POLAND
COMPETITIVENESS REPORT 2022

TOWARDS A SUSTAINABLE ECONOMY IN A PANDEMIC ERA

Edited by
Arkadiusz Michał Kowalski
Marzenna Anna Weresa

SGH Publishing House

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WARSAW 2022

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First Edition

ISBN 978-83-8030-567-0

SGH Publishing House
162 Niepodległości Ave., 02-554 Warsaw, Poland
www.wydawnictwo.sgh.waw.pl
e-mail: wydawnictwo@sgh.waw.pl

Cover design and production
Magdalena Limbach

DTP
DM Quadro

Print and binding
volumina.pl Daniel Krzanowski
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71–063 Szczecin
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Order 90/VII/22

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Preface

Arkadiusz Michał Kowalski, Marzenna Anna Weresa

The COVID-19 pandemic as well as decisions and measures taken by governments and international organizations have dramatically changed the playing field for competition in the world economy. Resilience to crisis has become one of the key drivers of a strong competitive position, and the significance of the sustainable dimension of competitiveness has also grown. These new tendencies determine the research aim of this monograph, which is to identify the competitive position of the Polish economy in the COVID-19 pandemic era, taking into account the foremost components of sustainable competitiveness. The specific objectives of the monograph are to:

- present the theoretical background of the issue of international competitiveness in a time of crisis, with a particular focus on the significance of sustainable competitiveness and the issue of resilience and vulnerability to crises;
- define Poland's competitive position, in particular to assess the development of individual factors of competitiveness, such as land and water resources, investment, labour, innovation and technological development, and institutions;
- identify the international competitive position of Poland compared with other European Union member states, taking into account income competitiveness, foreign trade competitiveness, and sustainable competitiveness (including its environmental and social components).

Competitiveness is defined in the monograph through the lens of achieving a sustainable economic growth and enhancing the quality of life, strengthening the economic position in international markets, and improving attractiveness to foreign investors. This definition provides a general framework covering a variety of economic issues. The evolving theory of international competitiveness of a national economy includes two approaches to competitiveness, distinguishing between competitive ability and competitive position of a national economy. Competitive ability is a dynamic concept of competitiveness, which focuses on factors necessary for effective rivalry in international markets. It is the ability to derive benefits from factors of production available at home and acquired from abroad under conditions of an open economy, which leads to a relatively faster growth of the welfare level. The competitive position represents a static approach to competitiveness (output competitiveness), which is defined as the position of a country in international markets for trade in goods and

services, and in the technological, financial, and property rights markets, as reflected in the welfare level of the population [Weresa, 2008; Misala, 2014].

The wide range of issues involved in the concept of competitiveness requires reference to be made to its multiple dimensions, such as income, investment, technological, or digital competitiveness. A more granular overview of the various dimensions of competitiveness in theoretical terms is provided in the previous editions of this monograph [cf., e.g., Kowalski, Weresa, 2019, 2021]. This edition puts a special focus on sustainable competitiveness.

Figure 1. Analytical framework of international competitiveness

Source: Compiled by authors.

The structure of this monograph corresponds to the analytical framework outlined above, describing international competitiveness. The framework has been adopted in the monograph (Figure 1) taking into account the distinction between competitive ability and competitive position.

The monograph consists of three parts divided into chapters. The first part (Chapters 1–2) aims to seek a theoretical framework for a broader insight into the factors

of competitiveness, going beyond changes in income and taking into consideration social and environmental sustainability. The second strand analysed from the theoretical perspective concerns the implications for the concept of competitiveness of the new challenges that have emerged in the turbulent times of the pandemic, i.e. how to increase resilience in times of crisis and the adaptive ability of economies.

The second part of the monograph (Chapters 3–7) analyses the competitive ability of the Polish economy, focusing on factors describing the size, structure, and use of production resources, institutions, etc. The third part, which comprises Chapters 9–11, aims to determine the competitive position (output competitiveness) of the Polish economy, which shows the attained welfare level reflected by the level of national income, the efficiency of use of production factors, or position in foreign trade.

The monograph ends with final conclusions and economic policy recommendations arising from the research, which relate to building sustainable competitiveness and resilience of the Polish economy to external shocks.

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Part I

Sustainable Competitiveness and Resilience in the Times of Crises

Chapter 1

The Concept of Sustainable Competitiveness: Literature Review and Directions of Further Research

Marzenna Anna Weresa

1.1. Introduction

The 21st century, and its second decade in particular, are times marked by changes arising from new developments in the world economy. What came as a game changer for the evolution of the concept of competitiveness was the global financial and economic crisis that unfolded from 2008 onwards. The traditional understanding of competitiveness viewed through the lens of changes in productivity [Porter, 1990] or the ability to create welfare [Aiginger, 2006], or a country's ability to sell its products in international markets [Misala, 2014] proved insufficient [Aiginger, Vogel, 2015]. The need emerged to seek new paradigms that would be able to respond to changing challenges, such as growing social inequalities and exacerbation of global problems, including adverse effects of climate change and environmental degradation [Kirjavainen, Saukkonen, 2020]. The scientific discussion on competitiveness has shifted towards non-economic aspects of development. The notion of sustainable competitiveness has been coined, which is perfectly aligned with the sustainable development goals adopted in 2015 by the United Nations Agency under Agenda 2020 [UN, 2020].

The main goal of this chapter is to identify key components of sustainable competitiveness and to define the ways of measuring this phenomenon. The review of the existing literature will make it possible to identify the strengths and weaknesses of the concept of sustainable competitiveness and set the directions for further research on the issue.

1.2. Definition of sustainable competitiveness in the context of sustainable development goals

Sustainable competitiveness is a relatively new concept which was developed by a team of researchers working for the World Economic Forum (WEF) in response to the need to include new factors in the assessment of country competitiveness and development of a ranking published annually in the World Competitiveness Yearbook. Sustainable competitiveness was defined as set of institutions, policies, and factors that determine the level of productivity of a country in the long term while ensuring the sustainable social and environmental development [Blanke, Crotti, Drzeneik-Hanouz, Fidanza, Geiger, 2011; Corrigan, Crotti, Drzeniek-Hanouz, Serin, 2014, p. 55]. Social sustainability can be an outcome of institutional factors, including policies that enable all members of society to experience the best possible health and security, and provide opportunities for economic and social participation. Environmental sustainability is also associated with the functioning of institutions and policies that ensure an efficient management of natural resources to enable prosperity for present and future generations [Corrigan et al., 2014, p. 55].

The concept of sustainable competitiveness is closely related to the sustainable competitiveness goals adopted in 2015 by the UN in Agenda 2030 [UN, 2015]. Seventeen sustainable development goals are refined in 169 targets, which are closely integrated and reflect the three dimensions of sustainable development: economic, social, and environmental. They seek to realize the human rights, including the eradication of hunger, reduction of diseases and ensuring equal access to healthcare and education, elimination of social and economic exclusion (in particular, the achievement of gender equality), and improving the condition of the natural environment (ensuring access to drinking water, reduction of environmental pollution, etc.) [UN, 2015]. The sustainable development goals are also reflected in strategic measures taken by the European Union. The European Union strategy for 2020–2030 *Towards a Sustainable Europe by 2030* identifies the need to foster competitive advantages conducive to promoting wellbeing and sustainable development [European Commission, 2019, p. 6]. Inclusion of the sustainable development goals in the European strategy and policy that sets out current targets initiated a reflection on further development of a long-term vision of Europe and corresponding directions of sectoral policies.

Despite multiple aspects linking the concept of sustainable development with sustainable competitiveness, it must be emphasized that these are not identical concepts. Economic growth may sometimes have negative consequences, such as excessive exploitation and depletion of resources, air and water pollution leading

to climate change. Negative effects of economic activity may impede future development processes. In addition, development does not always mean an even distribution of benefits among different social groups. Balkyte and Peleckis [2010] schematically demonstrate relationships between the concepts of sustainable development and sustainable competitiveness, emphasizing that they intertwine. The environmental and social elements of sustainable development are often examined separately, in combination with economic growth. For its part, the concept of sustainable competitiveness assumes that social and environmental aspects are interrelated [Doyle, Perez-Alaniz, 2017].

Moreover, a country's resources and those institutions (including policy tools) that allow the productivity of factors of production to be improved while maintaining social stability and environmental sustainability are common to the concepts of sustainable development and sustainable competitiveness.

1.3. Social aspects of competitiveness

There is no consensus in the literature about the detailed characteristics of social sustainability, but recurring topics can be identified in different approaches proposed so far. Social sustainability as a component of competitiveness goes beyond the issue of social inequalities to include also respecting human rights, social equality and justice, public health, and resilience of social systems to crises [Corrigan et al., 2014, p. 59]. This corresponds with the discourse on inclusive growth, which is conducive to social inclusion [OECD, 2019]. Inclusive growth means that all citizens participate in creating a country's welfare and distribution of resulting benefits. The fulfilment of common goals and non-discrimination, e.g. on grounds of age, gender, social background, or low income, is a necessary condition of social inclusion.

Many analyses have shown that innovations may be a way of reducing the exclusion of certain groups of population from some areas of social and economic life and alleviating social and income inequalities [Prahalad, Mashelkar, 2010; Grillitsch, Asheim, 2018; OECD, 2019]. This concerns especially what are referred to as "inclusive innovations" and "frugal innovations". These two concepts are interconnected and can be defined as new solutions which are created to increase access to new technology, e.g. for low-income groups [Foster, Heeks, 2013]. Frugal innovation is a cheaper (and usually less advanced) version of a new product. By minimizing the consumption of materials and funds, it is possible to cut production costs and product prices, which means better affordability of a product for a wider consumer base, including low-income consumers [Prahalad, Mashelkar, 2010].

This is conducive to reducing social and economic inequalities and strengthening social cohesion, thereby contributing to an improvement of competitiveness in its sustainable dimension.

1.4. Condition of the natural environment and competitiveness

Environmental protection issues were first included in the debate on competitiveness in the literature tackling the subject as early as the 1990s. Porter and Linde [1995] analysed the relationships between environmental goals and competitiveness. Their analyses challenged the traditional thinking according to which the relationship boils down to a trade-off between social benefits arising from an improved environmental condition and costs incurred by the private sector or by government. Well-designed regulations may lead to the improvement of competitiveness through innovations which may result from compliance of enterprises with those regulations. However, tools must be employed for this purpose, which operate through the market mechanism, e.g. by applying pollution taxes, systems of tradable emission allowances, intended to provide incentive for ongoing environmental innovation and the use of technologies that exceed current standards and reinforce resource productivity [Porter, Linde, 1995]. This conclusion is confirmed by empirical research on the implementation of environmental technology innovations in different countries, although the significance of regulations depends on various determinants of business operations. A comparative analysis of enterprises/providers of environmental technologies in Italy and in Poland confirmed the significance of regulations as a source of eco-innovation, but they are complementary to other factors, such as technology, market, and enterprise characteristics [Marczewska, 2016, p. 162]. Case studies of Dutch firms in the housebuilding sector confirmed that energy efficiency regulations set by the Dutch government are a key driver of the development of green innovations [Oorschot, Halman, Hofman, 2021].

Environmental protection innovations as a key component of sustainable competitiveness are also emphasized in many theoretical and empirical studies on countries, regions, or cities [Balkyte, Peleckis, 2010; Weresa, 2015; Doyle, Perez-Alaniz, 2017; Möbius, Althammer, 2019; Cincikaite, Meidute-Kavaliauskiene, 2021]. The concept of sustainable innovations (eco-innovations) emerged in the literature, which consists in introducing new products, services, and technologies to the market, as well as the implementation of processes that contribute to better satisfaction of human needs and ensure the rational use of natural resources and regenerative capacity [Tello, Yoon, 2008; Marczewska, 2016]. For example, the development of solar or wind energy

generation technology leads to saving fossil fuels and reduction of pollution related to their use, and new solutions contribute to the reduction of CO_2 emissions [Thore, Tarverdyan, 2016, p. 109]. According to their broadest definition, eco-innovations are new solutions aimed at achieving the goal of sustainable development through the reduction of negative environmental impact or improvement of the efficient use of natural resources and energy [Weresa, 2014].

According to the OECD, eco-innovations are new solutions, either technological or non-technological, which bring about benefits for the environment. They can be analysed in terms of their goals, mechanism, and impacts on the economy. Eco-innovation goals refer to the improvement of the functionality of products and processes, institutional changes, workplace organization, and marketing methods. The mechanism of eco-innovation involves the creation of new solutions previously unknown in the world, looking for alternatives to existing solutions, modifying or re-designing products and processes in a different, previously unknown way [OECD, 2009].

In the context of sustainable competitiveness, innovations of this type can be expected to bring about an increased market share, improved product quality, reduction of units costs of material consumption, improved environmental condition, strengthened security and public health (Table 1.1).

Table 1.1. Eco-innovations and sustainable competitiveness

<table>
<tr><td colspan="5"></td><td>Impact on sustainable competitiveness</td></tr>
<tr><td rowspan="4">Goals of eco-innovation</td><td>Institutions</td><td colspan="3" rowspan="2">Non-technological changes</td><td rowspan="2">Higher potential environmental benefits but more difficult to co-ordinate</td><td rowspan="4">▪ Increased market share
▪ Improved product quality
▪ Reduced unit cost of material consumption
▪ Improved environmental condition (e.g. reduction of CO_2 emissions)
▪ Strengthened security
▪ Improved health across society</td></tr>
<tr><td>Organizations and marketing methods</td></tr>
<tr><td>Processes and products</td><td colspan="4">Technological changes</td></tr>
<tr><td colspan="2"></td><td>Modification of processes and products</td><td>Re-design</td><td>Alternative solutions</td><td>Creation of new solutions</td></tr>
<tr><td colspan="2"></td><td colspan="4">Mechanisms of eco-innovation</td></tr>
</table>

Source: Compiled by author based on the eco-innovation typology proposed by OECD [2009, p. 13].

Another issue, discussed in the literature in the context of the environmental aspect of sustainable competitiveness is the issue of natural resources, their ownership and management for the improvement of their efficiency. Natural resources are a public good, but their use may cause adverse external effects (e.g. related to resource

degradation or increased environmental pollution). Environmental sustainability can lead to competitiveness improvements if the country has formal or informal institutions in place that define property rights so as to guarantee the adoption of sustainable processes over the use of scarce resources [Corrigan et al., 2014]. One example of insight into resource management is an in-depth analysis of the ownership of forest resources in Europe and implications for possible changes in forest ownership in Lithuania. It leads to the conclusion that state ownership of forest resources can bring more benefits for society than their privatization, provided that management improvements are implemented in this area. This would enable forests to be used as a future driver of the sustainable dimension of competitiveness [Balkyte, Peleckis, 2010]. Natural resource endowments and resource management can have a direct positive effect on competitiveness in its sustainable dimension, but it can also erode competitiveness by distorting economic policy choices [Sachs, Werner, 2001; Delgado, Ketels, Porter, Stern, 2012].

Growing environmental problems and increasing green awareness give rise to environmental expectations of the public about ensuring resource management that will satisfy current needs without limiting access to resources for the generations to come. In response to this challenge, the concept of circular economy emerged. Circular economy is defined as a model of production and consumption that allows efficient use of materials and energy through resource recovery from waste products and their reuse. The key element of this concept is recycling, which makes it possible to extend the life cycle of products and reduce demand for raw materials [Kirchherr, Reike, Hekkert, 2017; Ekins et al., 2019]. In the light of this definition, circular economy is linked to sustainable competitiveness, especially in its environmental dimension, but these are not identical concepts.

To sum up, many analyses indicate that sustainable competitiveness related to the natural environment can be improved through innovations and application of new technologies [Thore, Tarverdyan, 2016].

1.5. Methods of measuring sustainable competitiveness

The definition of sustainable competitiveness is reflected in the methodology used for its measurement. When developing the concept of sustainable competitiveness, the World Economic Forum modified the methodology for the calculation of the Global Competitiveness Index (GCI) in order to better capture individual elements of sustainable development. The adjusted GCI includes both social sustainability and environmental sustainability coefficients [Corrigan et al., 2014, p. 64].

Three key groups of indicators were used to measure social sustainability, such as [Corrigan et al., 2014, pp. 65–66]:

- the level of population's access to basic necessities, measured by indicators describing access to sanitation, access to improved drinking water, and access to healthcare services;
- vulnerability to economic exclusion measured by the indicators of vulnerable employment, extent of the informal economy, and social security net protection;
- social cohesion measured by the income Gini index, social mobility, and youth unemployment indicators.

Environmental sustainability includes the following components [Corrigan et al., 2014, pp. 65–66]:

- environmental policy, the effectiveness of which is measured by indicators reflecting the stringency and enforcement of environmental regulations, the extent to which land areas are protected, and the number of international environmental treaties signed by a country;
- the use of renewable resources (measured by the baseline water stress indicator, wastewater treatment, forest cover change, and the overexploitation of fish stocks);
- the level of environmental degradation (particulate matter concentration, carbon dioxide intensity, and other detailed metrics of the quality of the natural environment).

In addition, the Social Progress Index (SPI) is one of the synthetic indicators supporting the assessment of sustainable competitiveness, in particular social sustainability. It describes the degree of meeting basic human needs, opportunities for personal development, and participation in welfare [Porter, Stern, 2015].

Doyle and Perez-Alaniz [2017] conducted a review of indicators used in the literature, which could be used to measure environmental sustainability and social sustainability. The main lesson from those analyses refers to the need to focus on the interaction of economic factors with social and environmental elements of sustainable development, looking at both those groups of elements jointly.

An alternative way of measuring sustainable competitiveness is viewing it in terms of fulfilment of the 17 sustainable development goals adopted in Agenda 2030. The Sustainable Development Goals Index (SDG Index) using dozens of subindexes on a scale of zero to 100 measures countries' progress in the achievement of those goals [Lafortune, Fuller, Moreno, Schmidt-Traub, Kroll, 2018; Sachs, Schmidt-Traub, Kroll, Lafortune, Fuller, 2021]. The index does not correspond fully with the concept of sustainable competitiveness, but it can serve as an approximation for its assessment.

Other proposals for the measurement of phenomena related to sustainable competitiveness refer to one or several selected goals of sustainable development.

Empirical studies covering the EU countries employ a method based on Weber's median vector to monitor the implementation of certain types of innovations which, as noted above, are a key element of sustainable competitiveness [Szopik-Depczyńska et al., 2018].

Attempts are also made to measure sustainable competitiveness at regional level by constructing synthetic indexes for regions with the use of the principal component method and structural equation models [Möbius, Althammer, 2019]. An even higher level of measurement disaggregation is represented in an attempt at the empirical assessment of the sustainable competitiveness of cities [Cincikaite, Meidute-Kavaliauskiene, 2021].

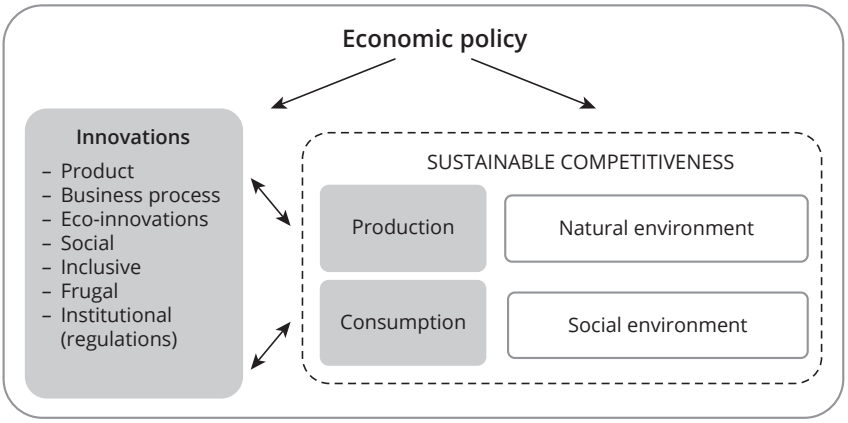
1.6. Conclusions

To sum up the analyses contained in this chapter, it should be noted that sustainability in the environmental and social dimensions as elements of sustainable competitiveness refer to the country, region, city, and enterprise levels. In a longer run, all types of innovation – technological, organizational, and institutional (e.g. regulatory) innovations – are key to the achievement of sustainable competitiveness. It is worth emphasizing the special role of eco-innovation in efforts towards environmental sustainability and, in the context of social sustainability, the role of frugal innovations and inclusive innovations (Figure 1.1). Innovation and other factors of competitiveness are influenced by economic policy. The role of economic policy tools increases in the times of economic crises, which is also confirmed by the COVID-19 pandemic experience.

The new challenges now facing the world economy – economic and demographic crises, climate change, and the COVID-19 pandemic – encourage the development of research on the concept of sustainable competitiveness and require its main factors to be considered in the long-term context. The COVID-19 pandemic has triggered a number of negative effects and created a completely new situation both across the world and in individual countries, affecting all aspects of human life, in particular health, the social, economic, and political environment, as well as education and culture. These changes also lead to various consequences for the achievement of the seventeen sustainable development goals adopted by the UN [Leal Filho et al., 2021]. During the COVID-19 pandemic, the issues of public health, access to healthcare, and functioning of the healthcare system have become of key significance. The question also arises about the future sustainable competitiveness leadership in the global economy.

Extensive economic, social, and environmental issues, interconnected within the concept of sustainable competitiveness, relating to the improvement of welfare level, improvement of public health, alleviation of inequalities and exclusion, and the need to protect the environment require a comprehensive approach.

Figure 1.1. Innovations and sustainable competitiveness



Source: Compiled by author.

Future directions of research will certainly involve a system-based approach to those multiple phenomena and seek to map linkages between macro-, meso- and microsystems. Analyses may seek to explain how to effectively achieve the goals of global, national, organizational, and individual sustainable development. Hitherto approaches to sustainable competitiveness, which are largely rooted in fragmentary and linear ways of looking at complex phenomena, can be expanded by taking a holistic, systemic viewpoint. It seems that one of the possible paths to follow in exploring the topic of sustainable competitiveness could involve complementing it with aspects related to education (economic, environmental, social), which is a necessary element of welfare improvement and levelling of inequalities.

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Chapter 2

Resilience and Vulnerability to Economic Crisis: Implications for Competitiveness

Arkadiusz Michał Kowalski

2.1. Introduction

Since 2020, the world economy has been experiencing the COVID-19 pandemic shock, with strong implications for the concept of international competitiveness. Globalization has contributed to the unprecedented speed, severity, and breadth of spread of the outbreak across the globe. The international market mechanisms, which were believed to promote economic growth and mitigate the effects of exceptional and unexpected shocks, have failed to provide the relief in a timely manner.

Resilience itself is a multidimensional concept that encompasses many distinct characteristics of an economy's performance, so there is no widely recognized method for operationalizing or measuring it. Hence, different methodologies that were applied in different studies aiming to assess economic resilience are presented. As economies go through business cycles, Schumpeter's concept of creative destruction is discussed, with an attempt to identify possible technological areas (mostly digital technologies) for breakthrough innovations that may induce economic development.

2.2. The concept of international competitiveness during economic crises

The COVID-19 pandemic has had a negative impact on the economic situation of many countries by reducing their respective economic growth rates and having an adverse effect on employment and welfare levels [Galindo-Martín, Castaño-Martínez, Méndez-Picazo, 2021]. The associated economic crises challenge the traditional understanding of the concept of international competitiveness. As each crisis has different reasons and characteristics, the one resulting from the COVID-19 pandemic is unlike any other, with unforeseeable consequences for economies. Much

is dependent on the virus's epidemiology, the effectiveness of prevention measures, and the development of therapeutics and vaccines, all of which are difficult to predict. Furthermore, multiple countries are already dealing with a number of crises, including a health crisis, a financial crisis, etc., all of which are intricately linked. Hence, one of the key dimensions of competitiveness is economic resilience, or an economy's ability to recover from or react to negative external shocks while benefiting from positive shocks [Briguglio, Cordina, Farrugia, Vella, 2009, p. 5]. According to Gourinchas [2020], the effects of the COVID-19 pandemic's shock can be classified into three types:

1) medical shocks – workers infected with SARS-CoV-2 are unable to work and are not producing GDP;
2) economic shocks – as a result of governments imposing social distancing measures;
3) expectation shocks.

In the light of the massive impacts of the coronavirus on public physical and psychological health, the economic and financial impacts may seem secondary. However, the economic effects are potentially going to be of first-order importance. The feature makes the new coronavirus crisis different from most of the past crises in that it was not mainly caused by a collapse in demand as usual, but even more by a collapse in supply. The COVID-19 crisis, in particular, has demonstrated that the present global value chain is vulnerable to global shocks [Yagi, Managi, 2021]. Business disruptions have lowered production, creating shocks to supply, whereas the reluctance of consumers and businesses to spend has lowered demand. The impact of this shock can be transmitted via supply chains to downstream sectors around the world, including to countries not currently experiencing a major virus outbreak [Wei, 2020]. On the supply side, a direct reduction is witnessed in the supply of labour due to sick leaves, caregivers having to be employed to take care of young children because of school closures, and due to a spiking death toll. Yet what has an even larger effect on economic activity are measures taken to tame the spread of the pandemic, including lockdowns and quarantines, leading to capacity underutilization. Besides, supply chains hiccups may deprive manufacturers of access to the components they need. As China is a key supplier of intermediate goods to plants across the world, the disruption there has already come as a shock to downstream operators. These disruptions result in rising business costs and "constitute a negative productivity shock, reducing economic activity" [Gopinath, 2020]. On the demand side, there will be forced change in consumption patterns resulting from health-related measures [Gali, 2020]. Moreover, people will tend to spend less in the face of contagion risk, potential loss of income, and growing uncertainty about the future. Declining consumer and business sentiment may prompt expectations of lower demand and make companies reduce their spending and investment, which will only bring about more business

closures and layoffs [Gopinath, 2020]. According to Quah [2020], unlike a routine economic shock, which may have an impact up to a standard deviation on price and quantity, the novel coronavirus brings into focus questions of heightened social fears for market participants.

The COVID-19 pandemic, which has caused global instability and economic destruction, has been one of the most difficult crises in human history. Nobody could have predicted the contagious nature of pandemics, let alone the health risks, so the virus forced global disruptions such as lockdowns, the closure of airports and ports, the suspension of all kinds of tourist activities, the introduction of new strict rules pertaining to health protection, as well as the closure of some industries and the limitation of imports and exports. As a result of the shutdown, industrial production has suffered, resulting in additional layoffs, high unemployment, slowed demand, and lower industrial income. Many industries, such as aviation, tourism, entrainment, and transportation, suffer and fight for survival, even if it is sometimes a losing battle.

The impact of the COVID-19 pandemic on international competitiveness is significant because governments have implemented public health containment measures that would appear severe in any other context. The term "controlling the epidemic" refers to "flattening the epidemiological curve". This is accomplished by slowing the rate of infection by instituting social distancing measures such as limiting person-to-person contact and the operation of businesses, public institutions, educational and cultural institutions, as well as travel bans or mandatory quarantining of individuals exposed to infected people. Social distancing policies have a significant impact on economic performance. According to Gourinchas [2020], flattening the infection curve in the short term always steepens the macroeconomic recession curve, resulting in a significant drop in, for example, production and commerce. While the former is equivalent to the commencement of the global financial crisis, the service reduction induced by the COVID-19 epidemic appears to be greater. In this regard, Odendahl and Springford [2020] highlight the distinction between post-epidemic recovery in industry, which may experience a quick rebound, and the service sector, which may be affected by the crisis for a longer length of time.

2.3. Resilience and vulnerability of the economy

Resilience has become an important economic problem in the light of the COVID-19 pandemic and associated economic crisis. However, this topic was studied in economics much earlier, with increased interest following the 2008 global financial crisis. The term itself is derived from the Latin *resilire*, which means to recover from, and it characterizes

how a system responds to shocks, disturbances, and perturbations [Alessi et al., 2020]. The origins of the resilience concept are usually attributed to ecology [Holling, 1973] but has since been widely applied in the physical, engineering, psychological, and organizational sciences, as well as economic geography [Martin, 2012]. In economics, resilience has rapidly gained traction as a concept among researchers, policymakers, and practitioners trying to understand both why certain areas are better equipped to endure and/or recover fast from economic shocks than others, and what they can do to affect these capabilities [Dawley, Pike, Tomaney, 2010]. Nonetheless, despite its popularity and importance, the understanding of resilience requires further refinement. There is still much disagreement on what is meant by this concept, how it should be understood and assessed, what its causes are, and how it relates to long-run growth patterns [Martin, Sunley, 2020].

Resilience, with its focus on stability of a system near its equilibrium, clearly resonates with the assumption of self-correcting forces. According to this viewpoint, the economy is self-equilibrating: any shock that causes the economy to deviate from its equilibrium condition automatically initiates compensatory adjustments that bring it back to equilibrium. It is possible that those compensating, self-correcting changes will take some time to take effect, but the assumption is that the economy will eventually revert to its pre-shock equilibrium state [Martin, 2012]. This characteristic is the inverse of vulnerabilities and is determined by both external factors, such as the kind and strength of shocks and transmission channels, and endogenous elements, such as the economy's structural and institutional characteristics [Wojtyna, 2010].

Martin [2012] and Martin and Sunley [2015] identified three different dimensions of economic resilience:

1) resistance, i.e. the degree of sensitivity or depth of reaction of an economy to a recessionary shock;
2) recovery, i.e. the speed and magnitude of the recovery;
3) reorientation and renewal, i.e. the ability of an economy to adapt in response to the shock and renew its growth path.

Economic resilience extends to the concept of adaptive resilience, which characterizes the ability to adapt, learn, and reorganize in the face of specific shocks [Martin, Sunley, 2015]. Adaptive resilience refers to a system's ability to undergo anticipatory or reactive reorganization of form and/or function in order to reduce the impact of a destabilizing shock. The emphasis is on the system's adaptive capabilities [Martin, 2012].

2.4. How to measure the resilience of the economy?

For a variety of reasons, operationalizing the concept of resilience is not a straightforward task. Resilience is a multidimensional concept that encompasses many distinct characteristics of a economy's performance, so there is no widely recognized method for **experimentally** measuring resilience [Boschma, 2015]. In recent years, the number and variety of resilience indicators and toolkits have been developed in order to try to determine whether an economy is resilient, and to benchmark the resilience of different economies. However, measuring resilience is much more difficult than identifying and understanding it [Carpenter, Walker, Marty Anderies, Abel, 2001], as three fundamental questions must be addressed [Faggian, Gemmiti, Jaquet, Santini, 2018]:

1) resilience "to what", as it would be ideal to test an economic system's overall resistance to all possible external stressors, but discovering perfect natural experiments is nearly impossible;
2) resilience "of what", as once the external stressor that informs the scope of the analysis is identified, the question is how to measure the resilience of an economic system and to select proper resilience indicators;
3) resilience "over what period", as some economic systems may be able to recover or move to a different locally stable equilibrium more quickly than others, and there is an open question about a correlation between short and long-term resilience.

As for the indicator used to measure the resilience of the economy, most researchers usually use traditional economic indicators such as:

- employment [Martin, 2012; Fingleton, Garretsen, Martin, 2012; Lagravinese, 2015];
- employment growth rate [Augustine, Wolman, Wial, McMillen, 2013];
- GDP per capita [Cellini, Torrisi, 2014];
- patent generation as a proxy for innovation [Balland, Rigby, Boschma, 2015];
- occupation rates in housing [Carpenter, 2015];
- indicators listed by Foster [2007]: wages, unemployment, poverty rates, income inequality, out-migration, local government debt and revenues.

Alternative, more sophisticated attempts to measure the resilience of the economy, rely on the development of a multi-dimensional index. One of the first attempts was made by Briguglio, Cordina, Farrugia and Vella [2006], who proposed an index computed by taking a simple average of the four groups of components:

1) macroeconomic stability (the fiscal deficit to GDP ratio, the sum of the unemployment and inflation rates, and the external debt to GDP ratio);
2) microeconomic market efficiency (the size of government, freedom to trade internationally);

3) good governance (judicial independence, impartiality of courts, the protection of intellectual property rights, military interference in the rule of law; political system and the integrity of the legal system);
4) social development (the education and health indicators used to construct the Human Development Index – HDI).

Another example of measuring the resilience of the economy in the form of multi-dimensional index was provided by CLES [2010], which proposed ten resilience measures, mostly related to the regional economy:

1) the strength of the commercial economy, defined as the generation of economic prosperity by privately owned and profit-driven enterprises;
2) the public economy, which comprises services provided on behalf of government organizations at the national, regional, and local levels, which are supported by the public purse;
3) the social economy, which encompasses a wide range of communal, voluntary, and non-profit activities aimed at bringing about good local change;
4) the commercial economy's relationship with the public economy, which investigates the existence and efficacy of commercial and public sector partnerships, as well as the level of contact between the two sectors of the economy;
5) the public economy's interaction with the social sector, which investigates the presence and efficacy of public-social partnerships;
6) the connection of the social economy to the commercial economy, which investigates the presence and efficacy of partnerships between the commercial and social sectors;
7) health and wellbeing, as well as their connection to the local economic territory;
8) the relationship between the local economic territory and operating within environmental limitations, which investigates how the climate change agenda has been integrated into the economy, focusing on both mitigation and adaptation methods;
9) the connection between the local economic region and the local identity, history, and context;
10) the connection between the local economic territory and government.

More recent attempt to measure the resilience of the economy in the form of a multi-dimensional index was proposed by Alessi et al. [2020], who proposed a set of 34 system variables, further differentiated to financial-economic indicators (i.e. core economic variables) or going beyond economic and financial indicators, primarily societal constructs (i.e. non-core variables). These indicators were classified according to which part of the system they belong to:

1) assets (the inputs): investment (core), and dwellings, expenditures on education, expenditures on health, fairness, trust in people (non-core);

2) engine (represents those processes and services that connect assets and outcomes): government deficit, government debt, household loans, house prices, inflation, labour productivity, corporate loans, private debt, stock prices (core); and social activity, trust in European Parliament, trust in legal system, expenditures on active/passive labour market programmes, expenditures on R&D, incidence of temporary work, wages (non-core);
3) outcomes (the outputs): employment rate, GDP, unemployment rate (core); and happiness, health, household consumption, income inequality, youth not in employment, education or training (NEET), social exclusion, household income, satisfaction (non-core).

It is clearly seen that the above classification is somewhat arbitrary for certain indicators; however it provides information on the functioning of socio-economic systems during crisis. The conclusion from the above overview of the examples of the methods to measure the resilience of the economy is that there are different ways to perform this task with no universal set of indicators. The selection of specific methodology and measures depends on the objectives of the specific study, characteristics of analysed economies and the availability of statistical data.

2.5. Economic crises, creative destruction, and business cycles

An economic crisis deteriorates a country's international competitiveness, and it can last for a few months to several years, depending on the severity of the conditions. An economic collapse does not always occur as part of the normal economic cycle. It can happen at any point in the cycle, causing contraction and recession. Concerning the relationship between innovation and business cycles, two extreme hypotheses can be outlined: according to the first, innovation is cyclical and therefore firms tend to reduce their innovation efforts during the downswing of the economy, while according to the second, it is instead counter-cyclical, leading to claims that recessions are a fertile environment for firms to innovate [Filippetti, Archibugi, 2011]. Increased competition as a result of a crisis can encourage economic operators to improve their ability to innovate as a competitive component. An organization's innovative initiatives are meant to offer it a competitive advantage by allowing it to be a first mover [Kowalski, 2011]. In particular, innovation can be seen as a way to counteract the negative consequences of the economic downturn brought on by the COVID-19 pandemic. The theory of economics, particularly Schumpeter's [1942] idea of creative destruction, backs this up. It is, in essence, a process that perpetually revolutionizes

economic structures from within, eliminating old systems and continuously establishing new, more efficient ones.

The concept of creative destruction may be analysed at the microeconomic, mesoeconomic, and macroeconomic levels [Zorska, 2011, p. 21]. According to Schumpeter's theory, the process of creative destruction underpins all economic change and progress. The stimulant that kickstarts this process is microeconomic innovation – innovation at the level of a single company, which entails abandoning outdated production methods, disposing of them, and applying new solutions that boost production, sales, and profits. This incentivizes other businesses to make similar adjustments, resulting in a variety of structural changes in the industry, i.e. at the mesoeconomic level. Today, the issue of mesoeconomic creative destruction is discussed in a broader context, and it may include elements such as industrial structures, traditional business regulations, traditional competitive strategies, and standard technological assumptions and concepts of scientific and technological progress [Domański, 2010, p. 38]. At the macroeconomic level, implemented innovations and structural reforms are favourable to economic development and increased competitiveness. However, in the following era of creative destruction, competition among enterprises, as well as insufficient demand, result in decreased earnings and the clearing of the market of unprofitable businesses. As a result, the economic crisis is marked by heightened competition, driving businesses to innovate in order to maintain a competitive advantage [Filippetti, Archibugi, 2011]. Following this, industrial consolidation and concentration occur, as well as the establishment of various sorts of cooperative partnerships. The introduction of new technologies and industrial clusters is frequently triggered by structural issues in conventional areas of the economy. A true industrial revolution, according to Mokyr [1997], includes not only technological advances, but also those that have an impact at the level of industrial organization. Furthermore, when there is a crisis, new specialization patterns emerge, such as the emergence of new sectors and technology solutions, which is critical for economic recovery. An economic downturn can trigger the growth of a new industry and/or totally new technology through:

- recombination of existing knowledge and techniques, free of legacy ties that impose a specific way and context of use;
- adoption of an existing technological solution in a completely new context; this type of innovation, while not a major innovative development, opens up new markets and applications for existing technologies and determines the emergence of new technological trajectories [Siedlok, Andriani, 2007].

An economic downturn can act as a spur for technique recombination and self-organization. Traditional industries are collapsing, releasing resources, expertise, and physical infrastructure. In this situation, the crisis allows the development of

new competencies, technologies, business models, and organizations. On the one hand, challenges connected with current economic activity compel businesses to seek new markets and uses for their knowledge, while on the other hand they urge them to collaborate and create a new "economic ecosystem". Entities are subject to coevolution in this setting, and they actively shape the new economic space with their own resources. As a result, the formation of knowledge recombination and exaptation processes, as well as the creation and development of new socio-technological systems, technologies, and markets, is aided by crisis [Kowalski, 2011].

One aspect of innovations in Schumpeter's idea of creative destruction is that they do not arrive on a regular basis, resulting in oscillations in the product growth rate and the economy's cyclical development. Combining Schumpeter's notion with the theory of business cycles, it can be shown that the introduction and dissemination of base technologies such as the steam engine have historically conditioned the recovery from crises and the start of long economic cycles, known as Kondratiev waves [Kowalski, Weresa, 2021]:

1) steam engine and technological solutions enabling the development of the textile industry (1st K-wave: 1780–1850);
2) railway and heavy industry (2nd K-wave: 1850–1890);
3) electrical engineering and chemistry (3rd K-wave: 1890–1940);
4) automotive industry and petrochemicals (4th K-wave: 1940–1990);
5) information technologies (5th K-wave: 1990s).

According to Kovalevskaia, Fedoritenko and Troian [2021], we are at the beginning of the 6th K-wave, which is stimulated by digital technologies and sustainability, manifesting itself e.g. in raw material efficiency, renewable energy, and eco-innovations. The examination of the evolution of K-waves reveals the shortening in their duration. Additionally, it is visible that services did not become a driver of economic expansion until the last phase, but in prior stages they were based on industrial breakthroughs. In the light of the worldwide economic crisis caused by the COVID-19 pandemic, it is appropriate to ask where innovation may help to induce economic growth. When looking for a solution to the dilemma of creative destruction, it is important to underline the importance of developing inventive solutions, especially in two areas:

1) digital technologies, which make it possible to use telework, distance education, and telehealth more regularly in order to improve health security and at least partially offset the pandemic's impacts;
2) work on innovative medicines.

The first of these categories is inextricably tied to the Fourth Industrial Revolution's transformation process, which entails the advancement of digital technology and electronics, as well as the integration of digital and physical systems across all sectors

of the economy. The application of new technologies allows the construction of an interactive network of products, machines, and people, which improves value chain links and influences competitive conditions [Weresa, Kowalski, 2019]. The Internet of Things, artificial intelligence (AI), big data analytics, cloud computing, and augmented reality are all examples of the digital transformation of ICT-driven manufacturing processes [Kagermann, Helbig, Hellinger, Wahlster, 2013; Armengaud et al., 2017]. In particular, Xu Guo and Huang [2021] find that the COVID-19 pandemic has highlighted the value of using artificial intelligence (AI) which helps to solve problems arising due to social distancing. It is because this technology can make predictions and provide efficient solutions in a timely manner by utilizing massive volumes of data and complex analytics. New business models are evolving, and modern technologies are increasingly altering the way government functions, resulting in increased economic and regional competitiveness [Porter, Heppelmann, 2014].

Schumpeter's creative destruction, particularly in connection to the COVID-19 pandemic, necessitates collaboration between internal and external entities, with an emphasis on enhancing human inventiveness in order to decrease vulnerabilities faced throughout the global economy. When it comes to coping with natural pandemics, the notion of creative destruction provides answers to developing issues. In this sense, Schumpeter's theory has been centered on the fundamental subject of entrepreneurship [Jackson, 2020], where human ingenuity is regarded as the most essential instrument in combating the COVID-19 epidemic. Entrepreneurship, particularly in areas pertaining to new technologies associated with industrial production, service delivery networks, and education, must take a new turn, which invariably may skew people's perceptions of the new normal, which is typically associated with the vagaries of emerging technologies [Jackson, 2021].

One of the instruments in the recovery process during the COVID-19 pandemic may be cluster policy. This goes in line with the cluster-based economic development concept, which is understood as a set of activities and instruments instituted by authorities at various levels to improve economic competitiveness through stimulating the development of existing cluster systems or by creating new systems [Kowalski, 2020]. According to this approach, clusters can be used as tools for achieving policy objectives, e.g. they can be used to restore value chains. This requires the engagement of multiple actors at different stages of the value chain, including design, research, manufacturing, and supporting services. Additionally, clusters can be used to identify new technological trends, in particular, those emerging at the crossroads of different but connected sectors.

2.6. Conclusions

The COVID-19 pandemic and accompanying economic difficulties call into question established notions of international competitiveness. The aspect that distinguishes the new coronavirus crisis from most previous crises is that it was driven more by a fall in supply than a collapse in demand. Business interruptions have reduced output, causing supply shocks, while the reluctance of consumers and businesses to spend has lowered demand. One of the crucial factors of international competitiveness can be found in resilience with its three different dimensions: resistance, i.e. the degree of sensitivity or depth of reaction of an economy to a recessionary shock; recovery, i.e. the speed and magnitude of the recovery; and reorientation and renewal, i.e. the ability of an economy to adapt in response to the shock and renew its growth path. Despite increasing popularity of resilience, operationalizing and measuring it is challenging, as it is a multidimensional concept encompassing many distinct characteristics of an economy's performance. In general, there are two main methods for assessing resilience: based on single indicators or relying on the development of a multi-dimensional index. However, the selection of specific measures is arbitrary and the selection of the methodology is determined by research aims, the characteristics of the economies under consideration, and available data.

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Part II

Competitive Ability

Chapter 3

Land and Water Resources in Poland: An Empirical Study

Artur Franciszek Tomeczek

3.1. Introduction

The use of land and water has gained increasing importance in public discourse in recent years. They are related to such wide-ranging topics as rapid urbanization, environmental issues, social policies, food supply, energy production, transportation networks, and national security. Historically, economic sciences have regarded land and water as important resources to be utilized in the process of economic development and one of the tenets of the classical theory of growth. As the sustainable development policies have rightfully gained increasing support, economists must re-examine and modernize their stance on the exploitation of one of the classical factors of production.

3.2. Methodology

This research aims to show how the use of land and water resources in Poland compares to other selected economies. It starts with a narrative literature review of related issues in economic research.

The main empirical part of the comparative analysis considers the following geographical areas: three largest European economies (Germany, France, and the United Kingdom), four Visegrad Group countries (Czech Republic, Hungary, Poland, and Slovakia), the world (average), and high-income countries (average). The separate comparative overview of the fishing industry is based on a different set of countries due to data availability.

For the final part of the study, Pearson's *r* correlation matrix and five ordinary least squares linear regression models are constructed. The dependent variable is the gross national income (GNI) per capita and 18 selected independent variables are relevant

to the use of land and water resources. The models are based on cross-sectional data and their sample size depends on the regressors used (ranges from 82 to 149).

3.3. Literature review

Land and water resources are important drivers of economic growth. It is widely accepted that the destruction or misuse of these natural resources will harm future economic and social development [Górka, 2014]. The agricultural sector has traditionally been seen as one of the primary uses for the land. Farming in Poland is usually labour-intensive, characterized by relatively small individual fields, good quality of land, and pronounced differences and specializations between regions [Ziętara, 2008]. The status of land tenure is an important economic factor, as land tenants tend to have higher profitability and landowners tend to have higher productivity [Kagan, Ziętara, 2018]. Most of the agricultural land in Poland is obtained by its current private owners through family inheritance [Marks-Bielska, 2013]. There is an increasingly large quantity of agricultural land that is not used for agricultural production [Dzun, 2014]. The process slowed down temporarily after Poland joined the European Union but remains dangerous as it also affects fertile land [Dzun, 2012; Szymańska, 2015]. However, modern land use is diverse and with complicated implications, e.g. for housing, energy supply, industrial production, mining, tourism, environment, and quality of life [Górka, 2014].

The growth of cities has been one of the leading causes and effects of economic development over the past decades. While further urbanization might be seen as a requirement for further growth in many regions, the focus should be on its sustainability [Ochoa, Tan, Qian, Shen, Moreno, 2018; Wu, 2010]. There are many categories of cities in the literature, such as influential world cities [Alderson, Beckfield, 2004; Taylor, 2001], innovative smart cities [Eremia, Toma, Sanduleac, 2017; Szczech-Pietkiewicz, 2015], and enormous megacities [Cheeseman, de Gramont, 2017; Hall, Pain, 2006]. There can be a significant overlap between these categories. The geographic dispersion of economic activity is especially important considering the high impact of clusters on the regional development of Poland [Kowalski, 2010, 2013; Lis, Kowalski, Mackiewicz, 2021; Mackiewicz, 2019]. The reverse trend of migration from urban to rural areas, especially from the largest cities to their wider functional areas, is also present in Poland [Rosner, 2014; Źróbek-Różańska, Zysk, 2015].

Healthy ecosystems, including forests, rivers, and lakes, are crucial for mitigating the adverse impacts of climate change on the economy, such as extreme weather, destructive storms, droughts, disappearance of bees, and spread of tropical diseases

[Pierzgalski, 2008]. Poland has a large forest area, which provides it with timber used in various industries such as construction, furniture, pulp and paper, shipbuilding, and textiles. Wood and paper have also increased in importance as packaging materials due to their recyclability and the negative environmental implications of plastics. Extreme weather in Poland, resulting in heatwaves and droughts, is modelled to have a significant impact on agriculture in the future [Szwed et al., 2010].

According to long-term forecasts, economic growth is the primary driver of water scarcity [Alcamo, Flörke, Märker, 2007; Distefano, Kelly, 2017]. The water resources of Poland are relatively limited compared to other European countries [Żurek, 2008]. Most water comes in the form of rainfall, which can lead to irregularities and droughts. Since the turn of the century, climate warming has led to a decrease in water resources in Poland [Ziernicka-Wojtaszek, 2015]. The ever-increasing complexity of water management is determined by this scarcity [Małecki, Gołębiak, 2012]. Variability of rainfall is a significant determinant of economic development [Brown, Lall, 2006]. As is the case with the use of land, agriculture plays a key part in the use of water [Mioduszewski, 2006]. Forests and green areas help regulate water resources and prevent floods [Pierzgalski, 2008].

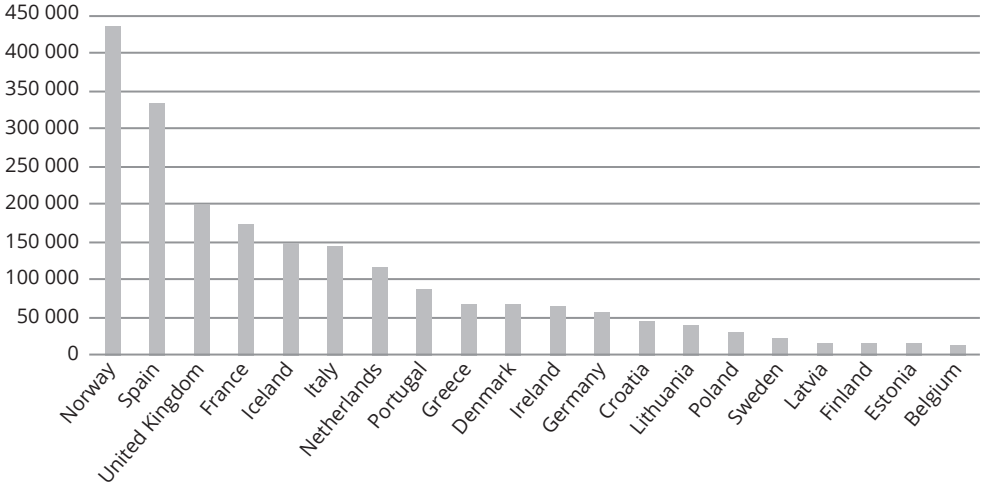
The interest in renewable energy is currently at an all-time high. The Green New Deal, supported by both the European Union and the United States, places utmost importance on the use of environmentally conscious energy sources. The use of fossil fuels, especially coal, is a subject of vigorous debate in Poland. The pandemic has had a significant impact on crude oil prices [Nyga-Łukaszewska, Aruga, 2020]. Coal mining activities have a significant impact on landscape by causing pollution, and the loss of biodiversity and the necessary land reclamation projects take time and have high costs [Bian, Inyang, Daniels, Otto, Struthers, 2010; Hendrychová, Kabrna, 2016; Xiao, Hu, Fu, 2014]. Coal mining also causes damage to farmland in coal-cropland overlapping areas, which hurts the quantity and quality of agricultural production [Hu et al., 2014]. The drop in land efficiency caused by coal-related land destruction varies by region [Li, Chiu, Lin, 2019]. Importantly, Poland is relatively self-sufficient in meeting its coal needs [Nyga-Łukaszewska, Aruga, Stala-Szlugaj, 2020].

3.4. Fishing industry

The bounty of the land and sea has sustained humanity since its earliest days. The European Union promotes sustainable development as a safeguard from the environmental destruction caused by unfettered exploitation of resources. With the focus on sustainability, overfishing is seen as a big problem. It seems important to

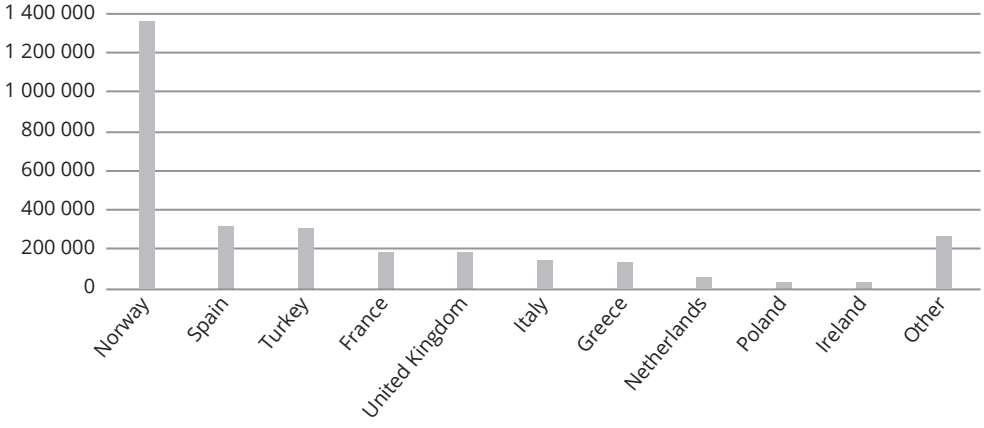
look at which countries benefit from it the most. Figure 3.1 represents the fishing fleet size of European countries by gross tonnage. Norway takes first place with 437 thousand GT, followed by Spain (332 thousand), the United Kingdom (198 thousand), France (172 thousand), and Iceland (149 thousand). Clearly, the size of the fishing fleet in Europe is determined by access to the Atlantic Ocean. Poland is ranked 15th with 32 thousand GT. Notably, it overtakes the Scandinavian countries of Sweden (23 thousand) and Finland (16 thousand).

Figure 3.1. Fishing fleet size in 2019 (gross tonnage)



Source: Eurostat [2021].

Figure 3.2. Aquaculture production in 2018 (tonnes live weight, excludes hatcheries and nurseries)



Source: Eurostat [2021].

Figure 3.2 shows the size of aquaculture production. OECD [2021] defines aquaculture as "the farming of aquatic organisms including fish, molluscs, crustaceans and aquatic plants. Farming implies some sort of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators and so forth. It also implies individual or corporate ownership of the stock being cultivated". In other words, aquaculture has more in common with raising livestock than with hunting. Norway is again ranked first but this time the gap is much larger (1.36 million for Norway and 319 thousand for Spain). Poland is ranked ninth with 37 thousand, which places it ahead of Denmark (11th, 32 thousand), Germany (12th, 32 thousand), and Iceland (16th, 19 thousand).

3.5. Comparative analysis

Table 3.1 shows the variables chosen for the comparative analysis and linear regression model. The regressors are grouped into four categories: "Population and urbanization" (three variables), "Agriculture" (five variables), "Environment and water" (five variables), and "Energy and natural resources" (five variables). The table also gives the unit and date (most recent available). Table 3.2 provides the values for the selected geographical areas: three largest European economies, four Visegrad Group countries, the world (average), and high-income countries (average).

Out of the selected countries, Poland has the lowest GNI per capita (USD 15,350) and penultimate degree of urbanization (60%). Poland's degree of urbanization is significantly behind high-income countries (81%), and only higher than Slovakia's (54%). Population density is the highest in the United Kingdom (275) and Germany (237) – other countries, including Poland and France, have around half of their values. The percentage of the urban population living in the largest city is, somewhat surprisingly, by far the lowest in Germany (6%) and Poland (8%).

When it comes to the use of land for agriculture, all the countries are somewhat even, except the United Kingdom, which simultaneously has the highest percentage of agricultural land (72%) and the lowest percentage of arable land (25%). Worryingly, Poland has, by far, the lowest agricultural productivity per worker: USD 6,870, compared to Slovakia's USD 41,082 and France's USD 51,257. The cause of this might be very high agricultural employment in Poland (10.6%).

Forest cover is the highest in Slovakia (40.4%), but Poland (30.9%) is still slightly above the world average (30.7%). Terrestrial protected areas in Poland represent 39.7% of total land while marine protected areas constitute 22.6% of territorial waters. The latter figure is much lower than in Germany (45.4%). When it comes to annual

freshwater withdrawals, Poland's 21.4% of internal resources pale in comparison to Hungary's 84.2%. Annual carbon emissions per capita are on average highest in high-income countries (10.8). Considering Visegrad Group countries, Poland (7.5) pollutes more than Hungary (4.2) and Slovakia (5.7) but less than the Czech Republic (9.2).

Table 3.1. Variables

Variable	Category	Definition	Unit	Date
GNI	economic development	gross national income per capita, Atlas method	USD	2019
POP1	population and urbanization	urban population	% of total population	2018
POP2	population and urbanization	population density	people per sq. km	2019
POP3	population and urbanization	population in the largest city	% of urban population	2018
AGR1	agriculture	land use: arable land	% of land area	2018
AGR2	agriculture	agricultural land	% of land area	2014–2016
AGR3	agriculture	fertilizer consumption	kilograms per hectare of arable land	2014–2016
AGR4	agriculture	agricultural employment	% of total employment	2014–2016
AGR5	agriculture	agricultural productivity: value added per worker	2010 USD	2016
ENV1	environment and water	land use: forest area	% of land area	2018
ENV2	environment and water	terrestrial protected areas	% of total land area	2017
ENV3	environment and water	marine protected areas	% of territorial waters	2017
ENV4	environment and water	annual freshwater withdrawals	% of internal resources	2014
ENV5	environment and water	carbon dioxide emissions: per capita	metric tonnes	2014
ENE1	energy and natural resources	energy use per capita	kilograms of oil equivalent	2014
ENE2	energy and natural resources	sources of electricity production: coal	% of total	2015
ENE3	energy and natural resources	sources of electricity production: renewable sources	% of total	2015
ENE4	energy and natural resources	sources of electricity production: nuclear power	% of total	2015
ENE5	energy and natural resources	total natural resources rents	% of GDP	2016

Source: World Bank [2021a, 2021b].

The comparison of sources of electricity reveals stark differences. For nuclear power, Poland (0%) is last while France (77.6%) leads the way. In fact, Poland is the only country in the comparison without any nuclear power, with Slovakia (56.9%) and Hungary (52.2%) generating more than half from this source. The use of coal is still widespread, and Poland (80.9%) is by far the most dependent on it, followed by the Czech Republic (53.1%) and Germany (44.3%). France (2.2%) has successfully limited its use of coal. On the other hand, Poland's (12.7%) energy from renewable sources is remarkably good, trailing only Germany (26.3%) and the United Kingdom (23%). Poland (0.8%) has relatively high rents from natural resources, compared to France's 0%, Germany's 0.1%, and the Czech Republic's 0.3%. This indicates that Poland still places a relatively high priority on the exploitation of its natural resources, primarily coal. Moderate efforts to push out fossil fuels focus on renewable energy instead of nuclear power.

Table 3.2. Values

Variable	World	High income	Germany	France	United Kingdom	Czech Republic	Hungary	Slovakia	Poland
GNI	11 571.0	45 354.0	48 580.0	42 450.0	42 220.0	21 940.0	16 500.0	19 210.0	15 350.0
POP1	55.0	81.0	77.0	80.0	83.0	74.0	71.0	54.0	60.0
POP2	58.0	35.0	237.0	122.0	275.0	138.0	107.0	113.0	124.0
POP3	16.0	19.0	6.0	20.0	16.0	16.0	25.0	15.0	8.0
AGR1	11.1	10.3	33.7	33.5	24.9	32.3	47.8	28.0	35.3
AGR2	37.0	35.0	48.0	52.0	72.0	45.0	58.0	39.0	47.0
AGR3	140.6	136.6	197.2	163.1	252.9	196.1	128.3	125.8	172.8
AGR4	28.3	3.3	1.3	2.9	1.1	2.9	5.0	2.9	10.6
AGR5	3351.0	34 171.0	47 249.0	51 257.0	47 672.0	24 996.0	24 078.0	41 082.0	6870.0
ENV1	30.7	29.0	32.7	31.2	13.1	34.6	22.9	40.4	30.9
ENV2	14.7	15.1	37.8	25.8	28.7	22.2	22.6	37.6	39.7
ENV3	11.4	23.2	45.4	45.0	28.9	n/a	n/a	n/a	22.6
ENV4	n/a	n/a	30.8	14.9	5.5	12.5	84.2	4.4	21.4
ENV5	4.7	10.8	8.9	4.6	6.5	9.2	4.2	5.7	7.5
ENE1	1922.0	4677.0	3779.0	3659.0	2777.0	3915.0	2314.0	2943.0	2473.0
ENE2	39.2	28.6	44.3	2.2	22.8	53.1	19.5	12.5	80.9
ENE3	6.8	9.6	26.3	6.2	23.0	9.2	9.8	8.2	12.7
ENE4	8.1	17.1	14.3	77.6	20.9	32.5	52.2	56.9	0.0
ENE5	1.7	1.0	0.1	0.0	0.3	0.3	0.2	0.3	0.8

Source: World Bank [2021a, 2021b].

3.6. Linear regression model

Five linear regression models (ordinary least squares) are proposed based on cross-sectional data. GNI is the dependent variable in all models. Models 1–4 include only regressors from individual categories. Model 5 includes 17 regressors. Table 3.3 provides a correlation matrix for the variables. Of particular interest is the first column showing which variables are positively or negatively associated with GNI per capita. The strongest positive correlation is noted for energy use per capita (ENE1, 0.611), urbanization (POP1, 0.580), and carbon emissions per capita (ENV5, 0.498). On the other hand, agricultural employment (AGR4, −0.615) is the only strong negative correlation. Table 3.4 shows a summary of the models. All of them are statistically significant at a 0.1% level. Model 5 has lower degrees of freedom (*df*) because of more regressors and a smaller sample size. Model 5 also has the highest adjusted R^2 (0.552) and the lowest error.

Table 3.5. includes the coefficient for all the models. Model 1 includes only variables related to urbanization. Urbanization (POP1) and population density (POP2) are statistically significant at a 0.1% level and the population of the largest city (POP3) is statistically significant at a 5% level. POP1 and POP2 have positive coefficients, while POP3 has a negative coefficient. Urbanization (POP1) has the highest impact on GNI with a standardized coefficient of 0.554.

Model 2 considers agriculture variables. Only two variables are statistically significant: fertilizer consumption (AGR3) at a 5% level and agricultural employment (AGR4) at a 0.1% level. The former has a modest positive impact on GNI, and the latter has a strong negative impact with a standardized coefficient of −0.571.

Model 3 comprises the impact of the environment and water resources. As is the case with the previous model, there are two statistically significant variables: marine protected areas (ENV3, 1% level) and carbon emissions per capita (ENV5, 0.1% level). Both have a positive association with GNI, but the standardized coefficient of carbon emissions per capita is the highest (0.509).

Model 4 is related to energy production and the exploitation of natural resources. The only variable not statistically significant is the use of coal (ENE2). Nuclear power (ENE4) and total rents (ENE5) are significant at a 5% level while energy use per capita (ENE1) and renewable energy (ENE3) are significant at a 0.1% level. Energy use per capita has a strong positive impact on GNI with a standardized coefficient of 0.612.

Model 5 includes all the variables but one. The proxies for economic activity per capita (ENV5 and ENE1) cannot be in the same model because there is very high multicollinearity between them as measured by the variance inflation factor (VIF).

Table 3.3. Pearson's *r* correlation matrix

	GNI	POP1	POP2	POP3	AGR1	AGR2	AGR3	AGR4	AGR5	ENV1	ENV2	ENV3	ENV4	ENV5	ENE1	ENE2	ENE3	ENE4	ENE5
GNI	–																		
POP1	0.580	–																	
POP2	0.310	0.210	–																
POP3	0.039	0.076	0.464	–															
AGR1	−0.033	−0.171	−0.012	−0.246	–														
AGR2	−0.230	−0.174	−0.156	−0.136	0.567	–													
AGR3	0.233	0.207	0.743	0.367	−0.126	−0.188	–												
AGR4	−0.615	−0.749	−0.156	0.047	0.071	0.204	−0.146	–											
AGR5	0.179	0.238	0.000	−0.015	−0.018	0.003	0.016	−0.216	–										
ENV1	−0.052	−0.012	−0.127	0.048	−0.249	−0.420	−0.049	0.026	−0.071	–									
ENV2	0.123	0.127	−0.011	−0.002	−0.056	−0.161	−0.067	−0.086	−0.025	0.316	–								
ENV3	0.245	0.268	−0.080	−0.264	0.058	0.017	−0.048	−0.326	0.047	0.134	0.352	–							
ENV4	0.003	0.081	0.375	0.092	−0.164	−0.156	0.199	−0.088	−0.026	−0.252	−0.157	−0.069	–						
ENV5	0.498	0.517	0.037	−0.008	−0.190	−0.274	0.204	−0.537	0.089	−0.108	0.051	0.114	0.306	–					
ENE1	0.611	0.511	0.077	0.052	−0.234	−0.349	0.193	−0.528	0.105	−0.088	0.019	0.051	0.237	0.877	–				
ENE2	−0.008	−0.038	0.056	−0.147	0.137	0.200	−0.054	−0.103	−0.058	−0.013	0.070	0.157	−0.154	0.031	−0.074	–			
ENE3	0.355	0.189	−0.071	−0.126	0.245	0.170	−0.052	−0.248	0.022	−0.022	0.210	0.196	−0.157	−0.063	0.061	−0.023	–		
ENE4	0.275	0.177	−0.052	−0.255	0.291	0.062	−0.050	−0.287	0.063	0.117	0.159	0.470	−0.090	0.049	0.128	0.034	0.063	–	
ENE5	−0.270	−0.190	−0.116	0.160	−0.222	−0.077	−0.052	0.372	−0.102	0.020	−0.114	−0.173	0.056	0.028	0.061	−0.175	−0.334	−0.223	–

Source: Compiled by author.

They are both statistically significant if included in the model, but the model with ENE1 has a slightly higher adjusted R^2 (0.552 compared to 0.524). As such, the final model includes energy use per capita (ENE1) and not carbon emissions per capita (ENV5). Furthermore, because of the data availability requirements for all 17 regressors, the model has the lowest sample size at 82. Model 5 has two statistically significant regressors: energy use per capita (ENE1) at 0.1% level and renewable energy (ENE3) at 1% level. Other regressors lose their significance, which includes both urbanization (POP1) and agricultural employment (AGR4). ENE1's standardized coefficient is 0.486 (a significant drop compared to 0.612 in Model 4) and ENE3's is 0.250 (a slight drop from 0.255).

Table 3.4. Model summary

H	*R*	R^2	Adjusted R^2	RMSE	*N*	ANOVA		
						df (residual)	*F*	*p*
Model 1 – Population and urbanization								
H_0	0	0	0	19 777				
H_1	0.664	0.441	0.429	14 938	146	142	37.378	<.001
Model 2 – Agriculture								
H_0	0	0	0	19 995				
H_1	0.650	0.423	0.402	15 458	149	143	20.926	<.001
Model 3 – Environment and water								
H_0	0	0	0	19 204				
H_1	0.614	0.377	0.345	15 538	106	100	12.080	<.001
Model 4 – Energy and natural resources								
H_0	0	0	0	20 514				
H_1	0.745	0.555	0.537	13 952	134	128	31.905	<.001
Model 5 – Large model								
H_0	0	0	0	20 083				
H_1	0.804	0.646	0.552	13 439	82	64	6.876	<.001

Source: Compiled by author.

We can see that the inclusion of energy and natural resources variables in the largest model dwarfs the importance of other variables. The fact that no model shows the statistical significance of the use of coal is important, considering Poland's energy policy and aspirations. Model 2 reveals a strong negative impact of agricultural employment on GNI per capita, which is worrying because Poland's (10.6%) is very high compared to advanced European economies. Excluding the proxies for economic activity per capita, Model 5 shows that renewable energy is the most significant driver

of development. Crucially, while Poland lags behind high-income countries in many categories, it overtakes them in this one (12.7% compared to 9.6%). The reason for that is most probably the fear of nuclear power that has traditionally been strong in Polish society. Still, the result is that Poland ranks high with regard to one of the most important aspects of development.

Table 3.5. Model coefficients

Model		Unstandardized	Standard error	Standardized	*t*	*p*	95% CI		Collinearity statistics	
							Lower	Upper	Tolerance	VIF
Model 1 – Population and urbanization										
H_0	(Intercept)	14 599.795	1636.729		8.920	<.001	11 364.865	17 834.724		
H_1	(Intercept)	−11 490.870	4440.916		−2.587	0.011	−20 269.723	−2712.018		
	POP1	489.369	57.033	0.554	8.580	<.001	376.626	602.113	0.944	1.059
	POP2	3.262	0.797	0.298	4.094	<.001	1.687	4.837	0.745	1.342
	POP3	−150.470	75.784	−0.141	−1.986	0.049	−300.281	−0.660	0.783	1.277
Model 2 – Agriculture										
H_0	(Intercept)	15 894.295	1638.060		9.703	<.001	12 657.288	19 131.302		
H_1	(Intercept)	29 762.938	2916.350		10.206	<.001	23 998.211	35 527.665		
	AGR1	90.900	109.977	0.065	0.827	0.410	−126.490	308.290	0.654	1.529
	AGR2	−96.405	75.398	−0.104	−1.279	0.203	−245.442	52.633	0.613	1.632
	AGR3	1.251	0.514	0.159	2.435	0.016	0.235	2.266	0.950	1.053
	AGR4	−528.712	62.483	−0.571	−8.462	<.001	−652.221	−405.202	0.886	1.129
	AGR5	0.009	0.012	0.046	0.706	0.481	−0.016	0.033	0.949	1.054
Model 3 – Environment and water										
H_0	(Intercept)	17 541.698	18 65.257		9.404	<.001	13 843.237	21 240.159		
H_1	(Intercept)	5501.286	3545.145		1.552	0.124	−1532.181	12 534.753		
	ENV1	−54.727	71.714	−0.066	−0.763	0.447	−197.006	87.553	0.827	1.209
	ENV2	186.689	170.934	0.103	1.092	0.277	−152.440	525.817	0.696	1.437
	ENV3	339.359	118.940	0.259	2.853	0.005	103.385	575.332	0.757	1.321
	ENV4	−3.774	2.215	−0.147	−1.704	0.091	−8.168	0.620	0.841	1.189
	ENV5	1455.636	242.02	0.509	6.015	<.001	975.475	1935.797	0.871	1.149
Model 4 – Energy and natural resources										
H_0	(Intercept)	17 168.284	1772.111		9.688	<.001	13 663.116	20 673.451		
H_1	(Intercept)	4024.699	2437.102		1.651	0.101	−797.523	8846.921		
	ENE1	4.179	0.411	0.612	10.165	<.001	3.366	4.993	0.959	1.043

Model		Unstandardized	Standard error	Standardized	*t*	*p*	95% CI		Collinearity statistics	
							Lower	Upper	Tolerance	VIF
	ENE2	8.140	48.427	0.010	0.168	0.867	−87.680	103.961	0.959	1.043
	ENE3	470.768	116.462	0.255	4.042	<.001	240.328	701.209	0.874	1.144
	ENE4	222.366	94.201	0.145	2.361	0.020	35.973	408.759	0.928	1.078
	ENE5	−463.63	187.789	−0.162	−2.469	0.015	−835.203	−92.056	0.804	1.244
Model 5 – Large model										
H_0	(Intercept)	18 923.78	2217.754		8.533	<.001	14 511.146	23 336.415		
H_1	(Intercept)	1433.358	14 804.378		0.097	0.923	−28 141.787	31 008.502		
	POP1	222.585	150.419	0.206	1.480	0.144	−77.912	523.082	0.286	3.491
	POP2	−1.306	8.242	−0.018	−0.158	0.875	−17.771	15.160	0.430	2.324
	POP3	−99.453	142.256	−0.067	−0.699	0.487	−383.641	184.736	0.604	1.655
	AGR1	11.714	165.737	0.008	0.071	0.944	−319.384	342.812	0.403	2.482
	AGR2	−131.149	108.252	−0.137	−1.212	0.230	−347.406	85.108	0.430	2.327
	AGR3	−0.177	2.589	−0.007	−0.068	0.946	−5.349	4.996	0.529	1.890
	AGR4	−79.654	206.586	−0.062	−0.386	0.701	−492.356	333.049	0.215	4.661
	AGR5	0.004	0.011	0.025	0.308	0.759	−0.019	0.026	0.852	1.174
	ENV1	−37.456	104.958	−0.040	−0.357	0.722	−247.133	172.221	0.450	2.221
	ENV2	−70.370	192.518	−0.035	−0.366	0.716	−454.969	314.229	0.615	1.626
	ENV3	216.198	156.679	0.135	1.380	0.172	−96.805	529.201	0.580	1.725
	ENV4	−2.316	2.742	−0.094	−0.845	0.402	−7.793	3.162	0.443	2.259
	ENE1	3.255	0.907	0.486	3.588	<.001	1.443	5.068	0.301	3.323
	ENE2	48.160	78.787	0.056	0.611	0.543	−109.234	205.555	0.650	1.538
	ENE3	399.205	144.634	0.250	2.760	0.008	110.265	688.146	0.671	1.490
	ENE4	79.518	148.318	0.052	0.536	0.594	−216.781	375.817	0.583	1.716
	ENE5	−554.424	395.243	−0.151	−1.403	0.166	−1344.013	235.165	0.475	2.104

Source: Compiled by author.

3.7. Conclusions

The exploitation of land and water resources is related to many important issues facing modern economies, including urbanization, agriculture, and energy production. Together with labour and capital, they form the three factors of production central to the classical theory of economic growth.

Based on the literature review, the empirical analysis examines economic development (dependent variable) and 18 regressors related to land and water resources grouped into four categories: "population and urbanization", "agriculture", "environment and water", and "energy and natural resources". The comparative analysis focuses mostly on the three largest European economies, four Visegrad Group countries, the world average, and high-income countries average.

Poland still assigns a high priority to the exploitation of coal. Moderate efforts to push out fossil fuels focus on renewable energy instead of nuclear power, as Poland is the only country in the comparison with no nuclear energy produced. Other variables where Poland ranks relatively low are GNI per capita, urbanization, and agricultural productivity. The last one is especially important considering the high level of employment in the sector. Despite its widespread use of coal, Poland has lower carbon emissions than the average for high-income countries. The population of Warsaw constitutes a small percentage of the total urban population compared to other countries (excluding Germany), which is somewhat surprising given the city's role in the national economy. The forest cover in Poland is above the world average. Poland's position concerning aquaculture production is relatively strong, while its fishing fleet is about average.

Pearson's *r* correlation matrix reveals that energy use per capita, urbanization, and carbon emissions per capita have a strong positive correlation with GNI per capita. On the other hand, agricultural employment has a strong negative correlation. Models 1–4 show a statistically significant positive impact of urbanization, population density, fertilizer consumption, marine protected areas, carbon emissions per capita, nuclear power, energy use per capita, and renewable energy. Models 1–4 also show a statistically significant negative impact of agricultural employment, urban population of the largest city, and total rents from natural resources. Model 5 has the most regressors and the highest adjusted R^2. Only two regressors used in this model show statistical significance: energy use per capita and renewable energy. They both have positive coefficients. Considering Poland's energy policy, it is important to note that no model shows the statistical significance of the use of coal.

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Chapter 4

Foreign Direct Investment in and from Poland in the COVID-19 Era

Tomasz Marcin Napiórkowski

4.1. Introduction

When the world started to learn what COVID-19 was at the beginning of 2020, financial markets were speculating about the impact this new phenomenon might have on the world's key economies (e.g., the United States and China) and on the global economy overall. From the investment perspective, COVID-19 became another risk factor [Ho, Gan, 2021]. While Foreign Direct Investment (FDI) differs from portfolio investment in many respects, such as the speed of response to changes in the economic and social environment,[1] the economic uncertainty of potential host countries and markets is not conducive to undertaking new or increasing existing FDI. The above observations are consistent with the UNCTAD [2020] report whose predictions about a "dramatic fall in FDI" in 2020–2021 were confirmed in its next edition [UNCTAD, 2021]. In Central European countries (including Poland), such changes in FDI may have an adverse impact on their economic development [Napiórkowski, 2017; Ciobanu, Şova, Popa, 2020].

The purpose of this chapter is to identify changes in long-term trends of FDI to and from Poland, visible in the COVID-19 pandemic era. Keeping in mind data availability,[2] the conclusions developed in this study should be treated as short-term ones. To achieve the said objective, a descriptive method using secondary data on Poland's inward and outward FDI positions in 2010–2020 will be used.

In the first part of the study, trends concerning FDI in the COVID-19 era in the literature will be identified, whereas the second part will consist of secondary data analysis.

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1 Especially for FDI stock – the variance of FDI flows is much greater.

2 Data from the National Bank of Poland for 2020 was published in October 2021. In the absence of data for other economies (e.g., in databases such as UNCTAD), a comparative analysis between countries was impossible.

4.2. Foreign direct investment trends in the COVID-19 pandemic era

According to the authors of the World Bank report on the impact of the COVID-19 pandemic on enterprises, the key problems firms have to face are constraints in employment and the investment level. It is also important to note such effects of COVID-19 as decrease in demand, disruption of the stability of value chains, and a general decline in revenue and profits [Saurav, Kusek, Kuo, Viney, 2020]. All this translates into reluctance of foreign investors to undertake or expand current FDI.

The authors of the UNCTAD [2020] report noted that reinvestment is expected to slow down in the short term. Such investor behaviour is attributable to a decline in profits on FDI. In the context of investment policy, the authors expect restrictions (especially in health-related sectors) and reduction in quick sales of domestic companies. In the medium term, phenomena such as managing capital between recessions are already visible. Changes in the consumer market will be key in this respect, as will be the ability of local firms to survive the expected local and global economic slowdown. The factors affecting the survivability of businesses will be their financial problems (arising, e.g., from default on payments by their contractors) and lack of access to credit, which will make it even more difficult for them to maintain liquidity. In the long term, which the global economy has not yet fully experienced, it will mainly see transnational corporations building more resilient global value chains. This is to involve mainly "critical resources" (e.g., energy sources, medicines). Such measures may result in more emphasis being placed on increasing the self-sufficiency of those chains at the national and regional level.

At the global level, FDI slowed down by 35% in 2020. As was the case with previous economic crises, and in the wake of the COVID-19 pandemic, the steepest decline in FDI activity (by 58%) was recorded in developing countries [UNCTAD, 2021]. Such behaviour of investors (who prefer safe havens in times of crises) is related, e.g., to a lower level of economic and political stability of developing economies [Nguyen, Lee, 2021].

Observations of declining FDI activity are consistent with those made by Fang, Collins and Yao [2021]. Having analysed FDI in the BRICS group and Singapore, the authors concluded that such indicators as new confirmed infections, new deaths, and cumulative infections have a statistically negative impact on FDI. In addition, Fang et al. [2021] expect that, as a result of China's incessant economic expansion (contrary, e.g., to the United States economy), the country will remain an attractive market for FDI allocation.

The increase in the number of deaths as a determinant of FDI activities was also noted by Fu, Alleyne and Mu [2021]. Interestingly, the authors concluded that the impact of COVID-19 on existing FDI will be very small and the deaths will translate into delays in closing FDI transactions. Expanding on previous observations, the results of research by Fu et al. [2021] additionally pointed to the service sector as the one most affected by the COVID-19 pandemic.

A negative correlation between the number of deaths and the sum of all COVID-19 cases was also confirmed by Nawo and Njagang [2021]. However, the authors show that in the case of countries with state-owned equity funds the negative impact of COVID-19 on FDI was not statistically significant.

The aforementioned fact that transnational corporations will be forced by the pandemic to reorganize their activities within value chains and thus to change their FDI behaviour was also noted by Hitt, Holmes and Arregle [2021]. The authors point to changes in areas such as competitive advantages at the local level and at the firm level, higher concentration of value chains, and focusing on regional and local strategies. Regarding FDI, the authors expect a decline in efficiency-seeking FDI, which should enable firms to increase and focus on domestic business. Greater emphasis is expected on market-seeking FDI and resource-seeking FDI.

As the impact of COVID-19 on FDI is not homogenous between economies, recovery from the present crisis is bound to be a heterogenous process as well. This may result, e.g., from a lack of homogeneity or substantial similarity of FDI policies [Saurav et al., 2020]. For instance, while the overall prospects for FDI in developing economies are negative [Saurav et al., 2020], for China negative effects of the pandemic are forecasted as short-term and limited [Duan, Zhu, Lai, 2020].

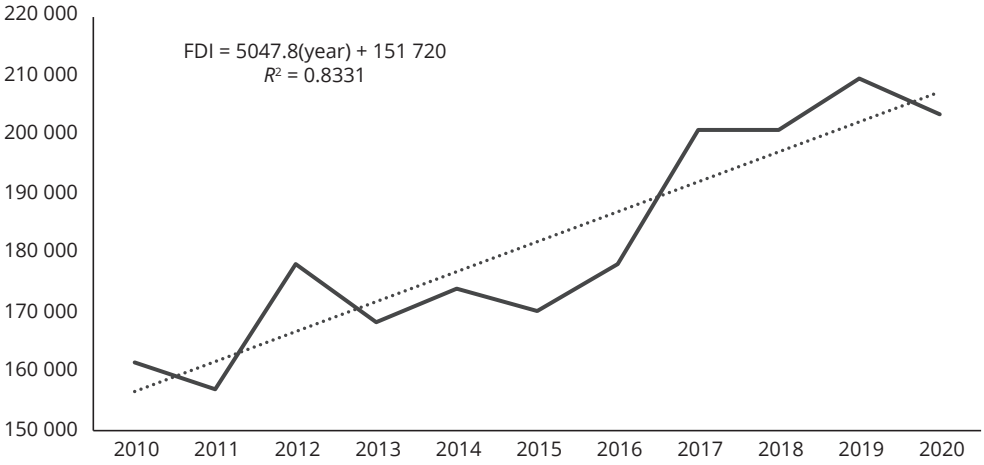
4.3. Foreign direct investment in Poland in the pandemic era – data analysis

Between 2010 and 2020, Poland's Foreign Direct Investment[3] inward position increased from EUR 161 377.7 m to EUR 203 308.5 m (i.e., by 26.03%; Figure 4.1). The analysed investments grew by an average of EUR 5047.8 m annually. Regarding the fact that Poland was classified as a developing economy during a large part of the examined period, FDI fluctuations in Poland correspond to fluctuations of the global

[3] "Foreign Direct Investment (FDI) stocks measure the total level of direct investment at a given point in time, usually the end of a quarter or of a year. The outward FDI stock is the value of the resident investors' equity in and net loans to enterprises in foreign economies. The inward FDI stock is the value of foreign investors' equity in and net loans to enterprises resident in the reporting economy" [OECD, 2021].

and, even more so, European economy. The latest drop (by 3%) is undoubtedly an outcome of uncertainty in global markets caused by the COVID-19 pandemic.

Figure 4.1. Poland's Foreign Direct Investment inward position at year end (EUR m)



Source: Compiled by author based on NBP [2021a].

European countries are the key source of Foreign Direct Investment in Poland (Table 4.1). In 2010–2020, investors from the Old Continent accounted for an average of 94.76% of FDI positions in Poland. Investments from America rank second (average of 3.52%) and those from Asia third (average of 1.67%). While in the period under study the role of Europe and Asia as FDI sources in Poland increased (from 91.83% in 2010 to 95.50% in 2020 and from 1.91% in 2010 to 2.65% in 2020, respectively), the role of American countries decreased (to 1.82% from 6.04%).

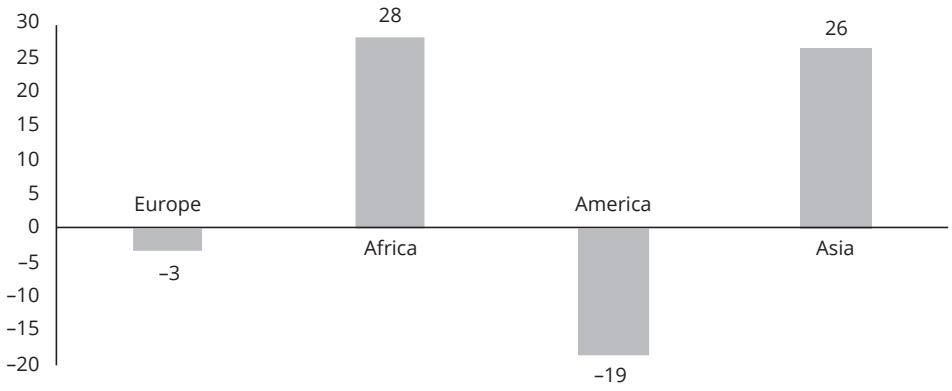
Table 4.1. The share of world regions in Poland's Foreign Direct Investment inward position at year end (% of total)

Region	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Europe	91.8	93.3	93.5	94.1	94.7	95.6	95.7	96.0	96.3	95.8	95.5
Africa	0.1	0.2	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
America	6.0	5.0	4.7	4.4	3.8	2.8	3.0	2.7	2.2	2.2	1.8
Asia	1.9	1.7	1.5	1.4	1.4	1.5	1.4	1.3	1.5	2.0	2.6
Oceania and Polar Regions	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1

Source: Compiled by author based on NBP [2021a].

In 2020, the steepest decline in FDI positions was reported by investors from America (19%; Figure 4.2). This is related mainly to a decrease in FDI stock from the United States (from EUR 4210.0 to EUR 3453.3 m) and Canada (from EUR 216.8 m to EUR 119.6 m). By comparison, FDI stock in Poland from Europe decreased by only 3%. At the same time, FDI stock from Asia increased by as much as 26%. Interestingly, in 2020 FDI stock in Poland from Asia were 82% higher than in 2018. There is one anomaly; namely, stocks from Oceania and Polar Regions, which were 9425% higher in 2020 than in the previous year. Such a huge change is a result of a very low base value (EUR 1.2 m in 2019).

Figure 4.2. Change in Poland's inward Foreign Direct Investment from selected geographical areas in 2019–2020 (%)



Note: Oceania and Polar Regions were excluded as outliers (with an increase of 9425%).

Source: Compiled by author based on NBP [2021a].

Table 4.2. Change in Foreign Direct Investment stock in Poland by type of economic activity of direct investment enterprises in 2019–2020 (%)

Type of economic activity of direct investment enterprises	Change 19–20
Other service activities	51.88
Administrative and support service activities	31.14
Information and communication	18.68
Professional, scientific and technical activities	11.03
Water supply; sewerage, waste management and remediation activities	11.01
Electricity, gas, steam and air conditioning supply	8.65
Real estate activities	7.99
Transportation and storage	7.77
Accommodation and food service activities	−0.09
Human health and social work activities	−0.67

cont. Table 4.2

Type of economic activity of direct investment enterprises	Change 19–20
Wholesale and retail trade; repair of motor vehicles and motorcycles	−1.76
Manufacturing	−2.06
Total services	−2.82
Construction	−7.88
Agriculture, forestry and fishing	−11.23
Mining and quarrying	−11.70
Financial and insurance activities	−26.40
Education	−32.67
Arts, entertainment and recreation	−33.45

Source: Compiled by author based on NBP [2021a].

In terms of types of economic activity of direct investment enterprises, in 2020 the largest decrease in inward FDI position in Poland was observed in arts, entertainment and recreation (33%) and financial and insurance activities (26%; Table 4.2). Situated at the other end (excluding other service activities) are administrative and support service activities (up 31%) and information and communication (up 19%). Manufacturing, which is the largest FDI area in Poland (after total services) reported a decline by only 2.06%, while total services saw a 2.82% drop.

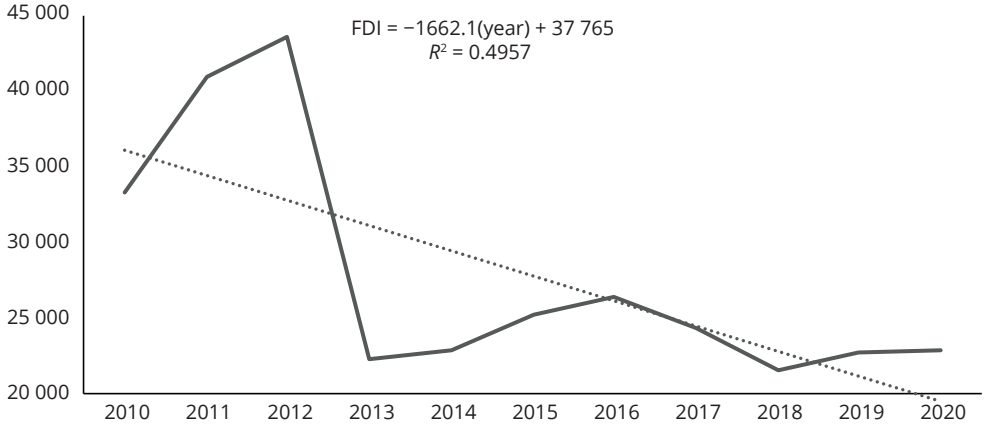
4.4. Polish Foreign Direct Investment in the world in the pandemic era – data analysis

Polish Foreign Direct Investment declined significantly between 2010 and 2020 (Figure 4.3). Poland's Foreign Direct Investment outward position decreased from EUR 33 264 m to EUR 22 914 m over that period (i.e., by 31%). The steepest decline (49%) was recorded after 2012. The position of Polish FDI in the world decreased by an average of EUR 1662.1 m annually. Such changes are surprising, especially given the classification of Poland as a developed economy in the last years of the period under analysis. What appears as good news, which testifies to the growing activity of Polish investors is a 1% increase in Poland's FDI outward position between 2019 and 2020 and a 6% increase between 2018 and 2020. However, this increase is too small to make up for earlier losses and return to the level seen in 2016.

As is the case with FDI sources, European countries are leaders in hosting Polish Foreign Direct Investment (Table 4.3). An average of EUR 89.27 out of each EUR 100 invested by Polish investors was located in the Old Continent. It should be noted, however, that while in 2010 as much as 91.89% of FDI from Poland was intended for

the European market, in 2020 it was 83.71% (a 7 p.p. drop from 2019). At the same time, American and Asian markets started playing an increasing role. The share of those geographical areas in Poland's Foreign Direct Investment outward position increased from 4.86% to 10.67% and from 2.73% to 4.82%, respectively.

Figure 4.3. Polish Foreign Direct Investment outward position at year end (EUR m)



Source: Compiled by author based on NBP [2021b].

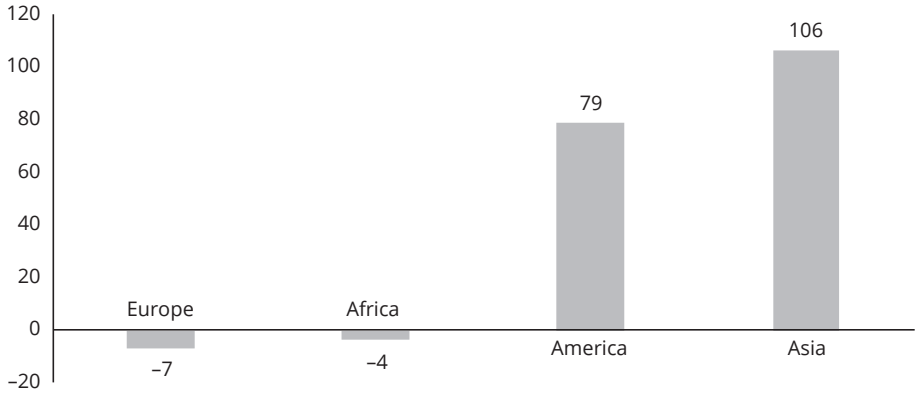
Table 4.3. Polish Foreign Direct Investment outward position by region (%)

Region	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Europe	91.9	92.9	93.3	93.5	92.0	89.1	82.5	83.6	88.7	90.8	83.7
Africa	0.4	0.4	0.4	0.7	0.7	0.8	1.0	1.1	0.9	0.8	0.8
America	4.9	4.5	4.0	2.4	3.6	6.7	12.7	11.8	5.6	6.0	10.7
Asia	2.7	2.2	2.2	3.2	3.6	3.4	3.8	3.6	4.9	2.4	4.8
Oceania and Polar Regions	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source: Compiled by author based on NBP [2021b].

Relative to the previous year, the largest decrease in Poland's outward FDI position in 2020 was reported for Europe (7%), and the largest increase for Asia (106%; Figure 4.4). The above ranking excludes Oceania and Polar Regions due to a very high data variance. For that geographical area, the change over the period 2018–2020 was −2400%, and for 2019–2020 it was 667%. As well as with investment in Poland, also in this case large changes are attributable to a very low base (EUR 0.2 m in 2018, EUR 0.6 m in 2019, and EUR 4.6 m in 2020).

Figure 4.4. Change in Poland's Foreign Direct Investment outward position in selected geographical areas in 2019–2020 (%)



Note: Oceania and Polar Regions were excluded as outliers (with an increase of 667%).

Source: Compiled by author based on NBP [2021b].

Table 4.4. Change in Polish outward Foreign Direct Investment stock by type of economic activity of direct investment enterprises in 2019–2020 (%)

Type of economic activity of direct investment enterprises	Change 19–20
Mining and quarrying	47.18
Other service activities	32.29
Financial and insurance activities	18.53
Information and communication	16.97
Agriculture, forestry and fishing	10.61
Manufacturing	8.62
Water supply; sewerage, waste management and remediation activities	8.56
Wholesale and retail trade; repair of motor vehicles and motorcycles	2.97
Education	0.00
Total services	−2.79
Real estate activities	−3.47
Arts, entertainment and recreation	−11.17
Transportation and storage	−12.10
Professional, scientific and technical activities	−18.61
Accommodation and food service activities	−19.29
Human health and social work activities	−80.51
Construction	−101.57
Administrative and support service activities	−168.61
Electricity, gas, steam and air conditioning supply	−211.13

Source: Compiled by author based on NBP [2021b].

In terms of the types of economic activity of direct investment enterprises, Polish FDI decreased most in electricity, gas, steam and air conditioning supply (211.13%), in administrative and support service activities (168.61%), and in construction (101.57%; Table 4.4). The position of the analysed investments increased the most over the same period in mining and quarrying (47.18%) and (excluding other service activities with an increase of 32.29%) in financial and insurance activities (18.53%). The increase, especially in the latter area, should be viewed as good news, as it is the second largest type of activity (after total services) in terms of Poland's Foreign Direct Investment outward position.

4.5. Conclusions

The purpose of this chapter was to identify long-term trend changes in inward FDI in Poland and Polish direct investment abroad, visible in the COVID-19 pandemic era.

The first step in the analysis was to diagnose the global trends in FDI changes triggered by the COVID-19 pandemic. The results for all items included in the literature review are consistent: the COVID-19 pandemic has adversely affected FDI across the world, in particular in developing countries.

The second step of the study was to analyse secondary data. Regarding the presence of foreign investors in Poland, represented by Poland's Foreign Direct Investment inward position, the data analysed in this chapter merits the conclusion that the COVID-19 pandemic has had no significant impact on Poland's FDI position. The recorded 3% decrease is distinctly smaller than that witnessed in 2013 (5%). This conclusion is backed by an analysis of FDI dynamics by type of economic activity of direct investment enterprises. Contrary to the presence of foreign investors in Poland, Polish presence in the world suffered a significant decline between 2010 and 2020. Poland's Foreign Direct Investment outward position decreased by as much as 31% over that period. During the COVID-19 pandemic, Polish FDI has continued its growth observed since 2018. One positive development is that the steepest declines in Poland's FDI position abroad in terms of types of activity are concentrated in areas representing a low investment position. The above conclusion regarding Polish investment is consistent with the observations by Jaworek, Karaszewski and Kuczmarska [2020], who pointed out that in analysing FDI-related risks Polish investors disregard such aspects as natural disasters, epidemics, and pandemics.

The descriptive method of data analysis applied should be seen as a constraint to this study. At the same time, it must be kept in mind that the statistical data available at the time this chapter was written did not allow advanced quantitative research methods

(e.g., econometric modelling) to be used, which would make it possible to estimate the value of impact of the COVID-19 pandemic on FDI in Poland.

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Chapter 5

Labour and Skills Availability in the Times of the COVID-19 Pandemic

Anna Maria Dzienis

5.1. Introduction

Over the past decade the situation in the Polish labour market considerably improved. The registered unemployment rate fell from 13% in 2012 to 5% in 2019 and the employment index increased from 60% in 2012 to 68% in 2019 [Statistics Poland, 2021a]. However, in 2020, due to the spread of the novel coronavirus, the World Health Organization (WHO) declared the COVID-19 pandemic. This made governments all over the world undertake a range of anti-crisis measures. Policy shaped the impact of the health crisis on economies, affecting to a large extent the functioning of labour markets. Hours worked dropped, many young people and temporary workers lost their jobs, coronavirus forced restrictions "reaffirmed the persistence of gender bias in social and cultural norms" [Thornton, 2020].

The aim of this chapter is to identify potential weaknesses of the Polish labour market revealed and stressed by the COVID-19 pandemic. For this purpose, the analysis of the key and newly developed by Eurostat labour market indicators is performed.

The approach taken by the author is a societal resilience perspective. Based on the conceptual model of the system outlined by Giovannini, Benczur, Campolongo, Cariboni and Manca [2020] (as explained below), the focus is on resilience of assets – human capital in the context of labour market.

5.2. Theoretical lenses

The COVID-19 pandemic has affected societies deeply. The pandemic has influenced "our health systems, social connections, travel, tourism, production, international trade, value chains, or trust in institutions" [Giovannini et al., 2020, p. 5].

Under the crisis circumstances, the concept of societal resilience gains an increasing attention. Walker, Holling, Carpenter and Kinzig [2004] define resilience as "the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks". Folke [2006, p. 16] wrote that resilient systems "survive, adapt, and grow regardless of uncertainty and un-foreseen disruptions". Societies need to deal with disruptions and persistent structural changes while caring for societal well-being and for what they are going to leave to future generations [Giovannini et al., 2020, pp. 5–6]. As society is a part of a complex, interconnected **ecological-socio-economic-political system** [Manca, Benczur, Giovannini, 2017, p. 9], the shock should be tackled with a multidisciplinary system approach and coordinated actions [Giovannini et al., 2020, p. 3].

In describing theory behind resilience, Pisano [2012, pp. 12–13] recalls Folke (2010) "Resilience Thinking: Integrating Resilience, Adaptability and Transformability", and clarifies the following three aspects: 1) **resilience** is "the capacity of a SES (socio-ecological system) to continually change and adapt yet remain within critical thresholds"; 2) **adaptability**, a component of resilience, is "the capacity to adjust responses to changing external drivers and internal processes, and thereby allow for development along the current trajectory (stability domain)"; 3) **transformability** is "the capacity to cross thresholds into new development trajectories".

Giovannini et al. [2020, p. 6] state that a shocked system needs strengthening resilience by stimulating various "resilience capacities". The authors explain that in a short term "absorptive capacity" is potentially the best way to react to a shock. With an increase in exposure to a shock and its intensity, "adaptive capacity" would strengthen capabilities to cope with small changes. Finally, transformation comes when adaptation would involve too large a change when bouncing back. In their opinion, the crisis should become an opportunity to progress and "bounce forward" through a combination of adaptation and transformation measures. They mention that resilience capacities derive from people and their own capacities, and underline that individual resilience requires support from institutions [Giovannini et al., pp. 6–7].

Resilience highly depends on the context where the shock hits, hence it needs to be examined within the whole system [Manca et al., 2017, p. 9]. Giovannini et al. [2020, p. 5] outline the system as three distinct but interconnected segments, i.e. **resilience of assets**, **resilience of the engine**, **resilience of outcomes**, which can be affected by a shock. Assets mean "human, social, natural and built capital", outcomes are "determinants of societal and individual well-being, (…) consumption and investment in a general sense, (…) diverse systemic fallouts"; the engine "transforms assets into outcomes through societal institutions and processes".

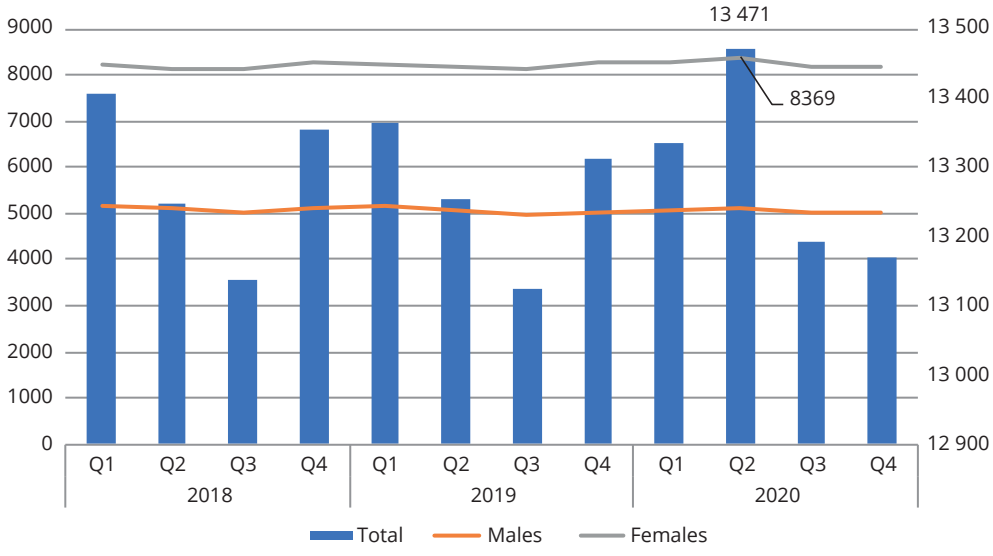
5.3. Context of labour market performance in Poland

In this section, the analysis of key labour market indicators is performed to identify characteristics of the Polish labour market resources. The focus is on any shifts in the functioning of the market in the wake of the pandemic so far.

Economic activity

According to the Labour Force Survey (LFS) conducted by Statistics Poland, the economic activity rate among those aged 15+ in Poland was 56% in 2020, having increased from 55.9% in 2019 [Statistics Poland, 2021b]. There are, however, some regional disparities in the index. In 2020, the voivodeships with an activity rate above Poland's average included Mazowieckie, Pomorskie, Wielkopolskie, Łódzkie, and Dolnośląskie. The lowest rates were recorded in Śląskie, Warmińsko-Mazurskie, and Zachodniopomorskie.

Figure 5.1. Economically inactive persons by sex (for total – right scale; thousands)



Source: Compiled by author based on Statistics Poland [2021b].

In Q2 2020, the highest participation rate was observed for the age group between 35 and 44 years, with an overall rate of 87%. In this group, men had an activity rate of 93.9% and for women it was 80.1% (rising from Q1 2020 by 0.3 p.p. for men and

decreasing by 1 p.p. for females). At the same time, the highest decreases in activity rate could be seen for the group aged 15–24, especially for women (5 p.p.). In the age group of 55–64 years, the index for males improved over 2020 (from 63.4% in Q1 2020 to 67.5% in Q4 2020).

During the same period of time, the number of inactive persons grew, mostly due to a higher number of economically inactive females (Figure 5.1). According to Statistics Poland, in Q2 2020 retirees, and schoolchildren and students accounted for 56% and 16% of this group, respectively, while the rest consisted of economically inactive people at working age. Approx. 7% of economically inactive persons indicated COVID-19 pandemic related causes as the reason for not seeking work [Statistics Poland, 2020, p. 6].

Employment

The number of employed persons in the national economy (end of period) decreased in Q2 2020 by 69.1 thousand people compared to the same period of the previous year, the first (year-on-year) decrease since Q2 2013. The contraction of employment (compared to the same period of the previous year) continued until Q1 2021 [Statistics Poland, 2021d].

Even though the number of employed people increased in Q2 2021 compared to Q2 2020, employment in several industries continued to shrink. The highest decreases could be seen for people employed in financial and insurance activities – 4.2%, and for those employed in mining and quarrying, and in real estate activities, at 3.5% each. The first two industries shrunk in Q2 2020 by 3.2% and 2.1%, respectively. On the other hand, employment in information and communication increased by 5% (compared to an increase of 4.2% y/y in Q2 2020). Transportation and storage continued to grow, by 2.9% in Q2 2020, and 1.4% in Q2 2021 [Statistics Poland, 2021d].

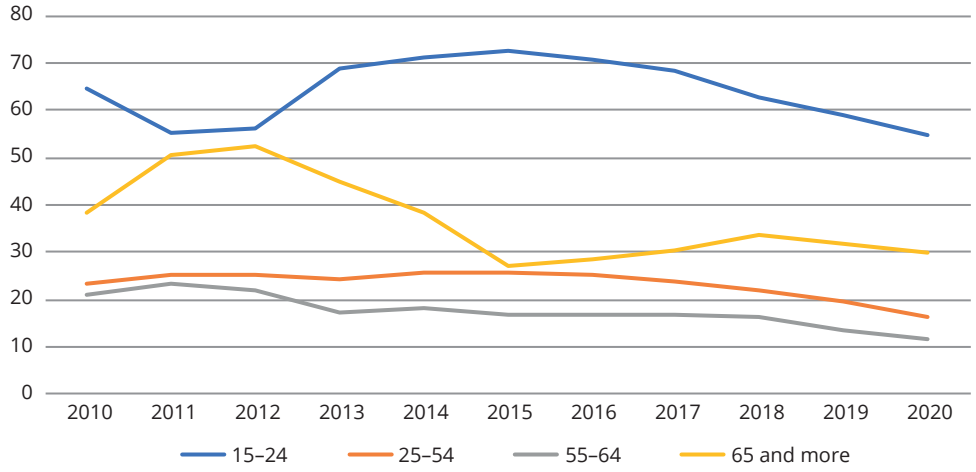
As far as shifts in employment by educational attainment level during the crisis (Q2 2020 compared to Q2 2019, quarterly data) are concerned, the following facts could be observed:

- less than primary, primary and lower secondary education dropped by 1.5 p.p. (–0.5 p.p. for males; –1.5 p.p. for females);
- upper secondary and post-secondary non-tertiary education decreased by 0.4 p.p. (it was up by 0.5 p.p. for males and down by 1.8 p.p. for females);
- tertiary education shrunk by 0.3 p.p. (–0.4 p.p. for males, –0.1 p.p. for females) [Eurostat, 2021a].

In 2020, temporary employment dropped by 3.2 p.p. compared to 2019. The highest drop of 4.4 p.p. was for the population aged 15–24, and the lowest of 1.6 p.p. for aged people 65 plus (Figure 5.2). Despite the fact that the share of temporary employment

in Poland decreased by almost 10 p.p. between 2014 and 2020, it is still higher than the EU-27 average, 19% vs. 14% in 2020 [OECD, 2021b].

Figure 5.2. Temporary employment indicator broken down by age group in 2010–2020 (as % of dependent employees)



Source: Compiled by author based on OECD [2021b].

Working time

According to Statistics Poland, among the 1,962 thousand people who were in employment in Q2 2020 but did not perform work during the analysed week, 1,221 thousand (62.2%) indicated that this was directly related to the pandemic. This constituted an over threefold increase in the number of people employed but not performing work for this reason compared to the previous quarter [Statistics Poland, 2020, pp. 2–3].

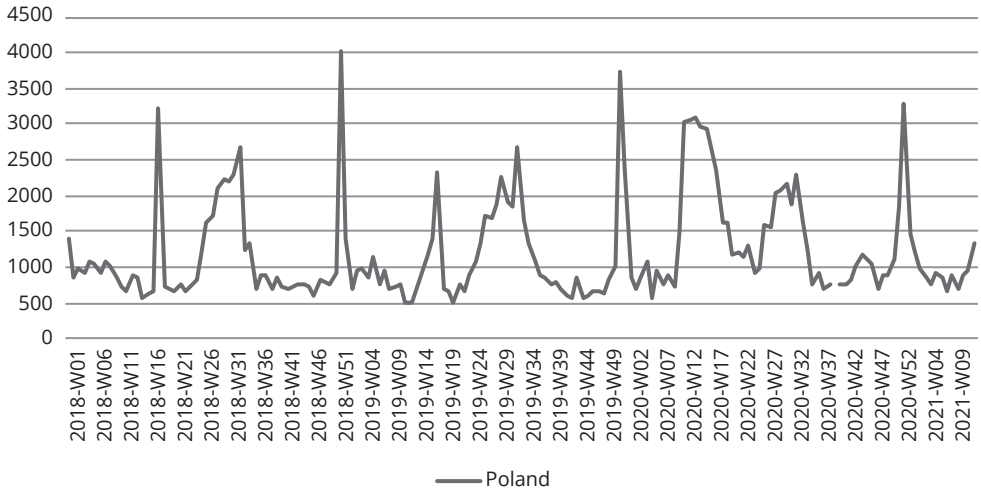
The indicator newly developed by Eurostat – weekly absences from work – shows that weekly absences from work in Poland increased sharply between the 11th and 14th weeks of 2020, against the trend from previous weeks [Eurostat, 2021 g; Figure 5.3].

In Q2 2020, the number of people who performed their work from home amounted to 2,124 thousand (13.1% of all employed people), which means that the number doubled compared to Q1 2020 (an increase of 1,077 thousand people) [Statistics Poland, 2020, p. 3].

ILO publishes new data on working hours lost due to the COVID-19 crisis. The indicator represents the percentage of hours lost compared to the latest pre-crisis quarter, i.e. Q4 2019, and is seasonally adjusted. According to this dataset, in 2020

Poland lost 3.5% of working hours due to the COVID-19 crisis, while the Czech Republic lost 4.3%, Hungary 5.2%, Germany 6.3%, whereas the EU-27 average loss of working hours due to the pandemic in 2020 was 8.3% [ILO, 2021b].

Figure 5.3. Weekly absences from work by sex and age (weekly data; thousands)



Source: Compiled by author based on Eurostat [2021g].

Unemployment

According to the LFS, the total unemployment rate went up from 2.9% (with total registered unemployment rate at 5.2%) in 2019, to 3.1% in 2020 (6.2%). In Q2 2020, the unemployment rate (measured by the LFS) reached 3.1% (6.1% in terms of registered unemployment data from Statistics Poland), down by 0.1 p.p. compared to Q2 2019 [Statistics Poland, 2021d]. In Q2 2020, the unemployment rate for females was slightly lower than for males (3.1% and 3.2%, respectively), unlike the previous quarters [Statistics Poland, 2020, p. 4]. The unemployment rate increased to 4% in Q1 2021 (3.1% Q1 2020) and reached 3.5% in Q2 2021, with no difference in rates between sexes [Statistics Poland, 2021d]. According to the monthly data from Statistics Poland LDB, from the beginning of 2020 until August 2021 no significant changes in the inflow into unemployment rate was observed.

In Q2 2020, 83 thousand people out of the group of unemployed lost their job as a consequence of the COVID-19 pandemic. Within this group, 35 thousand people lost job because of permanent closure of their workplace, and 18 thousand because of the abolishment of their position. A total of 18 thousand people terminated their work due

to its temporary character, while 12 thousand people indicated other reasons related to the pandemic [Statistics Poland, 2020, pp. 4–5].

In the regional dimension, increase in registered unemployment was the highest in 2020 in Zachodniopomorskie (1.5 p.p.) and Pomorskie (1.4 p.p.). The highest unemployment rate was recorded in Warmińsko-Mazurskie (10.1%), Podkarpackie (9.1%), and Kujawsko-Pomorskie (8.9%) [Statistics Poland, 2021a].

The composition of unemployment also varied with education. In 2020, the highest level of the index among the population with tertiary education was in Mazowieckie, while the most considerable increase in the unemployment rate among the population with tertiary education was recorded in Dolnośląskie (0.9 p.p.). For all voivodeships, the unemployment rate among people with general secondary education grew. On the other hand, the indicator among population with basic vocational/sectoral vocational decreased for all voivodeships in 2020 [Statistics Poland, 2021b].

Finally, youth unemployment between May and June 2021 was 13.5%, much below the previous peak of 28.1% in the period between 2008 and 2019 (against of the OECD average of 17.9%) and lower than the peak during the COVID-19 pandemic (15.3% vs. the OECD average of 9%). Nevertheless, youth unemployment increased from the pandemic outbreak in February 2020 by 4 p.p. [OECD, 2021a].

Labour market transition

As for the Eurostat's data on labour market flows, out of all unemployed persons in Poland in 2019, almost 32% (40% in the EU) remained unemployed, 36% (30% in the EU) moved to employment and 32% (30% in the EU) moved to the status of inactivity, in 2020 (Table 5.1).

Table 5.1. Transition in labour market status in Poland (as % of initial status), annual; EU-27 average in brackets (%)

	Employment in 2020	Unemployment in 2020	Inactivity in 2020
Employment in 2019	95.7 (92.3)	1.1 (2.5)	3.2 (5.2)
Unemployment in 2019	36.1 (30.0)	31.9 (39.8)	32.1 (30.1)
Inactivity in 2019	4.6 (7.0)	1.6 (3.4)	93.8 (89.6)

Source: Compiled by author based on Eurostat [2021d].

The probability of staying in inactivity (inactivity to inactivity transition) for Poland is one of the highest in the EU. Similar levels could be observed for the Czech Republic, Slovakia, and Croatia. Transition from inactivity to employment was relatively low, below the EU-27 average (the lowest value was recorded for Greece

at 1.4%, while the highest rate was seen in Iceland 16.4% and Denmark 13.5%). The change from unemployment to employment was the highest for Iceland at 53.8% and Denmark at 52.3%.

5.4. Skills availability

Job vacancy rate

In 2020, skills shortages were recorded in the following NACE sectors: information and communication – with a job vacancy rate of 1.6%, and in construction – standing at 1.3% (Table 5.2). Before the pandemic, the need for labour was growing annually in administrative and support service activities. In Q2 2020, the total job vacancy rate in Poland was relatively low at 0.7%, compared to 1.6% in the EU-27, 5.4% in the Czech Republic and 2% in Germany [Eurostat, 2021b].

Table 5.2. Job vacancy rate by selected NACE section in 2015–2020

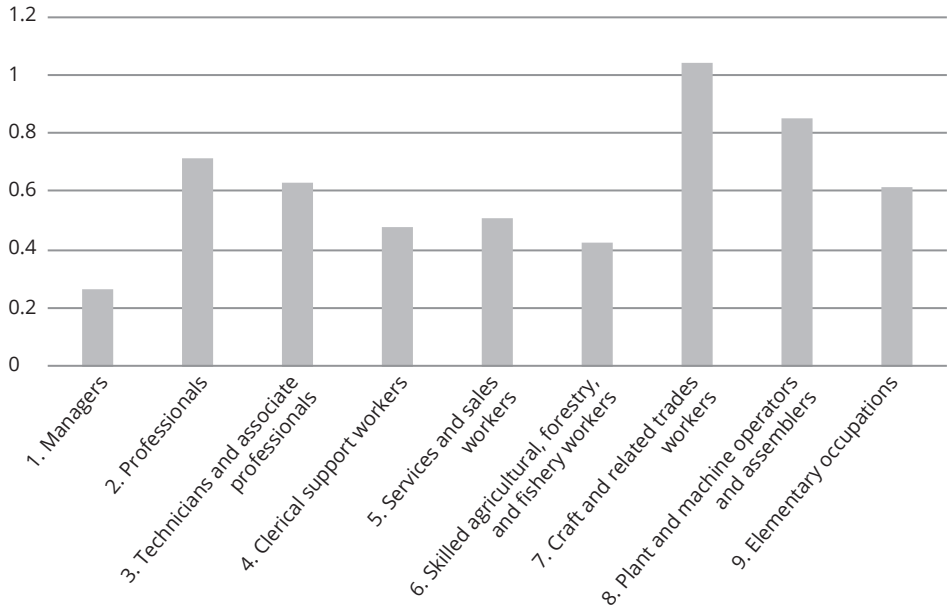
	2015	2016	2017	2018	2019	2020
Information and communication	1.93	2.07	2.10	2.41	2.24	**1.57**
Construction	1.01	1.33	2.44	2.82	2.91	**1.33**
Administrative and support service activities	0.62	0.71	0.80	1.06	1.17	1.04
Professional, scientific and technical activities	0.93	1.30	1.23	1.44	1.42	0.88
Transportation and storage	0.94	1.07	1.40	1.53	1.30	0.86
Human health and social work activities	0.32	0.39	0.54	0.70	0.73	0.70
Manufacturing	0.63	0.84	1.14	1.35	1.08	0.69

Source: Compiled by author based on Statistics Poland [2021c].

In 2020, job vacancies by occupation were the highest for craft and related trades workers (1%), while plant and machine operators and assemblers recorded a rate of 0.9%, and professionals 0.7% (Figure 5.4).

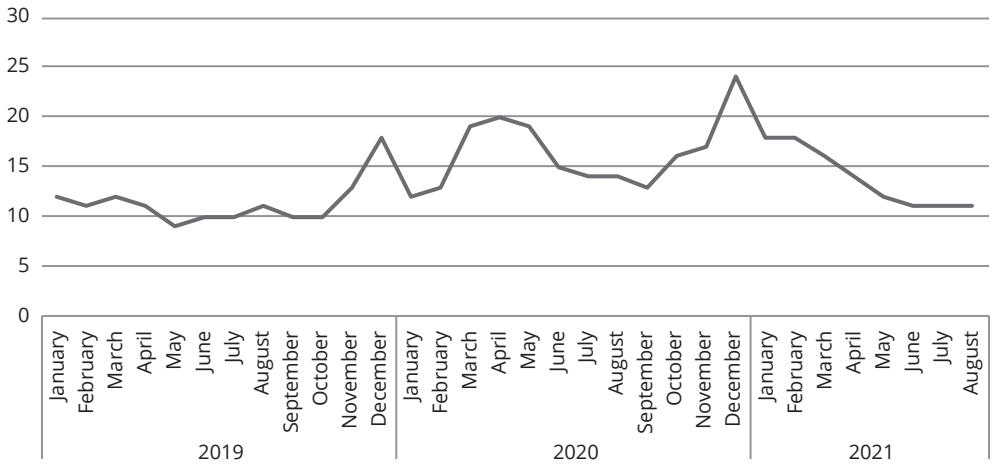
In 2020, the biggest year-on-year increases in the number of unemployed people per job offer appeared in March (58%), April (82%), May (111%), and in October (60%). The indicator continued to increase until February 2021 (the newest data available for August). Before the health crisis, the minima and maxima observed around August and December of every year suggested a seasonal character of the fluctuations (Figure 5.5).

Figure 5.4. Job vacancy rate by occupation in 2020 (%)



Source: Compiled by author based on Statistics Poland [2021c].

Figure 5.5. Unemployed people per job offer in 2019–2021 (monthly data)



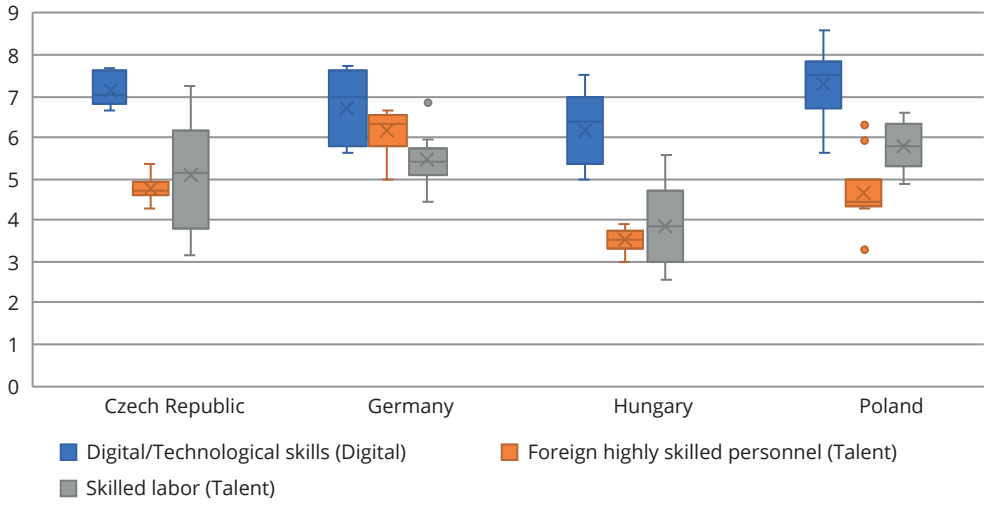
Source: Compiled by author based on Statistics Poland [2021b].

Skills availability in managers' opinion

The opinion of managers regarding the competitiveness of the Polish economy including skills availability in the labour market is assessed annually based on the results from the Executive Opinion Survey conducted by the IMD World Competitiveness Center. Respondents assess skills availability in the Polish labour market by answering questions about the following statements:

- digital/technological skills are readily available (Digital Competitiveness Ranking);
- foreign highly-skilled personnel are attracted to your country's business environment (Talent Ranking);
- skilled labour is readily available (Talent Ranking).

Figure 5.6. IMD World Competitiveness Executive Opinion Survey from 2011–2020 and 2021 (index 0–10)



Source: IMD [2021].

The results are published annually in the Talent Ranking and the Digital Competitiveness Ranking by IMD. Responses are presented as an index from 0 to 10. What can be seen from the results of the survey is that the assessment of skills availability in Poland is quite dispersed across the recent years 2011–2020 and 2021 for the Digital Competitiveness Ranking (Figure 5.6). It is also visibly lower for the years 2017–2020/2021 (Table 5.3), resulting in Poland's lower overall position in the IMD rankings, especially for digital and technological skills availability. The value of the latter variable may be a sign of economic recovery strengthening in 2021. Nevertheless, it may be alarming that managers are increasingly dissatisfied with digital and

technological skills availability. This should be seen as a window of opportunity for the cooperation of business and institutions, particularly at the regional level.

Table 5.3. Poland's position in the IMD rankings in 2017–2021

	Digital/Technological skills	Foreign highly-skilled personnel	Skilled labour
2011	29	40	34
2012	31	43	26
2013	6	21	15
2014	29	51	38
2015	15	42	19
2016	23	20	13
2017	34	41	32
2018	31	43	44
2019	46	45	46
2020	43	45	43
2021	**56**	n/a	n/a

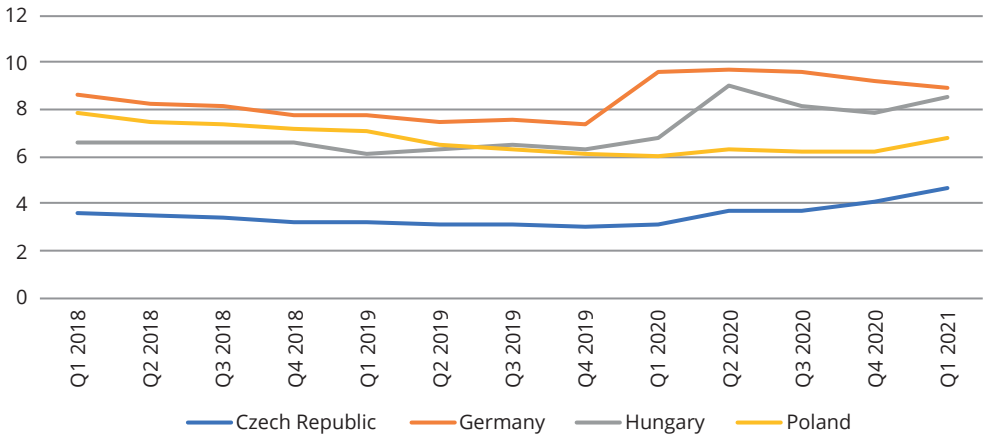
Source: IMD World Competitiveness [2021].

5.5. Impact of the pandemic on the Polish labour market: a new perspective

According to Eurostat Statistics Explained [2021], extended labour force includes people in employment and those in the labour slack, being the unmet demand for employment. Labour market slack consists of the unemployed, underemployed part-time workers and the potential additional labour force, which covers (1) people who are available to work but are not seeking work and (2) people who are seeking work but are not immediately available. Those in employment together with those in labour market slack constitute the extended labour force.

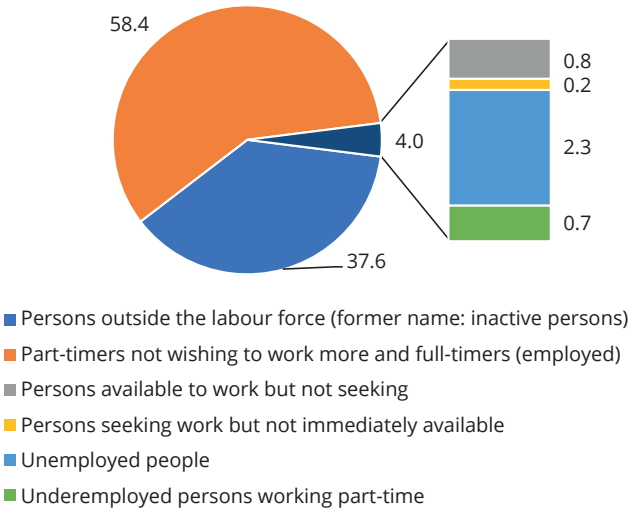
In Q2 2021, 58.4% (56.9% in Q2 2020) of the total population aged 15–74 was working as part-timers not wishing to work more and full-timers (former name in labour market statistics: employed). Almost 4% (3.8%) faced an unmet demand for employment (the labour market slack) which consisted of persons available to work but not seeking (0.8% vs. 1.2%), persons seeking work but not immediately available (0.2% vs. 0.2%), unemployed people as defined by ILO (2,3% vs. 1.9%), and underemployed persons working part-time (0.7% vs. 0.5%). The persons outside the labour force (former name in labour market statistics: inactive persons) represented 37.6% (39.3%).

Figure 5.7. Percentage of extended labour force which includes both those in employment and those in the labour market slack (quarterly data; %)



Source: Compiled by author based on Eurostat [2021c].

Figure 5.8. Part-timers not wishing to work more and full-timers, and labour market slack in Poland in Q2 2021 (% of total population aged 15–74)



Source: Compiled by author based on Eurostat [2021e].

Decrease in part-timers not wishing to work more and full-timers was observed between Q1 2020 and Q2 2020, when the first lockdowns were introduced. From Q4 2019 and Q1 2020 and later over the year no drops in this variable were seen. An increase in slack was recorded between Q1 2020 and Q2 2020 (0.1 p.p.), Q2 2020 and Q3 2020 (0.1 p.p.), and between Q4 2020 and Q1 2021 (0.3 p.p.). Persons seeking work

but not immediately available, a component of the labour market slack, remained almost unchanged. Change in persons available to work but not seeking was close to zero, with the highest drop of 0.3 p.p. between Q4 2020 and Q1 2021.

Between Q1 2020 and Q2 2020, the slack did not offset the decrease in the number of employed persons, and the number of persons outside the labour force increased (0.7 p.p.). Only between Q1 2020 and Q2 2020 could the slack be due to increase in persons available to work but not seeking. Increase in the labour market slack between Q2 2020 and Q3 2020 and the highest upturn between Q4 2020 and Q1 2021 was produced by a rise in the unemployed (0.5 p.p. in the case of Q4 2020 to Q1 2021), meaning that people were looking for jobs again. This was however partially offset by a decrease in people available to work but not seeking work (−0.3 p.p.), and underemployed persons working part-time (0.2 p.p.). During that time, persons outside the labour force (inactive persons) increased (0.7 p.p.) only at the beginning of the crisis, between Q1 2020 and Q2 2020.

The data by Eurostat reveals that Poland was the only country where the situation in employment in the group of part-timers not wishing to work more and full-timers in Q4 2019, just before the crisis, and in Q4 2020, remained stable. Three countries exceeded the pre-crisis level: Luxembourg, Greece, and Malta. Other indicators newly developed by Eurostat were also back to pre-crisis levels. In Q4 2019 vs. Q4 2020, persons outside the labour force represented 38.8% and 38.6%, respectively, part-timers not wishing to work more and full-timers accounted for 57.5% and 57.6%, and labour market slack was 3.7% and 3.8%, respectively.

5.6. Conclusions

The COVID-19 pandemic hit the Polish labour market the worst between Q1 2020 and Q2 2020. When the first shock occurred and the first lockdowns were introduced, the demand for work fell visibly. The highest decrease in the number of employed persons in the enterprise sector (Q2 2020 against the same quarter of the previous year) took place in mining and quarrying, and in financial and insurance activities. The most frequent reason for losing one's job was workplace liquidation or position abolishment. At the same time, economic activity dropped especially for those aged 15–24, and women. As a consequence, the pool of economically inactive people grew, supplied by females and people with basic education. In the annual perspective, temporary employment of young people shrunk. On the other hand, despite the pandemic and a high health risk, the employment of older people aged 65 and more was not that disturbed.

The results of the analysis of the new Eurostat indicators show that Poland was the only country in the European Union where the situation in employment in the group of part-timers not wishing to work more and full-timers in Q4 2019, just before the crisis, and in Q4 2020 remained stable. The group of economically inactive people proved to be stable, which most probably depends on structural and cultural characteristics of the nation. In 2020, 66% of this group was 55 years and more, while people aged 15–24 accounted for 18%. Fortunately, the number of people economically inactive due to reasons such as "convinced of impossibility to find work" or "tried every known method of job search" decreased between 2019 and 2020 by 20% and 11%, respectively [Statistics Poland, 2021b]. However, transition from inactivity to unemployment or employment happens rarely compared to the EU-27 average, and inactive persons most often remain being inactive. These intriguing facts could be an inspiration for future research.

First signs of recovery were seen in Q2 2021. The highest demand was still in information and communication, however, according to ManpowerGroup [2021a, pp. 7, 10], construction and manufacturing, and finance and services for business industries had high employment projections for Q4 2021. For the finance and services for business industry, the projection was the highest in two years. The previous decrease in employment in financial and insurance activities, observed throughout 2020, diverged from the global trends [ILO, 2021a], and could stem from differences in companies' adaptation strategies in response to the new situation under the pandemic.

Nevertheless, it may be alarming that managers are increasingly dissatisfied with digital and technological skills availability in the Polish labour market. ManpowerGroup [2021b] found out that 81% of entrepreneurs in Poland encounter difficulties in finding suitable workers. This should be seen as a chance for the cooperation of business and institutions, especially at the local level. The problem of institutional weakness in supporting labour market in Poland is not a new issue. As Górniak et al. [2015, p. 20] stress, the lack of mechanisms promoting employer engagement in skills formation existed years ago, and still exists. OECD Employment Outlook 2021 reports that (globally) firms accepted the challenge and restructure in the direction of, e.g., automation and digitalization. The OECD strongly recommends that governments should engage in upskilling to support especially those workers who have lost their jobs and could experience problems in finding new good-quality jobs [OECD, 2021a].

Referring to the conceptual model of resilient system by Giovannini et al. [2020], presented in sub-chapter 5.2, the asset in the form of labour market resources in Poland proved to be resilient to the shock of the COVID-19 pandemic. The process of bouncing back was observed, but the question is if the Polish labour market could generate bouncing forward. Giovannini et al. [2020, p. 4] explain that social trust is essential for

planning anti-crisis policies and accelerating bouncing forward "towards a better and more sustainable pathway from economic, social and environmental point of view".

The analysis is by no means exhaustive and further research is needed; nevertheless it points to some areas that require institutional intervention, particularly the phenomenon of economic inactivity and the growing need for suitable technological and digital skills.

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Chapter 6

Innovation and Technological Development

Arkadiusz Michał Kowalski, Małgorzata Stefania Lewandowska, Marzenna Anna Weresa

6.1. Introduction

The purpose of this chapter is to determine Poland's innovation performance between 2015 and 2020. The innovation performance of the Polish economy is analysed at three levels – macro- (the entire economy), meso- (regions) and microeconomic (enterprises). The innovation performance of Poland determined at the whole economy level is compared with that of other EU member states representing a similar level of development, with average innovation indicators for the entire EU used additionally as a benchmark. The mesoeconomic part focuses on a comparison of the innovation potential of Polish regions, whereas the last part of the chapter provides an analysis at the microeconomic level looking at innovations implemented by Polish enterprises.

6.2. Evolution of the national innovation system in Poland in 2015–2021

Both theoretical and empirical studies on the innovation performance of economies show that the innovative position of a country is influenced by a range of endogenous and exogenous factors and conditions. The factors most often subjected to analyses in the literature in the context of innovation performance of economies include the level and structure of research and development expenditure, availability of venture capital, human resources in R&D and education, technology transfer and diffusion of innovation within and between industries in the country and from abroad, scientific publications, protection of intellectual property (including patents obtained), technological specialization in international markets, export and import of advanced technologies and knowledge-intensive services, etc. [cf., e.g., Furman, Porter, Stern, 2002; Furman, Hayes, 2004; Klincewicz, Marczewska, 2017; Dzienis et al., 2019; Kowalski et al., 2020; Soete, Schwaag Serger, Stierna, Hollanders, 2021]. Indicators describing

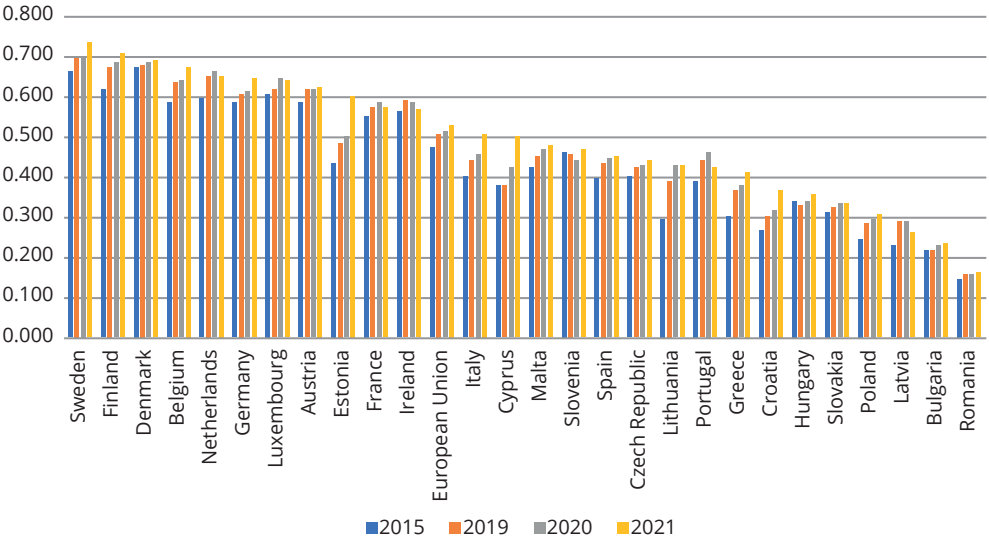
the groups of factors that determine innovation performance are used to construct innovation indexes, such as the Summary Innovation Index (SII) [Hollanders, 2021] or the Global Innovation Index [Cornell University, INSEAD, WIPO, 2020]. On this basis, country innovation rankings are created, which allow progress to be traced in building the innovation position in a comparative perspective. A similar approach can be used to measure changes in innovation of the Polish economy over the period 2015–2021. The objective is to identify general trends of change and indicate the main challenges to efforts towards the implementation of sustainable development goals and the need to face up to the challenges that have arisen in the pandemic era.

Poland falls within the group of countries with national innovation systems of the catching up type [Weresa, 2012]. The last five years have been a period of fundamental changes in the science and higher education system, which have taken place following the implementation of reforms under the so-called Act 2.0 [Dzienis et al., 2021]. Alongside internal factors such as the reform of higher education and the education system, Poland's innovation performance has also been significantly affected in recent years by external factors, in particular the COVID-19 pandemic, which accelerated the digitalization processes of the R&D sector and the related education system, including higher education. It also affected many other elements of national innovation systems, including the level of private sector research funding and international scientific cooperation. Moreover, the sustainable management goals laid out in the EU strategy *Towards a Sustainable Europe by 2030* also translate into the functioning of the research domain and business innovation. The question therefore arises as to how these tendences are reflected in the national innovation system and to what extent is the system based on environmental innovation (eco-innovation) and social innovation.[1]

However, the analysis of innovation trends regarding environmental protection and the social domain should be preceded by an overview of the innovation performance of the Polish economy, which is measurably represented by changes in the Summary Innovation Index (SII) (Figure 6.1). In the period 2015–2021, there was a gradual increase in the index, but the rate of its growth was not strong enough to improve Poland's innovation position in the EU. Although in 2021 the SII value for Poland represented almost 66% of the EU average in 2014, having increased by almost 15 percentage points compared to 2015, the value of the index still remains low. The COVID-19 pandemic has not changed the position of Poland in the European innovation ranking. Poland is continues to be one of the laggards in the EU, ranking ahead of only three countries – Latvia, Romania, and Bulgaria.

[1] For more on innovation driving sustainable competitiveness see Chapter 2.

Figure 6.1. Summary Innovation Index: Poland compared to other European Union – 2015 against 2019–2021



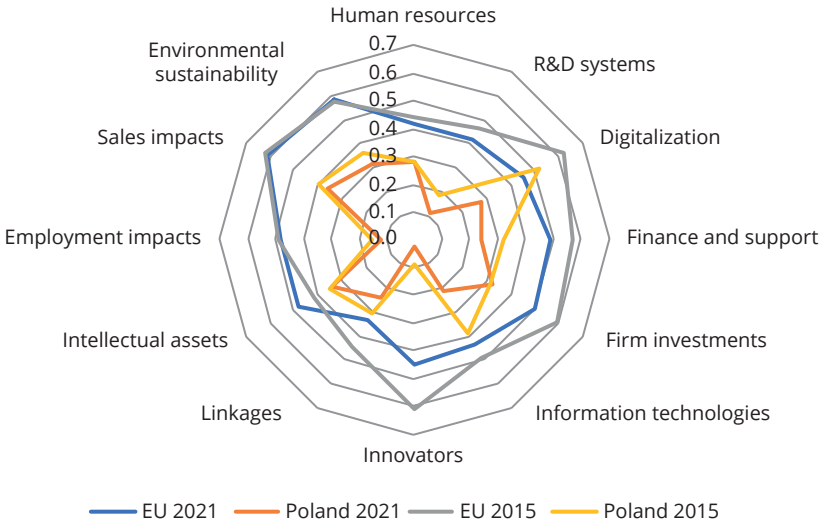
Source: Compiled by authors based on European Commission [2021].

The design of the innovation index allows it to be disaggregated into 12 dimensions [Hollanders, 2021]. The innovation gap between Poland and the EU average is the widest in three dimensions of the innovation index: "Innovators", "Research systems" and "Employment impact", while the smallest innovation gaps is reported for "Digitalization", "Intellectual assets", and "Information technologies", as in 2021 the indicators describing these dimensions exceeded 80% of their EU average. A dynamic approach to the SII dimensions, taking into account changes over the period 2015–2021 reveals three areas in which Poland's position deteriorated in 2021 relative to the EU average compared with 2015. These are: "Human resources", "Firm investments", and "Linkages". The other areas saw a slow improvement in the indexes describing them (Figure 6.2).

From the point of view of competitiveness analysed in this monograph in its sustainable dimension, innovations relating to the natural environment and the social domain are of key importance According to the EU strategy, by 2030 Europe's competitive advantage vis-à-vis other regions of the world will be achieved through the implementation of the circular economy (CE), including the bioeconomy. This will reduce environmental, social, and economic pressures and improve the quality of life. It is estimated that the economic benefits of implementing circular economy in the EU will amount to around EUR 1.8 trillion by 2030, and the key factors contributing

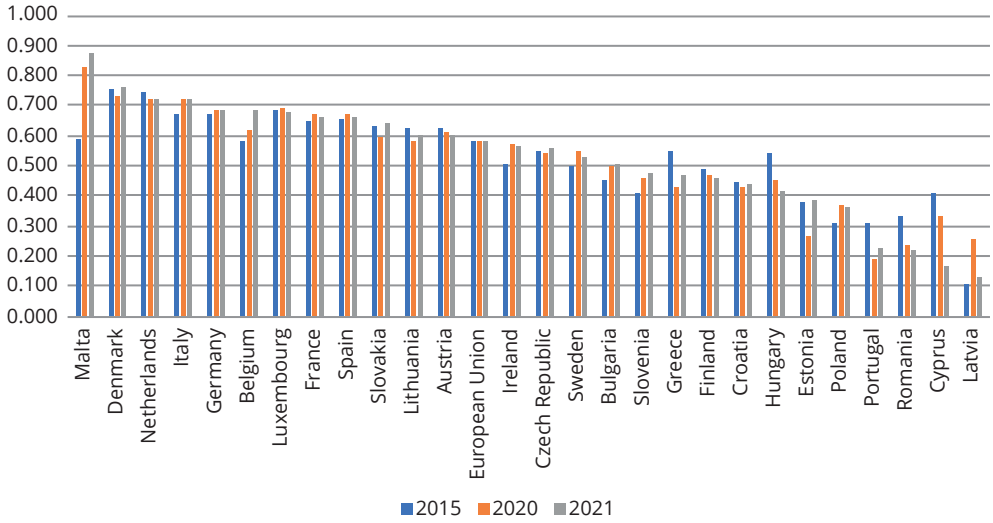
to building competitive advantages based on circular economy are technologies, research, education, innovation, and digitalization [European Commission, 2019, p. 16]. Similar conclusions on the significance of technologies, in particular innovations, are provided in Chapter 1 of this monograph. Therefore, having regard to the sustainable competitiveness issues dealt with in this monograph, a further analysis of Poland's innovation performance will focus on the SII dimension "Environmental sustainability" and indicators describing this dimension, such as (a) resource productivity expressed in terms of GDP in relation to materials consumed, (b) air pollution by fine particulate matter (PM2.5) per unit of value added in the manufacturing sector, (c) development of environmental technologies measured by the share of environment-related patents in the total number of patents. Poland's innovation performance in the "Environmental sustainability" area is relatively low compared to other EU member states, and the value of the index describing this SII dimension has not changed much since 2015. Poland ranked 23rd in the EU, ahead of only Portugal, Romania, Cyprus, and Latvia (Figure 6.3). However, a gradual (albeit slow) improvement in the index in relation to the EU average is noteworthy. In 2015, the index level reached 56% and in 2021 64% of the EU average.

Figure 6.2. Summary Innovation Index (SII): Poland compared to the EU average in 2015 and 2021



Source: Compiled by authors based on European Commission [2021].

Figure 6.3. Innovation in the "Environmental sustainability" area – Poland compared with the EU in 2015, 2020, and 2021



Source: Compiled by authors based on European Commission [2021].

The main reasons for such a low position of Poland in terms of environmental sustainability are very low resource productivity of 47% of the EU average in 2020 and high air emissions by fine particulate matter (PM2.5), four times higher than the EU average (see Table 6.1).

Table 6.1. Components of the SII dimension "Environmental sustainability" – Poland compared with the EU in 2015 and 2020

	Environmental technologies (share of environmental technology patents in the total number of patents)		Air emissions by fine particulates PM2.5 per unit of value added in manufacturing		Resource productivity (GDP per unit of materials consumed)	
	2015	2020	2015	2020	2015	2020
EU	13.69	11.20	0.09	0.08	1.93	2.20
Belgium	11.21	9.42	0.08	0.07	2.38	3.44
Bulgaria	16.44	20.94	0.19	0.27	0.67	0.78
Czech Republic	13.26	10.13	0.07	0.04	1.53	1.81
Denmark	25.65	20.12	0.02	0.02	1.55	1.62
Germany	14.41	11.62	0.02	0.02	2.02	2.55
Estonia	23.13	17.44	0.74	0.44	0.74	0.89
Ireland	8.45	5.90	0.04	0.02	1.84	2.44
Greece	18.81	11.08	0.24	0.25	1.50	2.12

cont. Table 6.1

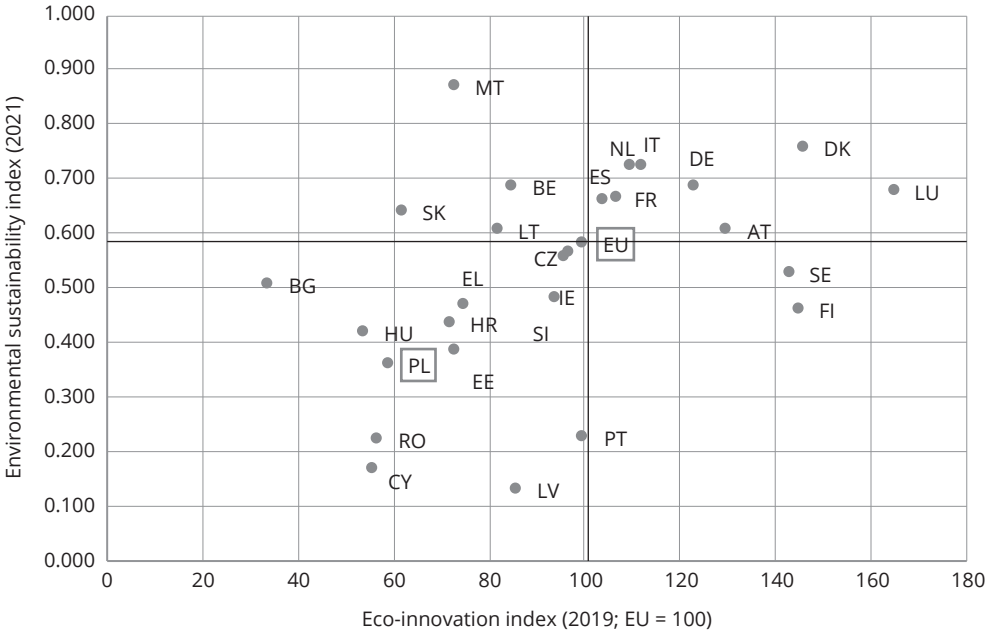
	Environmental technologies (share of environmental technology patents in the total number of patents)		Air emissions by fine particulates PM2.5 per unit of value added in manufacturing		Resource productivity (GDP per unit of materials consumed)	
	2015	2020	2015	2020	2015	2020
Spain	13.71	11.07	0.10	0.10	2.85	3.13
France	13.00	11.18	0.06	0.06	2.46	2.89
Croatia	13.43	9.46	0.27	0.19	1.72	1.87
Italy	10.96	9.58	0.07	0.06	3.16	3.71
Cyprus	10.56	0.00	0.33	0.48	1.54	1.48
Latvia	5.22	5.14	0.90	0.88	1.42	1.55
Lithuania	20.07	15.40	0.09	0.04	1.36	1.37
Luxembourg	14.79	10.18	0.17	0.11	3.40	3.53
Hungary	11.98	8.53	0.07	0.09	1.43	1.30
Malta	6.25	22.81	0.02	0.03	2.08	2.70
Netherlands	11.76	8.95	0.06	0.05	3.41	4.55
Austria	14.27	10.47	0.04	0.02	1.83	2.08
Poland	11.61	11.58	0.39	0.32	1.06	1.30
Portugal	14.90	10.50	1.02	0.87	1.34	1.48
Romania	13.22	5.13	0.29	0.22	0.79	0.79
Slovenia	6.99	9.27	0.16	0.14	1.69	2.04
Slovakia	18.10	16.20	0.12	0.06	1.66	1.78
Finland	15.59	11.72	0.10	0,09	0.96	1.10
Sweden	11.51	11.99	0.09	0.06	1.44	1.43

Source: Compiled by authors based on European Commission [2021].

It is worth comparing "environmental sustainability" with the eco-innovation index, which covers a wider range of issues and is calculated as a non-weighted average of the 16 sub-indexes, and represents a more holistic approach to innovation related to environmental protection. It covers not only eco-innovation inputs, eco-innovation activities, eco-innovation outputs but also resource efficiency outcomes and socio-economic outcomes, including employment in environmental protection and resource management activities [EIO, 2021a]. The scores for individual EU members states are presented relative to the EU average (EU index = 100). The index complements other approaches to measuring innovation performance of EU countries and aims to promote a holistic view on economic, environmental, and social outcomes. Eco-innovation in earlier periods represents a broad view of many diverse issues involved in "green" innovations; hence, it may influence the environmental sustainability index in subsequent periods. However, this is not confirmed by the Pearson coefficient of

correlation between those indexes, which stands at 0.41. Yet a comparison of both indexes allows the EU member states to be divided into three EU groups in terms of the value of both indexes taken together. The criteria for such division are the average values of both indexes in the EU.

Figure 6.4. Key aspects of environment-related innovation – Poland compared with other EU countries



Source: Compiled by authors based on European Commission [2021] and Eurostat [2021a].

The countries most advanced in terms of efforts to implement environmentally-friendly solutions are those in which both indexes – eco-innovation and environmental sustainability – are above the EU average. This group includes 8 EU member states – Denmark, Luxembourg, Austria, Italy, the Netherlands, Germany, France, and Spain. The second group consists of two countries – Sweden and Finland – with the eco-innovation index higher than the EU average but with the environmental sustainability index lower than average. The worse score for the latter index is due to a relatively low resource productivity indicator, which stands at approximately 50–60% of the EU average (cf. Table 6.1). The second group also includes four countries – Belgium, Malta, Lithuania, and Slovakia, which are more advanced than the EU average in terms of environmental sustainability but have eco-innovation index values lower than the EU average. The most numerous group of EU member states, which includes Poland,

consists of the Central and Eastern European countries (except Lithuania and Slovakia), Cyprus, Greece, Portugal, and Ireland. The countries are less advanced in the EU both in terms of eco-innovation and environmental sustainability. Both indexes are lower in this group of countries than their EU averages (Figure 6.4).

Why is Poland among the EU countries least focused on ecological solutions? Poland performs particularly poorly in terms of eco-innovation activities and expenditures, including R&D personnel and early-stage investment in environmental technologies. On the other hand, Poland's strengths include socio-economic outcomes, in particular the relatively high percentage of employment in eco-industry and the circular economy. The potential of eco-innovation remains untapped in Poland, and the most significant barriers include high implementation costs of green innovations, difficult access to capital, high risk and uncertain return on investment, and an insufficient system of economic and fiscal incentives encouraging eco-innovation [EIO, 2021b].

The second area related to innovation, which can have a direct impact on sustainable competitiveness, concerns the social domain. Identifying and measuring innovations related to social issues (including "inclusive innovations") is quite difficult due to their non-quantifiable nature. As an approximation, it can be assumed that they are related to social entrepreneurship. The mapping of this type of enterprises initiated by the European Commission allowed their number to be estimated – as of 2019, there were 29 535 of them [Ciepielewska-Kowalik, 2020, p. 38]. This is a relatively small number, but, by comparison, in Spain, which is similar to Poland in terms of size, the number of social enterprises is estimated at 9680 [Díaz, Marcuello, Nogales, 2020, p. 45], while in Germany there are more than 640 000 [Ravensburg, Krlev, Midenberger, 2018, p. 60].

In Poland, the majority (over 90%) of such social enterprises are entrepreneurial non-profit organizations [Ciepielewska-Kowalik, 2020]. Their significance in innovation activities is very small, although it has been increasing. According to Statistics Poland data, in 2020 the share of private non-commercial institutions in the total value of intramural expenditures of enterprises on research and development activities was only 0.2%, but it is worth noting that it increased nearly tenfold compared to 2015. The level of cooperation in innovation activities of the non-profit sector with commercial businesses is also very low. According to Statistics Poland, in 2017–2019, only 1.4% of innovative companies cooperated with non-profit organizations. However, the cited data on the involvement of the non-profit sector in research and innovation activities should be treated as highly imprecise estimates, as not all entities in this sector can be considered as social enterprises. The lack of detailed statistical data makes it impossible to assess the social dimension of innovation more precisely, but even these approximate estimates show that in Poland this is an area still at the initial stage of development.

6.3. Poland's innovation performance and technological development by region

In recent years, economists have been increasingly paying attention to the spatial diversity of innovation not only between individual national economies but also at the regional level [e.g. Thomas, Faccin, Asheim, 2021]. This relationship is connected with interactions between learning processes, institutions and spatial patterns of innovation activity. According to the proximity paradigm, geographical proximity, together with related other dimensions of proximity, such as cognitive, organizational, social, and institutional proximity, is an important factor in shaping innovation [Boschma, 2005]. This means that it is at the regional level that most interactions and cooperation between entities take place within innovation systems, leading to the development of the necessary technological critical mass for breakthrough research and innovation activities. Empirical research confirms that the externalities of the diffusion of knowledge are geographically limited, and the proximity of science and business entities reinforces knowledge spillovers from local universities to enterprises [Barra, Maietta, Zotti, 2021].

Research on regional innovation systems in Poland shows that they are less innovative compared to most regions in the European Union, and disparities in their innovation performance are one of the reasons for the low innovativeness of the Polish economy as a whole [Dzienis et al., 2019]. In the analysis of differences in the level of innovation between individual voivodeships in dynamic terms, σ-convergence is a useful metric, which can be measured by the standard deviation, expressed by the formula:

$$\sigma - coefficient = SD = \sqrt{\frac{\sum(X - \bar{X})^2}{N}}.$$

The first of the indicators analysed to examine the differences in the level of innovation between regions in Poland is the ratio of intramural expenditures on R&D activities in relation to GDP. Intramural expenditures on R&D include both current expenditures and capital expenditures on fixed assets related to R&D activities but do not include depreciation of fixed assets (Table 6.2, the regions are ranked in descending order in terms of indicator values in 2018).

An analysis of data from Table 6.2 indicates a heterogeneous regional innovation potential in Poland. In 2018, intramural expenditure on R&D exceeded 1% of GDP in six NUTS 2 regions – Małopolskie, Mazowieckie, Pomorskie, Podkarpackie, Dolnośląskie, and Lubelskie, whereas the smallest value of this indicator of 0.48% was recorded in Lubuskie Voivodeship. At the same time, the dynamically growing discrepancies

between individual voivodeships measured by the standard deviation (whose value increased from 0.323 in 2010 to 0.502 in 2018) are noteworthy, which indicates the occurrence of σ-divergence. The share of R&D expenditures in GDP is one of the most frequently used ratios in analysing the indicators of innovation capacity, understood as the potential of the economy or other entity (region, cluster, enterprise) to create and commercialize new ideas. It is an input approach to the issue of innovation. For the analysis of innovation, the outcome of the inputs and investments made, i.e. the innovation position, is important, being an output of innovation activity, i.e. the combination (in a specific economic and institutional environment) of society's creativity with its financial resources [Weresa, 2012, p. 32]. One of the indicators used to analyse the innovation position is the share (in %) of innovative enterprises in the total number of enterprises (Table 6.3, the regions are ranked in descending order in terms of indicator values in 2019).

Table 6.2. Intramural expenditures on R&D activities in relation to GDP in Polish regions in 2010–2018 (%)

	2010	2015	2018	Change (2010–2018)
Poland	0.72	1.00	1.21	68
Małopolskie	1.00	1.49	2.14	114
Mazowieckie	1.36	1.74	1.99	46
Pomorskie	0.60	1.12	1.40	133
Podkarpackie	0.92	1.29	1.10	20
Dolnośląskie	0.51	0.85	1.09	114
Lubelskie	0.64	1.07	1.01	58
Łódzkie	0.63	0.67	0.94	49
Wielkopolskie	0.58	0.75	0.75	29
Śląskie	0.46	0.61	0.72	57
Podlaskie	0.32	0.76	0.71	122
Kujawsko-Pomorskie	0.31	0.46	0.65	110
Opolskie	0.12	0.32	0.63	425
Świętokrzyskie	0.45	0.61	0.56	24
Warmińsko-Mazurskie	0.44	0.32	0.56	27
Zachodniopomorskie	0.31	0.33	0.55	77
Lubuskie	0.14	0.22	0.48	243
Standard deviation (SD)	0.323	0.447	0.502	–

Source: Compiled by authors based on Statistics Poland – Local Data Bank [2021a].

Table 6.3. Average share of innovative enterprises in total number of enterprises in 2010–2020 (%)

	2010	2015	2018	2019	Change (2010–2019)
Poland	14.9	13.7	21.8	15.5	4
Małopolskie	14.5	15.2	22.2	19.3	33
Mazowieckie	16.4	14.5	27.3	17.7	8
Podkarpackie	17.2	14.2	19.7	17.7	3
Dolnośląskie	14.9	14.2	22.8	17.2	15
Warmińsko-Mazurskie	13.6	11.3	14.9	15.8	16
Wielkopolskie	14.3	13.0	19.0	15.8	10
Pomorskie	14.3	12.6	25.6	15.4	8
Łódzkie	11.9	12.5	15.9	14.8	24
Śląskie	16.4	13.1	20.6	13.8	−16
Podlaskie	12.7	15.3	23.4	12.3	−3
Lubelskie	14.6	13.5	24.9	12.1	−17
Zachodniopomorskie	13.3	15.8	20.2	12.1	−9
Opolskie	16.5	15.0	21.2	11.7	−29
Świętokrzyskie	14.0	11.5	14.3	11.5	−18
Kujawsko-Pomorskie	13.6	12.5	21.0	10.8	−21
Lubuskie	13.4	11.6	18.1	10.2	−24
Standard deviation (SD)	1.489	1.445	3.724	2.829	–

Source: Compiled by authors based on Statistics Poland – Local Data Bank [2021b].

The analysis of the share of innovative enterprises in the total number of enterprises indicates the dominant innovative position of Małopolskie Voivodeship, for which the largest increase in this indicator was recorded in the period under study. At the same time, the dynamically growing discrepancies between individual voivodeships measured by the standard deviation (whose value increased from 1.489 in 2010 to 2.829 in 2019) are noteworthy, which indicates the occurrence of σ-divergence. The analysis confirms the observation by Godek [2020] that the regions with the most innovative economies are primarily the voivodeships with the largest and most dynamically developing agglomerations, which are the main creators of growth and employment. It is worth noting that especially in Mazowieckie Voivodeship there are very large intra-regional disparities, with the leading position of the Warsaw Metropolitan Area (WMA).

Observation of the geographical polarization of innovation activities in the global economy, in particular research and development (R&D) activities, is the starting point for an analysis of the importance of clusters for the innovation performance of an economy. This is related, *inter alia*, to locally determined knowledge spillovers and

technology transfer processes [Buzard, Carlino, Hunt, Carr, Smith, 2020]. Simultaneously, the importance of the innovation environment has been growing, as innovation capacity becomes one of the most important locational factors. The success of many clusters in the world has contributed to the popularity of clusters as an instrument of economic policy, with a diversity of approaches to cluster policymaking being observed in different countries on each continent, such as the bottom-up approach, top-down approach or the popular treatment of clusters in Asian countries as a tool for attracting foreign direct investment [Kowalski, 2020]. Since Poland's accession to the European Union, various cluster support programmes have been launched, which results in the establishment and development of many cluster initiatives. Statistics on the participation of industrial enterprises cooperating under a cluster initiative or other formalized cooperation as a percentage of innovation-active enterprises are shown in Table 6.4 (the regions are ranked in descending order in terms of the 2019 value of the indicator).

Table 6.4. Industrial enterprises cooperating under a cluster initiative or other formalized cooperation as percentage of innovation-active enterprises in 2010–2019 (%)

	2010	2015	2018	2019	Change (2010–2019)
Poland	4.0	8.2	21.0	20.5	413
Zachodniopomorskie	3.0	11.4	18.8	45.7	1423
Podkarpackie	6.2	21.1	32.8	35.3	469
Lubelskie	7.5	23.8	33.1	33.5	347
Świętokrzyskie	0.9	8.6	24.0	32.0	3456
Podlaskie	4.3	9.1	38.9	23.2	440
Małopolskie	2.6	5.6	21.0	21.0	708
Pomorskie	2.7	7.4	16.6	19.9	637
Lubuskie	2.6	5.6	17.7	19.1	635
Mazowieckie	2.7	4.7	15.1	18.4	581
Kujawsko-Pomorskie	2.6	5.4	22.2	18.0	592
Wielkopolskie	6.3	6.3	17.8	17.8	183
Śląskie	4.5	7.4	18.6	16.9	276
Opolskie	1.5	11.5	11.5	16.5	1000
Warmińsko-Mazurskie	2.3	4.8	26.9	14.9	548
Łódzkie	4.2	8.2	20.4	14.6	248
Dolnośląskie	4.3	7.1	25.6	12.1	181
Standard deviation (SD)	1.821	5.571	7.348	9.271	–

Source: Compiled by author based on Statistics Poland – Local Data Bank [2021b].

According to the data in Table 6.4, the largest percentage of innovation-active industrial enterprises cooperating under a cluster initiative or other formalized cooperation occurred in 2019 in Zachodniopomorskie (45.7%), Podkarpackie (35.3%), Lubelskie (33.5%), Świętokrzyskie (32%), and Podlaskie (23.2%). It is worth noting that four of the five voivodeships mentioned above are located in Eastern Poland, which is traditionally characterized by a low level of competitiveness and innovation. The region receives additional support from EU funds, e.g. under the Operational Programme Eastern Poland 2014–2020 or the European Funds for Eastern Poland 2021–2027 programme. One of the priorities of these programmes is to promote cooperation and networking, including through cluster initiatives. This way, the availability of EU public support contributes to increasing the level of cooperation and the number of innovative enterprises in Eastern Poland.

Clusters start to play an important role in achieving sustainable competitiveness, which is related to green reorientation of clusters [Sjøtun, Njøs, 2019] and the fact that clusters have been recognized by the European Commission as entities implementing the 2019 European Green Deal in EU small and medium-sized enterprises. Cooperation within clusters towards sustainable development and the creation of eco-innovations can take different forms and have different objectives, such as energy production from renewable sources, alternative ways of production and use of raw materials, circular management, eco-innovations, and producing organic food. Consequently, clusters fit into Creating Shared Value (CSV) concept [Porter, Kramer, 2011], according to which competitive advantage is obtained by satisfying needs in the enterprise environment, which leads to sustainable development [Weresa, Kowalski, Sieńko-Kułakowska, 2017].

The changes in the global economy related to the COVID-19 pandemic have disrupted value chains (also within clusters), which have largely lost their inherent agility and flexibility. The most important way to achieve the required business effectiveness of an organization in the face of emerging disruptions in value chains is their digitalization, which contributes to building resilient value chains and restoring their equilibrium. At the same time, the COVID-19 pandemic has accelerated the development of Industry 4.0 technologies in clusters, such as digital platforms, blockchains, the Internet of Things and the Industrial Internet of Things, artificial intelligence, cloud computing, and Big Data analytics. The deployment of digital solutions has the potential to enable clusters and enterprises to cope with the increasing complexity of operations that people are no longer able to manage efficiently without adequate technological support. The digitalization of value chains enables clusters and businesses to acquire real-time data, providing them with a tool with which to take preventive measures in crisis situations such as the disintegration of value chains during the COVID-19 pandemic

[Sasidharan, Reddy, 2021]. Despite potential benefits, the use of digital technologies is of an evolutionary nature and is currently at the initial stage of use in the management of value chains in Polish clusters.

6.4. Innovativeness and technological development of Polish enterprises – micro perspective

The degree of innovativeness of an enterprise is determined by its ability and propensity to innovate. The innovation capacity of an enterprise is the ability to create and apply/commercialize new ideas or innovative solutions. It is an input approach to the issue of innovation, one of the key measures of which is the amount of expenditures incurred on R&D.

The innovative position, in turn, is an output approach indicating the effect of innovative activity – the combination (in a specific economic and institutional environment) of society's creativity with its financial resources [Weresa, 2012, p. 32].

Despite attempts to move away from "hard" metrics of innovation, Boston Consulting Group's research conducted among 2700 managers of international enterprises shows that the most common measures of innovation used in their enterprises are the amount of expenses incurred in connection with an innovative project, the revenue from an innovation launched on the market, the allocation of funds for individual innovative projects, and actual sales relative to their projected level [Andrew, Haanaes, Michael, Sirkin, Taylor, 2009].

At this point, it is worth mentioning that the new Oslo Manual [2018] approaches the concept of innovation in a holistic manner, taking into account the relationships between different processes occurring [Oslo Manual, 2018, p. 3]. Compared to the previous edition [Oslo Manual, 2005], there was a significant change in the definition of business innovation. The list of types of innovation was reduced, compared to the previous one, to two main types: product innovation and business process innovation. "The revised definition also reduces the ambiguity of the requirement for a 'significant' change by comparing both new and improved innovations to the firm's existing products or business processes" [Oslo Manual, 2018, pp. 20–21].

A product innovation as defined in the Oslo Manual 2018 is "a new or improved good or service that differs significantly from the firm's previous goods or services and that has been introduced on the market" [Oslo Manual, 2018, p. 21]. "This includes the addition of new functions, or improvements to existing functions or user utility. Relevant functional characteristics include quality, technical specifications, reliability, durability, economic efficiency during use, affordability, convenience, usability, and

user friendliness. (…) Product innovations can use new knowledge or technologies, or be based on new uses or combinations of existing knowledge or technologies" [Oslo Manual, 2018, p. 71].

According to the Oslo Manual 2018, a **business process innovation** is "a new or improved business process for one or more business functions that differs significantly from the firm's previous business processes and that has been brought into use by the firm" [Oslo Manual, 2018, p. 21].

The following functions are distinguished within **business process innovations**:

1) **production of goods and services** (activities that transform inputs into goods or services, including engineering and related technical testing, analysis and certification activities to support production);
2) **distribution and logistics**, which includes: a) transportation and service delivery; b) warehousing; c) order processing;
3) **information and communication systems**, which include: a) hardware and software; b) data processing and databases; c) maintenance and repair; d) web-hosting and other computer-related activities; these functions can be provided in a separate division or in divisions responsible for other functions;
4) **administration and management**, which include: a) strategic and general business management, including organizing work responsibilities; b) corporate governance, including public relations; c) accounting, bookkeeping, auditing, payments, and other financial or insurance activities; d) human resources management (training and education, staff recruitment, workplace organization, payroll management, health and medical support); e) procurement; f) managing external relationships with suppliers, alliances, etc.;
5) **marketing and sales**, which include: a) product promotion, packaging, direct marketing, exhibitions and fairs, market research and other activities to develop new markets; b) pricing strategies and methods; c) sales and after-sales activities, including help desks, other customer support, and customer relationship activities;
6) **product and business process development**, which includes activities to adapt products or business processes in a systematic fashion or on an ad hoc basis, and be conducted within the firm or in cooperation with other entities; responsibility for these activities can lie within a separate division or in divisions responsible for other functions [Brown, 2008; Eurostat, 2008; Oslo Manual, 2018, Table 3.1].

Although the new taxonomy of business functions proposed in the Oslo Manual 2018 corresponds well with the process, marketing, and organizational innovation categories distinguished in the previous edition, significant changes have taken place in their categorization, as described in more detail in Gołębiowski et al. [2021, pp. 54 –107].

6.5. Innovation performance and intensity of R&D activities of total Polish enterprises compared to enterprises in the European Union

The internal economic conditions affecting innovation activity and, as a result, business innovation, include direct factors: accumulated human capital stock (knowledge and skills of employees); accumulated knowledge stock (measured by scientific research expenditure and the size of research staff); stock of materialized knowledge (in the form of machinery and equipment, buildings); external knowledge stock (acquired also through cooperation); organizational resources and factors indirectly linked to the level of innovation, such as the firm's financial resources which affect its ability to finance innovation; the size of the firm, which determines the level of its tangible and intangible resources [Wziątek-Kubiak, Balcerowicz, 2009, p. 17].

Acquiring technology from external sources, especially in the case of entities in countries such as Poland, which are constantly developing their technological potential, fulfils two basic functions. Firstly, it allows the existing technological gaps to be filled and, secondly, makes it possible to increase the potential of existing technologies and adapt them to the standards of more developed countries. Acquiring knowledge from outside sources on a paid basis has the advantage over in-house R&D in that it allows the firm to choose from a wide range of off-the-shelf solutions and does not require long-term expenditure to maintain its own infrastructure [Love, Roper, 1999; Anzola-Roman, 2018].

The tool used to collect data on the innovativeness of enterprises in the EU member states and associated countries, including data on their own research and development activities or purchases, is the Community Innovation Survey questionnaire, the methodology of which is based on the proposals contained in the Oslo Manual [2005], developed by OECD[2] and Eurostat specialists.

[2] On 14 December 1960, members of the Organisation for European Economic Co-operation (OEEC), which grouped together European countries supported by the US Marshall Plan, signed the Convention on the Organisation for Economic Co-operation and Development (OECD). The Convention was signed by representatives of 20 countries, members of the OEEC: Austria, Belgium, Denmark, France, Greece, Spain, the Netherlands, Iceland, Ireland, Canada, Luxembourg, Portugal, Norway, the United States, Switzerland, Sweden, Turkey, the United Kingdom, Italy, and the Federal Republic of Germany. In accordance with the provisions of the Convention, which entered into force in 1961, the member countries undertook to support the development of scientific research, the development of education, and promote the development of resources in the field of science and technology. The provisions of the Convention on the Organisation for Economic Co-operation and Development became the basis for work on establishing the principles and methods of collecting and processing information necessary for the implementation of the provisions of the Convention relating to the undertaking and strengthening of international cooperation in the field of research and development (R&D). In 1963, the OECD expert group on statistics agreed, at meetings held

The data in Table 6.5 makes it clear that Polish enterprises are lagging far behind in both in-house R&D activities and in R&D acquisition.

In the years 2016–2018, only 4% of total Polish enterprises declared that they conducted R&D activities on a continuous basis, and 3.5% did so an ad hoc basis compared to the average for the entire EU of 12.5% and 8.9%, and the average for the euro area of 14.9% and 10.5%, respectively. Only 3.8% of Polish enterprises declared they outsourced R&D services, with the EU average of 10% and the average for the euro area of 11.5%.

According to data 7.7% of Polish enterprises declared that they conducted R&D in-house and outsourced R&D services, with the EU average of 22.6% and the average for the euro area of 26.5% of all the enterprises surveyed in 2016–2018.

Table 6.6 presents data on the intensity of product innovation and various types of process innovation introduced by total Polish enterprises in 2016–2018 compared to the EU average.

Table 6.5. R&D activities of total Polish enterprises against the average for EU enterprises in 2016–2018 (%)

	In-house R&D activities performed on a continuous basis (permanent R&D personnel employed by the entity)	Ad-hoc in-house R&D activities (implementation of a research and development project)	In-house R&D activities and R&D outsourcing (procurement from external sources)	R&D outsourcing (procurement from external sources)
Poland	4.0	3.5	7.7	3.8
EU-27 average	12.5	8.9	22.6	10.0
Euro area average	14.9	10.5	26.5	11.5

Source: Eurostat [2021b].

The data shows that only 11% of Polish enterprises declared having introduced a product innovation during the period under study, compared with the average of 19.9% for EU-27 enterprises and 22% for euro area enterprises.

For process innovations introduced during the period under study, the average for Polish enterprises was 18.8% and for UE-27 and euro area enterprises it was 41% and 46.1%, respectively. The smallest gap is found between Polish and EU enterprises in terms of the introduction of new business practices for organizing procedures or external relations, while its intensity is still twice as low, and the widest gap is observed

in Frascati, Italy, on how to collect information on R&D activities and on the results of those activities. The arrangements, systematically expanded and refined, were published in a document commonly known as the Frascati Manual. Subsequent editions of the Manual are accompanied by annexes aimed at expanding the scope of R&D statistics studied and, as was the case with the 2007 annex, including more countries in the international system of R&D statistics.

in the introduction of new methods of data processing or communication, where the frequency of innovations introduced is almost three times lower than for euro area enterprises (for details see Table 6.6).

Table 6.6. Introduction of product and/or process innovation by Polish enterprises against the average for EU enterprises in 2016–2018 (%)

Countries	Product innovation	Total business process innovation	Methods for producing goods or providing services	Logistics, delivery or distribution methods	Business practices for organizing procedures or external relations	Methods of organizing work responsibilities, decision-making or human resource management	Information processing or communication methods	Methods of accounting or other administrative operations	Marketing methods for product packaging, pricing, promotion techniques, product placement, after-sales services
Poland	11.1	18.8	9.7	6.9	8.8	10.5	8.9	8.8	8.2
EU-27 average	19.9	41.0	20.9	12.9	15.2	20.5	22.8	17.6	16.6
Euro area average	22.0	46.1	23.5	14.4	17.3	23.4	26.4	20.2	18.4

Source: Eurostat [2021c, 2021d].

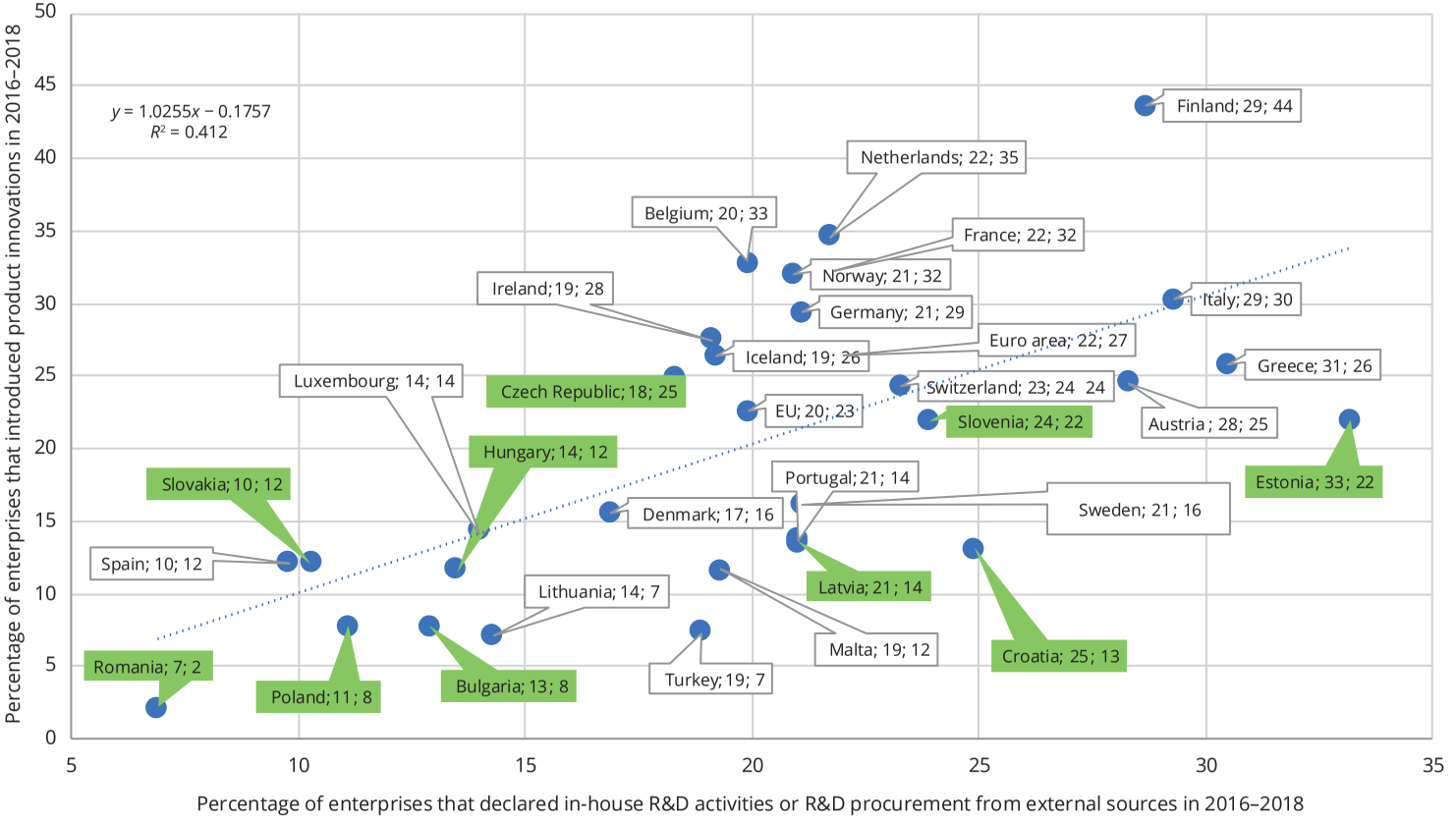
Figure 6.5 shows a comparison of data indicating what percentage of enterprises in the European Union introduced a product innovation and how many of them conducted in-house R&D or outsourced R&D services.

The data in Figure 6.5 shows great disparities in the intensity of introduction of product innovations among the EU member states. The average percentage of such declarations for the EU-27 is 20. The countries ranked much below the average are Romania (7%), Spain and Slovakia (10% each), Poland (11%), Bulgaria (13%), Hungary, Luxembourg, and Lithuania (14% each), Denmark (17%), the Czech Republic (18%), Turkey, Ireland, and Malta (19% each).

On the other hand, Belgium (20%), Norway, Latvia, Portugal, Germany, Sweden (all 21% each), the Netherlands, France (22% each), Switzerland (23%), Slovenia (24%), Croatia (25%), and the leaders Austria (28%), Finland and Italy (29% each) ranked average or higher.

The same questionnaire was also used to find out what percentage of enterprises declared in-house R&D or purchase of R&D from external sources. The EU average was 23%. Enterprises from countries such as Romania (2%), Lithuania and Turkey (7%), Poland and Bulgaria (8%), Malta, Hungary, Spain, and Slovakia (12% each), Croatia (13%), Portugal, Latvia, Luxembourg (14% each), Denmark, Sweden (16% each), Slovenia and Estonia (22% each) ranked below the average. The other countries performed above the average.

Figure 6.5. A comparison of the percentage of total enterprises in the European Union, which introduced a product innovation in 2016–2018 with the percentage of all enterprises which conducted their own R&D activities and purchased R&D from external sources



Source: Compiled by authors based on Community Innovation Survey 2016–2018 (Eurostat database).

We take the R^2 coefficient level as a measure of the quality of fit of real data. It indicates what part of variability of dependent variable Y (in this case, the introduction of a product innovation) can be explained by regression, i.e. by linear dependence on variable X (in-house R&D or R&D outsourcing). The coefficient takes on the values from 0 to 1, where 0 means no fit and 1 is complete fit. The R^2 coefficient for the dependence being examined is 0.41, which can be interpreted so that 41% of the innovativeness of the enterprises concerned, measured by the percentage of enterprises that declared the introduction of a product innovation during the period under study is explained by the fact they conducted R&D in-house or procured R&D services.

This is a significant dependence, which unambiguously indicates that the introduction of a product (i.e. technological) innovation is dependent on research and development inputs, irrespective of their source, while of course the impact of other factors should also be kept in mind.

The CIS 2016–2018 questionnaire does not contain questions referring directly to the issue of sustainable competitiveness (with special focus on eco-innovation and social innovation).

The only question that addresses this issue is that concerning the positive (initiating) or negative (preventing or cost-increasing) impact of various types of laws and regulations (on product/consumer safety; environmental protection; intellectual property; taxes and employment, worker safety or social affairs) on the introduction of innovations by enterprises in a country.

This question is not mandatory in the questionnaire, and data is available for 18 European countries only, including Poland.

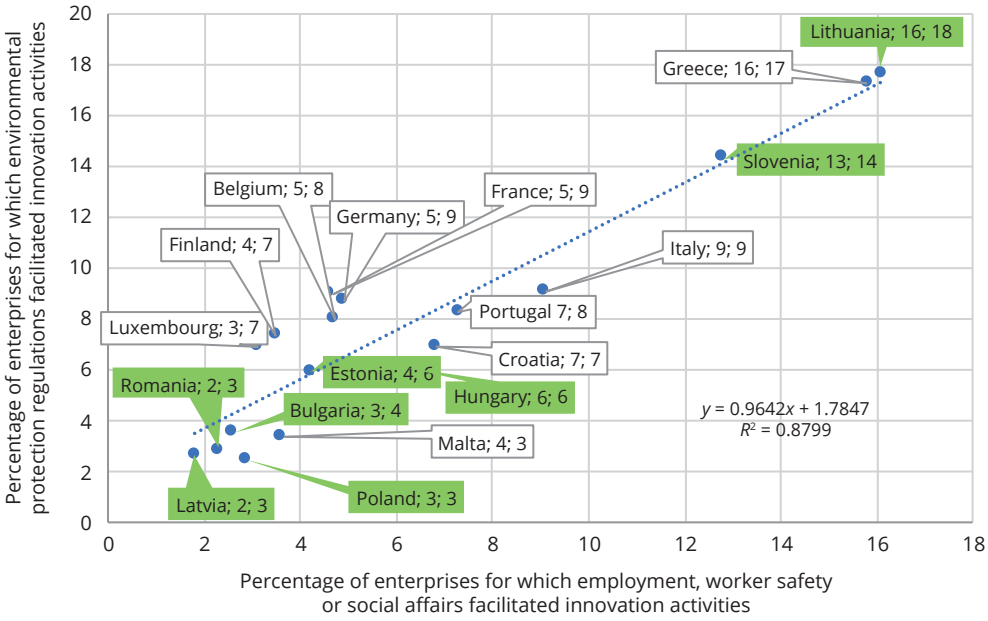
Figure 6.6 presents a comparison of data for enterprises in selected European countries, which declared that laws and regulations on employment, worker safety or social affairs initiate their innovation activity. The data was combined with data for those enterprises that declared that environmental laws and regulations are an element that initiates or facilitates innovation activity.

The chart clearly shows that declarations by total enterprises are at a relatively low level. The average percentage of enterprises for the whole sample of countries indicating that laws and regulations on social affairs initiate innovations in just over 6% of the enterprises surveyed; as regards the positive impact of environmental laws and regulations, the percentage was just under 8%.

Given that the data presented is a measure of effectiveness of laws and regulations on social affairs and environmental protection, which promote the initiation of innovations, high polarization can be seen between enterprises in the surveyed countries. The most conducive regulatory framework in both areas is found in Lithuania, Greece,

and Slovenia, whereas the situation is the worst in countries such as Latvia, Romania, Bulgaria, and Poland.

Figure 6.6. Percentage of total enterprises surveyed in selected EU member states which declared that their innovation activity in 2016–2018 was initiated or facilitated by employment, worker safety or social affairs or environmental protection



Source: Compiled by authors based on Community Innovation Survey 2016–2018 (Eurostat database).

6.6. Conclusions

The analysis of Poland's innovation performance conducted in this chapter can be summed up by highlighting the main tendencies that have manifested themselves in the period 2015–2021:

- from 2015, the innovation position relative to the average performance in the EU, measured by the Synthetic Innovation Index (SII) improved by as much as 15 p.p., but the value of the index remains low and in 2021 it reached only 66% of the EU average;
- in relative terms, the smallest innovation gap between Poland and the EU average is found in the areas of digitalization, intellectual assets, information technologies, as in 2021 the indicators describing these dimensions exceeded 80% of their EU

average; acceleration of the process of catching up with the EU average is considered very important in the context of the circumstances and changes caused by the COVID-19 pandemic;

- innovation areas which are important for the improvement of sustainable competitiveness, such as eco-innovation and social innovation, are not among the strengths of the Polish economy; the main causes of Poland's low innovation position in the field of natural environment are low eco-innovation inputs, resource productivity much below the EU average, and an insufficient level of investment in environmental technologies in the early stage of development;
- the potential of innovation in the social domain remains untapped in Poland, one of the barriers being an insufficient system of economic and fiscal incentives encouraging social innovations.

The analysis of the regional dimension of innovation performance in Poland prompts the following conclusions:

- there is a strong polarization of research, development, and innovation activities in Polish regions and the innovation gap between voivodeships has been growing, as indicated by the existence of σ-convergence in innovation;
- uneven development of regional innovation systems and growing disparities in innovation at the regional level may have a negative impact on innovation at the national level, which poses significant challenges for innovation policy;
- the last decade has seen a dynamic growth of cooperation between innovation-active industrial enterprises within clusters, which provides opportunities for the mobilization of resources and achievement of the necessary technological critical mass for research, development, and innovation activity.

On the other hand, the following conclusions can be drawn from the analysis of innovation at the enterprise level in Poland:

- the frequency of responses by Polish enterprises declaring R&D conducted in-house as well as the frequency of R&D purchases from external sources is among the lowest in the EU at a third of the EU-27 average;
- also the frequency of product innovations and business process innovations introduced by total Polish enterprises is among the lowest in the EU, at half of the EU-27 average;
- there is a statistically significant dependence between the frequency of product innovations introduced and in-house R&D or R&D procurement, found for enterprises in EU member states, which clearly shows that improvement of the innovation performance of Polish enterprises is strongly dependent on investment in R&D;
- as regards the frequency of product innovations introduced and the frequency of responses concerning R&D investments among enterprises in Central and Eastern

European countries, the laggards are entities in Romania, Poland, Bulgaria, Slovakia, and Hungary, with enterprises in the Czech Republic, Latvia and Croatia performing much better, and the leaders being firms in Slovenia and Estonia, which is indicative of a significant polarization within the CEE group and the fact that some of them catch up faster with the "old" countries of the euro area;

- the comparison of data for enterprises in selected European countries, which declared that laws and regulations on employment, worker safety or social affairs initiate their innovation activity, clearly shows that the policies in both areas in Poland fail to effectively play their role; this indicates, on the one hand, the need for government agencies to increase spending on innovation activities and, on the other hand, requires greater awareness among enterprises regarding the benefits of introducing various types of innovation (eco-innovations, social innovations) for building their market position, measured in a more holistic and long-term perspective [Lewandowska, 2020].

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Chapter 7

Influence of Institutions on the International Competitiveness of the Polish Economy in the Second Decade of the 21st Century

Katarzyna Kamińska

7.1. Introduction

Institutional economics and the tools it offers provide capability to perform a comparative analysis of economic systems as well as to identify the institutional basis of the comparative advantage of some forms of capitalism over others. The existence of this advantage is determined by the coexistence of several complementary factors of similar importance [Wojtyna, 2005, p. 17]. The most important factors are institutions, understood as rules of the game [North, 1997], whose task is to determine the role and function of the state in the modern economy in such areas as creating institutional foundations for market operation, ensuring the international competitiveness of the economy and its growth, working towards macroeconomic stabilization, and stimulating and verifying the directions of resource allocation set by the market [Jakóbik, 2006, pp. 72–92; Przesławska, 2009, p. 185]. The study seeks to assess the influence of institutions in Poland on the international competitiveness of the Polish economy after 2010 on the basis of data from the World Economic Forum (WEF) reports.[1]

7.2. The importance of institutions in economic growth processes

The growing interest of economists in the role and importance of institutions in economic processes is due to the fact that mainstream economics does not provide

[1] Many international organizations are involved in research on the international competitiveness of economies. Some notable examples include the World Economic Forum, the International Institute for Management Development, the World Bank, the OECD, and the Heritage Foundation. Based on assumed determinants of competitiveness, those organizations rank countries in terms of their competitive position in the world, taking also into account institutional aspects [Mazur-Wierzbicka, 2017, p. 228].

a comprehensive explanation of many economic problems, such as the reasons for the increase in income disparities between countries and the explanation of these disparities using traditional growth models or the failure of systemic transformation and its various effects visible among some post-communist countries [Miłaszewicz, 2011, p. 8]. The development of the New Institutional Economics (NIE) enabled the development of research on disparities in the level of economic development and an interdisciplinary approach to this issue. However, there is no consensus among economists on the importance and priority of fundamental growth factors. Today, three main approaches can be distinguished in this respect [Miłaszewicz, 2011, p. 12]:

- geographical factors are given key importance, including climate, natural resource endowments, exposure to diseases, transport costs, the spread of knowledge and technology from more advanced areas; the research carried out by Acemoglu, Johnson, and Robinson [2002] concludes that the type of colonization pursued influenced the type of institutions initially created, which then influenced the design of the institutions that exist today and the economic performance of postcolonial countries;
- predominant importance is attached to the opening up of the economy and in particular to international trade, which is viewed as a mechanism stimulating technical progress and enabling convergence; research by economists such as Noguer and Siscart [2006] proposes that institutional factors are an important determinant of per capita income; however, their primacy cannot be unambiguously established;
- institutional factors play a major role in shaping a country's growth path; in this respect, institutions such as the protection of property rights and the rule of law deserve attention, which influence the formation of the structure of stimuli forming certain behaviours of individuals; research conducted by Rodrik, Subramanian, and Trebbi [2002], indicates the quality of institutions as the most important of the fundamental factors of growth; an increase in the degree of openness of the economy has a positive impact on their development.

Effective institutions should perform a number of specific functions in a market economy [World Bank, 2002]. The first function is to enable the flow of information, and in particular its impact on the creation, collection, analysis, verification, and dissemination of information and knowledge Examples of such institutions include audit firms, credit registers, government regulations regarding constraints imposed on media, etc. The second function mentioned in the literature is to define and secure property rights and contracts through a country's constitution, its judicial system or various informal arrangements. The third function of properly working institutions

contributes to changes in the level of competition, which can have an impact on the level of innovation and the rate of economic growth.

Assessment of the quality of institutions in an economy can be carried out from the point of view of the fulfilment of their functions and conformity with the purpose for which they were established, distribution issues, as well as having regard to their creation of incentives supporting efficient markets and reducing uncertainty [Miłaszewicz, 2011, p. 14]. Different groups of indicators and their potential impact on economic conditions and growth can be used for such an assessment [Aron, 2000, pp. 107–112]. The first group consists of indicators describing the characteristics of institutions, the impact of which on economic conditions and economic growth can be described as indirect:

- measures of political instability;
- the characteristics of society;
- formal institutions.

The second group includes indicators that can have a direct impact on economic conditions and economic growth:

- the quality of social capital;
- the quality of governance, which can describe the degree of implementation of property rights or the security of contracts and property rights.

7.3. The quality of institutions in Poland in 2010–2019 according to the Global Competitiveness Index

One of the indicators measuring the international competitiveness of economies is the Global Competitiveness Index (GCI), developed by Xavier Sala-i Martin, an economist who studies the problems of economic growth and development. This measure is based on a set of factors that play a fundamental role in increasing the productivity and competitiveness of a country, also taking into account changes occurring in the world economy. The measurement of competitiveness is based on 12 pillars [Schwab, 2011, pp. 4–8]:

- **basic requirements:** institutions, infrastructure, macroeconomic environment, health and primary education;
- **efficiency enhancers:** higher education and training, goods market efficiency, labour market efficiency, financial market development, technological readiness, market size;
- **innovation and sophistication factors:** business sophistication, innovation.[2]

[2] In 2019, the pillars could be described as follows as follows: Enabling environment: Pillar 1 – Institutions, Pillar 2 – Infrastructure, Pillar 3 – ICT adoption, Pillar 4 – Macroeconomic stability; Human

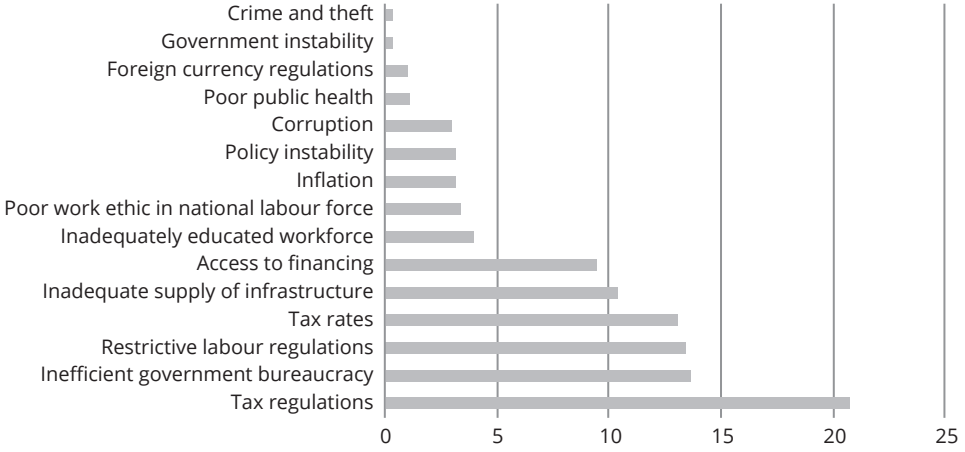
The first component of this indicator represents the quality of institutions. As mentioned above, institutions influence the evolution of basic conditions for business operation and adaptation of the domestic economic structure to stimulating growth processes in the changing environment of the global economy. The significance of institutions should therefore fall within a dynamic concept of international competitive ability of the economy, defined as "long-term capability of an open market economy (…) to challenge international competition" [Przesławska, 2006, p. 188; Kotyński, 2002, p. 2]. On the other hand, the concept of institutional competitiveness of a country describes the quality and characteristics of the institutional environment in a broad sense, including formal rules of the game, such as system of government, justice, bureaucracy, contract law, property law in creating the conditions necessary to achieve high international competitiveness [Dołęgowski, 2002, pp. 82–83; Przesławska, 2006, p. 188].

In 2010, according to the WEF report [Schwab, 2011], Poland was ranked 39th out of 142 assessed countries (with GDP per capita of USD 12.3 thousand) and was positioned among countries in which changes in competitiveness resulted mainly from efficiency improvements. Efficiency improvements as a source of competitiveness of the Polish economy were ranked 30th (more specifically, for higher education and training – 31st, market efficiency – 52nd, labour market efficiency – 58th, financial market development – 34th, technological readiness – 48th, market size – 33rd). Innovation played a much smaller role in this respect (18.3% and 57th position among the countries under study, including business sophistication – 60th, and innovation – 58th). According to the basic requirements, the Polish economy ranked 56th for competitiveness and 52nd for quality of institutions. In other categories, the ranks were as follows: 74th – infrastructure with the macroeconomic environment; 40th – health and primary education. As regards the most problematic factors for doing business in Poland, the respondents mentioned first tax regulations (20.7% of answers; see Figure 7.1).

Another factor indicated was the inefficient government bureaucracy (13.6% of responses), restrictive labour regulations (13.4%), tax rates (13.0%), inadequate supply of infrastructure (10.4), and access to financing (9.4%) (Schwab, 2011, p. 296). The smallest percentage of respondents chose crime and theft (0.3%) and government instability (0.3%), which means that basic business security was ensured.

capital: Pillar 5 – Health, Pillar 6 – Skills; Markets: Pillar 7 – Product market, Pillar 8 – Labour market, Pillar 9 – Financial system, Pillar 10 – Market size; Innovation Ecosystem: Pillar 11 – Business dynamism; Pillar 12 – Innovation capability [Schwab, 2019, p. 2].

Figure 7.1. The most problematic factors for doing business in Poland according to respondents interviewed for the Global Competitiveness Report 2011/2012 (% of indications)



Source: Compiled by author based on Schwab [2011, p. 296].

As factors related to the Polish tax system and tax rates are among the problems indicated by the largest percentage of respondents, they deserve attention at this point. The Polish tax system started to be subjected to market pressure in the early 1990s.[3] The reason for the emergence of this pressure was the need to raise international investment capital, necessary in the process of transformation of the Polish economy, attract more investors, and to improve the situation of domestic companies in terms of the profitability of doing business in the country. Various taxes, both direct and indirect, may be subject to international competition. Most often, international tax competition focuses around taxes affecting firms operating as corporations, primarily the CIT (Corporate Income Tax). This tax is one of the factors behind both domestic and foreign entities engaging in business in a country [Oręziak, 2007]. The lower the taxes imposed on businesses, the faster development of entrepreneurship can be expected. Conversely, the higher the taxes, the greater the likelihood of outflow of production and capital to countries where there are lower fiscal burdens [Grynia, 2014, p. 126]. As a rule, the provisions of EU directives have been implemented into the Polish tax system. The CIT rate was reduced from 40% in the 1990 s to 19% in 2004. For small businesses (with the small taxpayer status), the rate of this tax was also reduced. In 2017–2018, it stood at 15%, and since 2018 it has been 9%. The tendencies to reduce

[3] The following section of the study on the evaluation of the Polish tax system can be found in: Kamińska, 2021, pp. 53–54.

tax rates for small taxpayers and the general CIT rate should be viewed positively, as they may provide an incentive to set up new businesses.

In the light of international assessments, the Polish tax system has not been rated as business-friendly for a long time. It is perceived not only as one of the least stable but also the most complicated system among all OECD countries [SGI, 2011]. One measure that quantifies the extent to which the tax systems of 36 OECD countries promote competitiveness through a low tax burden on business investment and neutrality, owing to a well-structured tax system, is the International Tax Competitiveness Index (ITCI). The index is prepared by the Tax Foundation and includes more than 40 variables in five categories: corporate taxes, personal taxes, consumption taxes, property taxes, and international tax rules. In 2020, Poland was ranked 34th out of 36 countries. The last two places went to Chile and Italy. The leader was Estonia, which took the first place for the seventh time. It was followed by Latvia and then New Zealand. In the part of the ranking concerning Poland, three strengths and weaknesses of the Polish tax system were indicated. The first strength is the nominal corporate tax rate (19%), below the OECD average of 23.3%. Poland was ranked 9th in this respect. Only six countries have a rate below 20% – Ireland (12.5%), Lithuania (15%) and the Czech Republic, Slovenia, the United Kingdom, and Poland, all with 19%. The average CIT rate in Europe in 2021 is 21.7%. The highest taxes are paid in Portugal (31.5%), and the lowest in Hungary and Ireland, at 9% and 12.5%, respectively. In Germany, the statutory CIT rate is 29.9%, and in France it is 28.4%. Between 1990 and 2020, the CIT rate in Poland was reduced once in 2005 from 40% to 19%. The country's rating for personal tax is not much worse, where Poland was ranked 11th. The report points out that Poland's tax burden on wages is generally "flat", allowing the government to raise revenue from taxes on workers with relatively low efficiency costs. It was noted that Poland has a system covering 85 international tax treaties. One weakness of the Polish tax system pointed out in the ranking was the fact that Poland has a complex distortionary property tax system with separate levies on real estate transfers, estates, bank assets, and financial transactions. In addition, companies are severely limited in the amount of net operating losses that they can use to offset future profits. They are unable to use losses to reduce past taxable income. It was noted that companies can only write off 33.8% of the cost of industrial buildings (in real terms), while the OECD average is as high as 48.3% [Chudy, 2020].

In the category of complexity of consumption taxes, Poland emerged as the country with the worst result regarding the number of hours it takes a business to comply with those taxes (172 hours per year). This is mainly about VAT. The best score was recorded in Switzerland, where the entrepreneur uses only 8 hours a year to comply. The average number of hours in the entire OECD was 53.5 hours, i.e. more than

three times less than in Poland. The high complexity of the Polish tax system and incomprehensible regulations cause an increase in the cost of running a business and a decrease in business predictability.

Another index measuring the ease of paying taxes for businesses is the "Paying Taxes" ranking prepared by PwC and the World Bank. In 2020, Poland took the 77th position out of 190 countries [PwC, 2019]. Despite the fact that electronic solutions have been implemented to simplify tax compliance, Poland has not improved its position in the ranking.

Going back to the GIC analysis, in particular the institutional component of the index, it should be pointed out that in the 2020 report the following Polish institutional categories were assessed most favourably: strength of investor protection (36th position), business costs of crime and violence (37th), organized crime (40th), and irregular payments and bribes (39th). On the other hand, the following were indicated among weaker Polish institutions: efficacy of corporate boards (79th position), protection of minority shareholders' interests (79th), and a group of institutions related to the style of economic policymaking and the judiciary: public trust of politicians (76th), wastefulness of government spending (76th), transparency of government policymaking (93rd), efficiency of legal framework in settling disputes (97th), and burden of government regulation (124th).

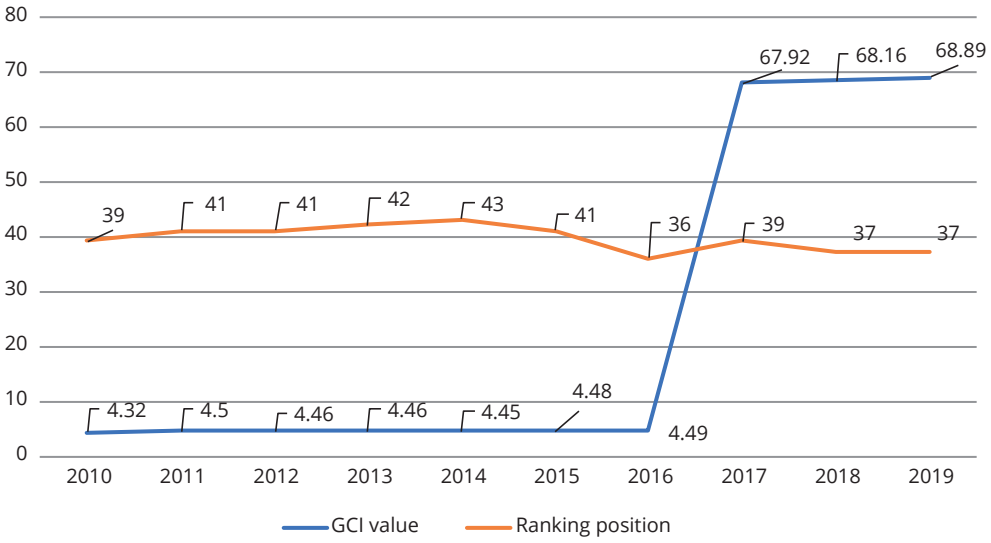
Among the institutions mentioned, it is worth noting the efficiency of legal framework in settling disputes, and thus the inefficient judiciary, which may constitute a serious barrier to the development of Polish entrepreneurship. In Poland, there is no dispute resolution mechanism alternative to court proceedings. In addition, the burden on courts related to keeping records of business transactions significantly limits their general availability. Another issue worth commenting on is the problem of wastefulness of government spending, which places this economy in the middle of this ranking. In Poland, the share of public expenditure in GDP relative to the level of per capita income is too high. In 2011, the share of public expenditure in GDP amounted to 43.6% and by 2019 it had fallen to 40.4% [Fundacja Republikańska, 2021]. With a given budget deficit, a high level of spending means an increase in taxes. This has a negative impact on the supply side of the economy. As the data indicates, with the share of expenditure in GDP at the level prevailing in economically developed countries (about 40%) and a much lower income per capita, even a savings rate of 30–35% of GDP can provide an investment rate only in the range of 15–20% [Przesławska, 2006, pp. 191–192].

In terms of defining and protecting property rights as one of the basic components of the institutional environment, Poland ranked 54th. Their key role is to weaken conflicts in the disposal of economic resources and to promote productive activities.

Research conducted by North indicates that in countries where there are no strong property rights the economy ceases to develop [Przesławska, 2006, p. 190].

In the following years, the value of the GCI for Poland was steadily increasing (see Figure 7.2) from a score of 4.32 in 2010 to 68.89 in 2019. Interestingly, however, this did not result in its significant advancement in the WEF ranking.

Figure 7.2. Polish Global Competitiveness Index and its position in the WEF ranking in 2010–2019



Source: Compiled by author based on Statista [2021] and Schwab [2011, 2019].

In 2010, the country was ranked 39th and by 2015 it had fallen by two places, and since 2016 it has improved its position to reach 37th place in 2019.

In 2019, the GDP per capita of the Polish economy amounted to USD 15.43 thousand, an increase of USD 3.13 thousand compared to 2010. Poland took the 27th place in the ranking. Particularly noteworthy is the first place out of 141 countries ranked for macroeconomic stability. In the field of human capital, especially regarding skills, the Polish economy took the 34th position [Schwab, 2019, p. 466].

As for the analysed institutional aspect, compared to 2010, Poland's position deteriorated in terms of the quality of institutions (60th place with a score of 56 points out of 100 possible). The institutional categories in which the Polish economy ranks highest include low homicide rate (26th), budget transparency (30th), incidence of corruption (34th), and environment-related treaties in force (36th). On the other hand, among the analysed institutions there is a group in which Poland is ranked lower than 100th. As for 2010, these institutions can be classified as those related to the style

of policymaking and the judicial system. Government ensuring policy stability was ranked 123rd, efficiency of legal framework in challenging regulations – 121st, judicial independence – 118th, burden of government regulation – 113th, and government long-term vision – 102nd) [Schwab, 2019, p. 467].

The areas of interest of the New Institutional Economy include the study of the impact of non-market institutions, such as the system of property rights or the rule of law, and judicial independence, on economic growth. One of the assumptions made during the study was that the existence of an independent judiciary as an important element of the non-market institutional environment would have a positive impact on reducing uncertainty in relations between individuals. They can be treated as a guarantee of compliance with the law by both individuals and representatives of state power, and thus it will be a factor stimulating the growth of long-term investment [Przesławska, 2006, p. 191]. What should be emphasized in this context is the fact that Poland's rank for the performance of independent courts may in the long run weaken the propensity to undertake investment. It is also worth paying attention to issues related to the determination and protection of property rights. Compared to 2010, Poland fell from the 54th to 90th position, which means a deterioration in the quality of the country's institutional environment.

7.4. Conclusions

One of the features of ongoing globalization is the strengthening of the regulatory function of government, which is manifested in its influence on the design of institutions and policies that are important for socio-economic development. In the analysed period, Poland slightly improved its position in the WEF ranking (37th in 2019), winning the first place in 2019 in terms of macroeconomic stability. On the other hand, the assessment of the quality of institutions deteriorated – from the 52nd position in 2010 to 60th in 2019. The foremost shortcomings of Polish institutions in the second decade of the 21st century are as follows: insufficient quality of the legal framework; burden of government regulations; relatively low, compared to other EU countries, competitiveness of the Polish taxation system; issues related to the operation and independence of the judicial system; the quality of institutions related to the long-term vision and stability of economic policy. All the imperfections of the Polish institutional system listed here may, to varying degrees, undermine development prospects of the Polish economy. This situation clearly indicates the need to launch institutional reforms in these areas, which may consequently have a positive impact on improving the international competitiveness of the Polish economy.

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Part III

Competitive Position: Poland and Other EU Members

Chapter 8

Changes in Total Factor Productivity

Mariusz Próchniak

8.1. Introduction

The analysis of total factor productivity will be performed using the growth accounting methodology. Growth accounting is an empirical exercise aimed at determining to what extent economic growth results from changes in the measurable production factors and from changes in the level of technology, measured by the growth rate of total factor productivity (TFP).

The analysis at the whole economy level covers 11 countries of Central and Eastern Europe, i.e. the EU-11 group (Poland, Bulgaria, Croatia, the Czech Republic, Estonia, Lithuania, Latvia, Romania, Slovakia, Slovenia, and Hungary) over the period 2011–2020. The study ends in 2020, as no reliable data was yet available at the time the calculations were made (autumn 2021). To assess the dynamics of changes in total factor productivity in the analysed years, we also present the average TFP growth rates for the following sub-periods: 2011–2013, 2014–2016, 2017–2019, and for 2020.

This study is a continuation of prior research presented in the previous editions of the Report [see, e.g. Próchniak 2018, 2019, 2020]. The 2020 edition of the study [Próchniak, 2020] additionally contained the economic growth account at sector level.

8.2. Changes in total factor productivity – theoretical background

The origins of growth accounting date back to the first half of the 20th century. The concept of total productivity and the view that labour is not the only production factor, and that in measuring the wealth of nations and productivity one should take into account other factors, such as capital and land, were discussed in the economic literature in the 1930s [Griliches, 1996]. The first mentions of the input-output ratio appeared in Copeland's paper in 1937 [Griliches, 1996]. In the 1940s and 1950s, many studies were published – to a large extent independently – which included results of

empirical research on TFP measurement. The first such study, conducted by Dutch economist Jan Tinbergen, was published in 1942. In the following years, further studies appeared, in which the authors examined the relationship between the output volume and the inputs [see, e.g. Tintner, 1944; Barton, Cooper, 1948; Johnson, 1950; Schmookler, 1952; Abramovitz, 1956; Kendrick, 1956; Ruttan, 1956].

Robert Solow was the first economist to formalize growth accounting [Solow, 1957]. Using the macroeconomic production function and differential calculus, he showed how the rate of economic growth can be divided into the part resulting from an increase in factors of production and the remaining part, referred to as Solow's residual. The latter shows what part of economic growth cannot be attributed to individual factors. Thus, it is a measure of technological progress, or TFP growth.

In the following years, further studies on growth accounting appeared, introducing new approaches and extensions of previously conducted research and containing new elements of empirical analysis [see, e.g. Solow, 1962; Griliches, 1964; Jorgenson, Griliches, 1967].

The decomposition of economic growth initiated by Solow forms the basis of modern growth accounting. The starting point of such an analysis is the macroeconomic production function. Its general form is as follows:

$$Y(t) = F\left(A(t), Z_1(t), \ldots, Z_n(t)\right), \tag{8.1}$$

where Y – output (GDP), A – level of technology, Z_1, …, Z_n – measurable factors of production. Two or three measurable factors of production are usually taken into account in empirical research, namely: labour, physical capital, and possibly human capital.

The analysis in this edition of the report will be carried out for two measurable factor inputs: labour and physical capital.[1] The production function (8.1) therefore takes the following form:

$$Y(t) = F\left(A(t), L(t), K(t)\right). \tag{8.2}$$

In order to decompose the rate of economic growth into individual components, equation (8.2) should be transformed into a form representing the growth rate of Y. For this purpose, we differentiate (8.2) with respect to time and then divide by Y. As a result, we obtain:

$$\frac{\dot{Y}}{Y} = \frac{\frac{\partial F\left(A,L,K\right)}{\partial A}\dot{A}}{Y} + \frac{\frac{\partial F\left(A,L,K\right)}{\partial L}\dot{L}}{Y} + \frac{\frac{\partial F\left(A,L,K\right)}{\partial K}\dot{K}}{Y}. \tag{8.3}$$

[1] In the 2012 and 2014 editions of the study, in addition to the basic growth accounting model, an extended model was also estimated, which included human capital [Próchniak, 2012, 2014].

After multiplying the individual components on the right-hand side of equation (8.3) by A/A, L/L and K/K, respectively, we get:

$$\frac{\dot{Y}}{Y}=\frac{\frac{\partial F\left(A,L,K\right)}{\partial A}A}{Y}\frac{\dot{A}}{A}+\frac{\frac{\partial F\left(A,L,K\right)}{\partial L}L}{Y}\frac{\dot{L}}{L}+\frac{\frac{\partial F\left(A,L,K\right)}{\partial K}K}{Y}\frac{\dot{K}}{K}. \tag{8.4}$$

Equation (8.4) shows that the GDP growth rate is the weighted average of growth rates of three factors: technology, labour, and physical capital. The weights are the shares of individual factors in GDP, measured as the marginal product of the factor (at the whole economy level) multiplied by the amount of a given factor and divided by the volume of output.

8.3. Method

The research method used in this chapter is economic growth accounting. In order to be able to calculate the TFP growth rate in an empirical study, additional assumptions should be made to equation (8.4) which shows the essence of economic growth accounting.

We assume, firstly, that the production function is characterized by Hicks-neutral technological progress. Therefore, this function can be described as follows:

$$F(A,L,K)=A\cdot f(L,K). \tag{8.5}$$

As can be seen, Hicks-neutral technological progress means that variable A, representing the level of technology, occurs in the product with production function f, making the output volume dependent on measurable inputs. Technological progress augments both production factors to the same extent, without changing the marginal rate of technological substitution between them. For the production function (8.5), the share of technology in income, i.e. the component $(\partial F/\partial A)\,A/Y$ in equation (8.4), equals 1. Equation (8.4) can then be written as:

$$\frac{\dot{Y}}{Y}=\frac{\dot{A}}{A}+\frac{\frac{\partial F\left(A,L,K\right)}{\partial L}L}{Y}\frac{\dot{L}}{L}+\frac{\frac{\partial F\left(A,L,K\right)}{\partial K}K}{Y}\frac{\dot{K}}{K}. \tag{8.6}$$

The above equation shows that the rate of economic growth equals the sum of technological progress (increase in TFP) and the average growth rate of labour and physical capital, weighted by the shares of both factors in income.

An additional assumption should also be made regarding the marginal products of both factors. The marginal product of labour and capital at the whole economy level is in fact non-measurable. We therefore assume that all markets are perfectly competitive and that no externalities exist. In this case, the marginal product of capital $\partial F/\partial K$ equals the price of capital r, while the marginal product of labour $\partial F/\partial L$ equals the wage rate w. By using s_K to describe the capital share of income (rK/Y) and s_L to describe the share of labour (wL/Y), equation (8.6) can be written as:

$$\frac{\dot{Y}}{Y}=\frac{\dot{A}}{A}+s_K\frac{\dot{K}}{K}+s_L\frac{\dot{L}}{L}. \tag{8.7}$$

Let us make the additional assumption that all income can be assigned to one of two factors of production: labour or physical capital, i.e. $Y = wL + rK$. In this case, the shares of labour and physical capital in income add up to 1: $s_K + s_L = 1$. Thus, formula (8.7) takes the following form:

$$\frac{\dot{Y}}{Y}=\frac{\dot{A}}{A}+s_K\frac{\dot{K}}{K}+\left(1-s_K\right)\frac{\dot{L}}{L}. \tag{8.8}$$

Equation (8.8)[2] is the basis for standard growth accounting. From this equation, the TFP growth rate can be calculated as the difference between the GDP growth rate and the weighted average growth rate of both factors of production:

$$TFP\text{ growth}=\frac{\dot{A}}{A}=\frac{\dot{Y}}{Y}-\left[s_K\frac{\dot{K}}{K}+\left(1-s_K\right)\frac{\dot{L}}{L}\right]. \tag{8.9}$$

8.4. Empirical study results

For the purpose of the analysis, we have gathered data forming the following time series:

a) the rate of economic growth,
b) the rate of change in labour inputs,
c) the rate of change in physical capital input.

The rate of economic growth is the annual growth rate of total real GDP, sourced from the IMF database [IMF, 2021]. The rate of change in labour inputs is measured using the employment dynamics data provided by the International Labour Organization [ILO, 2021]. We have calculated the time series of the physical capital stock on the basis

[2] This equation is in fact a Cobb-Douglas production function.

of the perpetual inventory method using the World Bank data [World Bank, 2021]. This method requires many assumptions to be taken into account. We have assumed that the depreciation rate is 5%, and the initial capital/output ratio is 3. In the perpetual inventory method, the initial year should be a little earlier than the years for which TFP is being calculated; in our study, we start calculations in 2000, which is the year to which the assumption of capital to output ratio of 3 applies. As investments, we use a variable measuring gross fixed capital formation. The shares of labour and physical capital in income equal 0,5.

In this edition of the study, we have updated all the time series of the analysed variables. All steps of the analysis have been recalculated. Therefore, the documentation of the results has been fully presented in the text of the study and it does not duplicate the information contained in the previous editions of the Report.

Table 8.1 presents detailed results of economic growth decomposition, while Tables 8.2 and 8.3 summarize the data from Table 8.1.

Romania, Lithuania, Latvia, and Poland recorded the highest TFP growth rate over the entire period (more than 1% annually). In Romania, TFP rose on average by 1.6% annually, in Lithuania by 1.5%, in Latvia by 1.4%, and in Poland by 1.2%. Poland's performance should be considered a major success (compared with other new EU members). If taken as an approximate measure of technological progress, TFP changes put Poland among the leading EU-11 countries in creating new technologies. In the remaining EU-11 countries, the productivity growth rate did not exceed the annual average of 1%. Over the entire 10-year period, Estonia and Slovenia reported an average increase in TFP by 0.9%, Bulgaria by 0.7%, and Hungary by 0.3%. In the Czech Republic and Slovakia, the average TFT growth was zero, whereas in Croatia total factor productivity even dropped.

In general, looking at the EU-11 group as a whole, the TFP growth rate was low in 2010–2020. As the analysis of data for the individual sub-periods will show, poor results are attributable to a steep decline in total factor productivity in the countries under study in 2020, i.e. during the coronavirus pandemic. A recession witnessed in all the countries in 2020 led to negative TFP growth rates in 2020.

In this chapter, TFP growth is treated as an approximate measure of technological progress. However, TFP calculated as residual on the basis of growth accounting has its drawbacks as an indicator of technological growth, which should be kept in mind when interpreting results. Firstly, the 2020 economic recession which resulted from exogenous factors and was not reflected that much in the accumulation of labour, and especially capital which an outcome of investments made in earlier years, leads to negative estimates of the TFP growth rate in 2020.

Table 8.1. The contribution of labour, physical capital, and TFP to economic growth in 2011–2020

		2011			2012			2013			2014			2015			2016			2017			2018			2019			2020		
		growth (%)	contribution (p.p.)	contribution (%)	growth (%)	contribution (p.p.)	contribution (%)	growth (%)	contribution (p.p.)	contribution (%)	growth (%)	contribution (p.p.)	contribution (%)	growth (%)	contribution (p.p.)	contribution (%)	growth (%)	contribution (p.p.)	contribution (%)	growth (%)	contribution (p.p.)	contribution (%)	growth (%)	contribution (p.p.)	contribution (%)	growth (%)	contribution (p.p.)	contribution (%)	growth (%)	contribution (p.p.)	contribution (%)
Bulgaria	L	−3.6	−1.8	−76	−1.1	−0.5	−147	0.0	0.0	5	1.6	0.8	42	1.7	0.8	21	−0.5	−0.2	−7	4.4	2.2	63	0.1	0.0	1.2	2.6	1.3	34.6	−3.4	−1.7	41.5
	K	2.8	1.4	60	2.3	1.1	318	2.2	1.1	343	2.1	1.1	56	2.2	1.1	28	2.2	1.1	29	1.6	0.8	23	1.7	0.9	27.8	2.0	1.0	26.6	2.1	1.1	−25.8
	TFP	2.7	2.7	116	−0.3	−0.3	−71	−0.8	−0.8	−248	0.0	0.0	2	2.0	2.0	51	2.9	2.9	77	0.5	0.5	14	2.2	2.2	70.9	1.4	1.4	38.9	−3.5	−3.5	84.3
	GDP	2.4	2.4	100	0.4	0.4	100	0.3	0.3	100	1.9	1.9	100	4.0	4.0	100	3.8	3.8	100	3.5	3.5	100	3.1	3.1	100.0	3.7	3.7	100.0	−4.2	−4.2	100.0
Croatia	L	−3.9	−1.9	976	−3.6	−1.8	76	−2.7	−1.3	301	2.7	1.4	−400	1.3	0.6	26	0.3	0.1	4	2.2	1.1	32	1.8	0.9	32.8	1.5	0.7	25.8	−1.3	−0.7	8.2
	K	1.5	0.7	−376	1.2	0.6	−26	0.9	0.5	−106	1.0	0.5	−142	0.8	0.4	15	0.9	0.5	13	1.3	0.6	18	1.5	0.7	26.5	1.8	0.9	31.6	2.2	1.1	−13.4
	TFP	1.0	1.0	−499	−1.2	−1.2	50	0.4	0.4	−95	−2.2	−2.2	642	1.4	1.4	59	2.9	2.9	83	1.7	1.7	50	1.1	1.1	40.7	1.2	1.2	42.6	−8.4	−8.4	105.2
	GDP	−0.2	−0.2	100	−2.4	−2.4	100	−0.4	−0.4	100	−0.3	−0.3	100	2.4	2.4	100	3.5	3.5	100	3.4	3.4	100	2.8	2.8	100.0	2.9	2.9	100.0	−8.0	−8.0	100.0
Czech Republic	L	−0.3	−0.1	−7	0.4	0.2	−23	1.0	0.5	−1047	0.8	0.4	17	1.4	0.7	13	1.9	1.0	38	1.6	0.8	16	1.4	0.7	21.6	0.2	0.1	2.9	−1.3	−0.6	11.1
	K	3.1	1.6	89	3.0	1.5	−190	2.5	1.2	−2711	2.2	1.1	48	2.2	1.1	21	2.8	1.4	54	2.3	1.2	22	2.5	1.3	39.2	3.1	1.5	50.5	3.3	1.6	−28.3
	TFP	0.3	0.3	18	−2.5	−2.5	313	−1.8	−1.8	3858	0.8	0.8	36	3.6	3.6	67	0.2	0.2	8	3.2	3.2	62	1.3	1.3	39.2	1.4	1.4	46.6	−6.8	−6.8	117.3
	GDP	1.8	1.8	100	−0.8	−0.8	100	0.0	0.0	100	2.3	2.3	100	5.4	5.4	100	2.5	2.5	100	5.2	5.2	100	3.2	3.2	100.0	3.0	3.0	100.0	−5.8	−5.8	100.0
Estonia	L	6.2	3.1	43	1.9	1.0	30	1.0	0.5	36	0.6	0.3	9	2.6	1.3	69	0.6	0.3	9	2.2	1.1	19	0.9	0.5	11.3	1.0	0.5	12.1	−2.2	−1.1	37.2
	K	1.0	0.5	7	3.0	1.5	47	3.7	1.9	128	3.5	1.8	59	3.0	1.5	81	2.5	1.3	40	2.7	1.4	23	3.6	1.8	43.0	3.3	1.6	40.1	3.5	1.8	−59.4
	TFP	3.7	3.7	51	0.7	0.7	23	−0.9	−0.9	−64	1.0	1.0	32	−0.9	−0.9	−51	1.6	1.6	51	3.4	3.4	58	1.9	1.9	45.7	2.0	2.0	47.8	−3.6	−3.6	122.2
	GDP	7.3	7.3	100	3.2	3.2	100	1.5	1.5	100	3.0	3.0	100	1.9	1.9	100	3.2	3.2	100	5.8	5.8	100	4.1	4.1	100.0	4.1	4.1	100.0	−3.0	−3.0	100.0
Hungary	L	0.7	0.4	18	1.8	0.9	−66	1.7	0.9	46	5.3	2.7	63	2.7	1.3	35	3.4	1.7	78	1.6	0.8	19	1.1	0.5	10.1	1.0	0.5	10.3	−1.1	−0.6	11.5
	K	1.2	0.6	31	1.1	0.5	−38	0.8	0.4	22	1.3	0.7	16	2.0	1.0	26	2.2	1.1	52	1.3	0.7	15	2.5	1.2	22.7	3.5	1.7	37.3	4.2	2.1	−42.7
	TFP	1.0	1.0	50	−2.8	−2.8	204	0.6	0.6	32	0.9	0.9	21	1.5	1.5	39	−0.6	−0.6	−30	2.9	2.9	66	3.6	3.6	67.2	2.4	2.4	52.4	−6.5	−6.5	131.1
	GDP	1.9	1.9	100	−1.4	−1.4	100	1.9	1.9	100	4.2	4.2	100	3.8	3.8	100	2.1	2.1	100	4.3	4.3	100	5.4	5.4	100.0	4.6	4.6	100.0	−5.0	−5.0	100.0
Latvia	L	1.3	0.6	10	1.6	0.8	19	2.1	1.0	45	−1.0	−0.5	−48	1.3	0.6	16	−0.3	−0.2	−7	0.2	0.1	3	1.6	0.8	20.2	0.1	0.0	1.8	−1.9	−0.9	25.8
	K	0.7	0.4	6	2.1	1.0	24	3.0	1.5	66	2.3	1.2	109	2.2	1.1	28	1.9	1.0	40	1.2	0.6	19	1.8	0.9	23.0	2.5	1.3	62.0	2.5	1.2	−34.3
	TFP	5.5	5.5	84	2.4	2.4	56	−0.3	−0.3	−11	0.4	0.4	40	2.3	2.3	56	1.6	1.6	66	2.6	2.6	79	2.3	2.3	56.8	0.7	0.7	36.2	−3.9	−3.9	108.4
	GDP	6.5	6.5	100	4.3	4.3	100	2.3	2.3	100	1.1	1.1	100	4.0	4.0	100	2.4	2.4	100	3.3	3.3	100	4.0	4.0	100.0	2.0	2.0	100.0	−3.6	−3.6	100.0

		2011			2012			2013			2014			2015		
		growth (%)	contribution (p.p.)	contribution (%)	growth (%)	contribution (p.p.)	contribution (%)	growth (%)	contribution (p.p.)	contribution (%)	growth (%)	contribution (p.p.)	contribution (%)	growth (%)	contribution (p.p.)	contribution (%)
Lithuania	L	0.5	0.2	4	1.8	0.9	23	1.3	0.7	19	2.0	1.0	29	1.2	0.6	30
	K	1.2	0.6	10	2.4	1.2	31	2.1	1.0	30	2.5	1.3	36	2.8	1.4	68
	TFP	5.2	5.2	86	1.8	1.8	46	1.8	1.8	52	1.3	1.3	36	0.0	0.0	2
	GDP	6.0	6.0	100	3.8	3.8	100	3.6	3.6	100	3.5	3.5	100	2.0	2.0	100
Poland	L	0.6	0.3	6	0.2	0.1	7	−0.1	−0.1	−6	1.9	0.9	28	1.4	0.7	17
	K	2.8	1.4	30	3.3	1.6	124	2.9	1.4	127	2.6	1.3	38	3.1	1.6	37
	TFP	3.1	3.1	64	−0.4	−0.4	−31	−0.2	−0.2	−20	1.1	1.1	34	2.0	2.0	47
	GDP	4.8	4.8	100	1.3	1.3	100	1.1	1.1	100	3.4	3.4	100	4.2	4.2	100
Romania	L	−2.1	−1.1	−56	0.9	0.5	22	−0.6	−0.3	−9	0.8	0.4	10	−0.9	−0.5	−15
	K	3.6	1.8	95	3.8	1.9	93	3.8	1.9	50	2.9	1.5	41	3.0	1.5	51
	TFP	1.2	1.2	61	−0.3	−0.3	−16	2.2	2.2	59	1.8	1.8	49	1.9	1.9	64
	GDP	1.9	1.9	100	2.0	2.0	100	3.8	3.8	100	3.6	3.6	100	3.0	3.0	100
Slovakia	L	−0.1	0.0	−2	0.6	0.3	16	0.0	0.0	1	1.5	0.7	27	2.6	1.3	27
	K	2.9	1.4	50	3.7	1.9	98	2.6	1.3	193	2.5	1.2	47	2.5	1.3	26
	TFP	1.5	1.5	51	−0.3	−0.3	−14	−0.6	−0.6	−94	0.7	0.7	26	2.3	2.3	47
	GDP	2.8	2.8	100	1.9	1.9	100	0.7	0.7	100	2.6	2.6	100	4.8	4.8	100
Slovenia	L	−3.1	−1.5	−180	−1.3	−0.7	25	−1.9	−1.0	94	1.2	0.6	22	0.1	0.0	2
	K	1.4	0.7	79	1.0	0.5	−18	0.4	0.2	−20	0.6	0.3	10	0.5	0.3	12
	TFP	1.7	1.7	200	−2.5	−2.5	93	−0.3	−0.3	26	1.9	1.9	68	1.9	1.9	86
	GDP	0.9	0.9	100	−2.6	−2.6	100	−1.0	−1.0	100	2.8	2.8	100	2.2	2.2	100

		2016			2017			2018			2019			2020		
		growth (%)	contribution (p.p.)	contribution (%)	growth (%)	contribution (p.p.)	contribution (%)	growth (%)	contribution (p.p.)	contribution (%)	growth (%)	contribution (p.p.)	contribution (%)	growth (%)	contribution (p.p.)	contribution (%)
Lithuania	L	2.0	1.0	39	−0.5	−0.2	−6	1.5	0.7	18.7	0.3	0.1	3.1	−1.5	−0.7	84.3
	K	2.9	1.5	58	3.0	1.5	35	3.4	1.7	43.4	4.0	2.0	45.5	4.1	2.1	−237.9
	TFP	0.1	0.1	3	3.0	3.0	71	1.5	1.5	38.0	2.2	2.2	51.3	−2.2	−2.2	253.6
	GDP	2.5	2.5	100	4.3	4.3	100	3.9	3.9	100.0	4.3	4.3	100.0	−0.9	−0.9	100.0
Poland	L	0.7	0.4	11	1.4	0.7	14	0.4	0.2	3.5	−0.1	−0.1	−1.5	−0.1	−0.1	2.1
	K	3.4	1.7	53	2.4	1.2	25	2.5	1.3	23.7	3.0	1.5	32.0	3.4	1.7	−61.8
	TFP	1.1	1.1	35	2.9	2.9	60	3.9	3.9	72.8	3.3	3.3	69.4	−4.3	−4.3	159.7
	GDP	3.1	3.1	100	4.8	4.8	100	5.4	5.4	100.0	4.7	4.7	100.0	−2.7	−2.7	100.0
Romania	L	−1.0	−0.5	−11	2.6	1.3	18	0.2	0.1	2.3	−0.1	0.0	−1.1	−1.8	−0.9	23.8
	K	3.3	1.7	35	3.0	1.5	21	3.1	1.5	34.4	2.7	1.4	33.3	3.5	1.8	−45.7
	TFP	3.6	3.6	76	4.5	4.5	61	2.8	2.8	63.3	2.8	2.8	67.8	−4.7	−4.7	121.9
	GDP	4.7	4.7	100	7.3	7.3	100	4.5	4.5	100.0	4.1	4.1	100.0	−3.9	−3.9	100.0
Slovakia	L	2.8	1.4	66	1.5	0.8	26	1.4	0.7	19.5	0.7	0.3	13.1	−2.0	−1.0	21.3
	K	3.9	1.9	91	2.8	1.4	46	2.8	1.4	38.1	2.8	1.4	55.2	3.1	1.5	−32.2
	TFP	−1.2	−1.2	−57	0.8	0.8	28	1.5	1.5	42.4	0.8	0.8	31.7	−5.3	−5.3	110.9
	GDP	2.1	2.1	100	3.0	3.0	100	3.7	3.7	100.0	2.5	2.5	100.0	−4.8	−4.8	100.0
Slovenia	L	−0.3	−0.1	−4	4.8	2.4	50	2.2	1.1	25.4	0.2	0.1	3.0	−0.5	−0.2	5.4
	K	0.4	0.2	7	0.2	0.1	2	0.7	0.4	8.4	1.3	0.6	19.2	1.5	0.8	−17.9
	TFP	3.1	3.1	97	2.3	2.3	48	2.9	2.9	66.2	2.5	2.5	77.7	−4.8	−4.8	112.5
	GDP	3.2	3.2	100	4.8	4.8	100	4.4	4.4	100.0	3.3	3.3	100.0	−4.2	−4.2	100.0

Source: Compiled by author.

Secondly, the part of TFP which results from increased labour productivity should be partially considered as contribution of human capital to economic growth. Due to the difficulties in calculating this type of capital for the analysed group of countries, TFP in our approach also includes the impact of human capital on economic growth.

The leading countries in terms of the rate of change in total factor productivity change over years. This results from the fact that economic growth accounting is an exercise whose results are strongly dependent on fluctuations of the individual variables (labour and capital inputs, volume of output). The variables (in particular output volume) are subject to strong fluctuations year on year, which results from business cycles and irregular fluctuations triggered by various demand and supply shocks, both endogenous and exogenous. Therefore, the ranking of countries for TFP growth rate is subject to large changes between successive years. The Baltic states were the leaders in TFP dynamics in the analyses prepared many years ago. Prior to the global crisis, they showed a very fast economic growth, which was difficult to explain by changes in labour and physical capital, which is why it was attributed to TFP. The position of Poland in those analyses was moderate – not as good as that of the Baltic states, nor was it trailing the group. The extension and shifting of the time horizon significantly changed the outcomes for individual countries in favour of Poland.

Table 8.2. TFP growth rates (%)

Country	Entire period 2011–2020			2011–2013	2014–2016	2017–2019	2020
	average	minimum	average	average	average	minimum	
Bulgaria	0.7	−3.5	2.9	0.6	1.7	1.4	−3.5
Croatia	−0.2	−8.4	2.9	0.1	0.7	1.4	−8.4
Czech Republic	0.0	−6.8	3.6	−1.3	1.5	2.0	−6.8
Estonia	0.9	−3.6	3.7	1.2	0.5	2.4	−3.6
Lithuania	1.5	−2.2	5.2	2.9	0.5	2.3	−2.2
Latvia	1.4	−3.9	5.5	2.5	1.4	1.9	−3.9
Poland	**1.2**	**−4.3**	**3.9**	**0.8**	**1.4**	**3.4**	**−4.3**
Romania	1.6	−4.7	4.5	1.0	2.4	3.4	−4.7
Slovakia	0.0	−5.3	2.3	0.2	0.6	1.1	−5.3
Slovenia	0.9	−4.8	3.1	−0.3	2.3	2.6	−4.8
Hungary	0.3	−6.5	3.6	−0.4	0.6	3.0	−6.5

Source: Compiled by author.

Croatia, the Czech Republic, and Hungary reported the highest variance in TFP growth rates in the years under study. The differentiation of the dynamics of productivity changes in these countries resulted mainly from a steep decline in TFP in 2020 due

to a deep recession in the wake of the coronavirus pandemic. In Croatia, the Czech Republic, and Hungary, real GDP dropped in 2020 by at least 5.0%, and these three countries experienced the deepest recession in the EU-11 in 2020. The difference between the highest and the lowest TFP growth rate in 2011–2020 was more than 10 p.p. in these countries. In the other CEE states, the spread of TFP growth rates was also high, ranging from 6.4 p.p. in Bulgaria to 9.4 p.p. in Latvia. Large disparities in TFP fluctuations result from substantial declines in productivity witnessed in 2020 in all countries due to the coronavirus pandemic. In Poland, the lowest TFP growth rate in the analysed period occurred in 2020 (–4.3%), and the highest – in 2018 (3.9%).

Table 8.3. Contribution of TFP to economic growth (%)

Country	Entire period 2011–2020		
	average	minimum	average
Bulgaria	13	−248	116
Croatia	48	−499	642
Czech Republic	456	8	3 858
Estonia	31	−64	122
Lithuania	64	2	254
Latvia	57	−11	108
Poland	**49**	**−31**	**160**
Romania	61	−16	122
Slovakia	17	−94	111
Slovenia	88	26	200
Hungary	63	−30	204

Source: Compiled by author.

Data for individual sub-periods shows different behaviour of countries as regards TFP dynamics. In general, TFP growth rates in all the identified sub-periods were not particularly high. In 2011–2013, three countries of the group under study (Slovenia, Hungary, and the Czech Republic) recorded a negative TFP growth rate. Of course, the TFP decline can hardly be treated as a technological regression – this result is a consequence of using the residual method of TFP calculation. Nevertheless, the negative values do not imply success in terms of productivity changes. In 2011–2013, three Baltic states led the way in total factor productivity dynamics, with an average TFP growth rate of 2.9% (Lithuania), 2.5% (Latvia), and 1.2% (Estonia).

In the following sub-period 2014–2016, no country reported a negative TFP growth rate. At the same time, the countries' positions in the ranking reversed markedly compared with the previous sub-period. Estonia and Lithuania, which were

productivity change leaders in 2011–2013, took the last two places in the EU-11 group for TFP dynamics. In contrast, Slovenia moved upwards significantly in terms of this criterion (from ninth to second position).

In the past decade, the best results in productivity changes were reported for the EU-11 group as a whole in 2017–2019. During that period, all EU-11 countries experienced an average annual TFP growth of more than 1%. The leaders were Romania, Poland, and Hungary, where TFP increased by 3.0% or more annually.

2020 saw a rapid deterioration of performance in terms of changes in total factor productivity. All EU-11 member states recorded a negative TFP growth rate. The slowest decline in TFP was observed in Lithuania (−2.2%), Bulgaria (−3.5%), Estonia (−3.6%), and Latvia (−3.9%). The worst performers were Hungary (−6.5%), the Czech Republic (−6.8%), and Croatia (−8.4%). Negative TFP growth rates result from the recession experienced in all the EU-11 member states in 2020 due to the COVID-19 pandemic. In 2020, the EU-11 countries also reported a decline in employment. On the other hand, the physical capital stock increased in these countries. The increase in capital stock results from the fact that capital expenditure is an outcome of investment undertaken in earlier years when nobody expected an outbreak of a global pandemic. In the perpetual inventory method we employ to estimate the volume of capital in 2020 draws on 2019 investment data (and prior years). Therefore, with a good economic situation in 2019 investment was high and the capital stock in all countries of the group concerned increased in 2020 at a rate not lower than in 2019.

The recession triggered by the pandemic led to the reduction of employment in 2020. In the majority of EU-11 countries, the decrease in employment was lower (in absolute terms) than decrease in output, which is consistent with Okun's law. Thus, having regard to the increase in physical capital stock, a small decrease in employment, and a large decrease in GDP, in 2020 the Central and Eastern European countries recorded very steep declines in residual total factor productivity.

As regards TFP contribution to economic growth, the numerical values for the period under study are partly distorted, *inter alia*, by the fact that positive TFP dynamics during recession means a negative TFP contribution to economic growth (example of Croatia in 2011). On the other hand, when there is a strong economic slowdown and the GDP growth rate is close to 0%, a change of a few percent in total factor productivity translates into a several thousand percent TFP contribution to economic growth (e.g. the Czech Republic in 2013). The coronavirus pandemic has also disrupted the statistics on TFP contribution to economic growth. Nevertheless, certain trends and regularities can be determined on the basis of aggregated results for the whole period.

As indicated by the data presented in Table 8.3, the percentage contributions of TFP to economic growth in most countries (except the Czech Republic, Slovenia, Estonia,

Slovakia, and Bulgaria) ranged between 48% and 64% in 2011–2020. This confirms the important role of TFP in the economic growth of the analysed countries in the past decade. In Poland, the TFP contribution to GDP growth averaged 49% in 2011–2020.

Finally, it is worth adding that research on the decomposition of economic growth and TFP estimates for Poland was also carried out by other Polish authors (apart from our studies already quoted).[3] For example, Florczak and Welfe [2000] and Welfe [2001] calculate TFP in Poland in 1982–2000 on the basis of standard growth accounting, taking into account two factors of production: labour and physical capital (machinery and equipment or total fixed assets). In their study, the elasticity of production in relation to fixed assets, i.e. the share of physical capital in income, is calibrated at 0.5 or estimated on the basis of the production function. In another study by Welfe [2003], the author estimates TFP for Poland in 1986–2000 using various alternative values of physical capital share in income (from 0.25 to 0.70). Florczak [2011] estimates, using the Wharton method, the TFP values cleared of short-term demand fluctuations for Poland in 1970–2008 and then examines the determinants of total factor productivity.

TFP estimates for Poland were also conducted by others, including Zienkowski [2001], Rapacki [2002], Piątkowski [2004], and Ptaszyńska [2006]. Roszkowska [2005] and Tokarski, Roszkowska, and Gajewski [2005] performed growth accounting for voivodships in Poland, while Bolińska [2018], Dykas and Misiak [2018], and Dańska-Borsiak [2020] made such calculations for selected Polish districts (*powiats*). Zielińska-Głębocka [2004] estimated TFP for 100 industries in Poland, Ciołek and Umiński [2007] calculated the TFP growth rate in Polish domestic and foreign enterprises, while Doebeli and Kolasa [2005] used the index number decomposition method in growth accounting for Poland, the Czech Republic and Hungary. Ulrichs and Gosińska [2020] estimated the parameters of sectoral production functions describing the contribution of variables representing the physical capital and labour to gross value added in Poland. Młynarzewska-Borowiec [2018] estimated the level and dynamics of TFP in EU countries, including Poland, in 2000–2014.

It is also worth referring to studies in this area conducted by Statistics Poland (GUS) [Kotlewski, Błażej, 2016, 2018, 2020]. In those works, the cited authors use the KLEMS productivity account and estimate, *inter alia*, the contribution of multifactor productivity (MFP) to output growth. Empirical research is conducted both at national level (for Poland and for selected other EU member states), as well as at the level of Polish voivodeships and individual sectors of the economy.

[3] Due to volume constrains, the results contained in those studies will not be described in detail.

8.5. Conclusions

The results show that changes in productivity played a significant role in the economic growth of Poland and the other EU-11 countries. In Poland, the average TFP growth rate amounted to 1.2% annually between 2011 and 2020, which was the fourth best result in the EU-11 group (the leader was Romania with a 1.6% productivity growth rate; Lithuania and Latvia also performed better than Poland) TFP growth in Poland should be interpreted as an improvement of the competitiveness of the Polish economy. Higher efficiency of production factors means an increase in management efficiency and a better competitive position in the international environment. Unfortunately, the coronavirus pandemic has had a highly adverse impact on TFP dynamics. All the EU-11 countries recorded a decline in total factor productivity in 2020.

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Chapter 9

Poland's Position in the World Economy during the Pandemic, Including Trade Competitiveness

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9.1. Introduction

The purpose of this chapter is to evaluate Poland's position in the world economy during the COVID-19 pandemic, with a particular focus on competitiveness in foreign trade. A series of interventions in 2020–2021, aimed to reduce transmission of the SARS-CoV-2 coronavirus or to protect access to goods of strategic significance, included diverse measures such as social distancing, border closures for people, or air transport restrictions, etc. These measures had a very strong impact on the development of economies of many countries, including international trade flows or foreign direct investment flows. No wonder then that the pandemic also influenced foreign trade by reducing both supply and demand. As indicated by UNCTAD [2020a, 2020b], 2020 saw the steepest decline in trade from the 2009 global recession level [see also Barlow et al., 2021]. The harmful impacts of COVID-19 on international trade were accommodated to some extent after the first wave of the pandemic, and its effects across industries were highly heterogenous [Hayakawa, Mukunoki, 2021]. The resilience of different countries to the crisis triggered by COVID-19 was also diverse, which may lead to a change in globalization patterns [Mena et al., 2022]. Buatois and Cordon [2020] suggest, for instance, that the pandemic may lead to greater regionalization of value chains. Arriola et al. [2020] emphasize that the shortening of value chains and reshoring may follow, and Javorcik [2020] also notes the diversification of supplier base and reshoring. UNCTAD [2020b], trying to sum up those discussions, presents four possible international configurations of production chains post pandemic: reshoring, regionalization, diversification, and replication. Each of these phenomena may have different implications for individual countries and industries. As pointed out by Radło and Sagan [2021], in the case of Central and Eastern European countries at least some of the changes in international trade caused by COVID-19 proved positive, at least in the short term. In this context, the assessment of Poland's position in the world economy

during the COVID-19 pandemic will include components such as presentation of main trends in Polish trade in goods and services, assessment of the impact of the pandemic shock on Polish foreign trade, as well the assessment of changes in the balance of payments – in the period 2020–2021.

9.2. Main trends in Polish trade in goods and services

The key data on Poland's foreign trade between 2015 and 2020, presented in Table 9.1, show that the COVID-19 pandemic which broke out in the first quarter of 2020 did not have an adverse impact on Poland's trade balance. In 2020, as in the years 2015–2019, the total value of exports increased annually, but when compared year on year the increase was smaller than in previous years (2% instead of 8–11%). A reverse situation was witnessed in total imports, where, for the first time in the period under analysis, their value decreased compared to the previous year. This resulted from COVID-19 restrictions and periodically limited access to certain goods and markets. As a result, the surplus in Poland's trade balance increased significantly – by 50% y/y – to reach PLN 159.8 bn in 2020, which represented more than 6.5% of the sum of exports and imports.

Exports and imports of goods manifested the same trends as total exports and imports – in 2020, the value of exports increased and the value of imports decreased compared to the previous year. Consequently, Poland achieved a significant surplus of more than PLN 55 bn in trade in goods, which accounted for 2.75% of the sum of exports and imports of goods. In the previous five years, the value of the balance on goods (positive in 2015–2016 and in 2019, and negative in 2017–2018) was low and did not exceed 1.5% of the sum of exports and imports.

An analysis of the data contained in Table 9.1 shows that the COVID-19 pandemic and related restrictions affected foreign trade in services to a much greater extent. In 2020, the value of exports and imports of services decreased (by 2.7% and 6.1% y/y) for the first time in the analysed period. Nonetheless, the surplus in trade in services was high (as was the case in previous years) at PLN 104.4 bn (2.8% more than in 2019), which represented almost 25% of the sum of exports and imports. However, its role in the formation of surplus in total trade balance diminished, although it was still dominant.

Analysing monthly data for 2020 and the first eight months of 2021 (Figure 9.1), it should be noted that the first wave of the COVID-19 pandemic (in March and April 2020) caused a decline in foreign trade both in goods and in services. Those two months saw a small surplus of imports over exports in trade in goods. From

May 2020, there was a dynamic growth in the value of goods exports, accompanied by smaller increases in the value of imports, which translated into a high positive balance on goods. Periodic declines in the value of goods exports in the second half of 2020 (in August, November, and December and in the first half of 2021 (in April and May) did not always coincide with the successive waves of the COVID-19 pandemic in Poland, but they also reflected the global pandemic situation and the seasonality of sales. The decreasing value of exports with a growing value of imports in the summer months of 2021 resulted in a deficit in trade in goods in July and August 2021. The deterioration of the balance on goods was due mainly to increased imports of fuels and raw materials resulting from a rise in their prices and a slowdown of the growth trend in exports of automotive parts caused by disruptions in semiconductor supply chains [NBP, 2021a].

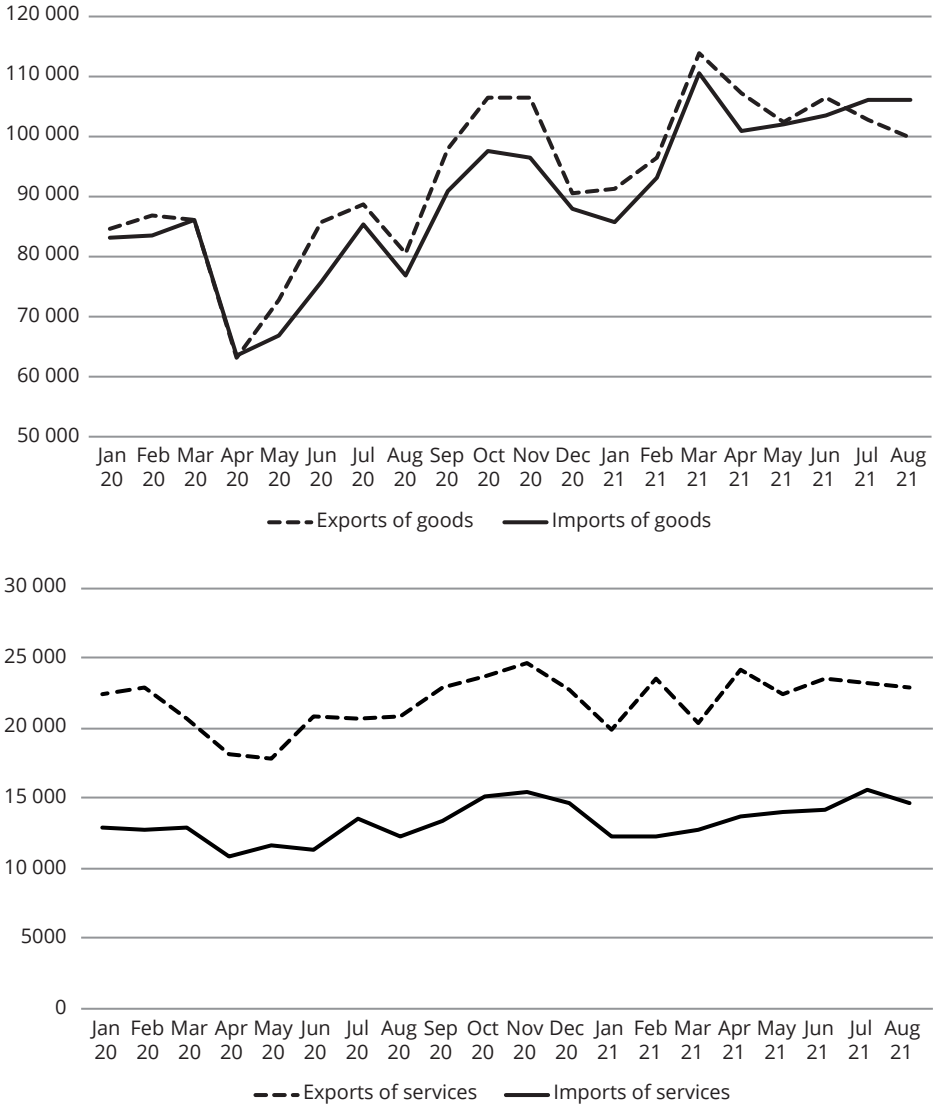
Table 9.1. Polish foreign trade in goods and services in 2015–2020

	2015	2016	2017	2018	2019	2020
Balance on goods (PLN bn)	3.40	8.90	–1.50	26.50	5.20	55.40
Balance on goods (% of the sum of exports and imports)	0.24	0.58	–0.09	–1.41	0.26	2.75
Exports of goods (PLN bn)	717.20	774.30	860.10	925.30	1001.10	1034.50
Imports of goods (PLN bn)	713.80	765.50	861.60	951.80	996.00	979.00
Balance on services (PLN bn)	45.50	60.00	75.90	90.60	101.60	104.40
Balance on services (% of the sum of exports and imports)	15.85	18.51	21.21	22.58	23.33	24.98
Exports of services (PLN bn)	166.30	192.10	216.90	245.90	268.50	261.20
Imports of services (PLN bn)	120.80	132.10	141.00	155.30	166.90	156.80
Total trade balance (PLN bn)	48.90	68.90	74.40	64.10	106.80	159.80
Total trade balance (% of the sum of exports and imports)	2.85	3.70	3.58	2.81	4.39	6.58
Total exports (PLN bn)	883.50	966.40	1077.00	1171.20	1269.60	1295.70
Total imports (PLN bn)	834.60	897.50	1002.60	1107.10	1162.80	1135.80

Source: Compiled by authors based on NBP [2021b].

The decline in the value of trade in services during the first wave of the COVID-19 pandemic was followed by a rapid growth in exports of services until the end of 2020 (except August and December, when decreases were recorded). The first eight months of 2021 saw greater fluctuations of the export value of services. In spite of that, also during the first wave of the COVID-19 pandemic, there was a significant positive balance on services, which, combined with a surplus in trade in goods (except March–April 2020 and July–August 2021) translated into a trade surplus.

Figure 9.1. Polish exports and imports of goods and services between 1 January 2020 and 31 August 2021 (PLN m)



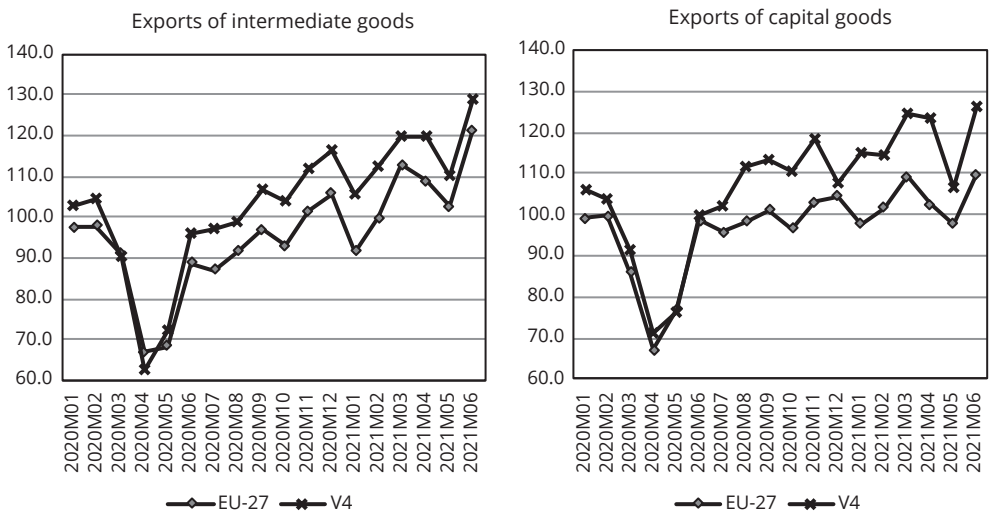
Source: Compiled by authors based on NBP [2021b].

9.3. Pandemic shock and its impact on Poland's competitiveness in foreign trade

Changes in exports of goods from Poland by end use category during the COVID-19 pandemic compared with EU-27

Changes in Polish exports of various types of goods by their end use were typical of different phases of the economic cycle. Related data is presented in Figure 9.2. Its analysis shows that consumer goods proved to be the most resilient to the collapse of exports. Their exports from Poland but also from the EU member states in general saw a much smaller decline than total exports. The EU-27 countries quickly made up for the losses and achieved the export level from one before – from June 2020, the export value of consumer goods varied but was close to that in the corresponding months of 2019. Against the backdrop of the EU as a whole, Poland saw a quicker recovery of exports than the EU-27 countries taken together over the entire analysed period. Interestingly, while the exports of those goods from Poland in 2020 grew slower than the exports of intermediate goods, it was faster in the first half of 2021. What proved to be the most sensitive to the pandemic shock were the exports of intermediate goods, reflecting forward linkages of value chains. Their collapse in April 2020 was deeper than in the case of total exports or the exports of consumer and capital goods – both in Poland and in the EU as a whole.

Figure 9.2. Monthly exports of goods by end use category in 2020 and in the first half-year of 2021 (corresponding months of 2019 = 100)



Source: Compiled by authors based on Eurostat.

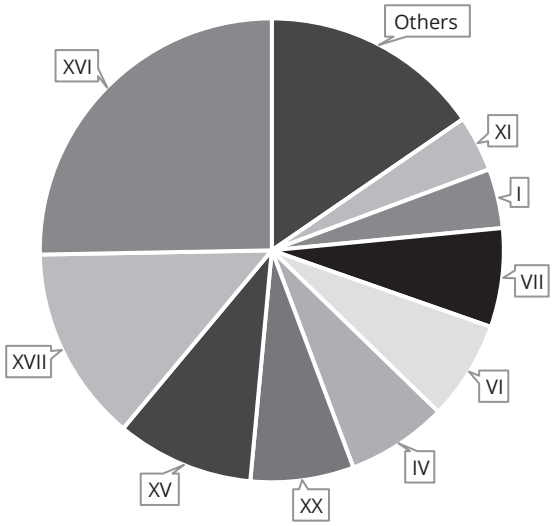
However, the exports of intermediate goods from Poland started to recover quickly and in mid-2020 it reach a value close to that reported in the previous year and was growing fast in the following months. At the same time, the growth of Polish exports of those goods was quicker than in the EU overall, where the revival of exports of intermediate goods was weaker and it was not until November 2020 that the value of exports of intermediate goods edged close to that reported in the previous year. As regards the exports of capital goods, characteristically, in April 2020 their exports from Poland decreased less than in the EU as a whole. What is more, the exports of those goods from Poland quickly grew to previous-year levels and significantly exceeded then in subsequent months, while in the whole EU their value ranged around the levels reported in 2019.

Changes in exports of goods from Poland by industry during the COVID-19 pandemic

The analysis of exports of goods from Poland by end use category is complemented by an overview of changes in Polish exports of goods by industry during the COVID-19 pandemic. Figure 9.3 presents the structure of exports of goods from Poland before the outbreak of the pandemic (in 2019) according to industries represented by sections of the Harmonized System Nomenclature (HS). Its analysis shows that three industries: "Machinery and mechanical appliances; electrical equipment; parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers,

and parts and accessories of such articles" (HS Section XVI), "Vehicles, aircraft, vessels and associated transport equipment" (HS Section XVII), and "Base metals and articles of base metals" (HS Section XV) accounted for almost half of Polish exports in 2019. The share of 9 largest industries in terms of export value was almost 85% of the total value of Polish exports in 2019.

Figure 9.3. Structure of exports of goods from Poland by industry (HS section) in 2019



Note: The names of HS sections are stated in Table 9.2; the item "Others" includes the following HS sections: X, V, XVIII, XIII, II, IX, XII, XIV, VIII, III, XXI, XIX.

Source: Compiled by authors based on real data on Poland's foreign trade in goods derived from Single Administrative Documents (SADs) and INTRASTAT declarations.

Table 9.2 shows data on changes in Polish exports of goods by industry – ranked from highest to lowest relative to the value of goods exports in 2019 – in the period January 2020 to April 2021. Both the 2020 and 2021 data was benchmarked against the corresponding month of 2019 so as to avoid the low base effect, which would occur when comparing 2021 data with 2020 data. The data presented shows that the outbreak of the COVID-19 pandemic in March 2020 and the resulting periodic restrictions imposed on business, movement of people and goods, etc., caused a collapse of Polish exports in March and even more so in April and May 2020. During the period March to May 2020, the value of goods exports in most industries was lower than in corresponding month of the previous year. In April 2020, total exports of goods decreased by more than a quarter compared to April 2019 and in May 2020 by more than 16%, compared with a corresponding month before the pandemic.

Table 9.2. Changes in exports of goods from Poland by industry between January 2020 and April 2021 (100 = corresponding months of 2019)

Section	Section name	Jan 2020	Feb 2020	Mar 2020	Apr 2020	May 2020	Jun 2020	Jul 2020	Aug 2020	Sept 2020	Oct 2020	Nov 2020	Dec 2020	Jan 2021	Feb 2021	Mar 2021	Apr 2021	2020	2021
XVI	Machinery and mechanical appliances; electrical equipment; parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories of such articles	105.5	108.6	98.2	73.0	85.0	114.5	111.2	104.2	115.6	117.5	124.6	119.5	118.1	127.7	137.2	134.9	106.8	129.5
XVII	Vehicles, aircraft, vessels and associated transport equipment	104.0	106.4	79.5	38.2	51.4	92.5	95.9	102.0	100.4	101.9	109.6	100.5	98.5	106.0	110.1	109.3	89.3	106.2
XV	Base metals and articles of base metals	98.7	95.7	93.1	78.3	83.3	99.1	95.6	95.9	99.7	105.9	110.4	117.6	112.1	115.4	124.8	121.2	97.2	118.6
XX	Miscellaneous manufactured articles	96.7	98.4	87.5	62.6	83.1	113.9	114.4	105.9	110.3	111.5	114.5	116.6	106.4	111.7	118.7	117.4	101.5	113.6
IV	Prepared foodstuffs, beverages, spirits and vinegar, tobacco and manufactured tobacco substitutes	103.4	111.5	119.5	103.7	109.6	127.0	114.6	109.8	115.0	115.8	113.8	110.4	107.8	119.4	130.0	108.6	112.9	116.5
VI	Products of the chemical or allied industries	108.9	110.8	118.6	96.2	101.9	117.2	111.5	112.6	120.4	103.9	127.0	104.9	117.6	128.4	133.9	133.3	111.1	128.5
VII	Plastics and articles thereof; rubber and articles thereof	99.3	104.7	98.8	74.4	80.3	104.0	101.9	100.0	107.3	107.6	113.5	117.9	106.9	114.0	127.2	121.7	100.4	117.6
I	Live animals; animal products	100.2	106.1	101.3	86.9	93.9	106.4	101.5	95.0	99.2	98.4	96.3	97.5	92.4	102.9	114.0	101.7	98.4	102.9
XI	Textiles and textile articles	123.4	122.2	100.5	91.9	111.1	134.9	115.8	117.1	131.7	117.5	119.4	117.8	138.7	154.6	153.9	141.9	116.9	147.2
X	Pulp of wood or of other fibrous cellulosic material; recovered (waste and scrap) paper or paperboard; paper and paperboard and articles thereof	100.0	97.6	103.7	92.3	91.8	109.5	103.6	101.9	105.2	104.0	111.4	113.0	101.8	109.9	116.2	115.5	102.8	110.8
V	Mineral products	91.0	80.4	73.5	49.0	59.0	63.1	56.9	64.0	83.3	84.3	96.3	96.7	76.8	76.3	82.4	93.5	73.6	82.1
XVIII	Optical, photographic, cinematographic, measuring, checking, precision, medical or surgical instruments and apparatus; clocks and watches; musical instruments; parts and accessories thereof	111.9	119.6	105.8	92.4	82.0	106.1	101.1	103.5	109.7	105.1	110.2	109.8	113.4	119.9	125.2	129.1	104.8	122.0
XIII	Articles of stone, plaster, cement, asbestos, mica or similar materials; ceramic products, glass and glassware	100.9	109.2	96.4	73.8	74.3	97.1	104.2	101.7	109.9	103.9	114.4	116.6	103.5	116.8	117.9	116.4	99.8	113.7
II	Vegetable products	120.6	131.5	144.0	136.1	125.9	119.0	102.1	117.2	123.2	116.9	122.8	131.2	132.0	147.4	149.0	138.2	124.1	141.9
IX	Wood and articles of wood; wood charcoal; cork and articles of cork; manufactures of straw, of esparto or of other plaiting materials; basketware and wickerwork	95.7	103.7	93.8	83.8	98.9	117.8	105.2	110.3	114.7	108.8	116.6	121.2	107.9	116.3	127.5	125.7	105.0	119.7

Section	Section name	Jan 2020	Feb 2020	Mar 2020	Apr 2020	May 2020	Jun 2020	Jul 2020	Aug 2020	Sept 2020	Oct 2020	Nov 2020	Dec 2020	Jan 2021	Feb 2021	Mar 2021	Apr 2021	2020	2021
XII	Footwear, headgear, umbrellas, sun umbrellas, walking sticks, seat-sticks, whips; riding-crops and parts thereof; prepared feathers and articles made therewith; artificial flowers; articles of human hair	130.0	128.4	87.5	73.7	95.4	115.9	110.6	117.8	104.9	113.9	108.4	109.0	124.3	137.4	132.0	126.9	107.3	130.2
XIV	Natural or cultured pearls, precious or semi-precious stones, precious metals, metals clad with precious metal, and articles thereof, imitation jewellery; coin	134.7	130.1	148.9	94.7	86.8	98.7	126.4	118.8	96.9	157.5	113.1	107.9	203.7	137.1	181.4	156.6	116.5	168.0
VIII	Raw hides and skins; leather, furskins and articles thereof; saddlery and harness; travel goods, handbags and similar containers; articles of animal gut (other than silkworm gut)	98.3	92.7	78.8	42.2	53.5	80.9	99.6	99.9	111.7	108.3	102.6	110.7	88.0	96.8	132.5	94.0	88.4	102.3
III	Animal or vegetable fats and oils and their cleavage products; prepared edible fats; animal or vegetable waxes	103.5	113.8	127.4	142.9	146.2	143.5	142.3	134.3	122.3	113.6	117.7	117.8	145.5	151.5	158.8	136.1	126.0	148.4
XXI	Works of art, collectors' pieces and antiques	91.0	95.4	56.4	38.9	34.6	46.4	54.8	52.2	47.8	26.7	29.5	32.6	50.5	32.4	34.6	43.1	50.7	39.5
XIX	Arms and ammunition; parts and accessories thereof	184.6	80.7	7.5	11.2	18.1	61.1	536.5	19.7	47.5	205.4	112.8	60.3	1009.6	191.9	66.3	46.6	60.1	113.0
	Total	103.9	106.4	97.7	74.8	83.6	108.4	104.9	103.6	110.0	109.7	115.8	112.8	110.6	118.4	126.3	122.1	102.6	119.5

Note: Owing to sectoral specificities and a relatively small value of exports, no changes in exports have been analysed for "Arms and ammunition; parts and accessories thereof" (HS Section XIX) and "Works of art, collectors' pieces and antiques" (HS Section XXI).

Source: Compiled by authors based on real data on Poland's foreign trade in goods derived from Single Administrative Documents (SADs) and INTRASTAT declarations.

Out of the top 10 industries in terms of the value of goods exports from Poland in 2019, the one most affected was "Vehicles, aircraft, vessels and associated transport equipment" (HS Section XVII), which ranked second in terms of the value of goods exports in 2019), in the case of which exports represented only 38.2% of the value of exports a year before in April 2020 and 51.2% in May 2020. The value of goods exports from Poland in April and May 2020, relative to the corresponding period of the previous year, decreased significantly also in "Miscellaneous manufactured articles" (HS Section XX, ranked fourth in terms of export value in 2019) to 62.6% and 83.1%, respectively, compared with the corresponding period of the previous year, and in "Plastics and articles thereof; rubber and articles thereof" HS Section VII, ranked seventh in terms of export value in 2019) – to 74.4% and 83.3%, respectively. In certain industries with a smaller share of the value of exports in 2019, the collapse of exports in the spring months of 2020 in the wake of the pandemic shock was even deeper, e.g., in the leather industry (HS Section VIII). A greater decrease in exports was reported mainly by industrial sectors being as a rule more integrated into global value chains, which had to face, e.g., more difficult access to intermediate goods.

However, several industries proved resilient to adverse conditions of foreign trade and, despite the pandemic restrictions in place, reported an increase in the value of exports in April and May 2020 compared to April and May 2019. These were – ranked from highest to lowest share in Polish exports of goods in 2019 – "Prepared foodstuffs, beverages, spirits and vinegar, tobacco and manufactured tobacco substitutes" (HS Section IV), "Vegetable products" (HS Section II), and "Animal or vegetable fats and oils and their cleavage products; prepared edible fats; animal or vegetable waxes" (HS Section III). This shows that exports of foodstuffs turned out to be the most resilient to the COVID-19 pandemic, which can be explained by the fact that in response to the outbreak of the pandemic most consumers in the world stocked up on food, which boosted international trade in foodstuffs.

June and following summer months of 2020 saw a relatively quick recovery of Polish exports of goods in most industries. The following industries took the longest to return to the pre-pandemic levels in terms of the value of exports: "Mineral products" (HS Section V; in none of the analysed months from the outbreak of the pandemic did exports reach the value of the corresponding month of 2019), "Base metals and articles of base metals" (HS Section XV; for the first time, the value of exports was higher than in the corresponding month of the previous year in October 2020), the leather industry (HS Section VIII; the previous year's monthly value of exports was exceeded for the first time in September 2020), and "Vehicles, aircraft, vessels and associated transport equipment" (HS Section XVII; the previous year's monthly value of exports was exceeded for the first time in August 2020). As a result, taking into account annual

data, most industries exported more in terms of value than a year before. Among the 10 largest industries in terms of the value of exports in 2019, the highest annual increase in the value of exports was recorded by the following industries: "Textiles and textile articles" (HS Section XI; 16.9% y/y) and "Prepared foodstuffs, beverages, spirits and vinegar, tobacco and manufactured tobacco substitutes" (HS Section IV; 12.9% y/y). The following industries out of the 10 largest ones in terms of the value of exports in 2019 were the worst hit by the pandemic, as reflected in the year-on-year decline in the value of exports: "Vehicles, aircraft, vessels and associated transport equipment" (HS Section XVII; down more than 10% y/y), "Base metals and articles of base metals" (XV section HS; down almost 3% y/y), and "Live animals; animal products" (HS Section I; down more than 1.5% y/y). In most cases, those industries that saw a steeper fall in exports in the wake of the outbreak of the COVID-19 pandemic were slower to recover their position in international markets than the industries that suffered less as a result of the pandemic shock. In the first months of 2021, the above relationship was not that visible.

At the beginning of 2021, exports were growing dynamically in almost all industries. Having regard to the data for the first four months of 2021, exports were lower than in the corresponding period of 2019 in only one industry: "Mineral products" (HS Section V). In the analysed months of 2021, the other industries exported more than in January–April 2019. Such quick recovery of their export position by the majority of industries in Poland (all of the top 10 in terms of export value) testifies to a relatively high resilience of the Polish economy to the pandemic shock and a firm position of Polish exporters in global value chains. It also means that the successive waves of the COVID-19 pandemic did not have a negative impact on the value of Polish exports.

Changes in revealed comparative advantages in the Polish foreign trade by industry during the COVID-19 pandemic

This subchapter presents an analysis of revealed comparative advantages of Polish foreign trade by HS section during the COVID-19 pandemic. Revealed comparative advantages were calculated logarithmically; hence the positive value of the index for a section means the existence of Poland's comparative advantage in international trade, whereas a negative value means that there is no comparative advantage in the section concerned. Data for the pandemic period (2020 and the first four months of 2021) was benchmarked against revealed comparative advantages in Polish international trade, calculated for 2019.

The data in Table 9.3 shows that the outbreak of the COVID-19 pandemic in the first half of 2020 and the related periodic collapse of trade caused, e.g., by transitional

restrictions on the movement of people and goods did no cause significant changes in revealed comparative advantages in Polish foreign trade across HS sections. During the COVID-19 pandemic (in 2021) Poland lost its comparative advantage in one industry only – in HS Section XIV covering "Natural or cultured pearls, precious or semi-precious stones, precious metals, metals clad with precious metal, and articles thereof, imitation jewellery; coin". However, Section XIV is one of less significant industries in Polish foreign trade, as the value of exports in that section in 2019–2021 represented less than 1% of the value of total Polish exports in each of the analysed years.

Changes in revealed comparative advantage occurred also in Section XVI, i.e., in trade in machinery and mechanical appliances; electrical equipment; parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories of such articles. Machinery and appliances included in Section XVI are the main pillar of Polish exports, as the export of goods under Section XVI accounted for more than a quarter of total Polish exports in the analysed period. In 2020, i.e., in the year the COVID-19 pandemic broke out, Poland lost its revealed comparative advantage in trade in goods forming Section XVI. However, the value of the ratio calculated for the first four months of 2021 is already positive, which means that Poland has regained its revealed comparative advantage in international trade within the section in question. Nevertheless, as was the case before the pandemic shock hit, the revealed comparative advantage in Section XVI is weak.

As regards the other HS sections, in the pandemic period under analysis, Poland neither gained new nor lost its pre-pandemic revealed comparative advantage. In terms of revealed comparative advantages in Polish foreign trade, all sections but one saw an erosion of their advantages in 2020 compared with the pre-pandemic period. Only in trade in vehicles, aircraft, vessels and associated transport equipment (HS Section XVII), i.e., in the second largest HS section in terms of export value in 2019–2021, did Poland strengthen its revealed comparative advantage in the year of the pandemic outbreak. An identical situation occurred in other HS sections, in which Poland did not have a revealed comparative advantage in 2019. In 2020, the index deteriorated except for Section II "Vegetable products".

Data for the first four months of 2021 shows that Polish exports rebounded quite quickly after the initial pandemic shock, which translated into consolidation of the pre-pandemic revealed comparative advantages in most industries, as well as improved exports to imports ratio in the industries in which Poland does not (and in 2019 did not) have revealed comparative advantages. This shows that Polish foreign trade has proved to be exceptionally resilient to the pandemic shock, which testifies to Poland's fairly well established position in global value chains.

Table 9.3. Revealed comparative advantages of Polish foreign trade by industry in the period from 2019 to April 2021

Section	Section name	2019	2020	2021*
1	Live animals; animal products	0.5120	0.4812	0.5343
2	Vegetable products	−0.1442	−0.0572	−0.0531
3	Animal or vegetable fats and oils and their cleavage products; prepared edible fats; animal or vegetable waxes	−0.7430	−0.7590	−0.6044
4	Prepared foodstuffs, beverages, spirits and vinegar, tobacco and manufactured tobacco substitutes	0.6387	0.5831	0.5766
5	Mineral products	−1.3226	−1.3269	−1.2722
6	Products of the chemical or allied industries	−0.3014	−0.3380	−0.3566
7	Plastics and articles thereof; rubber and articles thereof	−0.0332	−0.0499	−0.1196
8	Raw hides and skins; leather, furskins and articles thereof; saddlery and harness; travel goods, handbags and similar containers; articles of animal gut (other than silkworm gut)	−0.2244	−0.2555	−0.0929
9	Wood and articles of wood; wood charcoal; cork and articles of cork; manufactures of straw, of esparto or of other plaiting materials; basketware and wickerwork	0.9382	0.9091	0.9212
10	Pulp of wood or of other fibrous cellulosic material; recovered (waste and scrap) paper or paperboard; paper and paperboard and articles thereof	0.1393	0.1260	0.1339
11	Textiles and textile articles	−0.2759	−0.3162	−0.2378
12	Footwear, headgear, umbrellas, sun umbrellas, walking sticks, seat-sticks, whips; riding-crops and parts thereof; prepared feathers and articles made therewith; artificial flowers; articles of human hair	−0.2622	−0.3115	−0.3025
13	Articles of stone, plaster, cement, asbestos, mica or similar materials; ceramic products, glass and glassware	0.5038	0.4794	0.4811
14	Natural or cultured pearls, precious or semi-precious stones, precious metals, metals clad with precious metal, and articles thereof, imitation jewellery; coin	0.4182	0.1170	−0.3030
15	Base metals and articles of base metals	−0.0369	−0.0651	−0.0850
16	Machinery and mechanical appliances; electrical equipment; parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories of such articles	0.0052	−0.0380	0.0268
17	Vehicles, aircraft, vessels and associated transport equipment	0.1199	0.2223	0.2121
18	Optical, photographic, cinematographic, measuring, checking, precision, medical or surgical instruments and apparatus; clocks and watches; musical instruments; parts and accessories thereof	−0.1749	−0.1932	−0.1526
19	Arms and ammunition; parts and accessories thereof	−0.5018	−1.2771	−0.5014
20	Miscellaneous manufactured articles	0.8298	0.7577	0.7639
21	Works of art, collectors' pieces and antiques	−2.0951	−2.2849	−2.9736

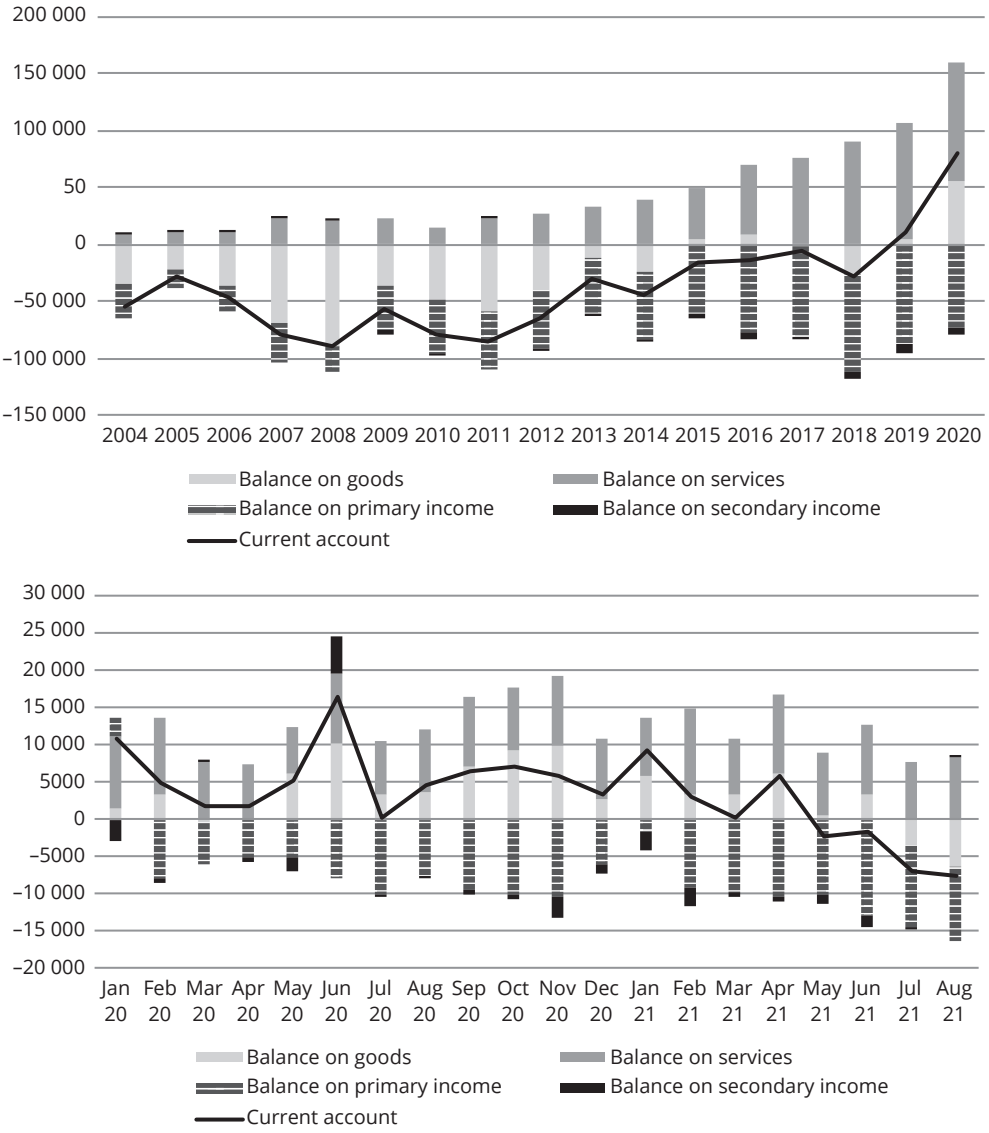
* For the period January–April 2021.

Source: Compiled by authors based on real data on Poland's foreign trade in goods derived from Single Administrative Documents (SADs) and INTRASTAT declarations.

9.4. Balance of payments and its components

Changes in the current account in the period 2004–2020 (y/y) and between 1 January 2020 and 31 August 2021 are shown in Figure 9.4.

Figure 9.4. Current account and its components in 2004–2020 and between 1 January 2020 and 31 August 2021 (PLN m)

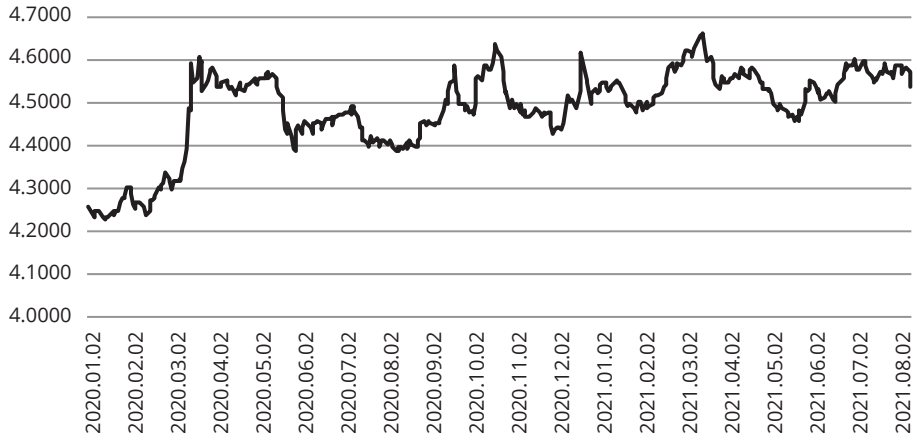


Source: Compiled by authors based on NBP [2021b].

The current account balance improved significantly over the analysed period and has been positive since 2019. The achievement of a surplus on current account resulted from a steadily growing surplus in trade in services and from a positive balance on trade in goods generated since 2015 (except 2017–2018). A detailed analysis of the balance on goods and the balance on services is presented in subchapter 9.2. The balance on current account was negatively affected throughout the analysed period by the balance on primary income and the balance on secondary income. The negative balance on primary income was determined by the transfer of foreign investors' income from their capital involvement in Polish entities, whereas the negative balance on secondary income was due, among other things, to the balance of the government sector and other sectors, and debits attributed to workers' remittances.

An analysis of short-term trends shows that the outbreak of the COVID-19 pandemic did not have a negative impact on the current account balance. In the successive months of 2020, Poland reported a surplus on the current account owing to a high surplus in trade in services and goods (except March and April). The current account balance was negatively affected by the balance on primary income (except January 2020) and the balance on secondary income (except March and June 2020). In the first four months of 2021, the current account balance remained positive and the signs of the balances constituting the current account remained the same as throughout most of 2020. Since May 2021, current account balance has been negative. The deterioration of the current account balance was caused by an increased deficit on primary income and a decreased surplus in goods trade. A faster growth of imports than exports, reported since July 2021, and consequently a negative balance on goods aggravated the current account deficit in July–August 2021.

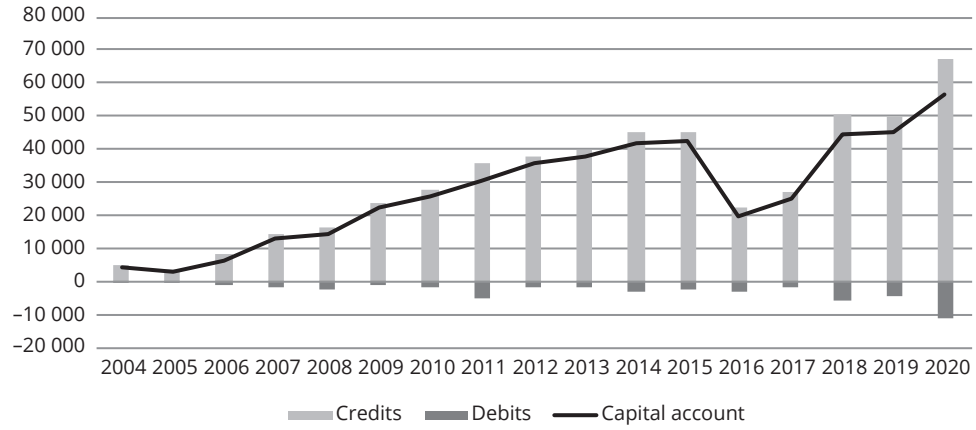
Figure 9.5. Average EUR/PLN exchange rate between 1 January 2020 and 31 August 2021



Source: Compiled by authors based on NBP [2021c].

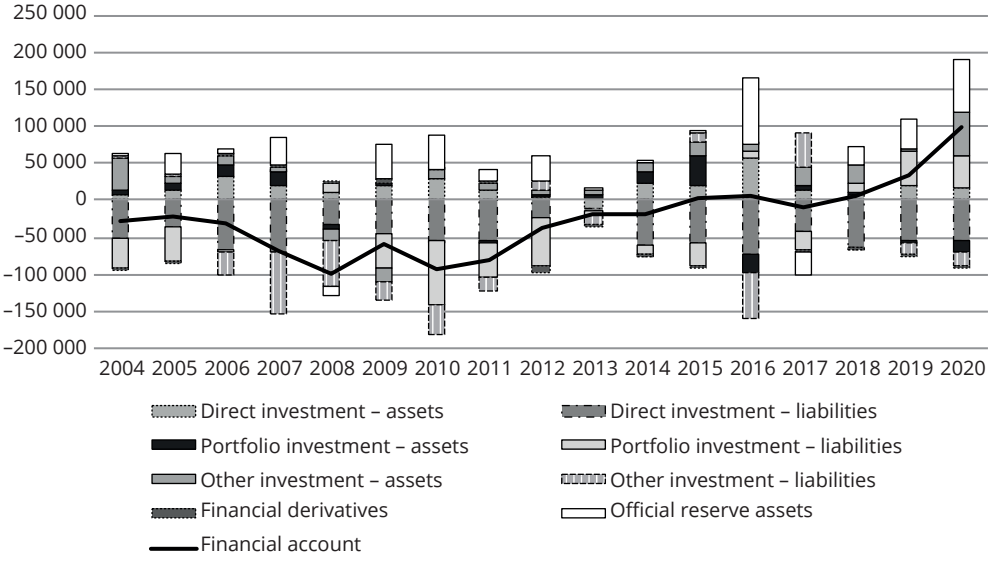
The data presented in Figure 9.5 shows that the zloty exchange rate responded to the outbreak of the COVID-19 pandemic by weakening against the euro. This contributed to a higher competitiveness of Polish exports of goods and services, as reflected in the balance on goods and the balance on services described earlier. Despite a later periodic strengthening of the zloty exchange rate against the euro, by the end of August 2021 the zloty exchange rate against the euro had not returned to its pre-pandemic level.

Figure 9.6. Capital account and its components in 2004–2020 (EUR bn)



Source: Compiled by authors based on NBP [2020b].

Figure 9.7. Financial account and its components in 2004–2020 (EUR bn)



Source: Compiled by authors based on NBP [2020b].

In the period 2004–2020 (except 2016–2017), the balance on capital account followed a rising trend (Figure 9.6), which was maintained in the first year of the pandemic. The surplus on capital account results mainly from capital transfers received by Poland from the EU budget.

Until 2014, Poland continuously reported a deficit on financial account (Figure 9.7). In 2015, the situation improved and Poland has since been reporting a positive balance on its financial account (excluding 2017), which has followed a rising trend in the past three years. This means a growth in Poland's net foreign assets.

9.5. Conclusions

Summing up the analyses presented, it must be pointed out that the pandemic shock had a severe impact on Polish foreign trade and its negative effects were very acute in the short term. However, Poland managed to revive its exports quite quickly after the first wave of the pandemic, and its subsequent waves did not produce such visible adverse effects as its first wave. Interestingly, Polish exports rebounded much quicker after the first wave of the pandemic than EU exports, and the performance of Polish exports in the latter part of 2020 and in the first half of 2021 was clearly better than the EU's. The sensitivity of goods and industries to pandemic shock effects was diverse. Trade in intermediate goods experienced a profound collapse, but exports of such goods from Poland quickly recovered. Exports of consumer goods were more resilient to collapse and they also saw a rapid growth, especially in 2021. Exports of capital goods were the most resilient to the pandemic shock. Their collapse was less severe – Polish exports rebounded and increased, whereas the EU as a whole saw their slight recovery and stagnation at 2019 levels.

In Poland, the industries related to food processing turned out to be the most resilient to the pandemic shock, and they were not affected by trade collapse in spring 2020. The industries that coped the worst with the pandemic shock were the industrial sectors dealing with vehicle and transport equipment, base metals and articles thereof, and miscellaneous manufactured articles – in their case, the collapse of exports was exceptionally deep and/or persisted exceptionally long. In the first months of 2021, virtually all industries recorded a dynamic growth of exports compared to the pre-pandemic levels.

The outbreak of the COVID-19 pandemic did not cause any major changes in revealed comparative advantages in foreign trade. Poland maintained most of its revealed comparative advantages throughout 2020, although they were weaker than a year before. Relatively quick recovery of Polish exports improved the exports

to imports ratio in most industries and thus contributed to consolidation of Poland's existing revealed comparative advantages in the first months of 2021.

Significant changes in the balance of payments occurred during the COVID-19 pandemic. A quick recovery of exports in 2020 resulted in a significant improvement of the balance of payments owing to high surpluses in trade in goods and services. However, 2021 brought about a deterioration of the balance of trade in goods, which caused a current account deficit in Poland in the summer months of 2021.

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Chapter 10

Poland's Income Convergence towards the EU Average

Mariusz Próchniak

10.1. Introduction

The purpose of this chapter is to analyse the income convergence of 11 Central and Eastern European (CEE) countries that joined the European Union in 2004, 2007 and 2013, i.e. Poland, Bulgaria, Croatia, the Czech Republic, Estonia, Lithuania, Latvia, Romania, Slovakia, Slovenia and Hungary (EU-11). The convergence of the development trajectories of these countries is analysed in relation to 14 Western European countries which are currently EU member states (EU-14). The study is a continuation of research on this subject, presented in previous versions of the *Report* [see, e.g. Matkowski, Próchniak, Rapacki, 2016a; Próchniak, 2017, 2018, 2019, 2020]. The 2013 edition of the report also includes an analysis of regional convergence covering the regions of all the EU countries [Matkowski, Próchniak, 2013].

10.2. Theory

Models of economic growth constitute the theoretical framework for the analysis of convergence in the level of income. Neoclassical models of economic growth [e.g. Solow, 1956; Mankiw, Romer, Weil, 1992] confirm the existence of conditional β-convergence. It occurs when less developed countries (with lower GDP per capita) show a faster rate of economic growth than more developed ones. The convergence is conditional because it only occurs when all countries tend to the same long-term equilibrium (steady state). The β-convergence hypothesis can be explained using the Solow model [see, e.g. Rapacki, Próchniak, 2012; Próchniak, Witkowski, 2012].

In the Solow model, the basic equation describing the dynamics of the economy tending to a steady state takes the following form:

$$\dot{k} = sf(k) - (n + a + \delta)k, \tag{10.1}$$

where: k – capital per unit of effective labour in year t, $\dot{k}$ – change of k in a time unit (from a mathematical point of view, it is a derivative of k with respect to time), s – savings rate, $f(k)$ – production function (expressed per unit of effective labour), n – population growth rate, a – rate of exogenous technical progress, δ – capital depreciation rate. In the analysis of the Solow model with technical progress, the symbols k and $f(k)$ mean, respectively, capital and output per unit of effective labour, where effective labour is a product of the level of technology and labour input.

If we assume that the production function is of the Cobb-Douglas type with the form $f(k) = k^{\alpha}(0 < \alpha < 1)$, equation (10.1) is transformed to

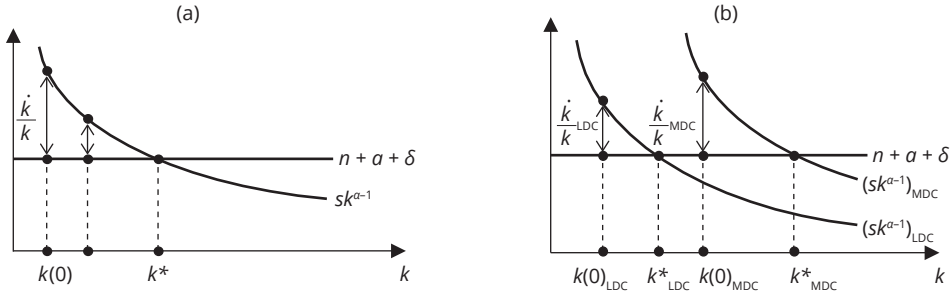
$$\dot{k} = sk^{\alpha} - (n + a + \delta)k. \tag{10.2}$$

By dividing equation (10.2) by k, we obtain a formula for the growth rate of capital per unit of effective labour during the transition period towards the steady state:

$$\frac{\dot{k}}{k} = sk^{\alpha-1} - (n + a + \delta). \tag{10.3}$$

As output is directly proportional to capital, the analogous equation characterizes the dynamics of GDP per unit of effective labour.

Figure 10.1. Economic growth in the Solow model



Source: Compiled by author.

The best way to illustrate the convergence hypothesis is to graphically analyse equation (10.3). This is shown in Figure 10.1. The rate of growth is equal to the vertical

distance between the $sk^{\alpha-1}$ curve and the $n + a + \delta$ straight line. As can be seen, the economy, which starts with the initial capital level $k(0)$ and reaches the capital level in long-term equilibrium k^*, shows a decreasing rate of economic growth. The convergence is conditional because it occurs only when both economies tend to the same steady state.

In order to illustrate the conditional character of the convergence phenomenon, let us consider two countries: a more developed country (MDC) and a less developed country (LDC), in which savings rates are different. Because the savings rate in a more developed country is higher, the capital level in a steady state is also greater. This is illustrated in part (b) of Figure 10.1. Although a more developed country is starting from a higher capital level, it shows faster economic growth because it is moving toward a different long-term equilibrium. In this situation, convergence will not occur.

An important goal of empirical research is to estimate the value of parameter β, which measures the speed of the convergence process to a steady state according to the following equation:

$$\frac{\dot{y}}{y} = \beta\left(ln\ y^* - ln\ y\right), \tag{10.4}$$

where: y – output per unit of effective labour in year t, $\dot{y}$ – change of y in time unit (derivative with respect to time), y^* – output per unit of effective labour in steady state.

Parameter β represents the distance which is covered by the economy tending towards the steady state during one period (year). For example, if $\beta = 0.02$, the economy covers 2% of the distance concerned each year.

Another type of catching-up is σ-convergence. It occurs when the income differential between countries decreases over time. The income differential can be measured by the standard deviation, variance or coefficient of variation of GDP per capita levels between countries or regions.

From a theoretical perspective, β-convergence is a necessary but insufficient condition of β-convergence. Therefore, it is possible (though unlikely) that the differences in the level of income between economies will be growing over time and at the same time a less developed country will show a faster rate of economic growth. This will happen when the less developed country reaches such a fast rate of economic growth that it outstrips the more developed country in terms of income level and the differences in the development level in the final period will be higher than in the initial one.

10.3. Method

To verify the occurrence of absolute β-convergence, we estimate the following regression equation:

$$\frac{1}{T} ln \frac{y_T}{y_0} = \alpha_0 + \alpha_1 ln\ y_0 + \varepsilon_t, \tag{10.5}$$

where y_T and y_0 are income per capita in the final and initial year, while ε_t is a random factor. Thus, the average annual growth rate of real GDP per capita at purchasing power parity (PPP) between period T and 0 is the explained variable, while the natural logarithm of GDP per capita in the initial period is the explanatory variable. If the α_1 parameter is negative and statistically significant (in the empirical analysis, we assumed a significance level of 5%), β-convergence exists. In this situation, we can calculate the value of coefficient β, measuring the speed of convergence:[1]

$$\beta = -\frac{1}{T} ln\left(1 + \alpha_1 T\right). \tag{10.6}$$

In order to verify the occurrence of σ-convergence, we estimate the trend line for the disparity of income levels between countries:

$$sd\left(ln\ y_t\right) = \alpha_0 + \alpha_1 t + \varepsilon_t, \tag{10.7}$$

where *sd* is the standard deviation, while t – time ($t = 1,\ldots, 29$ for the period 1993–2021). Thus, the explained variable is the standard deviation of natural logarithms of

[1] Barro and Sala-i-Martin [2003, p. 467], when analysing β-convergence based on the neoclassical model, derive an equation showing the relationship between the average rate of economic growth and the initial level of income:

$$\left(\frac{1}{T}\right) ln\left(\frac{y_{iT}}{y_{i0}}\right) = a - \left[\frac{\left(1 - e^{-\beta T}\right)}{T}\right] ln\left(y_{i0}\right) + w_{i0,T},$$

where y_{iT} and y_{i0} – GDP per capita in country i in the final and initial year, T – time period, β – convergence rate, a – constant, $w_{i0,T}$ – random factor. The coefficient at the initial income level, i.e. $-\left[\frac{\left(1 - e^{-\beta T}\right)}{T}\right]$ equals parameter α_1 in formula (10.5). Thus, from the equation $\alpha_1 = -\left[\frac{\left(1 - e^{-\beta T}\right)}{T}\right]$ we obtain formula (10.6). For a small T, estimation of the parameter in regression equation α_1 will be very close to coefficient β because with T tending to zero the expression $\frac{\left(1 - e^{-\beta T}\right)}{T}$ tends to β.

GDP per capita levels between countries, while time is the explanatory variable. If the α_1 parameter is negative and statistically significant, σ-convergence exists.

10.4. Empirical evidence

The study covers the period 1993–2021. All calculations were also made for three sub-periods: 1993–2000, 2000–2010 and 2010–2021, which allows the temporal stability of the phenomenon examined to be analysed. This also makes it possible to approximately determine the strength of impact of many other, deeper factors on the rate of income disparity reduction.

Table 10.1. Results of estimation of regression equations describing β-convergence

Time period	α_0	α_1	Stat. t (α_0)	Stat. t (α_1)	p-value (α_0)	p-value (α_1)	R^2	β-convergence	β
25 countries of enlarged EU									
1993–2021	0.2020	−0.0179	6.17	−5.48	0.000	0.000	0.5665	yes	1.80%
1993–2000	0.0555	−0.0023	0.73	−0.30	0.470	0.767	0.0039	no	–
2000–2010	0.3030	−0.0274	9.44	−8.76	0.000	0.000	0.7693	yes	2.77%
2010–2021	0.2160	−0.0190	2.79	−2.58	0.010	0.017	0.2241	yes	1.92%
2 regions (EU-11 and EU-14)									
1993–2021	0.2523	−0.0231	–	–	–	–	1.0000	yes	2.33%
1993–2000	0.1222	−0.0093	–	–	–	–	1.0000	yes	0.94%
2000–2010	0.3764	−0.0348	–	–	–	–	1.0000	yes	3.54%
2010–2021	0.4141	−0.0381	–	–	–	–	1.0000	yes	3.89%

Source: Compiled by author.

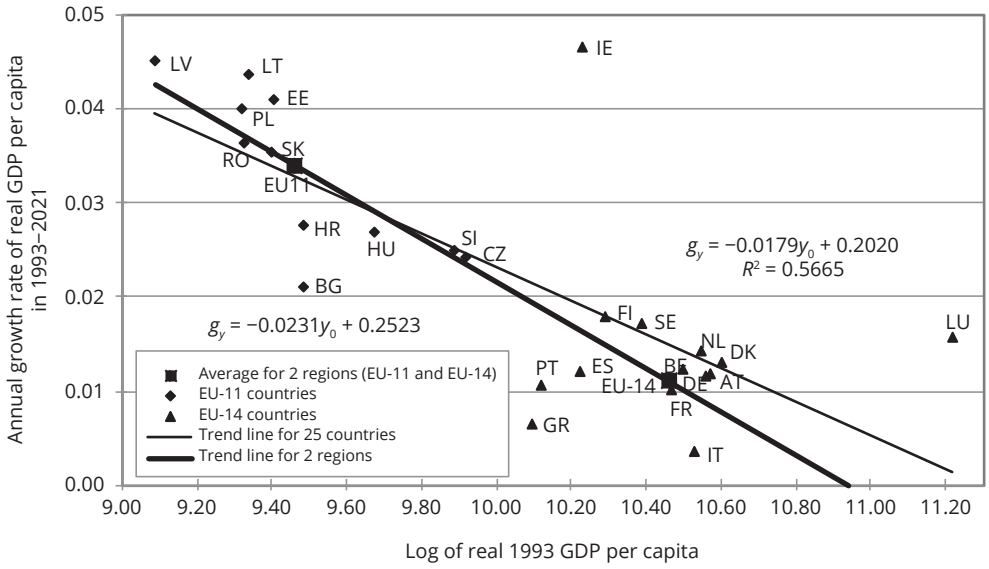
The calculations use time series of real GDP per capita at purchasing power parity (in USD) obtained from the International Monetary Fund data [IMF, 2021].

The results of the β-convergence analysis of the EU-11 to the EU-14 countries are presented in Table 10.1 and in Figure 10.2. Convergence is analysed both between the 25 EU countries and between two regions covering the EU-11 and EU-14 areas. Aggregated data for two areas, EU-11 and EU-14, are weighted averages with variable weights reflecting the population number of a given country included in a particular group in a given year.

The results obtained confirm the existence of clear income convergence of the EU-11 to the EU-15 countries throughout the 1993–2021 period. Convergence occurred both among the 25 countries of the group examined and between the two areas, EU-11

and EU-14. Countries with lower income levels in 1993 showed, on average, a faster rate of economic growth in 1993–2021 than countries initially better developed. As the group of less developed countries in 1993 consisted of the Central and Eastern Europe countries, these results confirm the clear convergence of the EU-11 countries to the average level of income in Western Europe.

Figure 10.2. Relationship between the GDP per capita growth rate in 1993–2021 and the level of GDP per capita at the beginning of the period



Source: Compiled by author.

The analysis of Figure 10.2 shows that the distribution of points representing individual countries fits quite well with the negatively sloped trend line. This results in a relatively high value of the determination coefficient at a level close to 60%. Thus, differences in the initial income level account for more than half of the economic growth rate differential in 1993–2018.

Looking at the points representing particular countries, the situation of the individual countries can be compared and, in this perspective, the changes in their competitive position over the whole period can be assessed. The fastest rate of economic growth among the Central and Eastern European countries was recorded in the Baltic states and Poland. Latvia, Lithuania, Estonia, and Poland showed an average annual economic growth rate of 4.0% or higher in the period 1993–2021, with a relatively low initial income level. Romania and Slovakia also recorded a relatively high rate of economic growth of approx. 3.5%. The performance of those countries strengthened

the convergence tendency in the group as a whole. As can be seen, the situation of Poland compared to other countries is favourable. Poland ranked fourth among the 11 countries of Central and Eastern Europe in terms of the average rate of economic growth in 1993–2021, which was one of the factors behind strengthening the competitive position of the Polish economy.

Aggregated data for two areas: EU-11 and EU-14 also confirm the existence of convergence in 1993–2021. In Figure 10.2, the points representing these two areas are marked with squares. The EU-11 group as a whole showed faster economic growth than the EU-14 with a much lower initial level of income.

The β-coefficients, which measure the speed of the convergence process, amount to 1.80% for the 25 countries and 2.33% for the two areas. They allow the time needed to reduce the development gap between the countries under study to be estimated. Namely, given that the average economic growth rate witnessed over the 1993–2021 period is maintained, the countries of the enlarged EU will need about 30–40 years to halve the distance separating them from the common hypothetical long-term steady state (this result has been calculated as follows: $-\ln(0.5)/0.0180 = 38.5$ years and $-\ln(0.5)/0.0233 = 29.7$ years). The above results show a slow convergence of the EU-11 countries to Western Europe. Based on these estimates, it is difficult to expect quick levelling out of income differences between Poland as well as other Central and Eastern European and Western Europe in the medium term.

This result should be looked at with some reserve, as it is based on model assumptions which may or may not prove correct in reality. The occurrence of a decreasing marginal productivity of capital (in accordance with the neoclassical production function), as well as the fact that economies tend towards the steady state and will reach that state in infinity. Therefore, in interpreting those results, it makes sense to refer to the half-life instead of the period needed to completely close the income gap. It is worth comparing those results with other forecasts, presented in the SGH Report at the Economic Forum in Krynica-Zdrój, which show that Poland will catch up with Western Europe in a dozen or so years [Próchniak, Lissowska, Maszczyk, Rapacki, Sulejewicz, 2019].

It is worth looking at the stability of the convergence processes over time. It turns out that in the separate sub-periods the speed of convergence was highly diversified. The high instability of the convergence rate in the countries under study was caused, *inter alia*, by the global crisis, and by diverse impacts of institutional factors on economic growth, related, e.g., to EU membership. For the 25 EU countries, in the years 1993–2000, there was no statistically significant reduction in the income gap between the EU-11 and the EU-14 countries (in average terms for the whole group). For the years 1993–2000, the slope of the trend line is negative but not statistically significant. Such estimation results of the model show the actual lack of convergence, despite the

negative slope of the trend line. A very strong acceleration of the convergence rate occurred in 2000–2010, which undoubtedly had its source in the EU enlargement.[2] The clear tendency towards convergence witnessed in the 2000 s declined steeply in the 2010s. This was largely attributable to the crisis in the wake of the COVID-19 pandemic and interruption of prior stable paths of economic growth in the countries concerned.

The β-convergence results presented here are averaged values for the entire region. As can be seen in Figure 10.2, individual CEE countries showed different dynamics of economic growth and different degrees of convergence to Western Europe. It is worth analysing the status of convergence of the particular EU-11 countries relative to the EU-14 in the separated sub-periods.

Figure 10.3 shows a decrease in income gap (in percentage points) of a given EU-11 country in relation to the EU-14 in the years 1993–2000, 2000–2008 and 2008–2021. The data presented in the figure partly confirms the conclusions of the β-convergence analysis. Namely, all the countries saw the slowest pace of closing the income gap in the first identified sub-period, i.e. 1993–2000. What is more, in those years two countries (Bulgaria and Romania) even saw an increased development gap with Western Europe. The unusual behaviour of Bulgaria and Romania resulted partly from the fact that the "integration anchor" related to EU enlargement started to work later in those countries than in other CEE states (except Croatia, which was the last country to join the EU). Between 1993 and 2000 Poland edged 8 p.p. closer to the 14 Western European states to become a leader in this respect (jointly with Estonia).

After 2000, the rate of catching up accelerated across the EU-11. Most CEE countries narrowed the income gap with the EU-14 by 10 p.p. or more both in the 2000s and 2010s. The leader was Lithuania, which caught up by 21 p.p. with Western Europe in terms of the development divide between 2000 and 2010 and by 27 p.p. between 2010 and 2021. Estonia, Latvia, and Romania also led the way in this respect, narrowing the distance to the EU-14 over the first two decades of the 21st century by 16 and 22 p.p. respectively (Estonia), 16 and 19 p.p. (Latvia), 15 and 18 p.p. (Poland), and 17 and 19 p.p. (Romania).

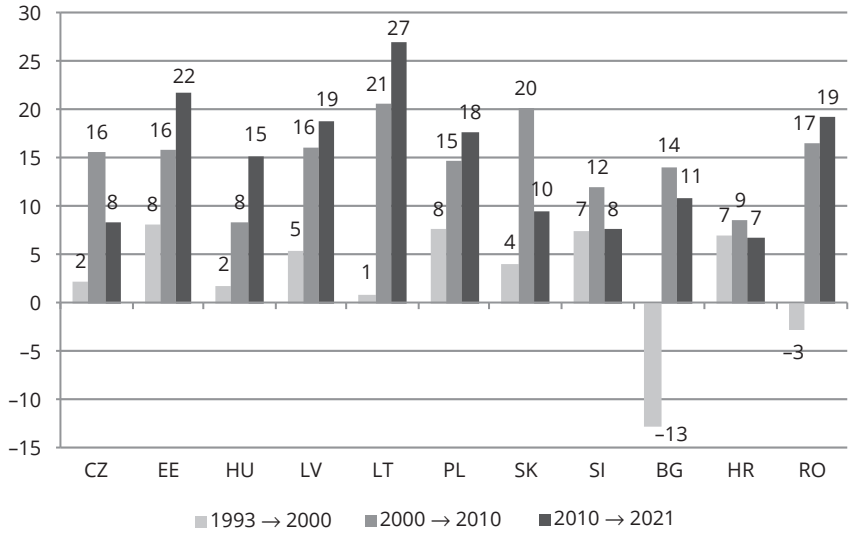
For Poland, an important role in accelerating the pace of convergence after the EU enlargement was played by the European funds, which increased the competitiveness of the country's economy. Poland was the largest beneficiary of the EU funds under the 2007–2013 budget. The stream of funding from the EU under various support programmes positively influenced the growth of the Polish economy on the demand and supply sides, thanks to which Poland performed relatively well in terms of

[2] The positive impact of EU membership on economic growth of the 11 CEE countries is also confirmed in an article by Rapacki and Próchniak [2019].

economic growth in recent years (e.g. it was the only EU country to avoid recession during the last global crisis). The EU budget for 2014–2020 and the continuation of a large inflow of structural funds to the new member states is also one of the factors conducive to maintaining the pace of Poland's convergence to Western Europe in the last analysed sub-period.

The expansive fiscal and monetary policy pursued by the government and central bank in Poland over the last few years has also been conducive to strong economic growth despite the COVID-19 pandemic. Large infrastructure projects, including the continued construction of motorways and expressways (e.g. Via Baltica and Via Carpathia), railway line upgrades and purchase of new rolling stock, the Vistula Split canal project, or the construction of the Świnoujście Tunnel, as well as large social resulting in an increase of household disposable income are only some examples of projects driving the Polish economy.

Figure 10.3. Extent of income gap closing between the EU-11 and the EU-14 countries in three consecutive sub-periods



Note: The changes are expressed in percentage points; for each year, the EU-14 GDP per capita at PPP is taken as 100.
Source: Compiled by author based on IMF [2021].

Consequently, Poland ranks fifth among the EU-11 countries in terms of relative income per capita (measured at PPP). According to October 2021 IMF data, in 2021 Poland's GDP per capita represented 72% of the average income per inhabitant of Western Europe (EU-14). Results better than Poland's are boasted by the Czech Republic (84%), Slovenia (83%), Estonia, and Lithuania (81% each). This marks a significant

improvement from data reported several years ago, when Poland was trailing the group. Hopefully, despite the persisting COVID-19 pandemic, the favourable development trends will be continued by Poland and in the years ahead the country will be further catching up with Western Europe.

The σ-convergence of the Central and Eastern European countries to Western Europe is measured by changes in the standard deviation of the natural logarithms of GDP per capita between the 25 EU countries, as well as between the two areas, the EU-11 and the EU-14. The results of the trend line estimation for standard deviations are presented in Table 10.2, and Figure 10.4 contains a graphical presentation of the results.

The data contained in Table 10.2 shows that for the whole period there was σ-convergence both among the 25 EU member states and between the EU-11 and the EU-15. The slopes of both estimated trend lines are negative and statistically significant at very high significance levels (as demonstrated by *p*-values equal to 0.000). High values of determination coefficients (over 90%) show a very good fit of empirical points to the trend line.

Table 10.2. Results of estimation of regression equations describing σ-convergence

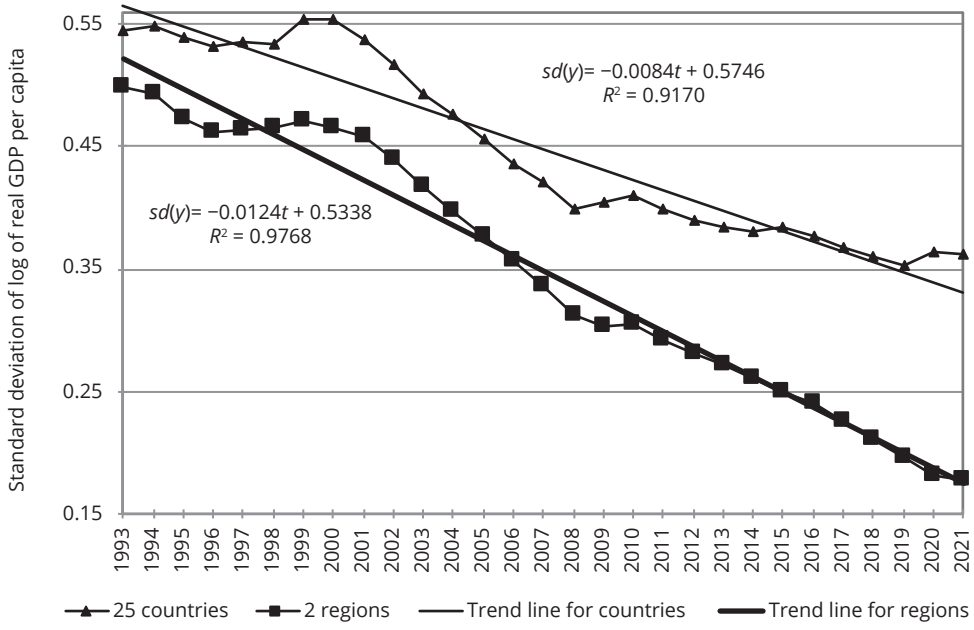
Time period	α_0	α_1	Stat. *t* (α_0)	Stat. *t* (α_1)	*p*-value (α_0)	*p*-value (α_1)	R^2	σ-convergence
25 countries of enlarged EU								
1993–2021	0.5746	−0.0084	68.87	−17.27	0.000	0.000	0.9170	yes
1993–2000	0.5387	0.0009	73.70	0.62	0.000	0.560	0.0597	no
2000–2010	0.5614	−0.0162	66.36	−12.98	0.000	0.000	0.9493	yes
2010–2021	0.4068	−0.0045	104.48	−8.51	0.000	0.000	0.8786	yes
2 regions (EU-11 and EU-14)								
1993–2021	0.5338	−0.0124	84.35	−33.68	0.000	0.000	0.9768	yes
1993–2000	0.4934	−0.0042	63.69	−2.76	0.000	0.033	0.5588	yes
2000–2010	0.4888	−0.0183	95.26	−24.18	0.000	0.000	0.9848	yes
2010–2021	0.3187	−0.0120	160.35	−44.44	0.000	0.000	0.9950	yes

Source: Compiled by author.

Figure 10.4 shows the tendency of standard deviation of log GDP per capita levels. As can be seen, the income differential between the new and the old EU countries showed, in general, a downward trend. The most visible and systematic decrease in income disparities occurred in the second part of the analysed period, i.e. from 2000 onwards. In 2009 and 2010 – as a result of the economic crisis and declining GDP growth rate in many previously fast developing countries – income disparities among the 25 countries of the group under study increased. A tendency towards divergence

in the EU-25 was also witnessed in 2020 as a result of the coronavirus pandemic, although this is not confirmed by averaged data for the two areas.

Figure 10.4. Standard deviation of GDP per capita in 1993–2021



Source: Compiled by author.

10.5. Discussion

There is much empirical research on the phenomenon of convergence, and it is impossible to list all of it here. A detailed review of the latest empirical research includes the article by Matkowski, Próchniak, and Rapacki [2016b]. Books by Malaga [2004], Michałek, Siwiński, and Socha [2007], Liberda [2009], Batóg [2010],Próchniak and Witkowski [2016], Jóźwik [2017], and Kotliński and Warżała [2020] are entirely or largely devoted to the phenomenon of convergence in the countries of the European Union or the OECD. For their part, books by Wójcik [2018] and Bernardelli, Próchniak, and Witkowski [2021] provide certain innovative approaches to measuring the convergence process, together with an extensive empirical analysis.

Comparing the results obtained here with the literature, it should be added that in recent years studies suggesting the possibility of divergence in Europe (both at the national and regional level) have been increasingly frequent. For example, Mucha

[2012] suggests that for some euro area countries having the single currency may be a source of many problems and cause the emergence of economic divergence relative to other members of the Economic and Monetary Union. Monfort, Cuestas, and Ordóñez [2013] analyse the real convergence of GDP per worker in 23 EU countries in 1980–2009 (Western European countries) and 1990–2009 (Central and Eastern European countries), showing that – using the club convergence research techniques – there is a strong case for the existence of per capita income divergence in the EU as a whole; however, for example, the countries of Central and Eastern Europe (excluding the Czech Republic but including Greece) form a group showing convergence. Borsi and Metiu [2013] analyse the real convergence of the 27 EU countries in the years 1970–2010, reaching the conclusion that there is no convergence of per capita income levels in the whole group and that there is convergence in the subgroups of countries that tend to different steady states. Staňisić [2012] analyses β-convergence in the EU-25 and within two groups of countries, the EU-15 and the EU-10, confirming the existence of β-convergence in the EU-25 (which means the convergence of the new EU member states to Western Europe) and denying the convergence within the EU-15 and the EU-10. The author of the quoted study also claims that during the recent crisis income disparities between the EU-25 countries increased, but the scale and time range of that increase were limited and did not affect the long-term convergence path, which is a conclusion very similar to the results of our study.

It is therefore clear that the convergence process is not an automatic phenomenon. Despite the strong tendency of decreasing income disparities between Central and Eastern Europe and Western Europe in recent years, there is no guarantee that this situation will persist in the future (as evidenced by the temporal instability of our results and increasingly frequent references in the literature to the possibility of divergence tendencies emerging in Europe). Thus, it is an extremely important task for economic policymakers to pursue measures to maintain the current long-term trends of economic growth in Europe, characterized by reducing the income differences between the eastern and western areas of the continent.

10.6. Conclusions

In the group of 25 countries of the enlarged European Union, income convergence occurs both in terms of β- and σ-convergence concepts. The rate of economic growth in 1993–2021 was negatively dependent on the initial level of GDP per capita. The new EU member states from Central and Eastern Europe achieved a faster rate of economic growth than the Western European countries, although the initial level of GDP per

capita in the Central and Eastern European countries was much lower. Disparities in the level of income decreased, especially after 2000, although they are still very large.

Therefore, a reduction in the differences in competitiveness measured by the standard of living of the societies of the old and the new EU countries cannot be expected unconditionally in the short-term perspective. Acceleration of the convergence process will depend, among other things, on a properly conducted economic policy aimed at reducing differences in the level of development between Central and Eastern Europe and Western Europe. The coronavirus pandemic will also have a significant impact on future economic growth. It carries the danger of statistical acceleration of convergence, which would be the case if the scale of recession in Western Europe were higher than in Central and Eastern Europe. Hopefully, no such statistical convergence will occur and the EU member states will see a positive economic growth and their development level will be improving.

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Chapter 11

Energy Supply and Sustainable Competitiveness

Honorata Nyga-Łukaszewska

11.1. Introduction

Energy is a vital component of economic development. For many economies, energy supply, the structure of its production, and the level of its consumption represent challenges of energy and climate policy. Along with the changing trends in climate protection, the progressive pressure to reduce greenhouse gas emissions and limit the negative impact of the energy industry on the natural environment, the role of energy in the economy is growing. The processes of decarbonization of economies, partial or complete elimination of fossil fuels, investment in low-carbon technologies are currently among the most important elements of countries economic strategies.

This clearly manifests itself in Europe in the form of political and economic initiatives by the European Union (EU) member states aimed at achieving climate neutrality. One example of proposed EU measures in this area is the European Green Deal. As Sachs noted, the strategy responds to the global challenges of environmental degradation and climate change.[1] Its aim is to transform European economies into modern, energy-efficient and competitive systems on a global scale [European Commission, 2019]. The European Green Deal aims to make Europe the first climate-neutral continent on Earth. The strategy proposes a new model of economic development based on ten different priorities. In addition to sustainable agriculture, transport and innovation, there are issues related to the achievement of climate neutrality by the EU countries.[2]

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1 "The Green Deal announced by the European Commission is a demonstration of European social democracy at work. A mixed economy, combining markets, government regulation, the public sector, and civil society, will pursue a mixed strategy, combining public goals, public and private investments, and public support" [Sachs, 2019].

2 In addition, climate neutrality, including the reduction of greenhouse gas emissions, is also to be achieved by reducing methane emissions, which have a significantly greater (than CO_2) global warming potential (GWP). This confirms the importance of methane emissions, in particular those coming not only from the energy sector, but mainly from the agricultural sector.

It is to be achieved by reducing greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels. This target is to be met, among other things, through the greening of the energy system. This means increasing the share of renewable energy sources (RES) in the energy mix and improving energy efficiency.[3] In particular, it is about achieving a 40% share of RES in the Community's energy mix by 2030 and reducing final and primary energy consumption by about 36–39% by 2030. The role of RES in the EU is also expected to increase significantly due to the commitment of the member states to increase the use of renewable energy for heating and cooling of buildings by 1.1 p.p. per year by 2030. This way, energy poverty is planned to be reduced and energy savings are to be achieved.

Europe also aims to develop low and zero-emission transport and to include this sector in the emissions trading system from 2026 onwards. In particular, this applies to the reduction of emissions by 55% and 50% from cars and vans, respectively, by 2030 and committing the automotive industry to sell only zero-emission new vehicles after 2035 [European Commission, 2021a]. The planned energy transition is expected to proceed in a socially equitable way. It is strongly emphasized that the shift towards a low-carbon economy will take place with the support of additional funding. The investment budget is to be based on the EUR 65–75 billion funding allocated to investments over the period 2021–2027, scheduled to be used to help the regions where changes in local economic and social systems are most needed.

At the same time, in July 2021, the European Commission presented a set of legislative proposals aimed at adapting EU regulations to the objectives set out in the European Green Deal. The *Fit for 55* package refers to the target of at least 55% emission reductions that the EU has set itself to achieve by 2030. Areas requiring additional clarification of the rules were identified, including the EU Emissions Trading System (EU ETS), the Effort Sharing Regulation targeting emissions in sectors not covered by the EU ETS, renewable energy sources, energy efficiency, alternative fuels infrastructure, emission standards for cars and vans, and energy taxation [European Council, 2021].

The EU's ambitious programme aimed at achieving climate neutrality is the Community's contribution to the global reduction of greenhouse gas emissions covered by the Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC). In 2021, the Conference of Parties (COP) is held in Glasgow (COP 26). The arrangements agreed during the participants' debates are aimed at reviewing the commitments arising from the Paris Agreement. This year's conference has four goals: adapt to protect communities and natural habitats, secure global net-zero by

[3] Energy efficiency has been put at the forefront as the "first fuel", having been previously treated as the "fifth fuel".

mid-century, work together to deliver on the Paris Agreement, but at the same time mobilize finance (USD 100 billion / year by 2025) for developing countries. While the first three goals of COP 26 are a continuation of the parties' previous commitments, the last item is an initiative to address the concerns of developing countries about the need to support this group of stakeholders in the implementation of climate protection commitments. European leaders who met at the European Council on 21–22 October 2021 called for an ambitious response to climate change, reaffirming the need to meet the COP 26 goals; in particular, they called on developed countries to urgently increase their contribution to climate finance support for developing countries.

The European Union's ambitious climate policy is a confirmation of the commitments made, e.g. under the Paris Agreement, but also an expression of climate leadership on the international stage. Nevertheless, this approach brings with it a number of challenges for Member States related to energy management,[4] which affect the competitiveness of countries in international markets. The aim of this study is to provide a preliminary assessment of the conditions of the Polish economy in the context of energy management and its international competitiveness. For this purpose, an analysis is conducted, preceded by the presentation of selected theoretical strands regarding energy management. Next, the position of broadly-defined energy in rankings assessing international competitiveness is presented, followed by secondary data that describes Poland's energy resources and the assessment of the country's international competitiveness. The analysis ends with conclusions and recommendations.

To prepare the study, literature on the subject was used along with data obtained from the World Bank and Eurostat databases. The analysis concerns Poland's situation in 2020 and therefore, where possible, data for 2020 was used; however, some of the data was not available during the preparation of this paper and in such cases the analysis was extended to 2000/2010/1990 so as to capture trends of the variables being analysed. In addition, where possible, Poland is shown in the context of the EU countries.

11.2. Energy resources in economic analysis

The subject of natural resources was already present in classical economics. In that approach, natural resources were seen as a factor that significantly influences the wealth of nations and their economic growth. Considerations of Adam Smith, David Ricardo, Thomas Malthus or John Stuart Mill provide no direct references to energy

4 The words "fuel" and "energy" are used here interchangeably.

resources because the authors referred to land (as a factor of production, Malthus, Ricardo) as a natural resource available in limited quantities (Malthus) or qualitatively diverse (Ricardo). Considerations about land as a natural resource are mainly related to the function of the agricultural sector in creating economic growth.

Nowadays, natural resources in general are analysed within the framework of environmental economics, while energy resources are dealt with by energy economics. It is a relatively young research area, the beginnings of which date back to the 1970s. It is the period in which the Club of Rome's report *The Limits to Growth* [Meadows, Meadows, Randers, Behrens, 1972] appeared. According to Zweifel, Praktiknjo and Erdmann [2017], it is a publication that aroused interest in the issue of the exhaustibility of energy resources (oil) and the negative impact of greenhouse gas emissions on the natural environment. The 1973 and 1979 oil crises confirmed the importance of energy resources in the world economy.

This does not mean, however, that the foundations of the economic analysis of energy resources did not emerge until the 1970s. One of the first studies addressing the issue of exhaustibility of energy resources and the economic effects of the extraction of minerals was undertaken by Hotelling. Making a number of assumptions,[5] the author came to the conclusion that with resources being in limited supply, the price of raw materials would increase over time, and the rate of its growth would depend on the interest rate in financial markets. Hotelling's work gave rise to reflections on exhaustible resources. Therefore, since its appearance in 1931, many subsequent theoretical works have emerged, which focused on the analysis of exhaustibility of resources.

As Epple and Londregan [2006, p. 1103] point out, the rapid development of new theoretical analyses failed to be backed by empirical analyses testing such new findings. All these works focused on the analysis of exhaustible resources, so the main factors taken into account in the analysis were the characteristics of the resource base, determinants of the pace and scale of exploration and extraction of resources. Theoretical models estimating non-renewable resources are determined by the choice of the extraction method, which appears directly as the production function or indirectly as the extraction cost function. Most models factor in technology in the form of a cost function. The non-renewable resource cost function is influenced by: extraction level (q), prices of factors of production (w), characteristics of the resource stock (z), and stochastic/random (unobservable) factors (ε).[6] It is assumed that all unobservable

[5] E.g. that markets for raw materials, factors of production are perfectly competitive, there is symmetry of information between market participants, the cost of extraction is constant, there is no inflation, no surplus stocks are maintained in excess of the volumes extracted, demand for raw materials depends only on energy price.

[6] To learn why the cost function for non-renewable resources takes the form: $c\ (q, w, z, \varepsilon)$, see Epple and Londregan [2006, p. 1080].

elements depend on the resource stock (z) and are a function of cumulative extraction ($z = \sum q$).[7] Therefore, the cost function for non-renewable resources takes the form:

$$C(q,z) = \min\{x_i\} \sum_{i=1}^{J} c_i * x_i \text{ with } x_i \leq R_i \sum_{i=1}^{j} x_i = q,$$

where: x_i – quantity of resource extracted from the i-th stock, c_i – unit cost of extraction from the i-th stock, R_i – quantity of resource remaining for extraction in the i-th stock, and q – complete extraction of resource x_i $q = \sum_{i=1}^{J} x_i$.

The above method of analysing the exhaustibility of energy resources is not the only one.[8] Other considerations focus, *inter alia*, on the distribution of resource deposits in geological strata or the endowment of deposits and their depth, volumes of resources remaining available for extraction, or even structures of competition in the energy resource market.

The exhaustibility of energy resources is one of the basic problems associated with their use. This applies in particular to fossil fuels such as hard coal, lignite, natural gas, oil, or uranium ore. The increased demand for fossil fuels will consequently lead to the depletion of their deposits. One way to deal with this challenge is to look for substitutes. As Dasgupta [2006, pp. 1114–1115] points out, there are nine mechanisms for substitution between resource stocks. Each of these mechanisms partly overlaps or is linked to another/next one, and each of them partly refers to innovation as a key element in the process of substitution of resources. The first mechanism concerns innovations enabling the use of a resource in a specific application. The second one is related to the development of the production of new materials (e.g. instead of natural fibres, the development of the production of synthetic fibres). The third and fourth mechanisms concern innovation in the field of impact on the extraction process, increasing its efficiency and reducing its costs. The fifth mechanism refers in particular to improving resource use efficiency. The sixth one concerns the development of techniques enabling economically viable extraction of hitherto unprofitable raw material low-grade resources. The seventh mechanism refers to the use of recycling, thanks to which the cost of the raw material is reduced and the efficiency of its use increases. The eighth mechanism, unlike the others, is not based on technological progress and innovation, but is the result of a gradual transition from high-grade to low-grade resource reserves. Thus, over time, the depletion of high-grade deposits leads to their being replaced by the extraction of lower-grade resources. The last, ninth mechanism, concerns substitution of capital resources understood as factors of

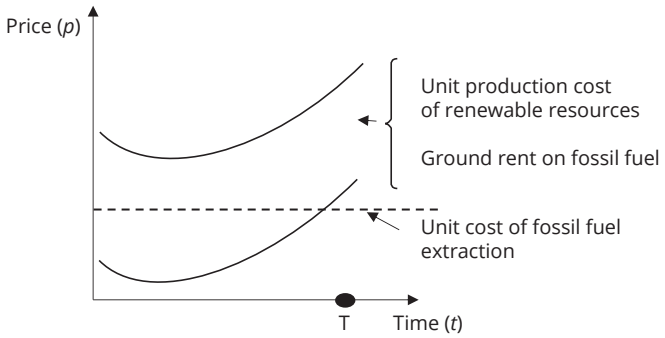
[7] One of common explanations is that over time the resources extracted are of increasingly low quality [Epple, Londregan, 2006, p. 1081].

[8] For a broader description see Epple and Londregan [pp. 1077–1103].

production for energy resources. Limited possibilities of substitution in this respect are noted, as capital is characterized by strong complementarity with a specific energy resource.

In the case of energy resources, substitution in the long term and on a macro scale is possible (in certain cases) thanks to energy transition to renewable sources. Renewable energy sources (RES) include solar, wind, water (including geothermal and tidal power), and biomass energy. These are resources, the use of which in the energy industry does not generate greenhouse gas emissions having an adverse impact in terms of climate protection, the substitution of fossil fuels for renewables is strongly dependent on the prices of these raw materials. Figure 11.1 shows that the substitution of fossil fuels with RES is a time-consuming process. During the time marked as *T*, it is assumed that thanks to innovations in research and development, affordable sources of renewable fuels will appear on the market. The pace of research on the use of RES will depend on the fossil resources but also on their prices. The smaller the resources, and the higher the prices, the faster the pace of work. Figure 11.1 shows that for a certain period of time fossil fuels coexist in the market with renewable sources.

Figure 11.1. Time of substitution between fossil fuels and RES[9]



Source: Compiled by author based on Dasgupta [2006, p. 123].

The gradual substitution of renewables for fossil fuels is a necessary element for the implementation of the *European Green Deal* strategy or for progress in reducing greenhouse gas emissions under the UNFCCC Paris Agreement. Replacing

[9] In this case, it is assumed that unit extraction costs are constant and do not change over time. The market price of a resource results from the price of extraction, but also from the costs of extraction and additional costs related to the treatment (processing) and transport of the resource. In perfectly competitive markets (at all stages from extraction to sale of a resource) the market price of the resource is the sum of the costs of extraction, treatment (processing), transport and mining licence fees (royalties; depending on the country and the geological concession system adopted, they may take different forms) [Dasgupta, 2006, p. 119].

carbon-intensive fuels for less emission-intensive sources is also part of the strategy for the sustainable use of natural resources. Although the concept of "sustainability" of resource use initially referred to forest resources, since 1987 – the year when the Bruntland Report was published – it has also been applied to energy resources [Zweifel et al., 2017, p. 131]. The Report [UN, 1987] describing the potential of sustainable development also refers to the issue of consumed energy resources. Zweifel et al. [2017, p. 131] note that in accordance with the principle of sustainable development put forward in the report it is possible to consume non-renewable energy resources so that future generations can satisfy their needs with a reduced or lack of resource base. As the authors emphasize, today this approach is referred to as weak sustainability, in contrast to the idea of strong sustainability, according to which future generations should have access to a minimum amount of non-renewable energy resources.

11.3. International competitiveness, sustainable development, and energy resources

Today, sustainable development is closely linked to international competitiveness. There is even talk of sustainable international competitiveness. Cheba, Bąk and Szopik-Bąk [2020] argue that sustainable competitiveness is the sum of sustainable capacity and competitive position,[10] making it clear that sustainability is different from sustainable competitiveness. Cheba et al. [2020] also conclude that the assessment of competitiveness in the sustainable dimension consists in estimating the competitive position of the country, e.g. as regards exporting environmentally friendly technological solutions. Sustainable competitiveness is defined as an outcome of the natural evolution of the phenomenon of international competitiveness [GSCI, 2021].

The assessment of international competitiveness itself is performed in a variety of ways. Here, only elements of international rankings are cited, the analysed energy resources being their components. One of the most widely used international rankings is the one based on the Global Competitiveness Index (GCI) designed by the World Economic Forum. Competitiveness is measured in twelve different pillars covering, e.g. institutions, infrastructure, macroeconomic environment, education and healthcare system, as well as financial and labour market conditions, but also the innovation ecosystem.

[10] Discussion on competitive position and competitive capacity is an area of in-depth scientific debate. While it is an important research strand, it does not fall within the scope of this study. Therefore, this issue is not elaborated on here.

As indicated in the Global Competitiveness Report 2019 [WEF, 2019], more internationally competitive economies are better placed to decarbonize their energy systems. This is manifested in various forms. This could be, e.g. a greater innovation potential of economies that create breakthrough environmentally friendly energy technologies. Examples of such countries include South Korea, Denmark, Japan, Germany, the USA, and Singapore. A comparison of the number of patents related to green technologies (average for the period 2014–2015)[11] to the score in the competitiveness ranking (GCI for 2019) showed that countries with the largest number of green patents are also economies ranked highest for international competitiveness. Other possible drivers of decarbonization are high-quality human capital and well-developed infrastructure. Countries with such conditions are more likely to introduce green technologies and fuels into the energy mix. In this context, reference is made to prioritizing efforts to eliminate fossil fuel subsidies, impose a higher tax burden on greenhouse gas emissions, increase incentives to invest in research and development of renewable and alternative energy sources, and include environmental requirements in technical specifications as part of public procurement procedures.

The report also stresses that international competitiveness and sustainable development are not achieved independently of each other. It is made clear that today environmental protection and economic development are one common element. At the same time, there is no need to resort to compromise solutions serving only one of the goals set. On the contrary, solutions are possible that have a positive impact on both areas. Some evidence of the close relationship between environmental protection and economic development is provided by the analysis of total factor productivity (TFP). TFP, which represents the "unexplained" part of GDP growth, includes technological progress, human capital, the quality of institutions or cultural conditions, but also differences in environmental standards. Differences in TFP increases are also responsible for the diversity of living standards between countries and thus the scores in the global ranking of international competitiveness of economies.

Energy resources and the way they are used in the economy are important determinants of international competitiveness. The "energy" category is one of the basic elements used to design indicators of international competitiveness. One such measure is the Global Competitiveness Index (GCI), and another is the index developed by the International Institute for Management Development (IMD), or the Global Sustainable Competitiveness Index (GSCI), which combines aspects of sustainable development and international competitiveness.[12] Apart from these three rankings,

[11] The number of "green patents" per million population according to OECD databases.

[12] For more on differences between the international competitiveness rankings, GCI and GSCI, see Solability [2013]. Criticism of the GCI index mainly concerns the method of data collection, the selection of

there is also another, authored by the WEF, which focuses strictly on the assessment of the energy transition of economies – the Energy Transition Index.

The GCI does not refer directly to energy resources, but it takes into account elements indirectly related to them, such as: 1) energy efficiency policy, 2) renewable energy, 3) access to electricity, or 4) quality of electricity supply. The first two aspects refer to he country's regulatory policy promoting energy efficiency or renewable energy sources. The scores achieved by countries in both categories range from 0 (not conducive) to 100 (very conducive). The score includes, in the case of energy efficiency, ratings for a given country based on twelve indicators and in the case of renewable energy on the basis of seven variables. The assessment of energy efficiency regulation includes the assessment of the national energy efficiency planning system, information provided to consumers on electricity consumption, energy efficiency incentive and penalty schemes in all customer groups (including industrial, commercial, and public), energy efficiency financing mechanisms, implemented minimum energy efficiency standards, energy certification systems, and the way carbon dioxide emissions are monitored. The assessment of renewable energy regulations coincides with energy efficiency with regard to financial and regulatory incentive systems, the monitoring of carbon dioxide emissions, or national regulations on RES development. Also taken into account are the possibility to connect RES to the transmission grid available in the country, plans to expand RES use in the country or investor risk in the RES industry. Two further energy-related aspects (3 and 4) included in the GCI are a strictly quantitative assessment of the percentage of the population with access to electricity and the percentage share of electricity transmission and distribution losses.[13]

The index developed by IMD, like the GCI, does not refer directly to energy resources as a determinant of the international competitiveness of countries. In this case, energy use is indirectly taken into account in the indicators of energy intensity of economies, RES consumption, or carbon dioxide emissions. In addition to healthcare spending or the level of quality of life, these are elements of the assessment of countries' healthcare and environmental infrastructure. The energy intensity of the economy is measured by energy consumption per USD 1000 of GDP. RES consumption is illustrated by their percentage share in the total energy demand in the country. Carbon dioxide emissions are represented by two indicators. One indicator is tonnes of total CO_2 emissions and

indicators, too much correlation with current GDP levels and little predictive suitability to assess the ability to create wealth in the future. One of the arguments raised against the GCI is that the high level of GDP closely correlates with international competitiveness, also in the case of oil countries in the Middle East, but does not take into account in any way the issue of resource depletion and the efficiency of resource use.

13 Besides these elements, in competitiveness assessment within the first pillar, the GCI section devoted to institutions also includes the participation of the country in 29 environment-related international treaties [WEF, 2019].

the other is tonnes of carbon dioxide emissions from industrial activities per USD 1 million of a country's GDP. In addition, the IMD competitiveness ranking also takes into account an aspect which is not directly related to the consumption of energy resources – the development of environmentally oriented technologies. It is calculated on the basis of a country's (percentage) share of the total number of technology patents [IMD, 2019, p. 445].[14]

The issue of energy is viewed in a much broader perspective in the Sustainable International Competitiveness Index (GSCI).[15] The GSCI [Solability, 2021] takes into account energy resources in two of the five pillars based on which the index is estimated. The first pillar, which includes natural capital, takes into account, among other things, the availability of resources and the degree of their depletion. The second pillar focuses mainly on productivity and resource use intensity as a measure of competitiveness in a world with limited resources. Natural capital is the physical characteristic of a country in terms of climate, population, biodiversity or resources. In this dimension, energy is taken into account in the form of the share of energy produced in hydroelectric power plants, the ability of a country to satisfy its own energy needs,[16] the dominance of fossil fuels in the total energy consumed in the country, but also, alongside other natural resources, in more general metrics of mineral resources (per unit of gross national income – GNI and per capita) or the rate of their depletion (as a percentage of GNI). Efficiency and intensity of the use of energy resources are represented by emissions of carbon dioxide, nitrogen oxides, sulphur dioxide or total greenhouse gas emissions per unit of GDP or per capita,[17] electricity consumption per GDP unit, per capita or the share of electricity produced from coal or oil or RES (excluding hydroelectric power plants) in the total electricity production and the overall energy intensity of the economy as energy consumption per unit of GDP or per capita. It is assumed that higher efficiency in the consumption of energy resources improves their availability, reduces the unit cost of production and improves the standard of living of the population [Solability, 2021].

A ranking partially similar to the GSCI is the World Economic Forum's Energy Transition Index (ETI).[18] Nevertheless, it is worth noting here that the ETI shows to

14 In addition, as in the case of GCI, the IMD competitiveness ranking also takes into account the country's participation in international environmental treaties. An additional element in the IMD is the inclusion of information on whether or not sustainable development is a priority for businesses.

15 Published since 2012.

16 Referred to as energy self-sufficiency.

17 For sulphur dioxide and total greenhouse gas emissions gross national income statistics are used instead of GDP [Solability, 2021, p. 59].

18 It was previously published by WEF in collaboration with Accenture as the Energy Architecture Performance Index (EAPI) [WEF, 2021a].

a greater extent the readiness of countries to change their energy systems towards more sustainable ones. The ETI is based on the idea of the "energy triangle" consisting of energy security, sustainable use of the environment, and economic growth. On the other hand, one part of the ETI index itself is determined by the values obtained from the indicators in the "energy triangle", while the other part is determined by the transition readiness index (TRI).[19]

Energy security is measured by the level of diversification of imported fuels and the diversity of the structure of primary energy consumption, power grid coverage of the country, the share of imported energy in the total energy consumed in the country, the quality of energy supply, the consumption of solid fuels per population. The uses of the natural environment are determined by carbon dioxide emissions per capita, energy intensity of the economy (amount of energy produced in MJ/USD 2011 PPP GDP), emissions of pollutants into the atmosphere (micrograms per cubic metre). Economic growth is analysed through the prism of electricity prices for industry (USD/kWh) and households (PPP USD/kWh), the level of energy subsidies (% of GDP) or fuel imports (% of GDP) or wholesale prices of natural gas (USD/MMBTU).[20]

The Energy Transition Readiness Index shows how the energy transition is affected by the stability of regulations and the quality of institutions, but also by the freedom to invest or the structure of the existing energy system. The following are taken into account: investment freedom, transparency, country rating, quality of education, and innovativeness of the business environment,[21] but also the expansion of the capacity to generate energy from RES (% of installed capacity), energy consumption per capita, power system flexibility,[22] coal or RES share in electricity production, share in global resources of fossil fuels,[23] but also declared emission reductions. The TRI seems to reflect to a large extent the concept of competitive capacity, while the ETI reflects the competitive position in terms of the energy transition of economies.

All the (selected) rankings described above for the assessment of international competitiveness include a component dedicated to energy issues. This is not always a direct reference to energy resources; more often, there is an indirect reference to the energy mix, its emissivity or the general energy intensity of economies. As a breakthrough approach, the GSCI index is designed so that it not only shows the

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19 The ETI is also similar to the World Energy Trilemma Index published by the World Energy Council, which is based on the energy triangle comprising energy security, sustainable use of the natural environment, and energy capital (energy access, prices, etc.).

20 The analysis also factors in the cost of unpriced externalities as % of GDP [WEF, 2021a].

21 The variables listed are categorized on a scale from 1 to 7 or from 0 to 100. The higher the score, the better the indicator [WEF, 2021a].

22 From 0 to 1, the higher the score, the greater the flexibility.

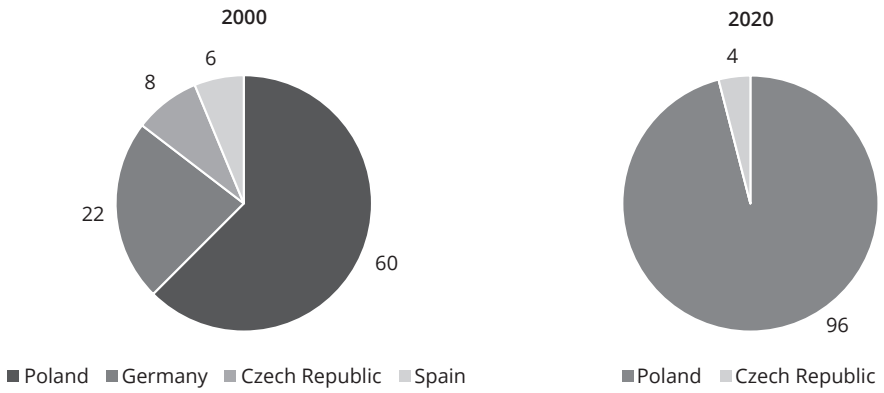
23 Measured by CO_2 emissions.

idea of sustainable international competitiveness but also takes into account energy resources in terms of both their availability and efficiency of use. This approach seems to correspond to a greater extent with the specificity of non-renewable energy sources described by Hotelling. A narrow sectoral approach is presented by the WEF – although it does not provide direct references to the idea of international competitiveness, the design of the Energy Transformation Index has become a faithful reflection of the concepts of competitive position and competitive ability. Therefore, in order to show the specificity of the Polish energy situation in the context of sustainable international competitiveness, the next part of this chapter will present statistics referring to the measures used in the reports referred to above, as well as the indicators of international competitiveness (also in sustainable terms) and energy transition for Poland.

11.4. Poland's energy resources in the context of sustainable competitiveness

Compared to the European Union countries, Poland stands out for its relatively large resources of solid fuels. Due to the significant domestic production of coal, the power generation mix in Poland is dominated by coal-fired power plants. Over the years 1990–2020, hard coal production in the European Union countries decreased from 277 million tonnes to 56 million tonnes. In 1990, besides Poland, hard coal was extracted mainly in Germany, the Czech Republic, Spain, and France. In 2020, hard coal production was continued only in Poland and the Czech Republic (Figure 11.2).

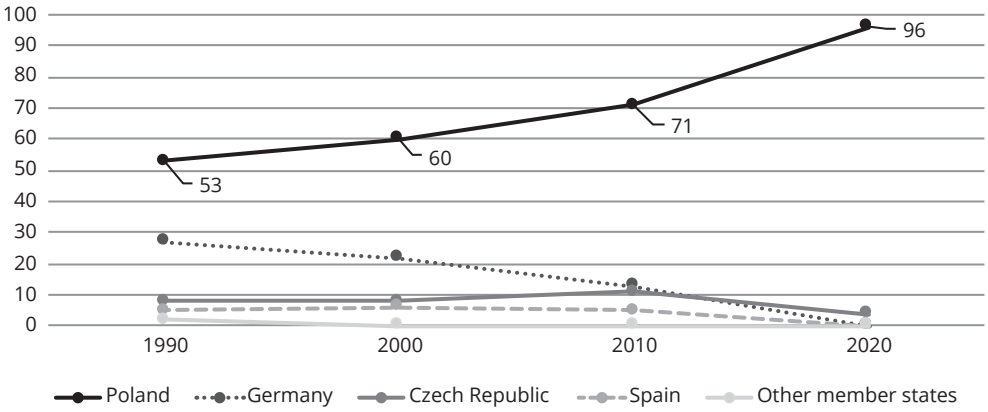
Figure 11.2. Share of EU countries in hard coal production in 2000 and 2020 (%)



Source: Compiled by author based on Eurostat [2021a].

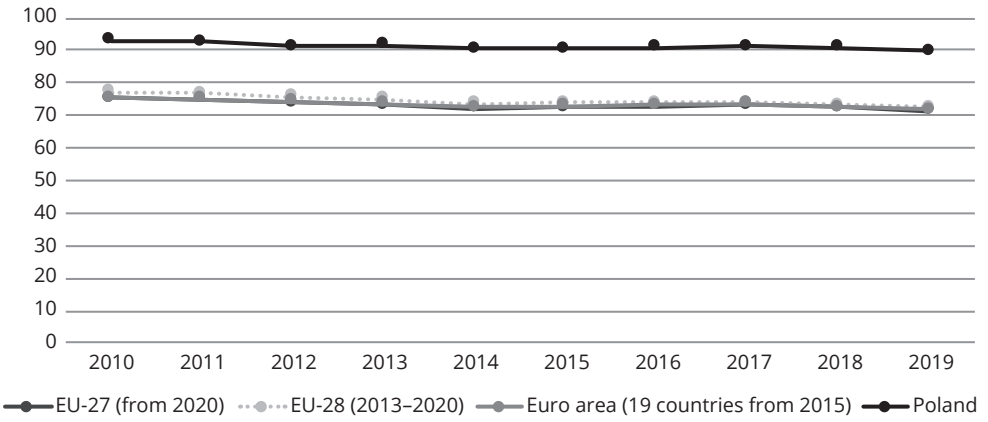
It is clear (Figure 11.3) that over the past 10 years the EU member states were gradually reducing hard coal extraction. Compared to 2012, which saw the last peak of hard coal production in the EU (106 million tonnes), in 2020 production was reduced by 31% in Poland and by 81% in the Czech Republic. All the other former hard coal producers (e.g. Germany and Spain) stopped production [Eurostat, 2021a].

Figure 11.3. Share of EU member states in hard coal production between 2000 and 2020 (%)



Source: Compiled by author based on Eurostat [2021a].

Figure 11.4. Share of fossil fuels in gross available energy in Poland and EU countries (including the euro area) between 2000 and 2019 (%)



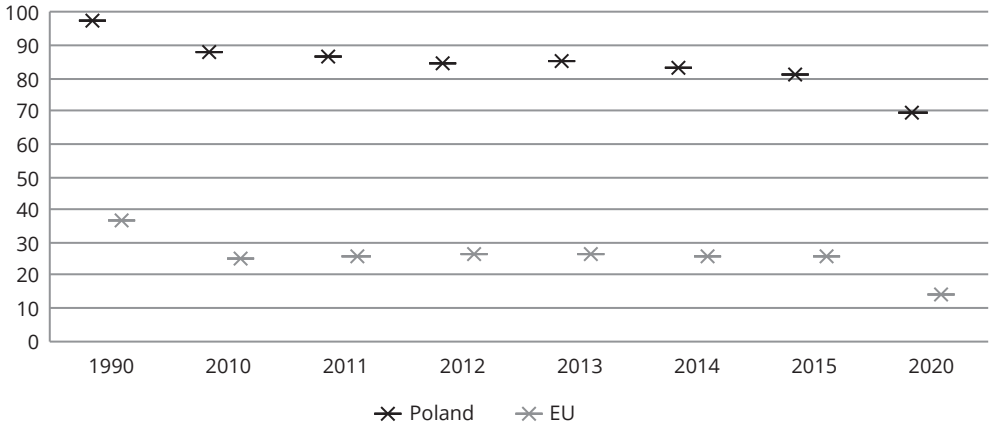
Source: Compiled by author based on Eurostat [2021b].

A similar trend can be seen in the consumption of lignite, the consumption of which in the EU decreased from about 700 million tonnes in 1990 to 246 million tonnes

in 2020. Lignite is used mainly in the country of extraction and is traded internationally only to a limited extent. Germany accounted for 44% of lignite consumption in the EU in 2019 and had a similar share in 2020. In 2019, Poland had a share of approximately 19% in the consumption of this resource and a similar share also in 2020.[24]

Abundant domestic coal resources and monocultural use of oil in transport mean that, compared to other EU countries, from 2010 onwards Poland invariably had a relatively high share of fossil fuels in the total energy consumed in the country (Figure 11.4).

Figure 11.5. Share of coal in electricity production in Poland and EU countries[25] between 1990 and 2020 (%)



Source: Compiled by author based on data from World Bank [2021a] for 1990–2015 and other data from Forum Energii [2021] and Ember-Climate [2021].

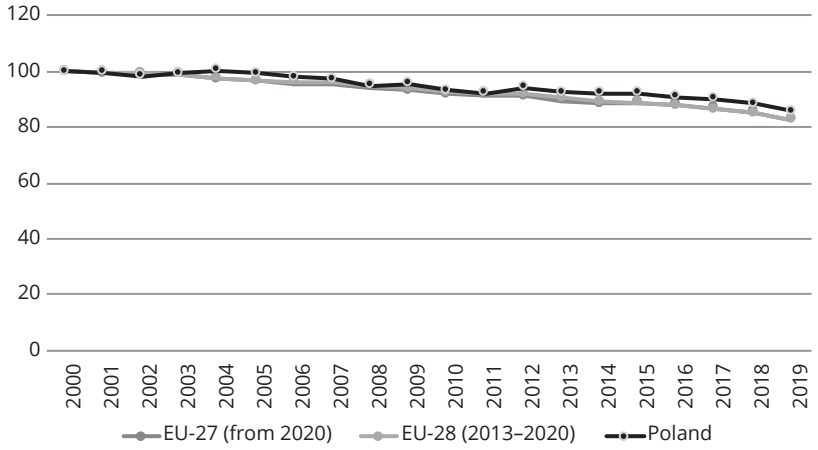
Nevertheless, the share of coal in domestic electricity production has been gradually decreasing (Figure 11.5). Between 1990 and 2020, it decreased from 97% to about 70%. At the same time, the European Union saw a decrease in the share of coal in electricity production from 36% to 14%. This results from an increased use of RES. In 2020, for the first time in the EU (27 countries), the share of total electricity generated from renewable sources (38%) exceeded that produced from fossil fuels (36.9%). A similar trend was already noticed in 2019 in the case of electricity produced only from wind and solar energy (16.97%) and coal (15.8%). This trend also continued in 2020 (19.57% and 13.22%, respectively) [Ember, 2021]. In 2020, Poland, compared to other EU countries, recorded the lowest share of electricity generated from renewable sources (17%), next to Hungary (15%) and Bulgaria (19%). When comparing these three countries, it is

[24] Other lignite consumers in 2019 and 2020 were the Czech Republic, Bulgaria, Romania, and Greece [Eurostat, 2021a].

[25] Variable number of countries in the analysed years.

worth noting the significant dominance of nuclear energy in Bulgaria and Hungary, whose share in electricity production in 2020 was 41% and 48%, respectively. On the other hand, the Polish power generation mix was dominated by total fossil fuels (83%) [Agora Energiewende and Ember, 2021].

Figure 11.6. Greenhouse gas emissions[26] in Poland and in EU countries (including the euro area) between 2000 and 2019 (tones of CO_2 / consumed energy unit)

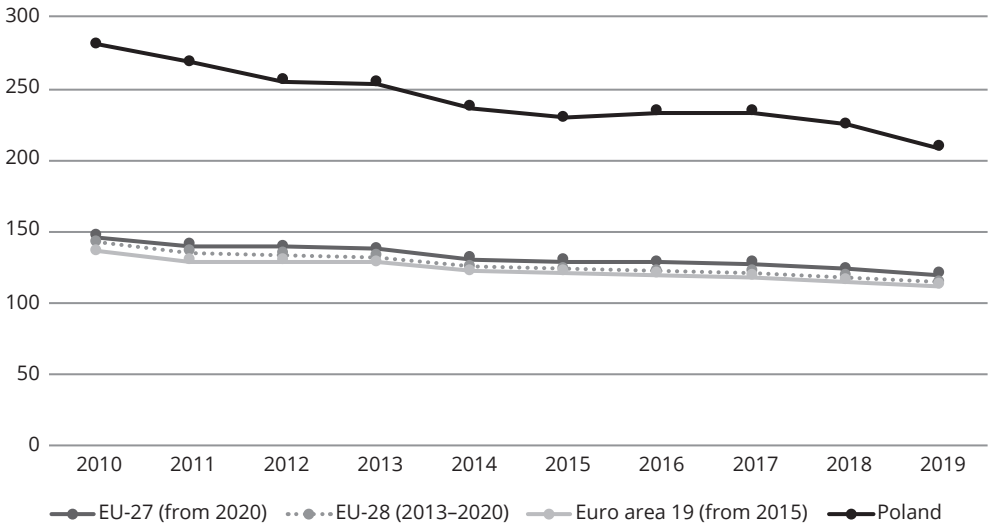


Source: Compiled by author based on Eurostat [2021b].

The dominance of fossil fuels translates into a high power sector carbon intensity in Poland. Although reduced compared to 2015, in 2020 it was the highest in the EU-27. Thus, Poland even overtook Estonia, which has reduced its share of carbon-intensive shale oil generation in recent years. The EU average (27 countries) of 226 grams of CO_2/kWh (2020) was exceeded, apart from Poland (724), by Greece (522), the Czech Republic (386), Bulgaria (352), the Netherlands (318), Germany (301), and Ireland (293). Interestingly, Germany, despite its strong commitment to promoting RES in the energy sector, was also characterized by a relatively high intensity of CO_2 emissions, mainly due to the share of lignite in electricity production [Agora Energiewende and Ember, 2021]. However, analysing the average values of total greenhouse gas emissions per unit of energy consumed in the entire economy, it can be seen that the values for Poland (2000–2019) were similar to those for other EU countries (Figure 11.6).

[26] Index base 2000, energy sector GHG emissions relative to domestic energy consumption. It shows how many tonnes of energy-related CO_2 equivalents were emitted in an economy per unit of energy consumed. Eurostat emission data comes from information on greenhouse gas emissions reported to UNFCCC.

Figure 11.7. Energy intensity of GDP[27] in Poland and in EU countries (including the euro area) in 2010–2019 (kgoe / EUR 1000)



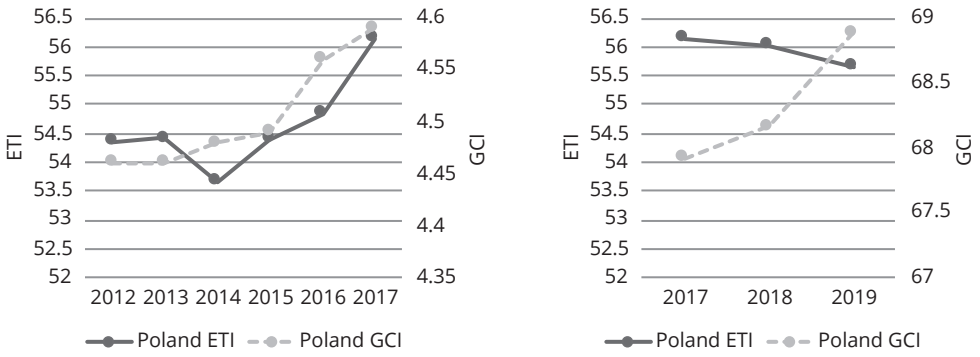
Source: Compiled by author based on Eurostat [2021c].

The economy's energy productivity can be seen, e.g. in its energy intensity (Figure 11.7). GDP energy intensity of the Polish economy compared to other EU countries was significantly higher in 2010–2019 than for UE-27/28. For each EU 1000 of GDP, Poland consumed 208 kgoe in 2019, while in UE-27 it was about 111 kgoe. A steady decline in the energy intensity of GDP in Poland marks a positive trend. This is clearly visible in the case of data for households or industry. However, energy intensity of transport has increased slightly in recent years.[28]

When analysing the innovativeness of the Polish economy in the context of reducing energy consumption, the eco-innovation index proposed by the EU can be employed, the components of which include scores for improving energy use efficiency. In the last eco-innovation ranking (2021),[29] Poland took the penultimate 26th place, ahead of only Bulgaria. The scores for improving energy efficiency put Poland in a little higher position (22nd, 2021), which does not alter the fact that in that ranking Poland is included among catching-up countries [European Commission, 2021b].

[27] Index base 2010.
[28] Based on Statistics Poland [2021] data. It is the latest data available for Poland.
[29] As in 2020.

Figure 11.8. GCI and ETI for Poland in 2012–2019[30]



Source: Compiled by author based on WEF [2021], World Bank [2021b], CEIC [2021], and Trading Economics [2021].

The comparison of the ETI and GCI in 2012–2019[31] for Poland shows that the international competitiveness of the Polish economy was growing, as was its rank in energy transition. In 2018–2019, there was a slight decrease in the value of the ETI, which rebounded again in 2020. It is worth mentioning that according to the results of the last ETI ranking (2021), Poland took the 62nd position (out of 115 possible), which puts it among the emerging economies of Europe. According to the Energy Transition Index, this group includes Latvia, Lithuania, Albania, Hungary, Romania, Croatia, Bulgaria (all ranked ahead of Poland) and Turkey, Serbia, Moldova, Bosnia and Herzegovina (ranked behind Poland) [WEF, 2021a]. Both the position of Poland in terms of energy transition and the country's capacity in this respect, as assessed on the basis of the ETI and TRI, deviate from the global and regional averages. Poland is by far the best at dealing with issues related to energy security (exceeding the average scores), and the worst in terms of the structure of the energy system dominated by fossil fuels [WEF, 2021b]. This, in turn, brings the analysis to the starting point, namely, the fuel resources and infrastructure solutions built on their basis in the energy sector, which determine the position of an economy and its ability to undertake low-carbon transition. In the case of the Sustainable Competitiveness Index, in 2021, Poland ranked 35th (out of 180 places), just behind China (33). In this ranking, it fared the worst in natural resource use efficiency (143rd position), behind Turkey and just ahead of Bulgaria [Solability, 2021].

[30] From 2017 onwards the method of estimating the GCI has changed. Therefore, the data is presented in two charts, kept to scale.

[31] GCI available at the time the 2019 text was under preparation, although the ETI covers the years 2020 (56.30) and 2021 (57.74) for Poland.

11.5. Conclusions

The analysis presented shows that energy resources or the broader category of "energy" have an important place in research on the international competitiveness of countries. Directly or indirectly, energy is one of the key elements of the resulting competitive position of countries. The cost of energy, treated directly, is a decisive factor in the international competitiveness of industries producing for export [McKinsey, 2009; APEC, 2017], as well as its indirect forms, e.g. energy efficiency [Gorb et al., 2020; Głowacka, 1996].

Rankings of international competitiveness are based on indicators describing the level of energy consumption, greenhouse gas emissions, but also the efficiency of energy resource use. The first two categories refer to absolute factor endowment, while the last one refers to the way in which these resources are used. It is clear that the rankings examining international competitiveness in general tend to refer to the first approach, while those specializing in the analysis of energy issues expand the analysis to include the efficiency of resource use. It seems that the next step in the analysis would be to include the export of low-carbon technologies and to study their impact on international competitiveness. As indicated here, this falls within quantitative assessment of sustainable competitiveness. It can therefore be concluded that the position of energy resources in the analysis of their impact on international competitiveness is evolving in a manner similar to how the circumstances of countries determining their international competitive position change: from competitiveness shaped by factor endowment, through improved efficiency of resource use in the country, to the dominance of innovation. The GCI and IMD indicators involve the first and partly the second element, the ETI concerns the second and partly the third one, while sustainable competitiveness assessment proposals refer to the third item.

The analysis of the Polish case shows that the international competitiveness of the country and its rank in energy transition are strongly influenced by domestic fossil fuel resources. Poland is currently the only country producing hard coal in the EU and one of few lignite producers. For this reason, even with the ongoing reduction in the production level and decreasing energy intensity of the economy – compared to the European Union countries – Poland is a country facing major energy challenges. This is clearly visible, e.g. in the energy transition ranking, in which Poland was classified among emerging economies.

However, the positive trend in energy security observed in the ETI, which significantly deviates from the values for the region and the world, is worth emphasizing. Such high scores for Poland are attributable to the consistently implemented strategy of

geographical and infrastructural diversification of fuel supply sources, as well as the diversification of contract terms in the supply of imported resources. Success in this area makes it possible to identify internal drivers and inhibitors of change. The conclusions of this analysis can be used as guidelines to determine the direction of a constructive evolution of the power industry and the coal and lignite mining sector closely related to it. Regardless of the conclusions in this respect, in order to deliver on the commitments made to reduce greenhouse gas emissions, it is proposed to further improve the efficiency of the use of mineral resources, but also to increase spending on research and development on the alternative use of coal also outside the energy sector. The introduction of innovations as a result of research – including fuel substitution – makes reference to Dasgupta's innovation mechanisms.

Research[32] confirms that regions with a higher TFP are those investing more willingly in research and development than in energy-intensive industries. As noted by the World Bank [Peszko et al., 2020], the decarbonization of economies should rather focus on diversifying resources, including physical capital, human capital, and energy resources, in order to build more efficient and competitive economies, supported by strong institutions and effective regulation. Such diversification of resources is to lead economies dependent on fossil fuel exports towards finding new comparative advantages. This can ensure strong sustainability of development. One of the activities aimed at building new comparative advantages in Poland is the promotion and export of green technologies under the GreenEvo – Green Technology Accelerator project. GreenEvo supports Polish companies in the commercialization of their achievements on the international arena. In 2021, 12 Polish companies offering green technologies took part in the Dubai Expo2020 fair.[33]

Due to its nature and the research approach adopted, this study has its limitations. Firstly, it mainly shows the Polish economy at a specific point in time (2020) without an in-depth reflection on the long-term socio-economic effects of decarbonization in the future. Secondly, the focus on solid fossil fuel resources, despite the fact that they pose the biggest challenge from the point of view of energy transition, does not reflect the complexity of the problems facing the Polish energy sector, including those related to the wider integration of RES into power systems.[34] Therefore, these areas are indicated as potential new directions of research.

[32] Based on the Italian example. Research has confirmed the two-way positive impact of TFP on R&D and vice-versa [Ladu, Meleddu, 2014].

[33] There were 10 winners of the 2020 competition, with 33 participants [Statistics Poland, 2021; CIRE, 2021].

[34] For more on RES issues in Poland see the report by the Polish Supreme Audit Office [NIK, 2021].

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Summary

Poland's Competitiveness in the Pandemic Period

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Competitiveness can be considered in a range of dimensions, from the vantage point of enterprises, industries, regions, countries, or even supranational entities. Traditionally defined competitiveness of the national economy focuses around productivity [Porter, 1990; Aiginger, 2006], but the understanding of this concept evolves over time and is adjusted to new challenges and changing conditions of doing business. Despite the multitude of definitions occurring in the literature, researchers agree that it is a multidimensional concept, and apart from traditional dimensions, such as income and investment competitiveness, new ones appear, e.g. technological and digital competitiveness. Moreover, in the times of crises, in particular in the face of the COVD-19 pandemic, relational competitiveness becomes increasingly important [Kowalski, Weresa, 2021].

The COVID-19 pandemic is only one of the challenges currently facing national economies and the world economy at large. The rapid deterioration of the natural environment, the growing pollution of air, soil, and water with the related climate change, as well increasing social inequalities have provoked interest from businesses, researchers, and economic policymakers in achieving objectives which go beyond a simple, performance-focused approach. Welfare improvement, a more even distribution of benefits generated through economic growth processes, and a high quality of life of societies have become important development goals. This triggered the evolution of the concept of competitiveness and shifted the focus of research on competitiveness towards its sustainable dimension covering social and environmental aspects. The monograph falls within this research trend, combining two strands – insights into national economies' resilience to crisis and the ability to adapt in external shock situations and to compete in international markets in a sustainable manner, i.e. sustainable competitiveness. This does not mean giving up analyses of traditionally defined dimensions of competitiveness, such as income competitiveness and the related issue of income convergence, or investment competitiveness, technological competitiveness, etc. These aspects are included in the monograph and complemented with an in-depth analysis of issues related to the rational management of resources,

natural environment protection, and selected elements of competitiveness in its social dimension.

In the theoretical layer, the monograph aims to expand knowledge on new dimensions of the competitiveness of economies, which are to respond to challenges arising from the crisis caused by the pandemic and challenges identified by the United Nations in Agenda 2030 [UN, 2015]. Seventeen sustainable development goals outlined by the UN and the development targets arising from them reflect three dimensions of sustainable management: economic, social, and environmental. In the empirical layer, the objective is to identify changes in the competitiveness of the Polish economy compared to other countries of the European Union between 2015 and 2021, taking into account the impact of the pandemic on the evolution of competitive advantages. Selected aspects of Poland's competitiveness in the social and environmental dimensions were also analysed at some length. The third objective of the analyses was to arrive at conclusions for an economic policy that would strengthen Poland's competitive position during the pandemic and in the post-pandemic period, also in the face of social and environmental challenges.

Several important conclusions can be posed to wrap up the theoretical reflections in this monograph. Innovations of various types – technological, institutional, organizational – are key to achieving sustainable competitiveness. Eco-innovations play a special role in efforts towards environmental sustainability, and social sustainability fosters social and inclusive innovations. The competitive ability of economies, which is manifested by factors that enable competitive advantages to be built effectively, can be shaped successfully through economic policy. The significance of economic policy for competition-promoting development increases in the times of economic crises, which has be become evident also during the COVID-19 pandemic. However, the aspect that makes the coronavirus pandemic crisis different from most previous crises is the slump in sales caused by the crisis, as well as the interruption of value chains and the related decline in production. Under crisis conditions, the degree of economies' sensitivity and the depth of their response to the recession shock, their ability to regenerate and speed of recovery from crisis, gain special significance. These factors should be included in analyses of the competitiveness of economies. In addition, issues that required in-depth theoretical analyses and development of a new approach, which have manifested themselves during the COVID-19 pandemic, concern the social dimension of competitiveness – improvement of public health, better access to healthcare, and healthcare system reforms. The questions that arise in this context and set the direction of further research on the competitiveness of economies concern new sources of competitive advantages post pandemic and the future leadership of the global economy in sustainable competitiveness.

Based on the empirical analyses provided in the monograph, which concern the competitiveness of the Polish economy as compared with the EU, the following conclusions can be drawn concerning Poland's competitive ability in the European Union.

- The availability and exploitation of land and water resources is related to making choices about agriculture development, degree of urbanization, energy production, etc.
- Poland is a country with relatively large land resources, with forests, which cover about one-third of the territory of the country, forming a major resource. Land use by agriculture in Poland is close to the levels in other EU member states – agricultural land represents about one-third of the country's territory (a ratio similar to that in Germany, France, or the Czech Republic). However, Poland has by far the lowest agricultural productivity per worker – several times lower than, e.g. Slovakia or France. This may be attributable to very high employment in agriculture in Poland (representing approximately 10.6% of the country's total population in employment.
- As for mineral resources, Poland stands out with its large deposits of copper and coal, with a high priority being given to coal production. Moderate efforts to displace fossil fuels are focused on renewable energy.
- The COVID-19 pandemic has adversely affected foreign direct investment flows across the world, in particular FDI in developing countries, but it had a minimal impact of FDI in Poland. On the other hand, Polish foreign direct investment outward position decreased, with the steepest decline seen in the sectors in which Poland had a relatively low investment position.
- The labour market in Poland showed little resilience to the pandemic shock. In the first phase of the pandemic, the percentage of economically active population decreased, with the steepest decline in the number of employed persons in the enterprise sector reported in mining and quarrying, and in financial and insurance activities.
- The first signs of recovery in the labour markets were seen in Q2 2021. The highest demand continued to be seen in information and communication; however, construction as well as finance and services for business industries had high employment projections for Q4 2021.
- Innovation performance and its significance for the competitiveness of the Polish economy have not changed basically during the pandemic. Poland still ranks among the EU countries with low innovation levels and the innovation gap between Poland and the EU average is relatively the narrowest in digital and IT technologies.
- The main causes of the low innovation performance of the Polish economy are the innovation gap between Polish regions, which slows down the process of catching

up with the average values of innovation indexes in the EU, an insufficient level of R&D investment by enterprises, and too little cooperation between different entities in innovation activities.

- The quality of institutions in Poland has deteriorated, which translates into a negative impacts on competitiveness in the long term. The most significant deficiencies of the institutional order in Poland in the second decade of the 21st century are: a low quality of many laws and regulations; low competitiveness of the Polish tax system compared with other EU countries; changes affecting in the operation of the judiciary and concerns about its independence; and instability of long-term economic policy.

The studies presented in this monograph also focused on the analysis of the competitive position, which is also known as output competitiveness, as it indicates the level of economic development achieved by a country and is reflected in the level of national income, the efficiency of use of production factors, or position in foreign trade. The key conclusions in this respect are as follows.

- Changes in productivity have played a significant role in Poland's economic growth, with the average growth rate of total factor productivity of 1.2% annually between 2011 and 2020, which means an increase in the efficiency of doing business and a better competitive position in the international environment. That said, the COVID-19 pandemic has contributed to a decrease in total factor productivity (−4.3% in 2020) in Poland, as has also been the case in other Central and Eastern European countries.
- The analysis of trade competitiveness shows that the pandemic shock has strongly affected Polish foreign trade, especially in the short term, during the first wave of the pandemic. What also draws attention is that Polish exports rebounded much quicker than EU exports, and the performance of Polish exports in the latter part of 2020 and in the first half of 2021 was clearly better than the EU's. Exports of capital goods were the most resilient to the pandemic shock, while exports of consumer goods performed worse in this respect, whereas the worst collapse was reported in intermediate goods trade. The sectors that proved to be the most resilient were food processing industries, while those least resilient were the industrial sectors dealing with vehicle and transport equipment, base metals and articles thereof, and miscellaneous manufactured articles. At the same time, the outbreak of the COVID-19 pandemic did not cause any major changes in revealed comparative advantages in foreign trade.
- An analysis of income convergence indicates a convergence of income both in terms β-convergence and σ-convergence within the group of 25 countries of the enlarged European Union. The economic growth rate measured by increase in GDP

per capita during that period was negatively dependent on the initial level of GDP per capita, and the EU member states from Central and Eastern Europe achieved a faster rate of economic growth than the Western European countries. Despite the convergence process, differences in income levels are still large and alleviation of disparities in income competitiveness cannot be reasonably expected in the European Union in the short term.

- What becomes a significant dimension of competitiveness is environmental competitiveness, which has been gaining particular importance in the context of the Green Deal promoting efforts towards the decarbonization of economies, reduction of greenhouse gas emissions, and mitigating the negative environmental impact of the energy sector. With the domination of domestic resources of fossil fuels as Poland's basic energy resource, the country is facing huge energy challenges. This is confirmed by the energy transition ranking in which Poland has been classified among emerging economies. One positive aspect is a consistently pursued strategy of geographical and infrastructural diversification of fuel supply sources.

Conclusions relevant to economic policies promoting competitiveness can also be drawn from the analyses conducted in the monograph. First, handling the fallout of the pandemic and the need to answer social and environmental challenges make it necessary to seek improvements to competitiveness in its sustainable dimension. The measures should centre around support for innovation, especially eco-innovation and social innovation, and the development of social entrepreneurship. A second important area that needs reform is the healthcare system and improvement of the quality of medical services. However, operational objectives in those areas will not be implemented without improvement of the institutional environment, recovery of social trust, and creation of relational capital. Fostering creativity of the young generation and promoting activities aimed at improving the quality of education at all levels are of key significance in this context.

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SGH Warsaw School of Economics is an innovative economic university that develops intellectual potential and creates leaders in response to the challenges of the future. It is an influential center for academic research, new ideas and initiatives undertaken by the academic community and alumni, as well as by business representatives, NGOs and public administration. As an autonomous and socially responsible university, SGH promotes ethical citizenship through its teaching, research and social engagement activities.

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The competitiveness of economies is an issue that becomes particularly important in times of crises. The collapse triggered by the COVID-19 pandemic, spreading virtually all over the world in 2020, has a different impact on individual economies and generates multiple social and economic effects. The debate on competitiveness in times of crisis focuses not only on maintaining or improving the competitive position, but also on the emergence of new dimensions of this phenomenon and the change in the significance of the various competitiveness factors. New economic policy approaches and instruments are also being developed to strengthen the resilience of economies to the crisis and improve competitiveness in difficult times.

Joining this debate by academics and practitioners, the present monograph seeks to find out the competitive position of the Polish economy in 2020 and the direction of its changes between 2010 and 2020, and to identify the factors driving these changes in the period under analysis.

In view of the pandemic-induced strong slowdown in international trade growth and capital flows, an additional specific goal of the monograph is to determine the status of Poland's bilateral economic ties with major economic partners and to identify new areas of cooperation yet to be untapped. The results of the analyses in the monograph provide a reference point for further research into the impact of the COVID-19 pandemic on Poland's bilateral economic cooperation and indicate the directions of economic policy aimed at strengthening Poland's international relations after the pandemic.

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ISBN 978-83-8030-567-0