category, which refers mainly to the availability of access infrastructure. In the area of digital public services, which includes e-government initiatives, while there has been an improvement in absolute terms, the digitalisation of public services was considerably faster and more pronounced in the rest of the EU which resulted in a drop in Poland's ranking by 7(!) places.

We consider different categories of digitalisation to be interrelated. Access to quality infrastructure predetermines access to the internet by consumers and firms, while at the same time, demand by firms and consumers feeds into demand for internet access. However, one can think of some of the aspects of digitisation to be more primary in this causal relationship. For example, it is difficult to expect firms to implement digital innovations when there is low demand for it on the part of consumers due to low access to infrastructure and insufficient level of skills on the part of the labour force to reap the supply-side benefits of digitalisation. Moreover, we also observe uneven development in many indicators, showing some persistent barriers to digitalisation.

Looking at the individual categories of digitalisation, uneven development is clearly seen in the connectivity category. Poland has made substantial progress in assuring access to the internet. This is reflected in the above-EU-average provision of very fast internet access (at least 100 Mbps) as well as access to mobile broadband. As it turns out, Poland has the highest use of mobile broadband services in the EU and their prices are very competitive. However, mobile broadband is not a perfect replacement of fixed-line internet access due to limited capacity, variable speeds, and the data caps present in most personal and business mobile access offers. The rapid increase in demand for mobile services in 2020 due to the COVID-19 pandemic and the unprecedented shift towards remote work and remote learning has put a visible strain on the ability of mobile networks to deliver quality internet access.[7] This is exacerbated by the fact that Poland has not allocated any licenses of the 5G spectrum that could, at least to some extent, solve these capacity problems and potentially provide an alternative to lagging fixed-line access development. At the same time, overall fixed broadband take-up is below the EU average with the gap widening since 2015. The low accessibility of access to fixed-line internet is well known, in particular in less densely populated areas. Furthermore, the coverage of fibre to home/business (FTTH/B) networks has been a problem (Sledziewska et al., 2016) and the penetration of fixed-line broadband remains below the government's targets (UKE, 2020). The available maps of broadband coverage show significant regional diversification in several inhabited locations with no broadband access, in particular in central and eastern Poland[8]. Despite the progress made, connectivity remains to be an important barrier to the growth of demand of digital services, in particular in the parts of the Polish population where it is combined with low digital literacy, geographical remoteness, and low income. It has to be noted that in Poland there is no designated telecommunications operator to ensure the universal service provision of internet access[9].

Digital skills, or human capital, are important for both the supply and demand of digitalisation and the development of these two categories is also uneven. On the one hand, the number of ICT specialists and ICT graduates entering the labour market is increasing and converging with the EU average and the number of firms facing difficulties in finding ICT specialists is one of the lowest in Europe. On the other hand, the demand for these specialists is also lower than the EU average (according to Statistics Poland [2020] currently only 25.2% of enterprises employ ICT specialists). One of the reasons for this can be the high level of wages of ICT specialists (the wage gap with the EU-15 is significantly lower than the average in the economy; it amounts to 59.7% in the ICT sector versus 67.7% overall in 2019[10]). However, it can also be due to structural reasons (e.g., the firm size or sector may be driving these results, see the next section). ICT specialists aside, the percentages of people having basic digital skills (roughly half of the

[7] See, for example: https://www.telepolis.pl/wiadomosci/taryfy-promocje-uslugi/zagrozenie-epidemiczne-szybkosc-internetu-w-polsce. The persistent increase of mobile traffic during lock-down was comparable to that observed during largest yearly traffic peaks (e.g., New Year's Eve).

[8] Available via the website provided by the Polish Office of Electronic Communications (UKE), https://mapbook.uke.gov.pl/ as well as in a less detailed form, here: https://www.gov.pl/documents/31305/436699/Narodowy_Plan_Szerokopasmowy_projekt.pdf/ac781add-c63f-b709-38eb-4683859e0874. The UKE's maps show that even within large cities and their suburbs, there are considerable numbers of white spots – places with no broadband access.

[9] While there has been some discussion on the introduction of universal service in internet access, e.g., https://www.telko.in/rz-internet-jako-uslug-powszechna-uke-chce-operatorzy-protestuja, nothing has materialised in the policy sphere so far.

[10] Own calculations based on Eurostat data.

population[11]) or above basic digital skills are below the EU average and are not improving over time – even in an absolute sense – which shows a long-term structural deficiency of the education system. The lack of these basic skills means that Polish enterprises need to invest more in the skills upgrading of the labour force while at the same time facing potentially lower demand in local digital markets than their EU counterparts. Currently, the number of enterprises offering training to develop or upgrade the ICT skills of their personnel is significantly below the EU average (13% of enterprises in Poland, versus 24% in the EU-28), with this gap being even more pronounced in small enterprises (9% versus 19% in the EU-28)[12].

The above factors are clearly visible in the third category, which is internet use. Here, all the subcomponents of the DESI – internet use (in all analysed categories), number of activities performed online, and transactions performed online – are persistently below the EU averages and are, to a large extent, following the upward trend visible elsewhere. The low number of people with at least basic digital skills corresponds to the overall low awareness (despite the above-mentioned enthusiasm towards digitalisation) in what the internet may offer and therefore leads to lower incentives towards the use of digital services and the low penetration of the internet in general. Hence, the lack of basic digital literacy and incentives related to the use of the internet and digitalisation overall is clearly an obstacle that should be continuously addressed by policy measures.

The three analysed measures primarily relate to the conditions Polish firms face in determining the level of digitisation of their businesses and the level of the provision of digital services related to their activity. The fourth category – integration of digital technology – shows the actual level of the digitisation efforts of the enterprises themselves. And these figures show that as many as 60% of enterprises have a very low level of digitalisation according to DESI scores (as compared to the EU: 39%) and only 11% of them are highly digitised (EU: 26%). These differences stem from Poland being below the EU averages in both the level of integration of digital technology and e-commerce. While online sales are clearly a dynamic part of the Polish economy (the share of e-sales in total sales grew from 8% in 2010 to 14% in 2019), growth elsewhere is equally fast[13]. However, other dimensions of business digitalisation (consisting of integration of internal processes, cloud computing services, bit data analysis, 3D printing, and robotics, among others) are lagging behind. While the average level of integration of internal processes (the percentage of enterprises who have an ERP software package to share information between different functional areas) in enterprises across the EU-28 in 2019 was around 34% (21% in 2010), in Poland the number amounts to only 29% (an increase from 11% in 2010). The situation is even worse when it comes to the use of cloud computing services, as only 11% of Polish companies did so in 2018 compared to the EU-28 average of 26%, despite some progress in this respect (6% in PL in 2014 compared to 19% across the EU-28)[14]. Finally, the low number of enterprises analysing big data from any data source – 8% in PL in 2018 as opposed to 12% in the EU-28 – does not improve the speed of the catching up process.

[11] DESI (2020) indicators.
[12] Eurostat data, https://ec.europa.eu/eurostat/databrowser/view/isoc_ske_ittn2/default/table?lang=en, for enterprises employing at least 10 persons, comparable data for micro enterprises is non-existent.
[13] Eurostat data, https://ec.europa.eu/eurostat/databrowser/view/isoc_ec_eseln2/default/table?lang=en
[14] Eurostat data, https://ec.europa.eu/eurostat/databrowser/view/isoc_cicce_use/default/table?lang=en

As for the technology itself, Statistics Poland (2020, data for firms over 9 employees) estimates that 24.4% of enterprises use paid cloud computing services (6.9 percentage points more than in 2019). Among the services offered in the cloud, electronic mail (email), used by 18.3% of enterprises (5.4 percentage points more than in the previous year), is the most popular one. Furthermore, 7.1% of enterprises use robots and 16.6% use devices or systems under the 'Internet of Things' (IoT) scheme. Yet, in 2019, slightly less than one in ten companies conducted Big Data analyses (approximately 8.5%); 3.4% of enterprises had 3D printers; and 16.5% of enterprises received orders electronically (with 12.1% selling through their own website or application, and 8.1% – via online trading platforms). At the same time, security measures are in place as in 2019 76% of Polish enterprises were in possession of policies protecting data and internal sources (just 1% less than the EU average), according to Eurostat[15].

Moreover, the overall expenditures of enterprises on digitisation are low[16]. Spotdata (2018) performed a cross-country comparison of overall spending on digitisation in Poland, combining data on the output of the ICT sector and the spending of firms on ICT infrastructure and services, and show that while the Polish level of spending is in line with the overall level of country development as measured by GDP per capita, both Hungary and Czechia perform considerably better. While the overall level of spending on digitisation was estimated at PLN 50 billion in 2017 (9.5% of GDP), the study suggests that increasing digitisation expenditures to a level corresponding with Czechia would require at least PLN 80 billion of expenditures (over 15% of GDP). It has to be noted that the available statistics on ICT outlays (covering computer and telecommunications equipment, leasing of ICT equipment, developing own software, or modifications of purchased software) points to a 27.8% decrease between 2017 and 2018[17].

The remaining DESI category is performance of e-government or digital public services. Here the progress over the last few years was significant in most European countries, including Poland. However, overall performance in Poland is below the EU averages due to deficiencies on both the demand side (i.e., number of people using digital services) and the supply side (in particular, quality of digital services for business). However, in the categories related to the coverage of online government (i.e., the share of administrative steps related to major life events and the amount of information in pre-filled forms) and the openness of data, Poland scores higher than the EU averages. We identify at least two areas where the coverage of digital public services is lacking: the legal system and health care.

The above five categories are broad, but they allow the identification of the main deficiencies of Polish digitisation. These are: insufficient digital competencies on the part of the Polish population and labour force together combined with lack of information on the opportunities provided by digital services which results in underperforming demand for digital and internet services. Moreover, on supply side, firms underperform in their degree of digitalisation, which is a result of the low level of human capital and the low level of digitisation expenditures. While some of the above problems are universal in the Polish economy, some are sector specific. In the next

[15] https://ec.europa.eu/eurostat/databrowser/view/isoc_cisce_ra/default/table?lang=en

[16] It has to be noted that Poland is one of the few countries in the EU that provides *no comparable data on ICT expenditures in its national accounts statistics* which makes cross-country comparisons very difficult. Given that ICT capital is widely regarded as an important growth driver, this is a major deficiency of public statistics.

[17] Latest available Statistics Poland data.

section, we put the different sectors of Poland's economy under more scrutiny to understand the structural sources of some of the above problems. In particular, we are interested in the range of problems faced by micro, small, and medium-sized firms as opposed to large firms, as well as the state of digitisation in the manufacturing sector and the services sector (including the banking sector). We also inquire into the main deficiencies of Polish e-government.

Sectoral issues

Digitisation and firm size: small and medium-sized enterprises

Around half of Polish GDP (as measured by value added) is generated by small (below 50 employees) and medium-sized (50-249 employees) enterprises, which places Poland among the countries where, economically, SMEs have the lowest importance, in particular small firms[18]. However, SMEs account for over 99% of firms, the bulk of which (94% of the total) are small and micro firms. More importantly, SMEs account for roughly 67% of employment in Poland (around half of this figure are employed in micro enterprises) and hence productivity improvements in this sector are important for improvements of allocative efficiency. As far as sectoral allocation is concerned, micro enterprises are predominantly located in services while larger SMEs are present in both manufacturing and services[19]. Few SMEs (less than 5%) sell their products or services in foreign markets. This is mainly driven by the very poor export performance of SMEs. According to analysis presented by PARP (2020), the employment share of firms exporting goods in the total number of firms between 10 and 50 employees amounted to 37.8%, with the corresponding number for firms between 50 and 249 employees at 51.9%. However, in services, export performance in the services sector is considerably worse with the relevant shares at 11.7 and 29.5, respectively. Therefore, export specialisation seems to be mainly the domain of large enterprises.

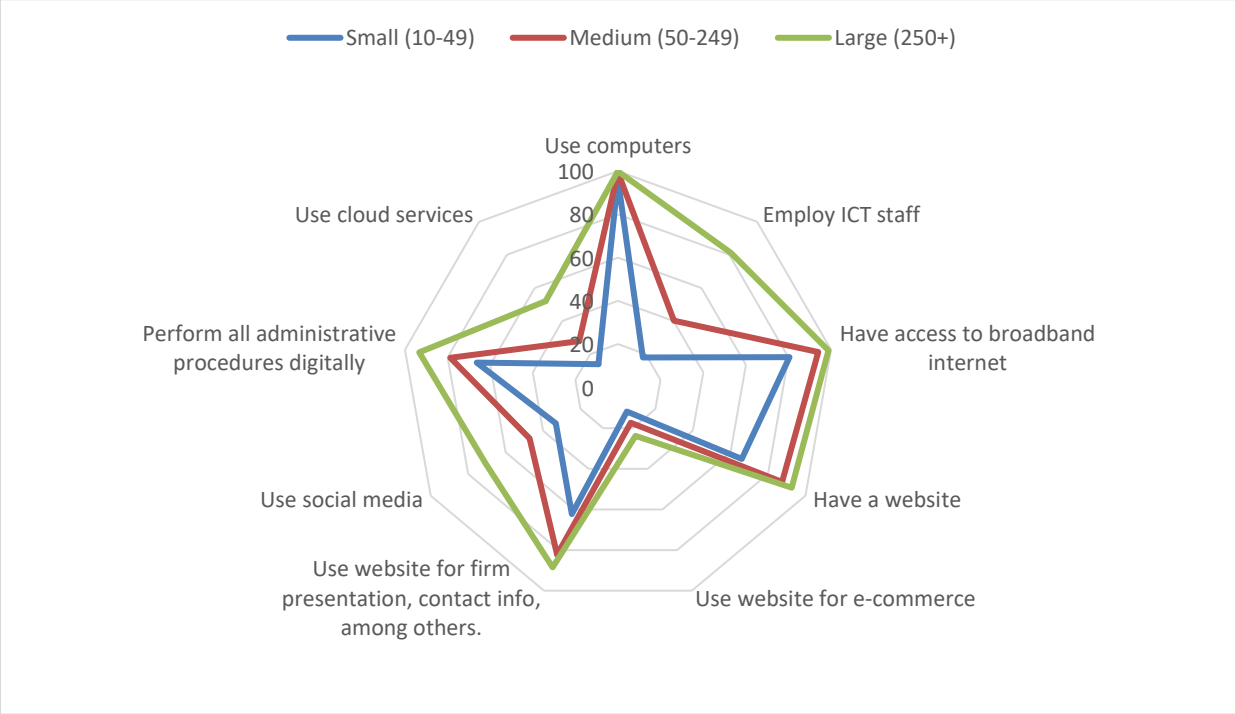
Given the overall large size and sectoral heterogeneity of the SME sector as well as its size relative to the rest of the economy, it is difficult to assess the level of digitisation in this sector as a whole. Moreover, while the SME sector is relatively well covered by digitisation statistics, unfortunately, statistical data on micro enterprises is very limited. The bulk of micro enterprises are sole proprietorships (which can employ up to 5 people); therefore, the level of digitisation and digital competencies of these firms is, to some extent, a reflection of the digital competences and access to technology of the firm owner. Evidence on micro firms is scattered, partially outdated, and not necessarily based on representative samples. For example, Lewiatan (2016)[20] shows that, in 2015, micro enterprises were the least digitally advanced compared to the rest of the SME sector, with the highest share (25.7%) of firms not using any digital technologies (email, social media, website for clients, mobile websites, e-invoices, resource management, or cloud services)

[18] Compared to latest Eurostat comparable data for 2018, business statistics.
[19] https://www.parp.gov.pl/storage/publications/pdf/ROSS-2020_30_06.pdf based mainly on Statistics Poland data.
[20] http://konfederacjalewiatan.pl/legislacja/wydawnictwa/_files/publikacje/2016/cyfrowa_transformacja_malych_firm.pdf, accessed 25.11.2020.

and with the shares of firms using each of the technologies considerably lower than in the remaining small and medium-sized firms. Orłowska and Żołądkiewicz (2018) using survey results show that the reasons for lack of investment in digital technology is predominantly lack of funds, lack of time, and perceived lack of areas for improvements, and half of the enterprises made decisions concerning these investments based solely on their own knowledge. Similar results were obtained by Lewandowski and Tomczak (2017). While we can expect that demand for the use of some digital technologies and automation increases with firm size and organisational complexity, lower outreach to consumers through online media and communication tools shows the unused potential for growth of the consumer base of the micro enterprise sector both at national and international levels. In smaller firms lacking designated ICT, social media, e-commerce, and marketing specialists, awareness of digital solutions may be limited and so may be the knowledge of their costs and benefits, leading to their inefficient use.

Information on the remaining SMEs is much more complete. As expected, the remaining small and medium-sized enterprises in general use computers in their daily operations; however, other dimensions of the use of digital technology are highly diversified by firm size. Medium-sized firms employ ICT specialists more often than small firms (but also use outsourced ICT services more often) and they are more likely to use cloud services and social media and take care all administrative procedures (such as taxes and social security, among others) fully electronically. While some of these characteristics are expected – large enterprises are more likely to have ICT specialists on site or whole IT units – it is quite surprising to see the low prevalence of the use of websites for e-commerce or the use of social media (which are rather inexpensive ways of conducting consumer outreach or following a marketing strategy) in small firms. Moreover, as many as 20% of small firms do not have access to broadband internet, which is clearly an obstacle to other ways of digitisation. The use of cloud services in small and medium-sized firms is not widespread and is mainly concentrated on the use of email services. The use of e-government is also less than satisfactory, in particular in small firms.

Figure 2 Use of digital technology by enterprise size class (percentage of firms)



Source: own elaboration based on data from Statistics Poland, data for 2018.

The digital performance of the Polish SME sector is worse than the EU average. The available indicators show that only 12.8% of medium-sized enterprises (10-249) are selling online as compared to 35% in Ireland, the best performer, and 18.4% for the EU average. While the number of SMEs selling online is growing steadily (a 3.5 percentage point increase overall since 2015), the gap with the EU average is increasing. Cross border sales are even less prevalent (5.3% of SMEs in Poland, with the EU average at 9.2%)[21], indicating that only a small fraction of firms use this opportunity to benefit from access to the Single European Market. Among the SMEs that had cross-border web sales in 2019, a considerably larger portion reported problems relating to the high costs of delivering and returning products, resolving complaints and disputes, adapting product labelling, and language barriers than was the case for the EU on average, with smaller firms being more disadvantaged with respect to medium firms[22].

Manufacturing industry

Manufacturing in Poland is export-oriented with several sectors exporting over 40% of output and with a mix of medium-high and low-tech industries, such as the motor vehicles (6.5% of overall industrial value added and 22% of exports[23]) and transport equipment sectors, the electrical appliances and machinery and equipment sectors, and some lower-tech sectors such as metals and metal products, textiles and wearing apparel, and tobacco. The food sector is the

[21] All data come from DESI indicators, http://digital-agenda-data.eu/datasets/desi/visualizations
[22] Eurostat data, https://ec.europa.eu/eurostat/databrowser/view/isoc_ec_wsobs_n2/default/table?lang=en
[23] Statistics Poland data.

largest manufacturing sector in Poland and while it sells to the domestic market, it is also a substantial provider of exports (10% of overall industrial value added and 11% of exports)[24]. Many of the export-oriented sectors are taking part in GVC – they provide parts to larger production processes. For example, some tasks of the automotive sector, as well as tasks from the furniture, food processing, textiles, and chemicals sectors (see, e.g., Bogdan et al., 2015) are offshored to Poland from other countries. The product structure in Polish manufacturing drives the overall low value added: products from traditional sectors (food, textiles, furniture) are of relatively low overall value with rather high domestic value-added content while the goods produced within GVC have relatively low domestic value-added content as they rely largely on foreign value added (see, e.g., Nacewska-Twardowska, 2019). This combined with relatively low research and development outlays in Polish manufacturing is a source of the low productivity level and curbs productivity growth (the labour productivity gap to EU-15 manufacturing is 68.5% with only a 3-percentage point gain over the last decade[25]).

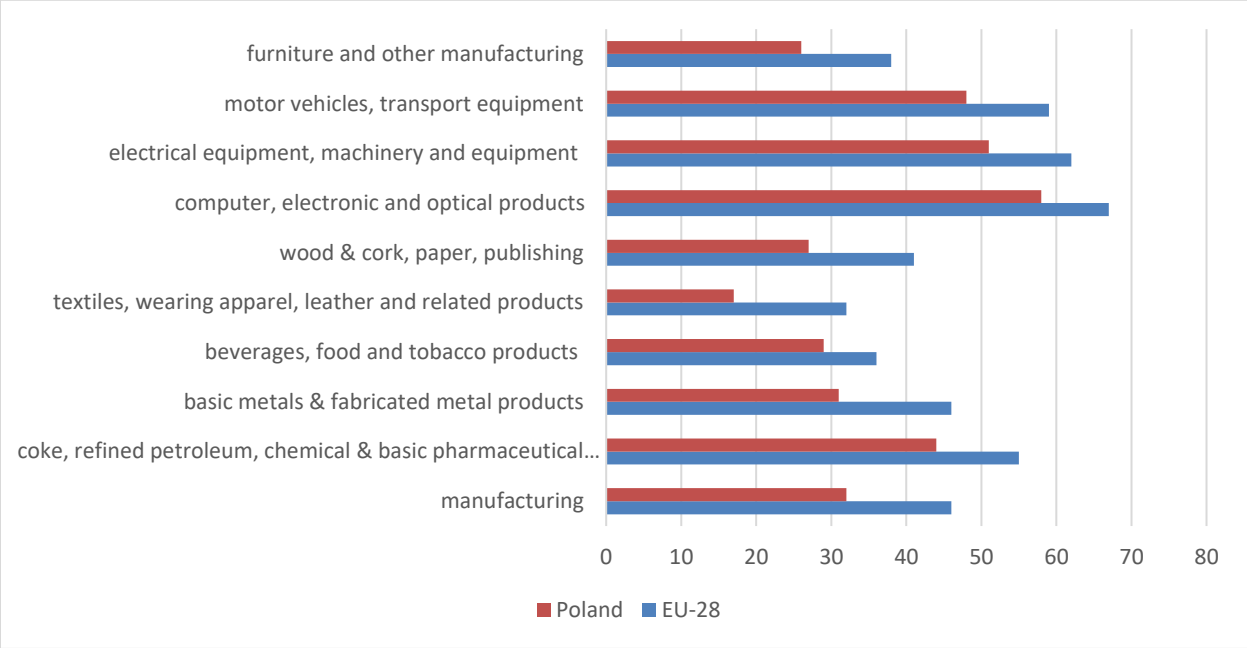
As digital technology is relatively accessible due to its low set-up costs and flexibility while being an area of fast technical progress itself, we believe that identifying gaps in the use of digital technology can be helpful in fostering productivity growth (see Kijek and Kijek [2019] for recent evidence of productivity gains from investments in ICT in Polish manufacturing). While the DESI indicators used in the previous sections do not refer to manufacturing as a separate sector, we will base our reasoning on other available reports. McKinsey (2016), on the basis of a cross-country and cross-sectoral comparison, shows somewhat of a sectoral duality regarding the degree of digitalisation. While Poland is, on average, significantly less digitised than the United States and Western Europe[26], there is a clear division between the advanced manufacturing sectors and the more traditional sectors. The digitisation level of advanced manufacturing is lower but comparable to that in Western Europe, while in the manufacturing of basic goods the gap is substantial. Therefore, the gap in digitisation is only partially due to the different sectoral structure of Poland versus the West.

Siemens (2020) provides more insight into the sectoral differences within manufacturing by providing a synthetic measure of the digitisation of production taking into account several areas such as planning, administration, system integration, production and operations, data management, and application of digital processes. The results of the study performed for four manufacturing sectors: food and beverages; chemical and pharmaceutical; automotive; and machinery show the machinery sector scoring the highest and the food sector scoring the lowest. While the Siemens study provides no international benchmark other than an artificial benchmark of ‘full digital transformation’, in most areas, all the analysed sectors are assessed as far from this ideal point. Progress in data management and the application of digital processes was assessed, in general, at the highest level and strategic planning, administration, and system integration were assessed on a level far from the maximum. In particular, what is striking is that a large percentage of surveyed firms (over 30%) have not considered any sort of digital transformation nor is there a relevant strategic plan in place. Furthermore, over 50% have no assigned budget for such purposes and only 39% of firms have plans to improve digital competencies for all or select

[24] Statistics Poland data.
[25] Own calculations based on Eurostat data.
[26] France, Germany, Italy, Sweden, United Kingdom.

employees. As far as digitisation of administration is concerned, this is mainly in the form of an ERP (enterprise resource planning) solution, which was undertaken by 42% of firms. Otherwise, in general, systems are not integrated (only 6% of firms possess fully integrated systems requiring only limited manual intervention). Automatisation is also only present in selected enterprises with only 1% of enterprises declaring a fully automated production process. At the same time, the use of digital technology for strategic planning seems to also be very rare. While the sectoral data on the level of integration are somewhat scarce, sectoral differentiation in integration across systems, as measured by the use of ERP solutions across functional areas of the company, is prevalent in more technologically advanced sectors and relatively less popular otherwise. At the same time, in all sectors analysed, it is less prevalent than on average in the EU-28.

Figure 3 Percentage of firms (10+ employees) using ERP data across functional areas of the company



Source: Eurostat

It has to be noted that manufacturing, and in particular in the form that operates in Poland, needs a different form of digitisation than, for example, the services sector which is dominated by small firms. For example, the scope for e-commerce is relatively small as the supplier-customer relationships are much more specialised and potentially focused on larger volumes and a smaller number of consumers. However, there are important economies from automatisation – both in the production and administrative processes. The Polish manufacturing sector is not reaping these potential benefits by partially relying on labour-intensive manual tasks in both areas. While some digitisation exists, in particular in management and data gathering, due to a lack of integration this data is not used to its full potential. Therefore, it seems that it is not the lack of equipment and infrastructure that is the source of the poor digital performance of Polish manufacturing but rather the lack of strategic vision and the interoperability of systems in line with Industry 4.0 principles (i.e., to gather and process data and then efficiently use these data to together with technology to optimise and automatise production and management processes).

Given the demographic and labour market trends, the relative costs of labour are inevitably going to increase, and manufacturing firms should be ready to introduce advanced automatisation in the near future. Moreover, relying on labour-intensive production processes makes firms less immune to lockdown-type policies where there is a high probability of production disruptions. This may explain why shifting to digital tools during the COVID-19 pandemic has been less pronounced in this industry than in other areas in the economy, with little impact on ICT investment in the sector (World Bank & PARP, 2020). Digitisation of the industry may require a more long-term plan and therefore to 'wait and see' could have been a prevalent strategy in light of the lack of preparation for the lockdown.

Market (non-financial) services

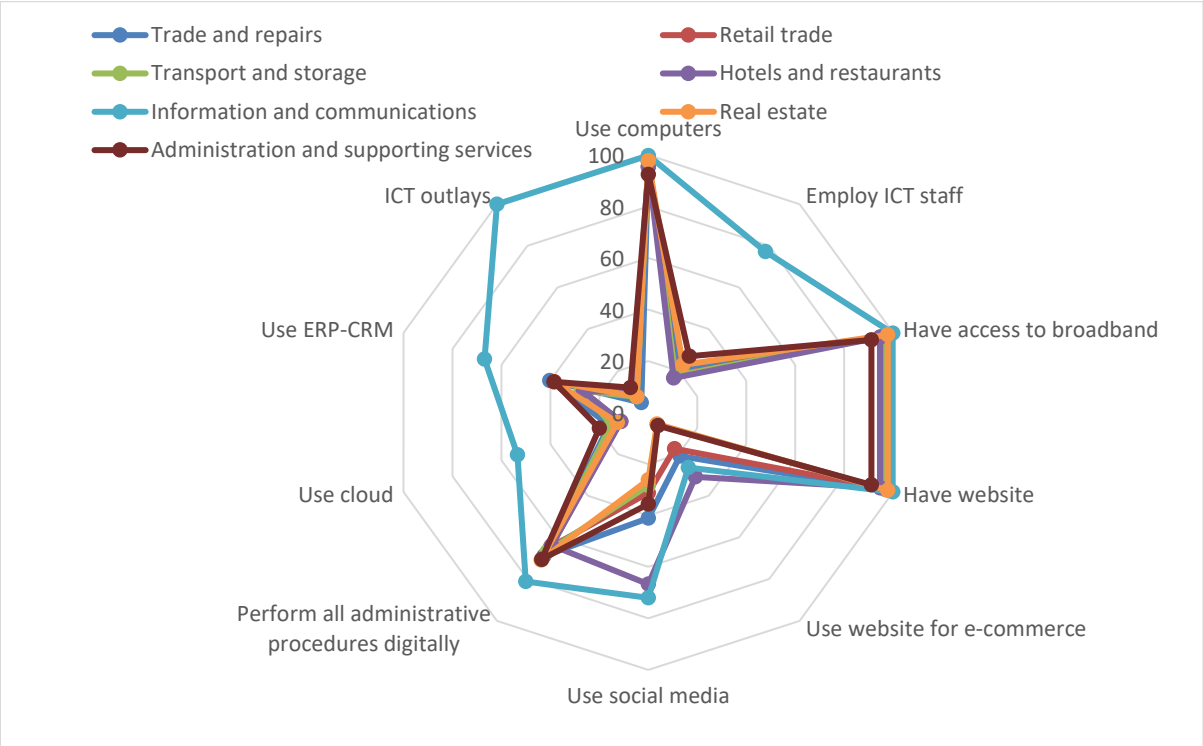
The services sector generates around 65% of overall gross value added in the Polish economy, while the share in market services is at least 51% of overall gross value added[27]. According to national accounts data from Statistics Poland, productivity (value added per person employed) in many service sectors exceeded that in manufacturing with a wide diversification in productivity levels across service sectors (for example, in hotels and restaurants, the productivity level in 2019 was only 58% of the level in manufacturing, with retail and wholesale trade and repairs at 137%, information and communication at 178%, and real estate at over 6 times the level of manufacturing). Given the size of the sector, there are firms of all sizes operating in it, but this sector houses the bulk of small and micro enterprises with the trade and repairs sector alone accounting for over 21% of total business establishments in Poland in 2020 and the overall services sector accounting for almost 77% of firms.

However, as far as the basic indicators of digitisation are concerned, their level of digitisation is similar and as indicated before, the differences within sectors and mainly across size classes are more important than the differences across service sectors. There are, of course, outliers such as the information and communication services sector that covers, among others, telecommunications, firms providing ICT business services as well as radio and television, where large companies dominate and ICT is the core business, leading to the highest scores in all the digitisation indicators. All the analysed service sectors predominantly use computers and have access to broadband internet (over 90% of firms in each category, with the lowest score in administration and supporting services). Outside information and communications services, the use of cloud services and ERP/CRM systems is not prevalent. Most services firms have a website, but only a small fraction use it for e-commerce, with the highest popularity found with hotels and restaurants and the lowest with administration and supporting services and real estate (where platforms and aggregators play a more pronounced role than own websites). The use of social media is diversified across service sectors (with high use in hotels and restaurants), but clearly not universal. It also has to be noted that compared to the ICT outlays in the communications sector, other service sectors outlays on ICT are minimal at the level of a fraction of a percent of annual revenues. Furthermore, while the levels of digitisation across the services sector in Poland may be similar, the potential for the digitisation of these sectors may differ. Indeed, while still

[27] Statistics Poland national accounts data, market services exclude public administration, education, and health and social care.

slightly lagging behind Western European benchmarks, Polish services – notably the retail trade sector, the media, and professional and business services – are among the most digitally advanced sectors in Poland. On the other hand, the transportation sector is severely lagging behind its Western European counterparts and, relative to those benchmarks, is one of the least digitised sectors in Poland[28]. This is quite striking as, for example, the Polish international road transport sector is currently the largest in Europe and is responsible for a significant portion of Poland's total services exports. The major source of comparative advantage remains to be, unfortunately, low labour cost.

Figure 4 Use of digital technology by enterprise size class (percentages of firms)



Source: Statistics Poland data. The numbers show percentages of all firms except for ICT outlays relative to revenues where data is expressed in percentages of the value in the ICT sector (100).

Banking

We have decided to devote a small section of our report to the banking sector as it plays a unique horizontal role in the economy as an intermediary in most transactions taking place between businesses and between businesses and consumers. Therefore, similar to e-government, its efficient functioning affects the overall efficiency of economic activity. However, unlike many other areas of the Polish economy, the banking sector has been undergoing a great deal of digital transformation with many pioneer solutions. For example, according the Deloitte (2020) Digital Banking Maturity study, 5 out of 13 surveyed banks operating in Poland were among

[28] McKinsey (2016).

the 31 global digital leaders[29]. McKinsey (2016) shows the Polish financial sector as one of the most digitally advanced across all sectors in Poland with the lowest (but still visible) gap with regard to Western Europe.

Innovations in digital banking include a widespread cashless payments system that is not limited to debit cards but also includes several types of contactless payments (Poland is among the countries with the highest shares of contactless transactions in Europe[30]: in the first quarter of 2020, 84.1% of card transactions were contactless payments[31]) and mobile device payments as well as BLIK (simple system meant for digital and traditional transactions that does not require any specialised infrastructure on the part of the seller). Moreover, banks also play a role in increasing the popularity of e-government services through providing authentication services through the 'Trusted Profile' (Profil Zaufany), allowing log-ins to all online public services and securely signing official documents.

Innovations in the payment system are not limited to banks. There are several other fintech companies offering services independently from banks or in cooperation with banks. For example, in recent years, a number of payment systems have emerged including PayU, Przelewy24, BlueMedia, SkyCash, and others, acting as intermediaries in internet transactions, interfacing between many Polish internet stores and credit cards, bank accounts and other payments systems such as PayPal or Google Pay. They also offer payments using either traditional web access and/or mobile apps as well are many others including firms offering crowdsourcing services, peer-to-peer loans, or crypto-currency dealers, among others.

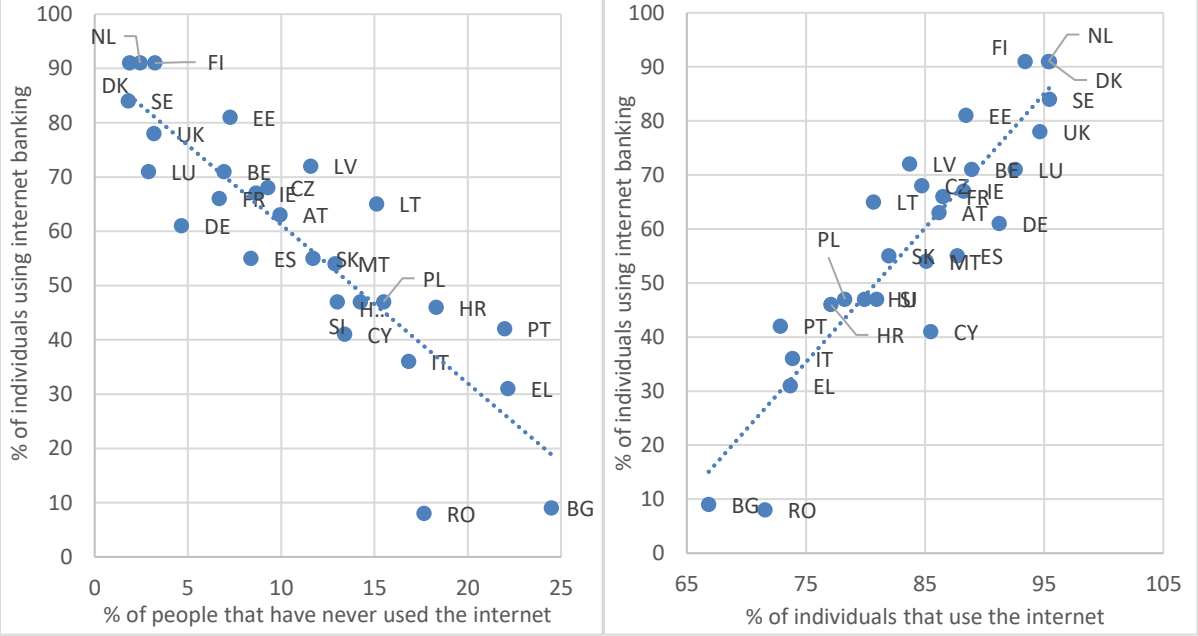
However, there are several perceived barriers to innovation in this leading Polish industry. A report by Fintech Poland (2020) identifies them to be, among others, a tendency to overinterpret EU law (for example, in the area of electronic currencies), the differing positions of different state institutions, excessive reporting and certain laws concerning the outsourcing of financial services to non-banks, and the lack of regulations concerning crowdfunding and peer-to-peer loans. However, banking regulations are actively accommodating the technical progress. For example, one of the new solutions proposed by the Financial Supervisory Commission is a regulatory sandbox[32] where start-ups will be allowed to test new fintech products in interactions with actual clients in cooperation with sandbox operators, which include several commercial banks and other firms.

However, while the supply of digital services in Poland is clearly at a high level, with multiple financial innovations, the demand side for these services is still lagging behind the rest of Europe. The use of online banking is below the EU average (47% of individuals use internet banking in Poland versus 58% in the EU, Eurostat data) as well as well below the EU frontier (for example, in Finland, the Netherlands, and Denmark, the respective number in all three countries stands at 91%). The distance to the EU-average is decreasing gradually over time but given the large

[29] The study compared 1108 different aspects of banks functioning (such as opening of accounts, signing documents, available services etc.)
[30] https://www.statista.com/statistics/946228/contactless-payments-market-share-at-pos-in-europe-by-country/, accessed 25.11.2020.
[31] https://www.nbp.pl/systemplatniczy/karty/q_01_2020.pdf, accessed 25.11.2020.
[32] https://www.knf.gov.pl/dla_rynku/fin_tech/Piaskownica_regulacyjna_KNF, accessed 25.11.2020.

differences between countries and the gap between the average and top performers, this is not reassuring. However, the problem seems to not be the banking sector *per se*, but rather the overall penetration of the internet which is low when compared to many EU countries. On the other hand, the number of people that have never used the internet is quite high. The relationship between these variables and the use of internet banking is quite robust as shown by Figure 5[33]. Poland is located slightly above the regression line suggesting that the use of internet banking is slightly higher than it would be considering overall internet penetration; however, this deviation is insignificant. Therefore, the main obstacle in the popularity of internet banking is structural – it is related to the demand side rather than supply side inefficiency. In the COVID-19 era, the popularity of contactless payments is clearly beneficial from the safety point of view, but the tendency to move financial services online may be a source of not only digital exclusion but also to some extent, exclusion from access to safe financial services for those who do not use the internet at all.

Figure 5 Internet banking use versus overall internet use



Source: Eurostat, DESI indicators

E-government

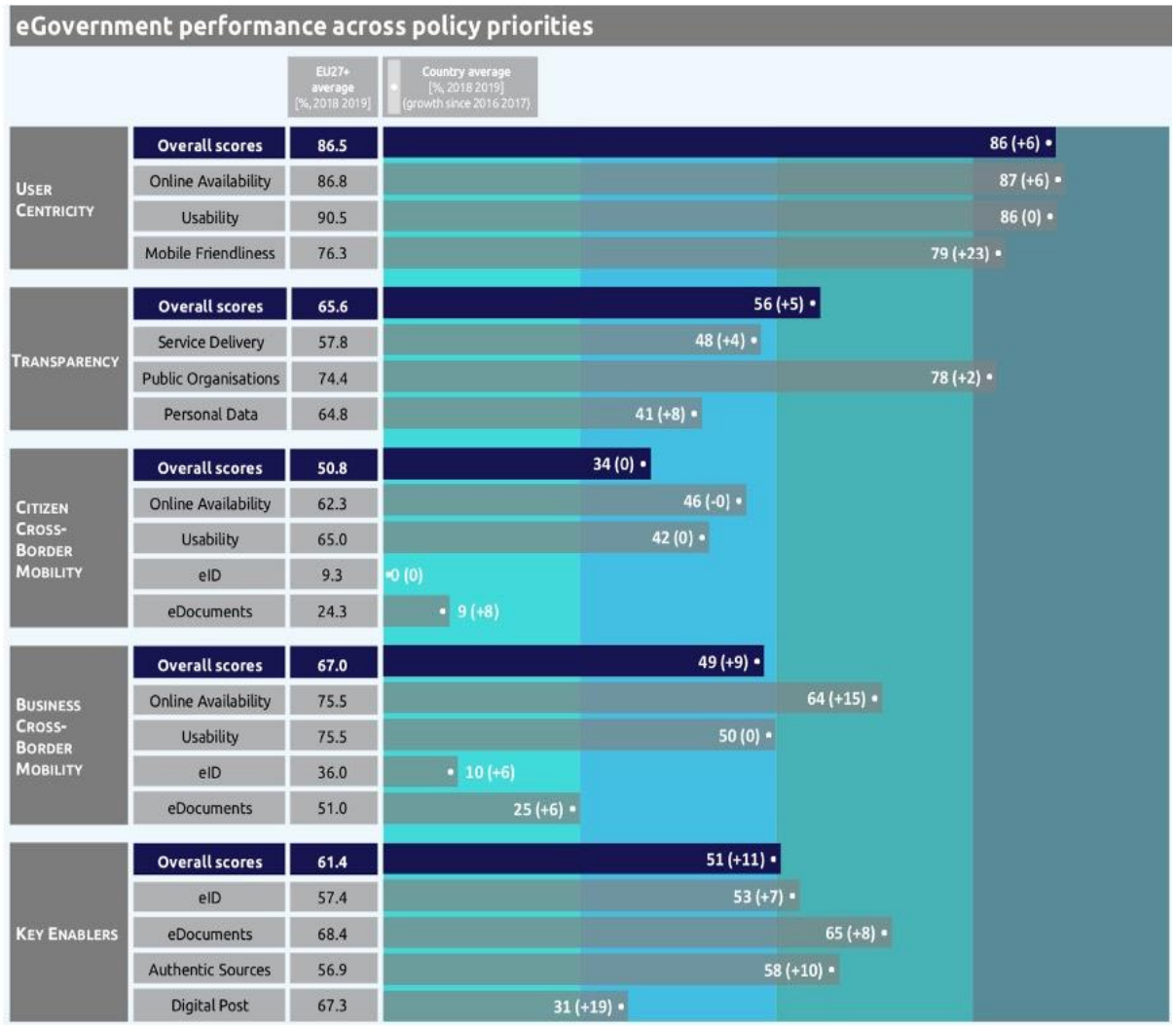
The concept of e-government and digital public services imply that high-quality services for citizens, including entrepreneurs, are to be provided by modern IT solutions supporting a logical and coherent government IT system, developed and maintained with the cooperation of all actors at various levels of public administration. A priority task in the field of e-government is to allow the widest possible range of public services to be provided digitally, thereby enabling citizens to

[33] The relationship explains 76% (left panel) and 81% (right panel) of the overall variation of internet use in the cross-section of EU countries.

handle their business remotely. It will be necessary to ensure the interoperability of public IT systems and to computerise the internal processes of the administration[34].

According to Statistics Poland (2020), in 2020 around 42% of the Polish population aged 16-74 used digital (virtual) public administration services. In fact, in recent years, the group of people who use information searches, download electronic forms, and return completed ones has grown annually. In 2020, the percentage of people searching for information on public administration websites increased by 2.3 percentage points, and the percentage of people submitting completed forms – by 2.1 percentage points. These numbers are lower than EU averages and correspond to the overall low demand for internet services in Poland.

Figure 6 eGovernment performance in Poland and the EU



Source: EC (2020b)

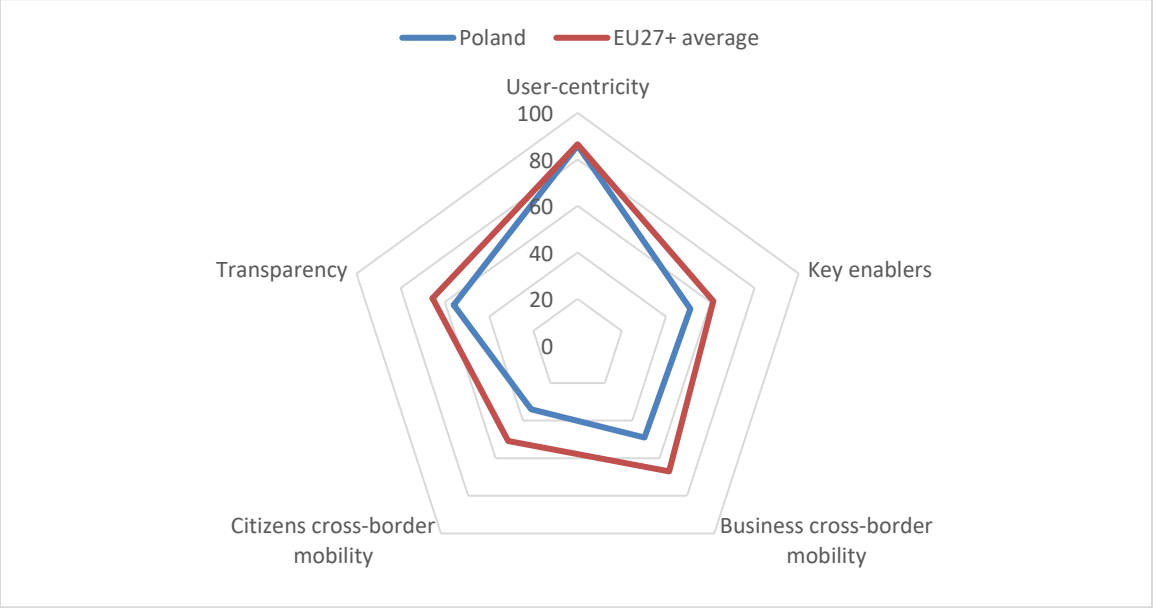
34 https://ec.europa.eu/digital-single-market/en/news/egovernment-benchmark-2020-egovernment-works-people, accessed 25.11.2020.

However, according to the EC's 'eGovernment Benchmark 2020. eGovernment that works for the people' report (EC, 2020b), which analyses e-government practices in 36 European countries, Poland still lags behind in several categories of the supply of public digital services. While user-centricity is similar to that of the EU average, other categories of e-government quality are at insufficient levels. This applies mainly to citizen cross-border mobility (the experience of individuals from another MS using Polish e-government services), which analyses, among others, online availability, usability; eID; and e-documents, with an average score of 34% (50.8% in the EU), as well as business cross-border mobility (the experience of businesses from another MS using Polish e-government services), with a country average of 49% (67% in the EU). Both of these categories are important in light of the limited internationalisation of Polish firms and relate to, for example, employing foreign nationals, cooperation with foreign businesses, and physical presence abroad, among others.

According to the same benchmark study, Poland is characterised by a medium-low level of penetration and a medium-low level of digitisation. Therefore, e-government in Poland is classified as 'non-consolidated' and therefore the ICT opportunities are not fully exploited (EC, 2020b). In both penetration and digitisation, Poland's performance is lower than the European average. However, Poland's performance, and especially penetration level, have improved in recent years, but are still not sufficient to be aligned with the European average.

Looking at the different categories of public services, we can see significant gaps in digitisation coverage. While the eID services provided by the Trusted Profile (Profil Zaufany) allow for communication with local and regional authorities with regard to most official matters, and many systems (car registrations, id cards, car insurance) are integrated with electronic documents substituting for physical ones, this does not extend to all areas of public services. For example, legal services still require physical presence, hard copies of documents, and physical signatures. Moreover, in the area of public healthcare, the government's Patient's Portal successfully introduced e-prescriptions that are now widely used, but the functionalities of the portal with regard to storing health histories, handling appointments, referrals, and so on remain limited (WEI, 2020). Improvements in these functionalities would certainly contribute to an overall improvement of the functioning of Polish healthcare, but potentially would also help increase the popularity of using digital public services among groups where the use of the internet is less prevalent (e.g., older people). Moreover, existing sources point to overall insufficient use of telemedicine in Poland (see, e.g., PWC, 2020; EC, 2018).

Figure 7 eGovernment indicators in Poland



Source: eGovernment Benchmark Report 2020 (EC, 2020b)

Medium and long-term government programmes are aimed at boosting e-government measures, particularly those involving the effective use of ICT in public administration.

For example, the Strategy for Responsible Development undertakes activities aimed at:

- *Providing e-services relevant to real needs, as reported by citizens and entrepreneurs;*
- *Creating a single information and e-services website for the government administration so as to improve access for citizens and entrepreneurs;*
- *Introducing a uniform and secure system for identifying citizens (eID) in e-services systems of public administration;*
- *Ensuring a dominant share of digital document flow in administration and economic trade;*
- *Increasing access to public sector information, including through interfaces for software developers;*
- *Adopting a standard for digital documentation management systems in public administration, guaranteeing an efficient exchange of information with the public administration's domain-specific systems;*
- *Integrating e-government data processing infrastructure and the development of a state register system. Ensuring the necessary reliability and availability of e-government systems and their integration*[35].

[35] https://www.gov.pl/web/fundusze-regiony/informacje-o-strategii-na-rzecz-odpowiedzialnego-rozwoju, accessed 25.11.2020.

It is worth mentioning that there are other elements linking this Strategy to the EC's Digital Single Market Strategy[36], the implementation of which is governed and monitored by the Digital Affairs Department of the Prime Minister's Office[37].

Existing digitalisation support programmes

The current and previous Polish governments have been aware of these significant deficiencies and this has resulted in the establishment of several programmes meant to improve the provision of digital services by the government, improve the skill levels of society, and improve access to infrastructure. EU funds have been an important element of the strategy of digital transformation. In the previous financial perspective, the Work Programme Digital Poland (2014-2020) was undertaken to improve the overall level of digitalisation. Its main pillars included improvements in access to high-speed internet, the provision of friendly and effective e-government, increasing digital competencies in Polish society, and technical assistance to the least developed and remote regions. The programme goals were, *inter alia,* to cover 100% of households with fast internet access and considerably improve the percentage of households and enterprises using the internet in general, and in particular in their contacts with public institutions, as well as increase the share of people having at least basic digital skills, therefore directly focusing on the largest obstacles to Poland's digitalisation. To a large extent, these goals are also covered by the National Integrated Informatisation Programme[38] (PZIP; 2014-2022) which has been recently updated (September 2019). The programme was initially intended to cover the reorientation of public administration towards services focused on the needs of citizens as well as the implementation of horizontal tools supporting the activities of public administration. However, recently, a focus on the digital competences of citizens, administration employees, and specialists in ICT became crucial.

The State Information Architecture[39] was created in 2018. Through its creation, the previous Ministry of Digital Affairs planned to coordinate IT infrastructure and 'adopt a method for managing their development in accordance with the guidelines of the National Integrated Informatisation Programme' with clear protocols, principles, and standards. The developed concept 'allows for an agile approach to the process of organising and expanding the architecture of the State's information systems'[40].

Digitisation is also an element of a long-term strategy of the Polish government, the *Strategy for Responsible Development (SRD)*[41]. The SRD is a framework document that includes references to many other government programmes, including those that are EU-funded –many of the SRD's elements are in fact elements of the EU Work Programme Digital Poland. The SRD

[36] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52015DC0192&from=EN, accessed 25.11.2020.
[37] https://www.gov.pl/web/cyfryzacja, accessed 30.11.2020.
38 https://www.gov.pl/web/cyfryzacja/program-zintegrowanej-informatyzacji-panstwa, accessed 30.11.2020.
[39] https://www.gov.pl/web/cyfryzacja/program-zintegrowanej-informatyzacji-panstwa, accessed 30.11.2020.
[40] https://www.gov.pl/web/cyfryzacja/program-zintegrowanej-informatyzacji-panstwa, accessed 30.11.2020.
[41] https://www.gov.pl/web/fundusze-regiony/informacje-o-strategii-na-rzecz-odpowiedzialnego-rozwoju, accessed 25.11.2020.

includes, *inter alia*, a chapter on digitisation including increasing the penetration of internet access to households, improving digital competencies, and improving the functioning of e-government. The strategic programmes under the umbrella of the Strategy include the National Broadband Plan[42], updated in 2020 with goals to ensure universal broadband access, very fast (over 1gbps) access in all economically important locations in Poland, and 5G coverage in major cities and communication pathways. The government has also published a Digital Competence Development Programme which aims to develop digital skills. The new programme is expected to focus on those skills needed by citizens, ICT professionals, and employees of SMEs and the public administration. Other programmes within the Strategy include, among others, the Open Public Data programme, aimed at increasing the availability of publicly accessible data, as well as the National Education Network, aimed at connecting schools to the internet in Poland. It should be noted, however, that recent changes to the organisational structure of the government (e.g., the liquidation of the Ministry of Digital Affairs in 2020) have made it difficult to track progress in the implementation of the programme. Furthermore, it seems that the COVID-19 pandemic has contributed to some delays in its implementation.

As for sector-specific programmes and initiatives, in Poland, the key government strategy designed to reform the manufacturing sector, including its digitisation and digital transformation, is the 'Strategy for Responsible Development' adopted in 2017. It is aimed at, *inter alia*, improving the productivity and innovativeness of Polish industry. While the strategy encompasses a wide range of investment projects aimed at selected sectors of the economy and goes beyond issues of digitisation, one of the key projects of the programme is the Polish Platform for Future Industry initiative that went into operation in late 2019 after a two-year delay. The platform is organised around a website, a medium aimed at increasing awareness of the advantages of technical transformation, supporting the introduction of digital products and services and promoting business models based on the Industry 4.0 principles (data science, automation, robotisation, virtualisation of processes, and cyber security). To date, the activity of the platform is mostly centred on organising training webinars and information on funding available from other institutions as well as tax deductions related to innovative activity and research and development.

Some emerging technologies are also on the radar of the Polish authorities. For example, work on the Artificial Intelligence (AI) Policy of Poland[43] was initiated and led by the previous Ministry of Digital Affairs. A team of independent experts identified five areas in which immediate action should be taken for the development of AI in Poland: 'innovation companies, education, the public sector, intercontinental cooperation and society'. Following this initiative, the previous Ministry of Digital Affairs analysed the feedback received on the document's draft to verify if these areas are in line with the vision of the Polish government and the vision of EU strategies in AI. Although the final version of the strategy was supposed to be available in Q1 2020, it has yet to be published.

The objectives of these programmes are generally in line with the largest deficiencies of Polish digitalisation. Yet, they are typically implemented later than expected which oftentimes results from organisation changes in the Polish government (for example, providing internet access to schools began on a larger scale in 2019 with only 13% of schools having access to fast internet

[42] https://www.gov.pl/web/cyfryzacja/narodowy-plan-szerokopasmowy---zaktualizowany, accessed 25.11.2020.
[43] https://www.gov.pl/web/cyfryzacja/droga-do-polskiej-strategii-ai, accessed 25.11.2020.

in that year[44]). Furthermore, some of the strategies and programmes duplicate the government's key policy goals (i.e., the Work Programme Digital Poland and the updated the National Integrated Informatisation Programme). At the same time, the core objectives of the programmes and incentives change, which seriously limits their impact (e.g., the National Integrated Informatisation Programme). The COVID-19 pandemic has now exposed many of these deficiencies, mainly insufficient skills and insufficient infrastructure. Given the difficulties of doing business during the COVID-19 pandemic, relatively fast improvements in these deficiencies can at least partially alleviate economic shocks.

EU Recovery Fund and its role in Poland's post-COVID-19 digitalisation

On 27 May 2020, the EC introduced an initial plan aimed at addressing the economic and social fallout resulting from the COVID-19 pandemic[45], naming it the largest stimulus package ever. This significant recovery plan for Europe consists of two components: the Multiannual Financial Framework (MFF) of the EU for 2021-2027, worth EUR 1,100 billion, as well as the newly created Next Generation EU Fund in the amount of EUR 750 billion, which 'will boost the EU budget with new financing raised on the financial markets for 2021-2024'[46].

The pillars of this new Next Generation EU Recovery Fund are the following:

1. Supporting MS to recover (consisting of: Recovery and Resilience facility[47], Recovery Assistance for Cohesion and the Territories of Europe – REACT-EU[48] focusing on green and digitalised recovery, Reinforced rural development programmes[49], Reinforced Just Transition Mechanism[50]);
2. Learning the lessons from the crisis (consisting of: New Health programme[51], Reinforced rescEU[52], Reinforced programmes for research, innovation, and external action[53])
3. Kick-starting the economy and helping private investment (consisting of Solvency Support Instrument, Strategic Investment Facility, Strengthened InvestEU programme).

While the majority (80%) of Next Generation EU funding will be channelled through additional public investment outlays, the support to the private sector has two major components: support to private investment including supporting green and digital transitions, where estimates of investment needed are at least EUR 1.5 trillion in 2020-2021 alone[54], and the Solvency Support

[44] https://konkret24.tvn24.pl/polska,108/tylko-13-proc-polskich-szkol-ma-szybki-internet,959823.html, accessed 30.11.2020.
[45] https://ec.europa.eu/commission/presscorner/detail/en/ip_20_940 accessed 28.11.2020.
[46] https://euraxess.ec.europa.eu/node/529484 accessed 28.11.2020.
[47] https://ec.europa.eu/info/sites/info/files/2020mff_covid_recovery_factsheet.pdf accessed 28.11.2020.
[48] https://ec.europa.eu/regional_policy/sources/docgener/factsheet/2020_mff_reacteu_en.pdf accessed 28.11.2020.
[49] https://ec.europa.eu/commission/presscorner/detail/en/qanda_20_985 accessed 28.11.2020.
[50] https://ec.europa.eu/commission/presscorner/detail/en/qanda_20_931 accessed 28.11.2020.
[51] https://ec.europa.eu/health/sites/health/files/funding/docs/eu4health_factsheet_en.pdf accessed 28.11.2020.
[52] https://ec.europa.eu/echo/files/aid/countries/factsheets/thematic/2020_rescEU_MFF_en.pdf accessed 28.11.2020.
[53] https://ec.europa.eu/commission/presscorner/detail/en/qanda_20_988 accessed 28.11.2020.
[54] https://cdn4.euraxess.org/sites/default/files/factsheet_1_en.pdf accessed 28.11.2020.

Instrument[55], mobilising some EUR 300 billion to provide urgent equity to private entities put at risk by the crisis. Focusing on the areas directly and indirectly related to digitalisation, the EU plans boost the InvestEU Programme[56], the EU's main financing push securing investment across the MS in areas such as sustainable infrastructure and digitalisation. The EC also proposed to create a new Strategic Investment Facility[57] to secure financing in key sectors important for the EU's future resilience and strategic autonomy with regard to green and digital transitions (in line with the Dutch Non-paper digitalisation in the EU recovery strategy for COVID-19[58]). The planned investment in key sectors and technologies include, *inter alia*, ICT privacy, 5G and AI, as well as clean renewable energy sources (RES).

Furthermore, on 30 September[59] the EC published a Communication on a new European Research Area for Research and Innovation. This renewed European Research Area[60] will improve the EU's research and innovation landscape while focusing on climate neutrality and digital leadership. In this document, the Commission set out strategic operations and tasks to be implemented in close cooperation with the MS, in order to promote investments related to, among others, digital transformation involving improved infrastructure, technologies, and fair access to different ICT tools for citizens across the EU.

Keeping these priorities in mind, on 10 November 2020, the European Parliament (EP) and the Council agreed on some of the most problematic issues of the plan[61]. According to the available information, the bulk of the Next Generation EU (EUR 750 billion) spending will be allocated to cohesion, resilience, and values (96% of the total), and the rest towards the single market, innovation, and digitalisation (1.4%) as well as natural resources and the environment (2.3%). Considerably larger funds towards digitalisation (together with the single market and innovation) will be available in the overall MFF (EUR 1,100 billion), where the allocated amount is over 12%, with cohesion funds at 34% of the total and the environment at 32%[62].

Yet, at the MS-level, the basis for obtaining support under the Recovery Fund will be the presentation to the EC of a National Reconstruction Plan (KPO[63]), containing a comprehensive reform programme aimed at strengthening the country's resilience. If the EC accepts the plan, the total amount of funds available to Poland may even amount to approximately EUR 57 billion[64]. Work on the KPO has been underway in Poland since July 2020 and the whole process is coordinated by the current Ministry of Development Funds and Regional Policy, which conducted a series of consultations with the participation of, among others, representatives of employers'

[55] https://ec.europa.eu/info/sites/info/files/economy-finance/ssi-factsheet.pdf, accessed 28.11.2020.
[56] https://ec.europa.eu/commission/priorities/jobs-growth-and-investment/investment-plan-europe-juncker-plan/whats-next-investeu-programme-2021-2027_en, accessed 28.11.2020.
[57] https://ec.europa.eu/info/sites/info/files/economy-finance/investeu-factsheet.pdf, accessed 28.11.2020.
[58] https://www.euractiv.com/wp-content/uploads/sites/2/2020/05/NL-non-paper-digitalisation-in-the-EU-recovery-strategy-for-COVID-19.pdf, accessed 28.11.2020.
[59] https://ec.europa.eu/commission/presscorner/detail/en/ip_20_1749, accessed 30.11.2020.
[60] https://ec.europa.eu/info/research-and-innovation/strategy/era_en, accessed 30.11.2020.
[61] https://www.consilium.europa.eu/en/press/press-releases/2020/11/10/next-multiannual-financial-framework-and-recovery-package-council-presidency-reaches-political-agreement-with-the-european-parliament/, accessed 28.11.2020.
[62] https://ec.europa.eu/info/strategy/recovery-plan-europe_en, accessed 30.11.2020.
[63] https://www.gov.pl/web/planodbudowy, accessed 30.11.2020.
[64] https://www.gov.pl/web/planodbudowy/co-to-jest-kpo, accessed 28.11.2020.

unions, while providing information on the requirements that should be met by applications for support in line with reforms related to achieving climate neutrality by 2050 or digitalisation. The draft list of projects is already available on the government's website[65]. The projects are directly devoted to specialised industrial projects such as intelligent factories, biotechnology, and the pharmaceutical industry, as well as to projects devoted to improving general competencies such as a project of an educational platform promoting innovation, a project devoted to analysis of the labour market needs and training in digital technologies, as well as a project devoted to digitisation of the investment process in the construction industry. While these projects at least partially address the deficiencies identified by this report, the details regarding these projects are scarce. Moreover, this list is not exhaustive as over 1,000 projects were submitted by different institutions and no comprehensive information regarding this topic exists[66].

We have identified several deficiencies in the level of digitalisation in Poland. As shown above, a large part of EU spending over the next financing perspective will be directly spent on issues related to digitalisation. Digitalisation can also be a part of spending on cohesion and digitalisation projects can be combined with projects devoted to green transformation (a topic that in Poland is also lagging behind the rest of Europe). Therefore, Poland can certainly use this opportunity to at least reduce the various gaps in digitalisation with the European frontier given the momentum in the growth of demand for digital solutions that has occurred during the COVID-19 pandemics.

Our report has shown that even if the supply of digital services is not necessarily particularly low in Poland, given its level of development, the demand side of the Polish economy is considerably weaker, with a large number of people not having basic IT literacy and access to the internet. The crisis has demonstrated the value of fixed and mobile networks as the backbone of people and their schools and enterprises and underlined the urgent need to invest in and speed up the deployment of secure and high-quality connectivity to boost the digital transformation further. Given the breakneck conversion to mass home-offices, the quality of connectivity will be more critical than ever – both for business existence, as a facilitator for emerging technologies like 5G, AI, and IoT, and for expansion for enterprises and their workers so they can emerge from the current and potential difficulties more resilient. Despite the competitive prices of network access and infrastructure when compared to the rest of the EU (EC, 2020a), Poland could boost funding for affordable high-quality network infrastructure and emerging technologies, such as 5G, robotisation, or AI in areas where the market conditions are such that private entities, especially micro and small ones, will not be able to finance such endeavours on their own. They could do so using the funds in the Recovery Fund/MFF devoted to digitalisation EU, for example, the Connecting Europe Facility 2.0[67], or this could be financed through cohesion funds, particularly regional development funds as proposed by the European Parliament[68]. Similarly, Poland could secure alternative funding opportunities, for example, through a lump-sum discount or voucher scheme to back disadvantaged users who are not in a position to pay for the installation of a high-speed broadband connection. This support scheme can be a digital parallel to similar measures

[65] https://www.gov.pl/web/planodbudowy/projekty, accessed 28.11.2020.
[66] https://filarybiznesu.pl/1200-projektow-w-ramach-krajowego-programu-odbudowy/a6106, accessed 28.11.2020.
[67] https://ec.europa.eu/digital-single-market/en/connecting-europe-facility-telecom, accessed 30.11.2020.
[68] https://esifa.eu/wp-content/uploads/2019/06/European-Regional-Development-Fund-and-Cohesion-Fund-2021_2027.pdf, accessed 28.11.2020.

in Poland and many countries for access to heating and electricity for low-income families[69]. Such support could be coupled with a renewed universal service programme for broadband[70] subsidising connectivity in more remote areas where commercial solutions prove insufficient.

5G (and eventually 6G) connectivity remains one of the fundamental blocks for Europe's digital future and to the EU. Therefore, Poland could be encouraged to award 5G spectrum frequencies by the end of 2020 or in early 2021 (under predictable and investment-conducive conditions) to secure a timely deployment of high-capacity network infrastructure all over Europe (EC, 2020a).

We have also identified significant deficiencies in human capital, a low level of digital skills, and a large share of the population subject to digital exclusion. We believe that the focus of at least some of the projects undertaken with financing from the Recovery Fund should be geared towards reducing digital exclusion. This has two dimensions: improvements in the provision of digital skills in basic primary and secondary education requires improvements in human capital infrastructure and connectivity in schools. Stalling levels of average digital skills point to large deficiencies in these areas while many schools, in particular in rural areas, are lacking basic connectivity. The other dimension is on-the-job training and the skills-upgrading of the adult population where the provision of ICT-related training to employees is insufficient. The EU Recovery Fund could be used in financing in both the subsidisation of employer-provided training, in particular at the SME-level, and publicly financed open training programmes for the general population with an accompanying information campaign.

In Poland, SMEs, in particular small and micro firms, are lagging behind in digitisation and need financial support for digital investments, including establishing an online presence through websites, e-commerce, and social media, as investment in digital technologies is perceived by many micro and small enterprises owners as costly. At the same time, especially in those micro and small firms, digital improvements in internal processes and dealing with public administration could reduce the costs of operation. Moreover, an online presence is one of the key features of breaking the barriers of firm internationalisation. Boosting cross-border sales is particularly important in the SME and services sectors, the largest segments of the Polish economy. In this case, small scale subsidies, grants and tax incentives (e.g., up to EUR 10 thousand for micro firms), or loans could be co-financed through the Recovery Fund as suggested by Digital Europe – a major trade association representing digitally transforming industries in the EU[71]. This could include extra incentives for those who enable online and remote working for their employees.

The above could be coupled with launching a common pan-European information exchange tool on available financial support for SMEs within the EU Recovery Fund[72]. Such an information exchange tool on available funding and technical support opportunities could significantly help Polish micro and small enterprises in making their work more efficient while spending less time searching for information, but instead actually using their available resources. Such a platform

[69] https://www.gov.pl/web/aktywa-panstwowe/jak-uzyskac-dodatek-energetyczny-, accessed 30.11.2020.
[70] Poland used to have a universal service provider for fixed-line telephony until 2011.
[71] https://www.digitaleurope.org/resources/post-covid-recovery-plan-for-a-stronger-digital-europe/, accessed 30.11.2020.
[72] https://www.consilium.europa.eu/en/policies/eu-recovery-plan/#, accessed 30.11.2020.

could also increase the awareness of the benefits of digitalisation, as a lack of such awareness is one of the main reasons firms in Poland do not invest in digitalisation.

In sectors dominated by larger firms, such as manufacturing and banking, digitisation should be combined with digital transformation, automation, and the use of big data, among others, to sustain competitiveness over the longer term. One of the ways to achieve this is enhancing the European Cluster Collaboration Platform launched by the EC's DG GROW in 2016, in order to provide a forum for cooperation between European start-ups and manufacturing firms. This could enhance the participation of Polish micro and small firms in international markets as well as overcome barriers to innovation with the help of larger entities. For the large manufacturing firms this would be an opportunity to head towards the direction of digital transformation to transition towards non-price competitiveness, automation, optimisation of processes, and reducing the share of labour-intensive tasks while improving the factor allocation.

Projects in the strategic investment sectors could be (co-) financed through the investment fund pillar available in the Recovery Fund. Here, companies could benefit, for example, from simplified export financing and export credit insurance access. This could be extremely beneficial for Polish micro and small enterprises in particular as they are still lagging behind larger entities when it comes to exports. Examples of sectors with high export potential could include emerging technologies such as cybersecurity, AI, e-health, and smart mobility, buildings, and energy.

A part of public investments financed by EU funds should be directed to improvements in digital public services. The Polish government should encourage the use of e-signatures and other e-government facilities to ensure that all enterprises, both SMEs and large entities, can avoid disruptions and can continue to operate digitally even in times of crises such as the COVID-19 pandemic. Moreover, the coverage of digital public services should be extended to areas where it is still lagging. For example, the funds available in the EU Recovery Fund's health programme should be at least partially used in completing the digitalisation of Polish healthcare including the more widespread use of telemedicine building on the Estonian experience (Pareliussen and Mosiashvili, 2020).

The Polish authorities could also mainstream digitalisation in public-financed programmes and projects, such as in urban infrastructure, to support innovation and the transition to a more sustainable economy as requested by the EU Green Deal, which also underlines the need of digitalisation[73]. This could actually become a condition for projects financed from regional development funds. For instance, investments from local and regional authorities in transport and eco-friendly city infrastructure boosting the local economy should also be digitalised. Such actions – financed predominately from the Just Transition Fund (also incorporated in the Recovery Plan for Europe[74]) – could include, among others, the installation of air quality sensors, which would help reduce the level of PM2.5 and PM10 pollution – a serious challenge for Polish cities and regions – and improve productivity and quality of life for residents and those working in these areas. The Polish government could ensure sector-specific support i.e., for energy efficiency –

[73] https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en, accessed 28.11.2020.
[74] https://ec.europa.eu/info/strategy/recovery-plan-europe_en, accessed 25.11.2020.

targeted at enabling such sectors to reduce their CO2 emissions and transition to more sustainable business models using digital infrastructure and skills.

Such investments could include:

- Funding for the energy efficiency of public buildings and the digitisation of the construction sector (smart buildings) to capitalise on the advantages building automation can create, i.e., as a part of the Clean Air Priority Programme – the biggest nationwide programme in Poland[75];
- Smart city data collection initiatives such as the already-mentioned air quality sensors, energy consumption meters, and movement data sensors which are currently extremely important for the COVID response. Implementation of such appliances could support the making of informed, sustainable decisions by local and national authorities and the further development of eGovernment facilities;
- Encouraging remote services for all installed infrastructure as an alternative to exclusively in-person services – this also could help in boosting e-government facilities further without draining public (national and local) budgets.

Conclusions

The Polish economy is largely dependent on two important growth pillars. One is the export of manufactured goods based mainly on sustained price-competitiveness and the other is the services sector which is partially geared towards the domestic market and partially supports the manufacturing sector in its exporting activities. In the first pillar, it is important to sustain high productivity growth, which can be, at least in the medium term, supported by reducing the distance of that sector to the European frontier in the level of digitalisation. On the other hand, there are still reserves of growth in the relatively large services sector which can expand to the Single Market by exploring the possibilities of consumer outreach, the reduction of transaction costs, as well as information asymmetry thanks to digitalisation.

In this report we have identified many areas where digitisation in Poland is lagging behind and these constitute important barriers to reaping the above opportunities:

- Insufficient demand for broadly defined digital services stemming from low digital literacy and significant barriers to internet access with existing policies failing to reach the target internet penetration.
- Low digital literacy translating to the insufficient skills of a large portion of the labour force, making digital investments in enterprises costly and limiting the perceived benefits from digitisation efforts.
- Low digitisation of Polish SMEs, in particular small and micro firms, manifesting itself mainly in the under-use of e-commerce and internet marketing, in particular in its cross-border dimensions. One of the reasons for this is that perceived benefits from digitisation given the relatively low internal demand are low and the perceived costs of digitisation are high.

[75] https://czystepowietrze.gov.pl, accessed 25.11.2020.

- Inefficient use of digital systems in production optimisation, planning, and risk management as well as low system integration compared to the EU averages in the manufacturing industry in almost all analysed subsectors.
- Incomplete coverage of e-government, in particular in the areas of the judicial system and public healthcare.

Our analysis shows that the most pressing and enduring challenges are the persistent lack of digital skills of the Polish population, which is not being reduced over time, and the falling but still significant digital exclusion of a considerable part of society. These remain a barrier to all other dimensions of digitalisation and should be addressed by persistent improvements in the digital skills acquired both during all stages of education as well as during continuing education in the form of open courses financed by the government, local, and regional authorities as well as grants and co-financing for training the labour force, in particular in SMEs.

Another important dimension of the demand barriers is inefficient access to the internet, in particular fixed-line broadband access, where progress in the construction of backbone infrastructure has been substantial but the provision of access to final consumers is still underperforming, due to high costs and low return from investment. This calls for continued intervention in the form of subsidising internet provider set-up costs as well as considering designation of universal access internet providers assuring access in the most problematic areas. As mobile technology is able to fill the gap left by fixed-line access only in its latest 5G technology, allocation of 5G frequencies is urgent along with regulatory assurance of service quality and effective competition of that segment of the market assuring the fair pricing of 5G services. Given the potential spillovers of benefits from the increased penetration of internet access (demand for digital services, skill upgrading of the labour force), the market provision of internet access may be inefficient and calls for a more pronounced policy response.

The low digital presence of SMEs is related to their focus on domestic markets where digital demand is low and there is a low awareness of the benefits related to internet presence. This problem can be alleviated by supporting initiatives related to the establishment of an internet presence, including the benefits of using e-government, security measures, and cloud solutions, through government-financed training provided to firms, firm owners, and managers, among others, on the opportunities related to online cross-border sales, tools, and solutions. This could be accompanied by financial support to digitisation projects (e.g., co-financing the purchase of equipment and the temporary hiring of ICT specialists) to small and micro firms where cost barriers may be prohibitive, in particular when this is related to the cross-border expansion of the firm. This is particularly important in sustaining productivity growth in services and in increasing the share of that sector in supporting economic growth.

On the other hand, the deepening of digitalisation is needed in the manufacturing sector, which suffers from the gradual loss of competitiveness but remains an important growth pillar. Our study has shown that the potential in the use of digital tools is not fully used. This could be strengthened by an increase in the cooperation between manufacturing firms and start-ups from the relatively advanced ICT services sector through collaboration platforms and joint research programmes. Here, there is a significant role for the government and its granting authorities.

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