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BARRIERS FOR INDUSTRY 4.0 IN EMERGING ECONOMIES – THE CASE OF POLAND

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Purpose: This study aims to identify the key barriers to implementing Industry 4.0 in emerging economies, with a particular focus on the role of human capital.
Design/methodology/approach: A literature review, industry report analysis, OECD and EUROSTAT data, industry reports.
Findings: Developing countries are expected to make extra efforts in changes in the structure of the economy to meet new challenges. The quality of human capital is of great importance here, i.e., society's demographic structure, digital skills, the structure of the economy, and enterprises' size.
Practical implications: Observation of economic reality allows sending opinions. The need is to form new skills among employees and change existing ones. Not all companies understand the opportunities and threats associated with the 4th revolution. In developing countries, this process should be supported systemically by introducing tax incentives for automation and robotization, promoting the creation of large companies, the pro-innovative transformation of the economy and creating a financial base for financing changes.
Social implications: Human capital in the emerging economies is not fully prepared for the challenges linked to the automation and robotization.
Originality/value: The article opens a discussion on macroeconomic conditions of the four industrial revolutions, mainly in the context of developing countries, and indicates potential directions of intervention and actions.
Keywords: fourth industrial revolution, unit labour cost, emerging countries, labour market, innovation, productivity.
Category of the paper: research paper.

Introduction

Human capital in emerging economies manifests a poor combination of functions to the digital economy and automation requirements. It is caused mainly by low labor cost, which paradoxically inhibits natural incentives to implement innovation. The barrier is also the primitive structure of the economy, size of entrepreneurs, lack of skilled workforce and shortage of financial resources. The dissemination of technology in human capital can have opportunities

and threats—the low level of automation results from low digital competencies. The primitive structure of the economy has contributed to the fact that in Poland, the sectoral economy is based on small enterprises and simple industries (peripheral economy). Besides, the share of agriculture and industry is still high in comparison to other EU countries. The structure of the economy is outdated and inefficient in terms of the knowledge industry. Poland and other emerging countries still lack a lot in the global race of automation and digitization. Hence they do not occupy the highest places in the global rankings.

Technical and scientific progress caused the entry to the next stage of global changes, called the fourth industrial revolution (in other words, FIR, Industry 4.0, I 4.0). The basis of these changes is information and communication technologies, the so-called ICT (information and communication technologies), which determine the speed and quality of the information provided. Due to this phenomenon's universality, ICT technologies are present in every sector, and the private sphere and increasingly cover most people. The fourth industrial revolution is not about gathering information but about processing it quickly and using it (Olender-Skorek, 2017, p. 42). Robotization and automation will undoubtedly change the face of the labor market. Thus the role of man and capital in it will change.

The fourth wave of industry's concept coincides with the assumptions of the European Union's development policy aimed at creating a solid foundation for a new economy. The implementation of industrial robots and ICT is intended to facilitate work. The final product will result from automated production lines, where people will play the role of "quality guardian" (Davies, 2015). However, the fourth revolution creates many development opportunities, provided that the country develops economic structures that absorb new solutions. Specialists believe that good preparation for new challenges requires a lot of work and human resources, which entrepreneurs are often unaware of. Even when awareness of opportunities and threats exists among the managerial staff, investment decisions are still short rather than long (Schwab, 2018, pp. 11-12).

Literature review

The fourth Industrial Revolution is not the only industry. It is driven by the increase in information and its analysis, using mobile connectivity to data transmission from different devices (Internet of Things IoT) and the automation of production (robotics). An important role plays other digital technologies, wide open as new solutions are constantly being created, e.g., 3D, cloud, etc. (Kuźniar, 2019, pp. 49-52).

The expectation of the Internet of things (IoT) is advanced Internetworking of physical devices. It is typically addressed to devices, systems and services which exist beyond machine-to-machine (M2M) communications combining different protocols, domains and applications

(Höller et al., 2014). Thanks to the interconnections of embedded devices, it is possible to implement automation in nearly all fields. An example is a smart grid or, in broader idea: a smart city. Such revolution is connections in real life of human beings is based on the Internet. First data transmission over the Internet is dated in 1969 year and was linked to two mainframe computers. Nowadays, Internet connections are available on a personal computer and many mobile devices. The milestone of computing was reached in 2010 when the total number of computers connected to the Internet has exceeded the number of people on the earth (Gershenfeld, Vasseur, 2014, p. 28).

Upcoming revolution (FIR) connected with intelligent technologies creates anxiety related to artificial intelligence (AI), flexible automation, big data, etc. The 4.0 industry is a time of advanced technology based on information and communication (Min et al., 2019).

Scientists predict technologies will change jobs around the world. It raises obvious concerns about automation processes and accompanying technological trends that cannot be fully recognized (McKinsey, 2017; Ford, 2015; Brynjolfsson, McAfee, 2014). It is currently difficult to evaluate how automation, tricks, and artificial intelligence affect the labor market and productivity. On the one hand, arguments are presented for this, artificial intelligence and robotics techniques would disown human work. On the other, many economists raised based on the analysis of technological processes translated in the final analysis not causing a decrease, but an increase in demand for work and salaries (Acemoglu, Restrepo, 2018a). It is also proved in the past that during industrial development growth process has been balanced with a share of labor in national income, which has not been significantly changed.

The research results regarding jobs under automation risk show that the tasks handled by employees are very different. Additionally, estimation depends on a used methodology. That is why they differ in the case of analyzing countries. Estimates range from a few percent (Arntz et al., 2016) to 60% (Frey, Osborne, 2013; Degryse, 2016; Manyika et al., 2017).

Think tank Technology and Innovation Foundation, in its report, calms down, based on data from 1850 to 2015, believes that historical experience proves that during the three previous industrial revolutions, the number of jobs denied was smaller than the newly created (Atkinson, Wu, 2017).

The impact of automation on tasks, productivity and work, has been studied by many economists (Acemoglu, Restrepo, 2018b; Acemoglu, Autor, 2011; Venturini, 2019), but the complete picture of consequences is still not adopted by most enterprises.

Material and methods

The aim of the article is to discuss the main economic and social barriers to the implementation of the 4th industrial revolution in emerging countries from the point of view of the use of human capital with particular regard to Poland.

The literature has been selected in this way to capture the latest reports on I.4, mainly based on the consequences of changes for human capital. The empirical analysis made use of Eurostat and OECD public statistics and industry reports. The time horizon 2000-2018 was introduced to capture the changes. However, in some indicators, the time horizons are shorter due to the lack of earlier data availability. The analysis concerns the position of Poland in comparison with the European Union and OECD countries.

Risk of automation in OECD countries and challenges for development

OECD is forecasting that risk of job automation is real but varies significantly across the countries. 14% of jobs are at high risk of automation, while 32% of jobs could be radically transformed (Fig. 1).

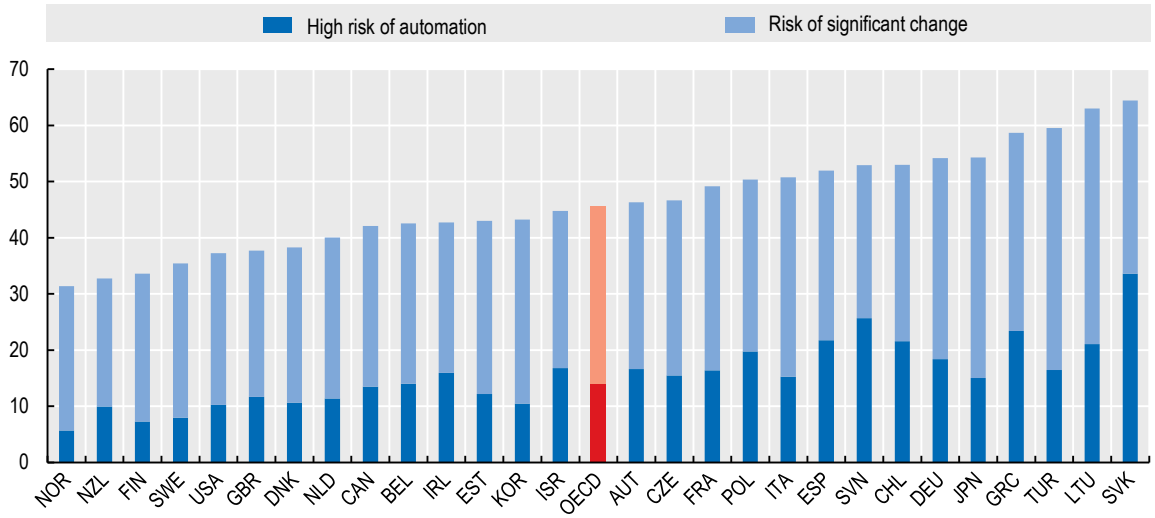

Figure 1. Jobs at risk of automation in OECD countries.

Source: OECD calculations based on the Survey of Adult Skills (PIAAC) (2012), http://www.oecd.org/skills/piaac/; Nedelkoska, Quintini, 2018), Automation, skills use and training, OECD Social, Employment and Migration Working Papers, No. 202, https://doi.org/10.1787/2e2f4eea-en27% of jobs at high risk from AI revolution, says OECD. Reuters OECD Employment Outlook.

In Poland, the high risk of automation is evaluated as 20%, and it is more significant than in Western EU countries. However, these numbers only include job positions that can be eliminated but do not include the scale and number of new jobs.

According to the OECD PIAAC survey, which studies people's abilities and qualifications, over 50% of young people have very basic IT skills such as writing e-mails or web browsing or do not have such abilities (OECD, 2016). Existing education systems are often unable to reduce the differences between individual groups of employees. Better educated and paid employees have much better access to training, mobility, and self-development (OECD, 2013).

What is more – adults do not have appropriate skills for the new jobs. Six out of the ten adults lack IT skills within OECD countries or have no computer experience (Survey of adults skills-PIAAC conducted in 29 OECD countries between 2012/2015). How can we make the labor market more stable in the FIR context? OECD claims that adults should better target the disadvantaged by skill (proportion of high/low), employment status (self-employed, FT permanent) and risk of automation (high/low). For all such labor disadvantages, social protection should be adopted for non-standard workers (self-employed, part-time and platform workers), a job with 50% less possibility to become unionized and 40-50% less likely to obtain income support after losing a job (OECD 2019b).

Emerging economies face a greater predicted risk of automation in their current stage of development. A mix of employment rates should shift labor from low productivity activities (like low value-added agriculture and industries which still make up a large share of employment) to higher-productivity activities, mainly in the manufacturing and in the service sectors. The researchers related to job automation based on occupation (The World Bank, 2016), tasks (Nedelkoska, Quintini, 2018) and work activities (McKinsey Global Institute, 2017) prove a higher risk of automation in emerging economies than more advanced ones.

Although automation concerns a growing sphere of human life, it may not be economically attractive in developing countries. Costly investments in advanced technology are out of reach for most micro, small and medium-sized enterprises, which stay a significant part of emerging economies.

In addition to that, the incentive for potential automation and innovation processes is suppressed by the relative abundance of cheap unskilled labor.

The growing labor costs and falling costs of technology accelerating automation processes are an opportunity for emerging countries to get out of the middle-income trap. On the other hand, this process may be threatened by premature deindustrialization, leaving developing economies in that trap (Rodrik, 2016).

Current status of countries in race 4.0

The level of the FIR can be estimated based on several measures. To main factors taken into account in the indices belong to the level of business and public digitalization, the availability and speed of the network, the availability of highly specialized employees on the labor market and the level of education (Agencja Rozwoju Przemysłu, 2018).

One of them is the Digital Economy and Society Index (DESI), which is a weighted average of 5 areas like connectivity (weigh: 25%), human capital (25%), Internet use (15%), integration of digital technology (20%) and digital public services. The index consists of 35 co-factors and enables digital progress evaluation and comparisons within EU countries (European Commission, 2018, pp. 3-4). Other measures for FIR are:

- NRI (Networked Readiness Index), firmed by World Economic Forum, examines the role of information and communication technologies (ICTs) in driving innovation.
- European Digital Progress Report (EDPR), which evaluates not only digital progress but also the state's approach to law.
- Digital Competitiveness Report made by IMD World Competitiveness Center shows the overall ranking for 63 economies covered by WCY. The rankings are calculated based on the 51 ranking criteria: 31 Hard and 20 Survey data. The methodology used in WDC ranking defines digital competitiveness into three main factors: Knowledge, Technology and Future readiness.
- ICT Development Index (IDI), public by International Telecommunications Union, evaluates access to ICT, use of ICT and ICT skills.

Poland is not at the top of the rankings list. Its results are as follows:

- in NRI (2016) - 42 out of 139 (World Economic Forum, 2016).
- DESI (2022) - 26 out of 28 (European Commission, 2022a).
- EDPR (2017) - 23 out of 28 (European Commission, 2017).
- Digital Competitiveness Report (2022) - 39 out of 63 (Bris, Cabolis, 2023).
- ICT Development Index (IDI) - 49 out of 176.

Barriers for Industry 4.0

We are far away from the top leaders, which raises the question of the restraints of FIR in Poland.

The barriers to the FIR development are:

- bureaucracy,
- lack of funds,
- high risk in relations to return,
- lack of professionals,
- lack of system support from government,
- low labor cost and high uncertainty in the labor market,
- low level of digital skills,
- rudimental - "primitive" structure of the economy,
- rapid society aging and low employment rate.

Demographics

The challenge in the case of FIR would also be the rapid pace of society aging in Poland.

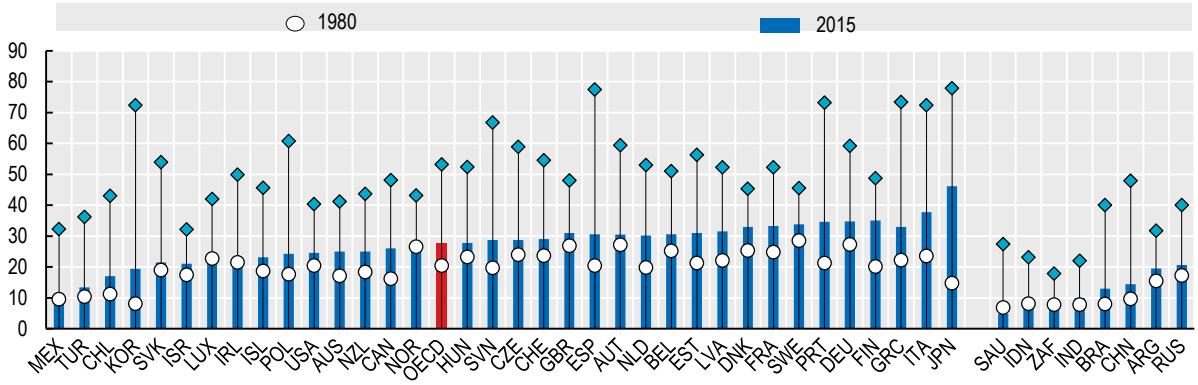

Figure 2. Projected change in the old-age dependency ratio in chosen OECD countries between 1980-2050.

Source: OECD; http://dx.doi.org/10.1787/888933966008.

The world's population is aging. In 1980, there were 20 persons aged 65 and over for every 100 people of working age (20-64) on average across the OECD (Fig. 2); by 2015, this ratio had risen to 28/100, and by 2050 it is projected that number will have reached 53 persons (65 old or more) for every 100 people (almost double rise between 2015 and 2050). Africa remains the youngest, while the rapid aging of the population coincides with the development of countries. The higher it is, the faster the aging process. It draws attention to the rapid aging of the population in Poland concerning the OECD. This process can be read in two ways. On the one hand, a higher standard of living, extending society's well-being, more accessible access to healthcare, and average life expectancy. In Poland, the aging process is very rapid, which increases the number of employees retiring compared to young people entering the labor market. Paradoxically, it can be a significant factor in performing a faster automation process or attracting immigration by eliminating the work shortage. Countries with the most rapidly aging populations have also been among the fastest to adopt industrial robots. However, this process is not so obvious (Acemoglu, Restrepo, 2017). Aging can be a severe problem when there is a shortage of digital skills within society required to adapt to new changes.

Structure of economy, GNP, business scale of enterprises and their impact on industry 4.0

The scale and pace of FIR implementation depend on economic fundaments. In emerging markets, the majority of sectors are rather primitive structure-based still on agriculture and obsolete industry.

Industry 4.0 can be a profound opportunity for society, factories, households, economies if only developing countries can adapt and prepare the strategies regarding a new approach to social and economic life. One of the most challenging tasks here is to reverse developing strategies that are now in place in emerging economies. Industry 4.0 requires a significant change in the labor market, which points to low labor costs so far in such countries. Entrepreneurs do not feel any incentive to digitize and automate as they can still pay relatively not too much to their employees, which is not appropriate in the long run, as it deepens the primitive structure of the economy based on low labor cost. This could push such economies to the periphery of the world economy. There is no possibility of maintaining such a strategy with FIR as countries need to have highly specialized operations, which are linked to highly professional, well-paid employees. With FIR, we can expect increased productivity, reduced waste, promotion to the circular economy and sustainability in production and consumption (Petrillo et al., 2018).

Fig. 3 presents a share of employment in services. The transformation towards a service economy is a long-term trend already observed in the EU in the second half of the 20th century. Employment in services has slightly increased from 66% in 2000 to 74% in 2022, while in Poland 51% in 2000 to 60% in 2022.

The most significant increases in the proportion of employment in service activities since 2000 in the EU were in detail: computer programming, consultancy and information activities, real estate activities, human health activities, legal and accounting activities, security and investigation and residential care activities. The share of telecommunication has decreased when it comes to services (European Commission, 2019b).

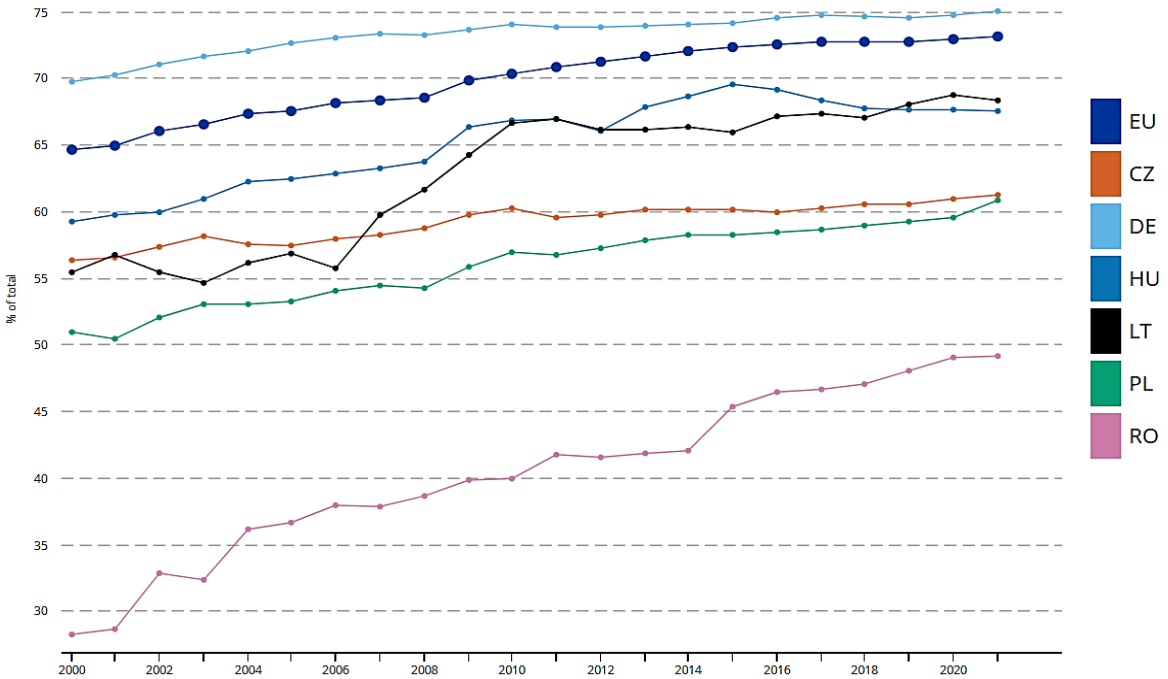

Figure 3. Share of employment in services in total employment between 2000-2022 in chosen EU countries.

Source: Eurostat, https://ec.europa.eu/eurostat/cache/digpub/european_economy/index.html?lang=en5

When it comes to employment in the industry, the trend for EU28 is diminishing (26% in 2000 and 22% in 2022 – see Fig. 4), which goes back to building a Knowledge-based economy (higher role of services).

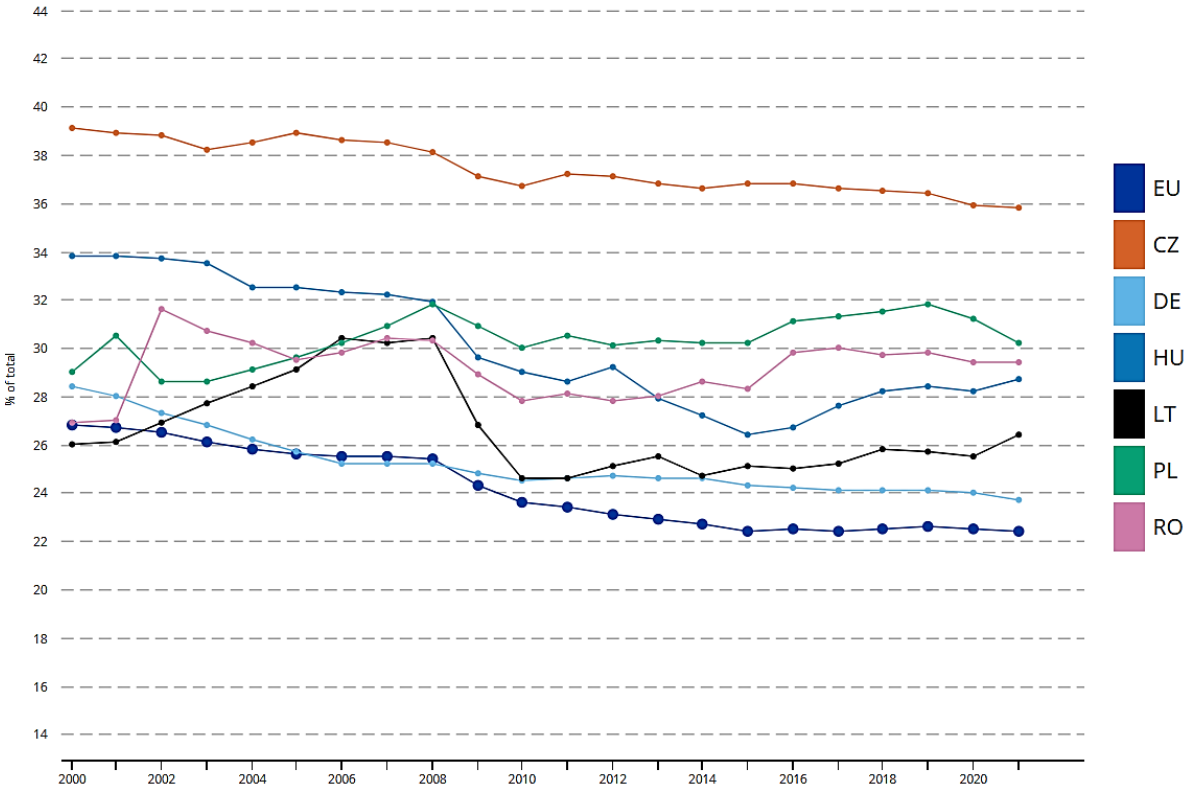

Figure 4. Share of employment in industry in total employment between 2000-2022 in chosen EU countries.

Source: Eurostat, https://ec.europa.eu/eurostat/cache/digpub/european_economy/bloc-3a.html?lang=en

Employment in agriculture in 2022 was accounted for 4% in EU, so halved from 7% in 2000 (Fig. 5). Agriculture and its productivity remain the Achilles heel of the Polish economy. The nature of this event is related to excessive defragmentation, which is rooted in the historical class division of society (Hartvigsen, 2014; Gorton et al., 2001; Bański, 2011). Employment in agriculture in Poland reached 20% in 2000 and less than10% in 2022 what is a significant positive change. However, there is still a challenge here to increase productivity and job automation.

The highest share of agricultural employment in 2022 was in Romania (more than 20% of total employment), Bulgaria, Greece and Poland. Among the EU Member State the highest share of industrial employment was noticed in Czechia (36%), Slovakia (32%), Poland (30%), Romania and Slovenia (both around 30%), while in service activities, 80% of total employment or just over are reached by the Netherlands, the United Kingdom, Belgium, Malta, France, Luxembourg and Denmark.

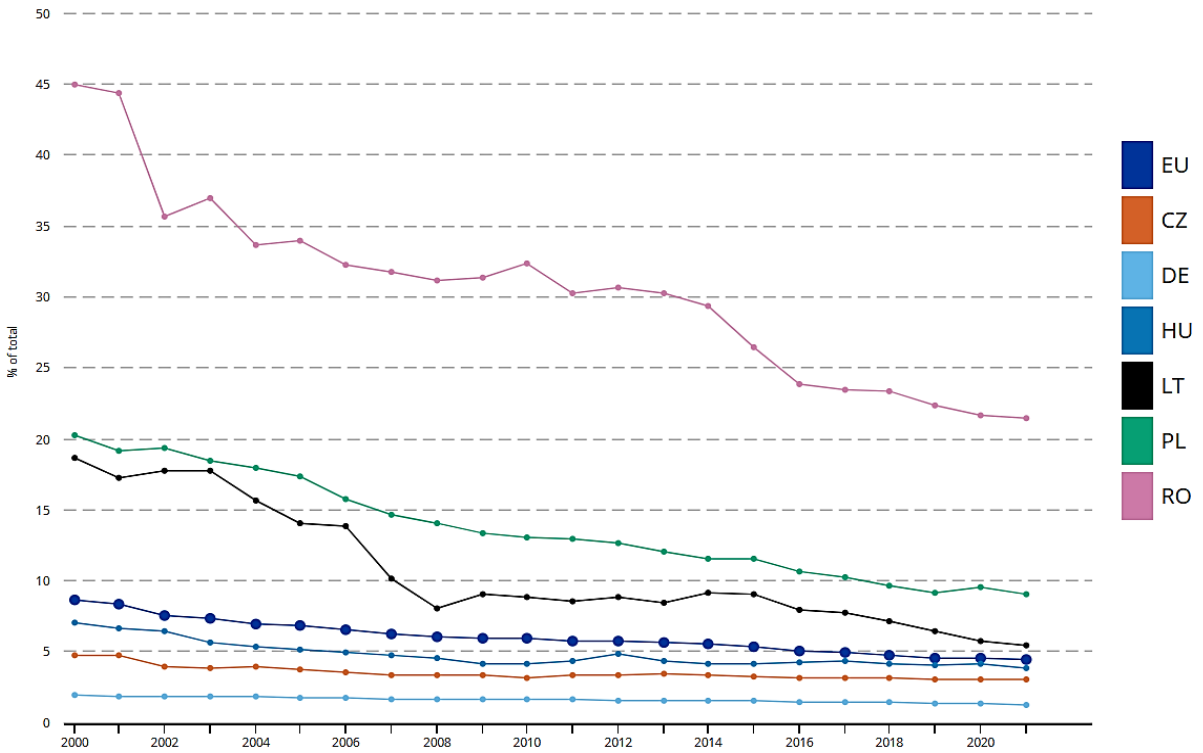

Figure 5. Share of employment in agriculture in total employment between 2000-2022 in chosen EU countries.

Source: Eurostat, https://ec.europa.eu/eurostat/cache/digpub/european_economy/bloc-3a.html?lang=en

Regarding value-added in EU, services generated 73 % of total value added in 2022, industry 22% and agriculture 5 % (Fig. 6, 7 and 8).

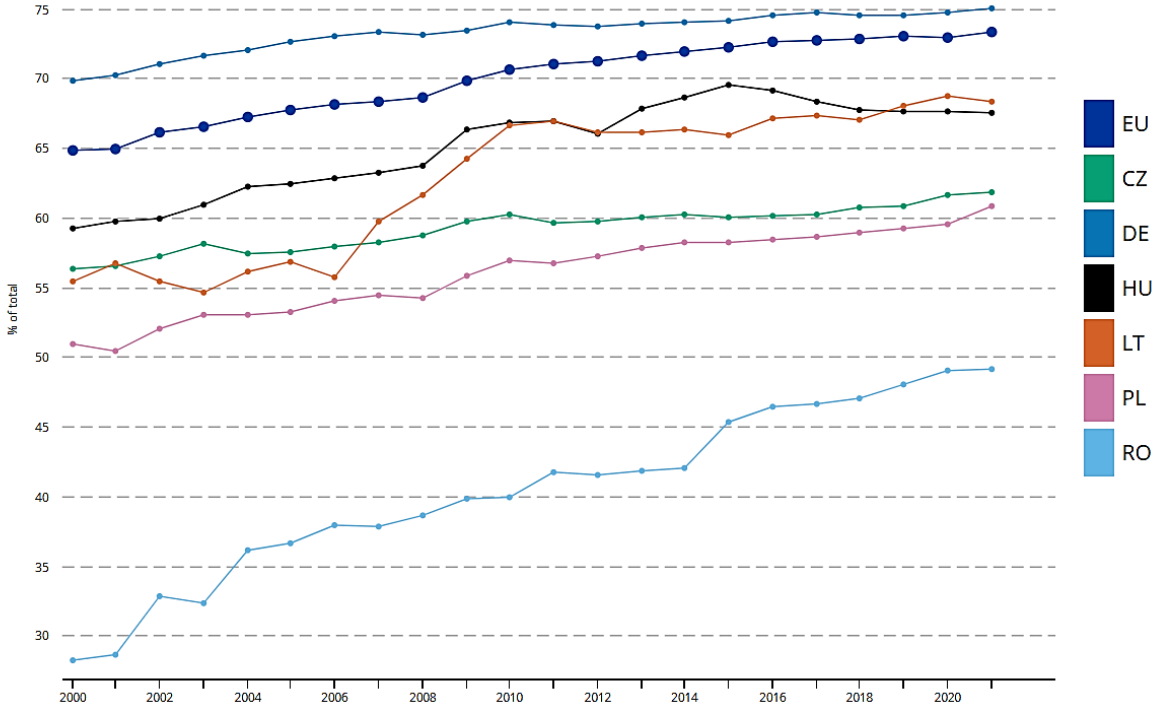

Figure 6. Gross value added by services as % of total gross value added.

Source: Eurostat, https://ec.europa.eu/eurostat/cache/digpub/european_economy/bloc-3a.html?lang=en

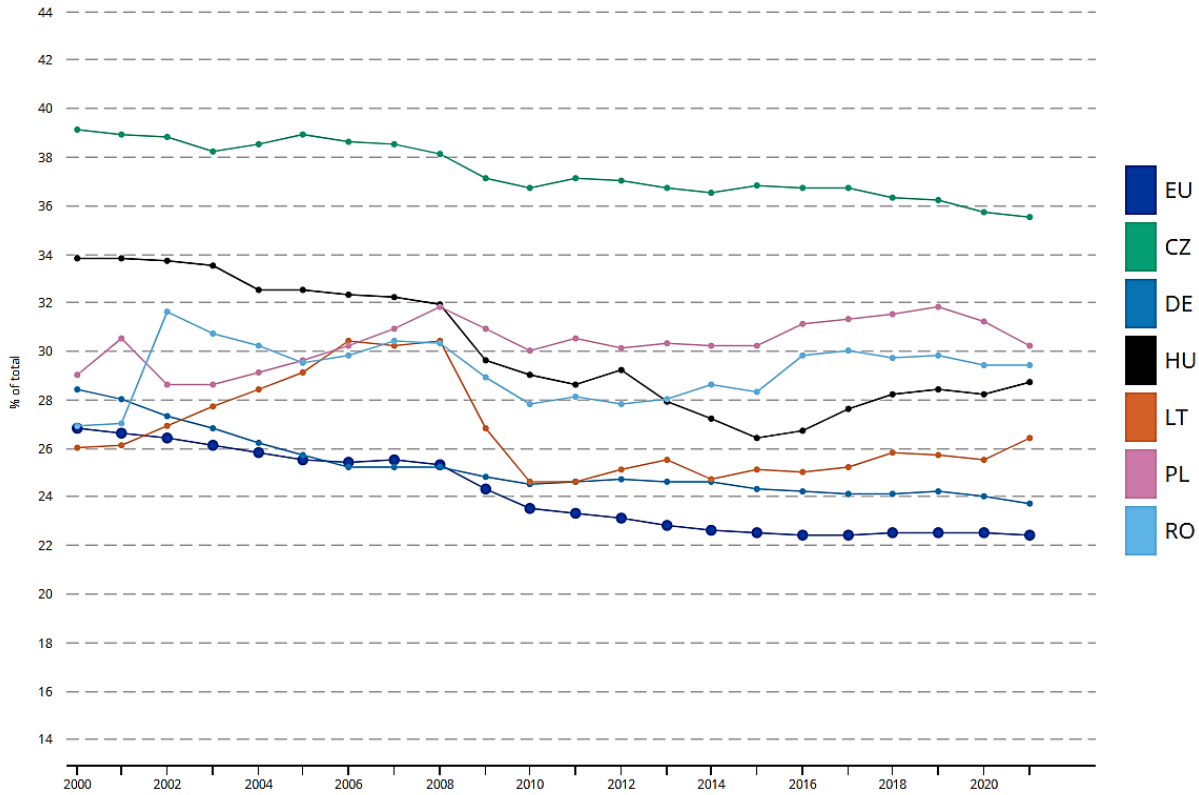

Figure 7. Gross value added by industry as % of total gross value added.

Source: Eurostat, https://ec.europa.eu/eurostat/cache/digpub/european_economy/bloc-3a.html?lang=en

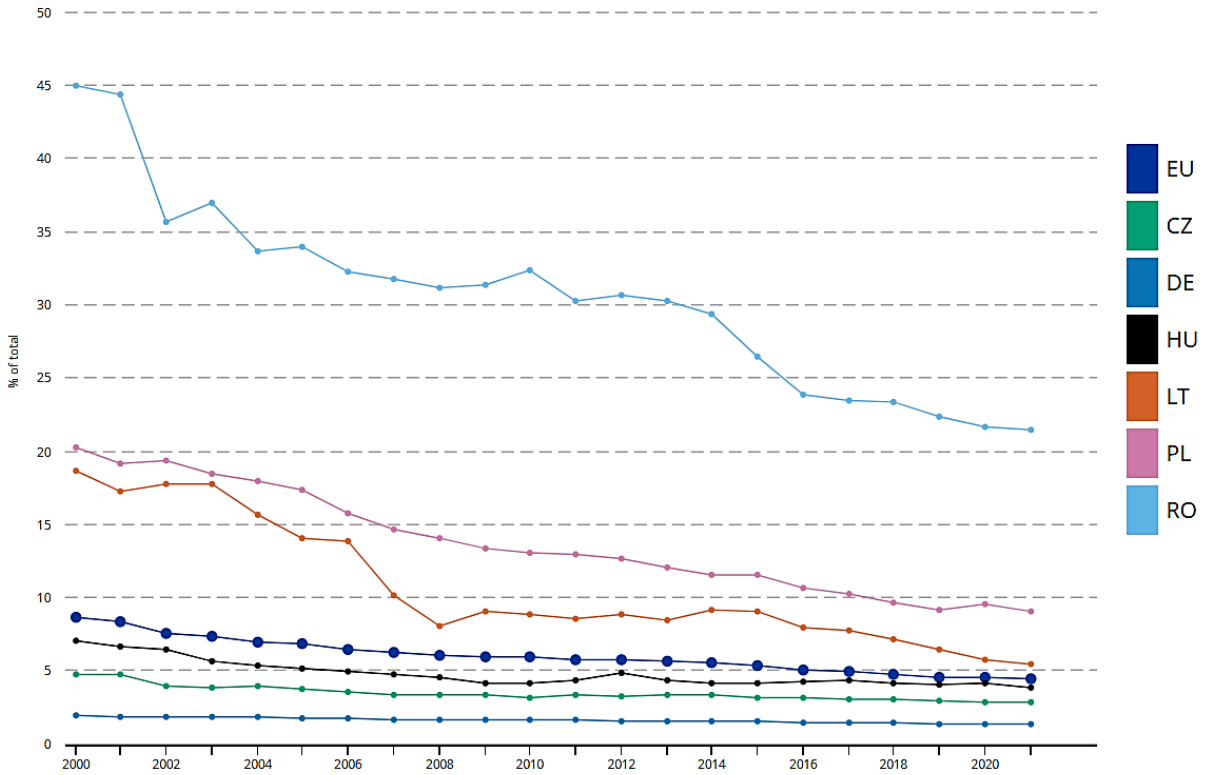

Figure 8. Gross value added by agriculture as % of total gross value added.

Source: Eurostat, https://ec.europa.eu/eurostat/cache/digpub/european_economy/bloc-3a.html?lang=en

Sectors by share in total employment and GDP are presented in Tab. 1. The main differences between Poland and the EU27 average can be seen in Agriculture, Arts, Financial activities and Construction.

Table 1.
Sectors by share in total employment and GDP in the years 2004 and 2022 for EU27 and Poland

NACE	GEO	Percentage of gross domestic		Percentage of gross domestic product	
		2004	2022	2004	2022
Agriculture, forestry and fishing	EU27	2	1,7	8,2	5,2
	Poland	3,3	2,8	17,1	9,6
Industry (except construction)	EU27	19	18,5	19,4	16,2
	Poland	22,4	22,3	24,1	24,5
Manufacturing	EU27	17,5	15,1	17,6	14,5
	Poland	16,4	17,5	20,2	21,4
Construction	EU27	5,3	5	7,8	7,5
	Poland	6,3	5,8	6,4	7,8
Wholesale and retail trade, transport, accommodation and food service activities	EU27	17,4	17,6	24,8	24,8
	Poland	22,3	21,8	22,8	23,3
Information and communication	EU27	4,3	4,8	2,4	3,4
	Poland	4,2	4,5	1,6	2,6
Financial and insurance activities	EU27	4,5	3,9	2,5	2,3
	Poland	3,4	4,7	2	2,5
Real estate activities	EU27	9	9,3	1	1,1
	Poland	5,4	4,8	1	0,9
Professional, scientific and technical activities; administrative and support service activities	EU27	8,7	10	9	12,6
	Poland	5,5	7,8	4,5	6,4
Public administration, defence, education, human health and social work activities	EU27	16,4	16,5	19,8	21,6
	Poland	13,8	3,1	17,9	19,5
Arts, entertainment and recreation; other service activities; activities of household and extra-territorial organizations and bodies	EU27	3,1	2,6	5	5,4
	Poland	1,9	1,7	2,6	3

Source: own calculations based on Eurostat data available at:
https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_10_a10_e&lang=en [nama_10_a10_e]

The most productive sectors in 2022 in Poland concerning the correlation between share in employment and GNP were Real Estate, Financial Services, Information and communication and Professional, scientific and technical activities. Agriculture offers much smaller value-added gains than those available for employment in this activity. Public administration, defense, education and both Industry and Construction will also provide a lower share of value-added than the total employed percentage (Fig. 9).

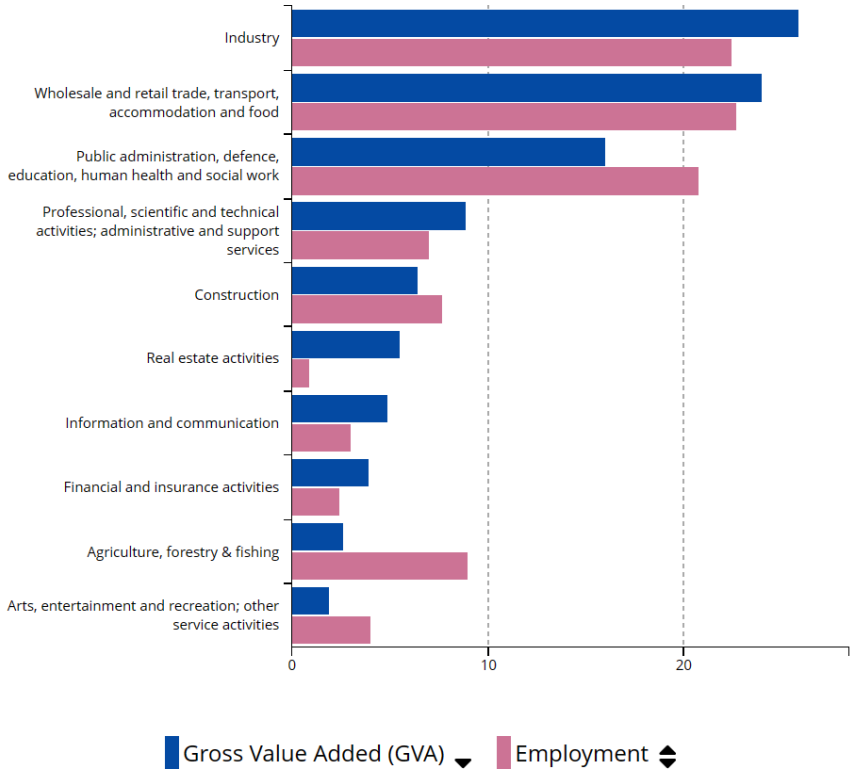

Figure 9. Gross value-added and employment by economic activity as % of the total in the 2018 year in Poland in 2022.

Source: Own calculation based on Eurostat data available at: https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_10_a10_e&lang=en [nama_10_a10_e]

Enterprises by size and its role in FIR implementation

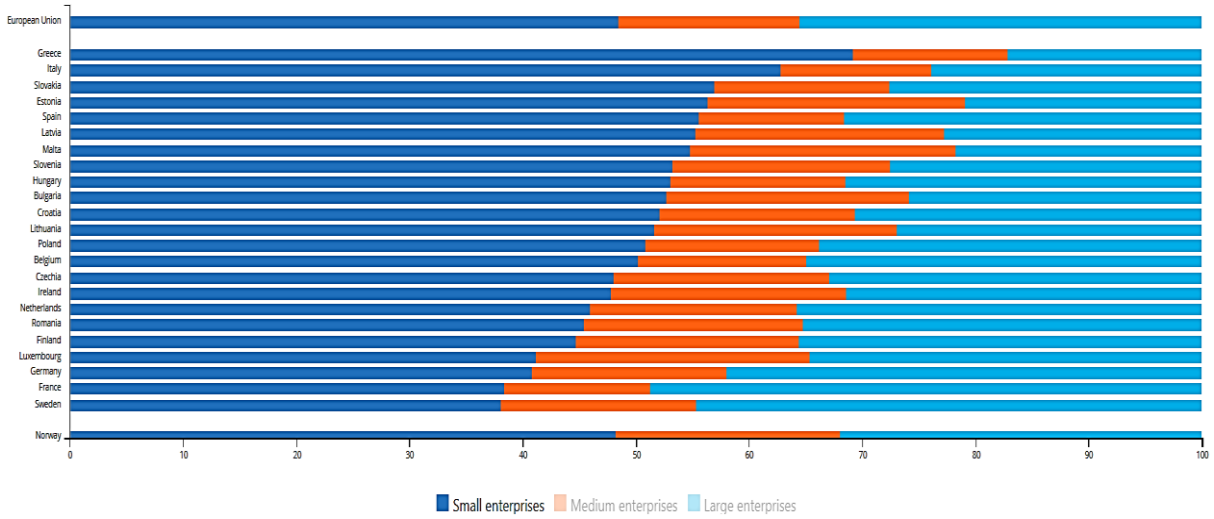

Figure 10. Number of persons employed by enterprise size class in the 2019 year in chosen EU countries (as % of total employment, total business economy).

Source: own calculation based on Eurostat: [sbs_sc_sca_r2].

Large companies in the EU account for only 0.2% of all companies. However, they generate around 35% of employment and 48% of value-added. Among EU countries, micro-enterprises most often employed in services are in Italy, Slovakia, Spain and Poland, the smallest in the Czech Republic and the Netherlands. According to the cross-section of employment for the EU average in 2019, almost half of people worked in micro and small enterprises (48,5%), 16% in medium and about one-third in large. For large enterprises, the highest proportions were found in France (49%), Sweden (45%) and Germany (42%) – see Fig. 10.

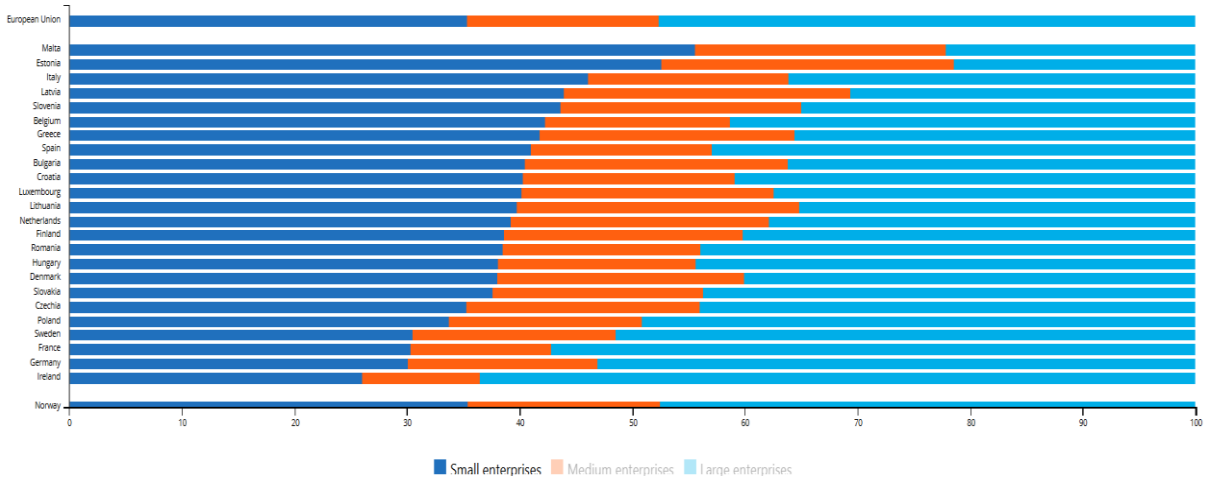

Figure 11. GNP by enterprises size in the 2019 year in chosen EU countries.

Source: own elaboration based on Eurostat: [sbs_sc_sca_r2].

The largest share in creating added value among companies in 2019 by large companies was recorded in Ireland (64%), France (57%), Germany (53%), Poland (52%) – see Fig. 11. Large companies in Poland, like in the EU, are more effective, which results from the use of economies of scale in production or the possession of adequate financial capital for development purposes. Many companies today indicate the impact of the 4th revolution on business. However, the SME sector is least prepared for technological changes and expectations (Horváth, Szabó, 2019; Smit et al., 2016). One of the main challenges is the lack of financing sources (Mittal et al., 2018). It excludes SMEs from many innovative projects. In Poland, this problem is obvious. Although the percentage of employed in micro and small enterprises is one of the highest in the EU, the share of GDP of these companies is among the lowest. Micro and small enterprises employ mainly people with the lowest qualifications, poorly secured on the labor market, often working on 'junk' or temporary employment contracts. This is related to high employment instability and lack of professional identity, defined by the term "uberization" of the labor market (Palier, 2018). In such circumstances, it is challenging to undertake long-term physical or personal investments. According to many authors, automation can hit mostly the middle class, which works in positions with medium skills, bypassing the most high-tech sectors, and people with the lowest qualifications performing non-routine manual work. This can increase income inequalities (Degryse, 2016; Graca-Gelert, 2019). Poland was one of the leading countries in the EU with the highest percentage of junk

and temporary employment contracts but in recent years has improved its position in this ranking – see Fig. 12. Netherland, Spain, Portugal, and Italy exceeded level of 15% in 2023 year. Also, in comparison with the OECD countries, Poland does not present itself and takes last places. According to the OECD, the share of employees on temporary contracts increased from 12% in 2000 to 26 in 2017 in Poland (OECD, 2019b). An improvement in the ratio was recorded between 2016 and 2017 (down from 27.4% to 26%), which may be explained by the fact that the junk contracts have been charged with social securities. The government has adopted the minimum hourly rate and improved Poland's situation in the labor market.

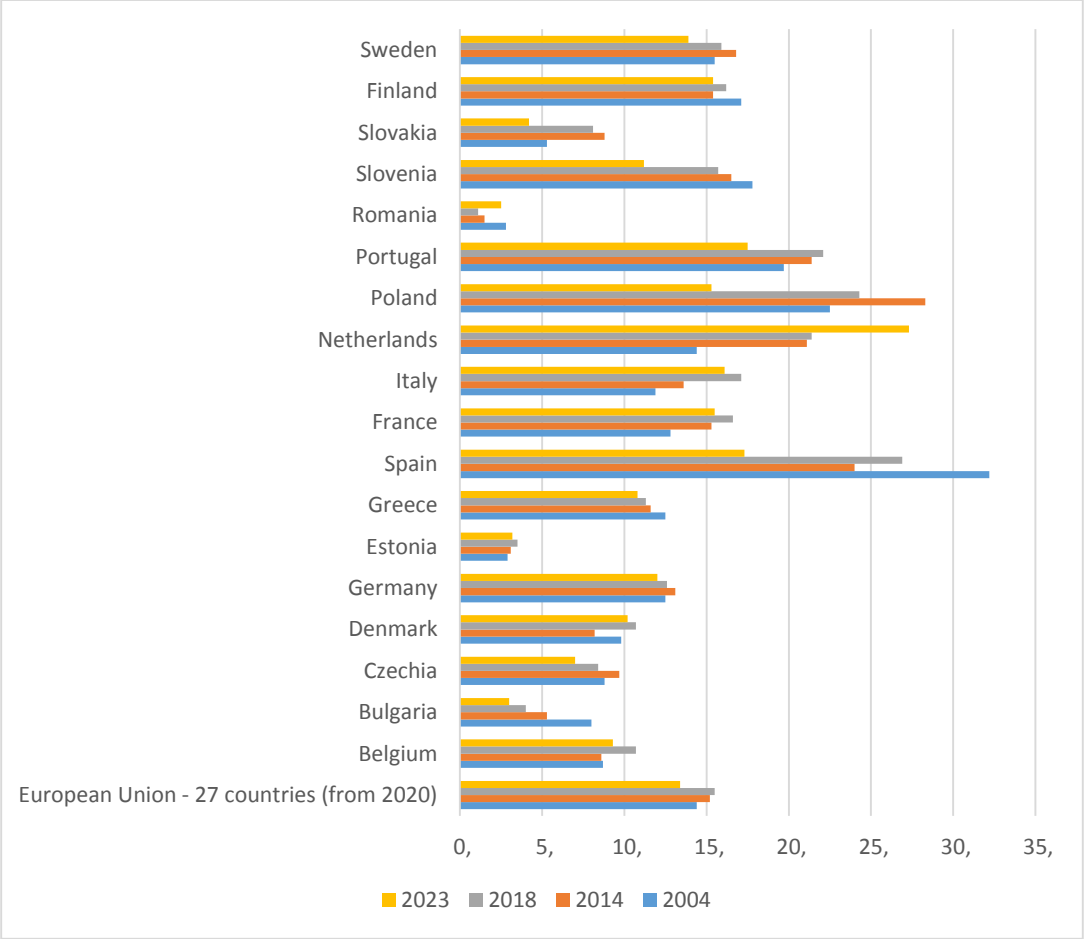

Figure 12. Temporary employees as a percentage of the total number of employees by chosen reporting EU countries between 2004-2023.

Source: own elaboration based on Eurostat [lfsa_etpgacob].

Labor cost and productivity

As being said, low labor costs result in a slower automation rate. In relatively low-cost countries, there is less job polarization than in higher industrialized ones. Capital and labor play an essential role in determining the profitability of investing in labor-replacing technologies

(OECD, 2017). The percentage increase in labor productivity[1] in Poland over 2000-2017 was much higher than unit labor costs[2]. On Fig. 13 it could be observed productivity in Poland has risen more than average for OECD.

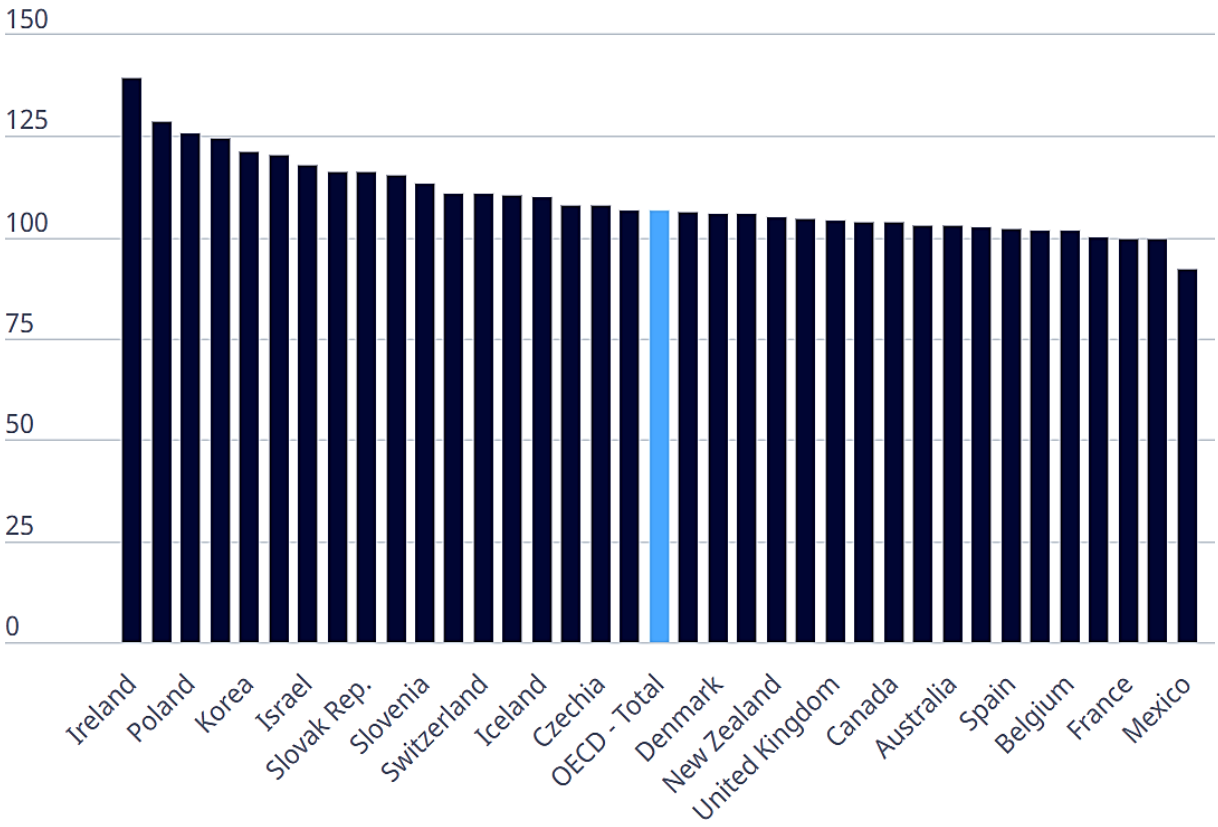

Figure 13. GDP per hour worked -Total, 2015=100, 2022.

Source: OECD (GDP per hour worked | OECD).

The analysis of hourly labor costs allows us to draw a more apparent border between the old and new EU countries – see Fig. 14. Central and Eastern Europe still provide a cheap labor base for more developed countries. This is particularly visible on the BPO (Business Process Outsourcing) market, i.e., outsourcing services in countries with low labor costs (Poland is a world leader as the location of BPO) or locating part of production (usually based on sub-components serial production). The low labor cost strategy hampers the willingness to innovate.

[1] (OECD, 2019a): Labour productivity, measured as gross domestic product (GDP) per hour worked, is one of the most commonly used measures of productivity at national level. Productivity based on the number of hours worked better reflects the utilisation of labour input than productivity based on the number of persons employed (head count).

[2] ULCs are defined as the average labour cost per unit of production produced. They can be expressed as the ratio of total hourly wage to hourly output (labour productivity). Total output is measured here as gross domestic product (GDP) in constant prices for the total economy and as gross value added in constant prices for the economic activity; whereas total compensation of employees is expressed in current prices.

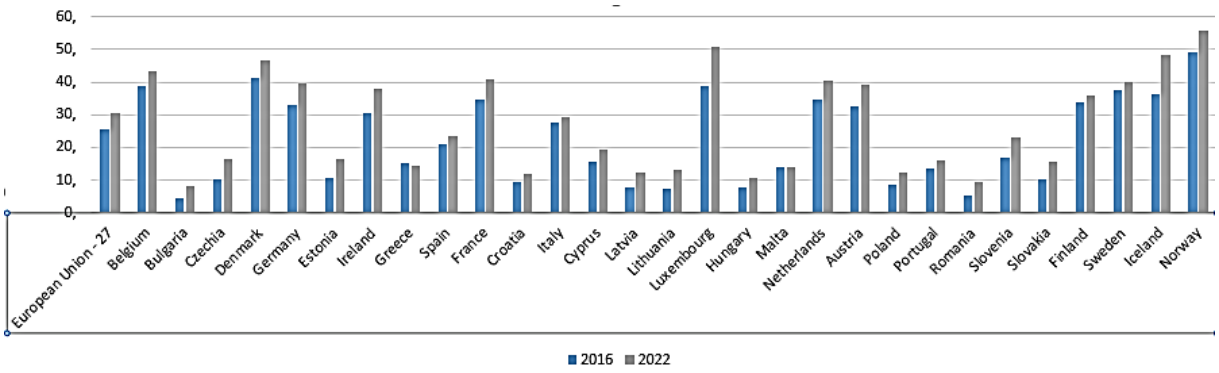

Figure 14. Hourly labor cost in Euro in chosen EU countries in 2016 and 2022 year (whole economy (excluding agriculture and public administration); in enterprises with ten or more employees).

Source: own compilation based on Eurostat (online data code: lc_lci_lev).

Conclusions

Due to Poland's low digital competencies, poor commercialization of research (low number of patents, inventions, R&D expenditures), transformations related to the fourth industrial revolution are slower. Additionally, the cost of implementing automated production lines makes the investment pay for itself within about 5-10 years. High costs of implementing new technologies, lack of large industrial plants and low labor costs cause a low level of robotization in Poland (Stolarczyk, 2017). Therefore, an increase in the minimum wage may bring about an acceleration of the automation rate. Revolutionary implementation of the concept of industry 4.0 in Poland, which requires enormous financial outlays, despite the pro-development perspective, seems impossible.

However, there is no doubt that some of the activities will be subject to cyclical robotization, which will create real economic and social challenges in human capital. Representatives of the most routine professions are threatened with professional exclusion. Hence, the need for the state's active reaction to promote lifelong learning may eliminate the harmful effects of social and economic transformations of the fourth industrial revolution.

At the higher levels of education, practical training, the matching of higher education courses with the needs of the labor market, or the practice of lifelong learning are lame. The FIR may be an impulse for exiting the trap of medium development. However, it may also deepen this distance to highly developed countries.

Recommendations on how to take advantage of the fourth industrial revolution should be read from the analysis of barriers to automation and digitization processes. Macroeconomic factors are key here. The competence mismatch will, e.g., deepen the rapid aging of the Polish society. Despite clear signals of this phenomenon, there are still no instruments that could improve the situation. Demographic changes will transform the demand line by shifting it from

the area of material goods (car, flat) to services (leisure, personal care, medical services). Automation could help sustain life quality and manage the labor market's loss resulting from people retiring quickly if other brakes were removed.

One of them is the primitive structure of the economy, with still a significant percentage of work in agriculture or industry with a simple structure (assemblies, components, not high-tech products). The transition from labor-intensive to knowledge-intensive sectors of the economy is essential in this context. Such transformation supports socio-economic development and reduces poverty in developing countries. The transition from a low-productivity, labor-intensive economy to higher productivity, capital and knowledge-intensive activities is the center of economic development. However, care must be taken that the changes do not increase income inequalities. This will continue to be the case until the competencies of the middle class in particular, which is most at risk from the FIR challenges, are strengthened.

It is crucial to address the help to today's 30 and 40-year-olds, who are sometimes referred to as the "lost generation". After introducing Poland's market economy, these are promised that they would receive high earnings after taking the trouble to complete their higher education. However, this did not happen. There is a relatively large mismatch between demand and supply in Poland's labor market. The earnings are far from those dreamt of. It is probably the reason why this generation has a high distrust of lifelong learning. The role of the state and investors is to break this deadlock. Improvement of the situation means better cooperation between science and business and the reversal of practical directions of education, support for raising adults' competencies and undertaking intangible investments connected with raising human capital.

Otherwise, the productivity of sectors will be further lower than that of highly developed countries. The reluctance to change is mainly due to low labor costs and a lack of companies' financial resources. In Poland in recent years, labor costs have been rising, but at a lower rate than productivity. Low wages and salaries of workers in Poland attract foreign capital and investments, which is positive but not necessarily in terms of the structure of investments. The businesses located are mainly BPO (Poland is the world leader in this area) or factories of large multinational corporations. However, in most cases, simple components are produced in Poland. Hence the often used term peripheral economy or assembly plant of Europe, the world. The low level of wages is to some extent caused by the class structure of Polish companies, where the vast majority of them are micro, small and medium enterprises, which are particularly struggling with the lack of funds for long-term purposes. It is reflected in the employment structure. Poland is one of the leading countries with the highest uncertainty on the labor market, read as a share of junk and temporary contracts to the total. This uncertainty does not motivate employees to improve their skills or entrepreneurs to invest. Despite the improvement of the situation resulting from the introduction of specific tools by the current government in recent years, the issue is far from ideal.

One concludes that Poland lacks large companies with a high critical mass that would accumulate significant capital and desirable investments.

FIR is the first revolution in which Poland can consciously take part. For historical reasons, we were omitted from all previous ones. Hence the great regional diversity in Poland, which hinders uniform and harmonized development.

It is essential to introduce incentives in the form of tax exemptions, guarantees. The R&D relief operating in Poland since 2016 is not addressed directly to automation and digitization processes. However, it may affect it indirectly if, under the law, the activity related to automation may constitute R&D activity. Similarly, the IP Box (the possibility of preferential taxation with a 5% tax rate on income earned by taxpayers from qualified intellectual property rights), which was introduced in January 2019, will incidentally affect the processes of robotization and automation when they create new solutions.

A solution is a one-off loss settlement in one of the following five tax years by not exceeding PLN 5 million. This solution introduced in 2019 is particularly beneficial for taxpayers whose income grows more slowly after incurring a loss. This type of investment may be precisely automation, the introduction of which requires considerable financial resources.

Despite the return that has occurred in recent years in Polish industrial policy, there is still a lack of tools addressed directly to automation. There are no tax reliefs for automation (which are used, e.g., in France, Italy, Singapore, South Korea), exemptions for automated activities (a tool used in Singapore, Thailand), favorable rules for depreciation of robots (France, Germany, USA, Singapore The financial markets: the banking sector and the stock exchange play a significant role here in supporting projects related to the introduction of artificial intelligence and digitization. The system of financial support for small and medium-sized enterprises is not very advanced in Poland, including high-risk undertakings. Hence the need not only for systemic solutions from the state but also from financial institutions.

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